

COURSE ASSESSMENT REPORT

**ROY G. PERRY COLLEGE OF ENGINEERING
ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT
PRAIRIE VIEW A&M UNIVERSITY**

ASSESSMENT REPORT COVER PAGE

**ELEG 4248 SENIOR DESIGN &
PROFESSIONALISM II**

SPRING 2022 SEMESTER

NAME OF INSTRUCTOR: Vewiser Turner & Sarhan Musa

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Detailed Course Syllabus
(Distributed to Students at the beginning of the Semester)

Course Title: Sr. Design & Professionalism II

Course Prefix: ELEG

Course No.: 4248

Section No.: P01/P81

Department of | **Electrical and Computer Engineering** | **College of** | **Engineering**

Instructor Name: | *Vewiser Turner & Sarhan Musa*

Office Location: | *Electrical Engineering Bldg. 347 (V. J. Turner)*
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U.S. Postal Service Address: | Prairie View A&M University

P.O. Box	519
Mail Stop	2520
Prairie View, TX 77446	

Office Hours: | **W 10:00am – 11:00am, Thur 11:00am – 12:30pm (Turner)**
M 9:00am – 11:00am or 4:00pm to 5:00pm, W 9:00am to 11:00am (Musa)

Virtual Office Hours: | N/A

Course Location: | *NENGR BLDG Room 137*

Class Meeting Days & Times: | **W 10:00-10:50am, R 1:00-3:50pm**

Catalog Description: | ELEG 4482. Senior Design and Professionalism II. (1-3) Credit 2 semester hours. A continuation of ELEG 4472 with required design modifications of the team projects necessary to produce a working prototype of the designs initiated in Senior Design and Professionalism I. Results of the design are presented as project deliverables (oral presentations, written reports, project prototypes). Elements of professionalism reinforce the importance of professional ethics, corporate culture, life-long learning, and globalization.

Prerequisites: | ELEG 4482 must immediately follow ELEG 4472 or a sequence must restart with ELEG 4472

Co-requisites: | N/A

Required Text: | 1. "Senior Design Manual" by College of Engineering, Prairie View A&M University

Recommended Text/Readings: | 1. "Fundamentals of Engineering Design," by Barry Hyman, 2nd Edition, Prentice Hall: 2003
2. "Design for Electrical and Computer Engineering," by Ralph Ford and Chris Coulston, McGraw-Hill: 2005

Access to Learning Resources: | PVAMU Library:
phone: (936) 261-1500
web: <http://www.tamu.edu/pvamu/library/>
University Bookstore:
phone: (936) 261-1990
web: <https://www.bkstr.com/Home/10001-10734-1?demoKey=d>

Course Goals or Overview:

To expose the student to the experience of working in a design team, doing project planning, writing design specifications, procurement of parts and acquiring skills and competencies in designing engineering systems and/or processes. Students will acquire effective communication skills by giving presentations to faculty and invited guests. Guest lecturers will be invited to discuss topics relevant to engineering practice, ethics, design, and real world experiences. The student is required in conjunction with his or her group to submit written reports and give oral presentations throughout the semester.

To give the student the fundamentals of engineering design methodology, and expose them to relevant topics in the field through discussions, lectures and team projects. Each team of students will work closely with faculty advisors knowledgeable in the areas of the project design.

Course Objectives/Outcomes:

Course Outcome 1

To teach students the ability to design and conduct experiments, as well as to analyze and interpret data (*ABET outcome b*).

Performance Criteria/Objectives

1. Ability to design experiments

Given a phenomenon to be experimentally investigated, the students are able to:

1.1 Plan and Understand the phenomenon

Students are able to

- (i) Identify the measurable parameters of the phenomenon
- (ii) Identify the relationship between the phenomenon and the measured parameters
- (iii) Identify different methods and the specific devices for measuring the parameters.

1.2 Select instruments/Design/Assemble Set-up and provide instructions for its use

Students are able to

- (i) Identify and select or design appropriate equipment or components for measuring the parameters and,
- (ii) Provide steps for setting up and conducting the designed experiment.

2. Ability to conduct experiments

Students are able to:

- (i) Demonstrate general lab safety.
- (ii) Follow experimental procedures for the experiment, while maintaining all safety precautions.
- (iii) Demonstrate knowledge of how equipment functions and their limitations.
- (iv) Complete Pre-Lab before coming to the lab when required.
- (v) Collect and record data using appropriate units of measurement and identify the dependent and independent variables in the experiment.

3. Ability to analyze and interpret experimental data

Students are able to:

- (i) Analyze the data to generate the required parameters using appropriate units and significant figures.
- (ii) Use statistical analysis as needed.
- (iii) Present the data (raw/derived) in tabular or graphical form to meet the objectives and to aid in interpretation.
- (iv) Discuss the raw and derived data/graphs and assess the validity of the results.
- (v) Demonstrate the ability to relate how experimental result can be used to improve a process.
- (vi) Draw appropriate or reasonable conclusions.

Course Outcome 2

To teach students to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustain ability (*ABET outcome c will not be assessed*)

Performance Criteria/Objectives

1. Ability to Define/Understand the Problem and then Plan the Project

Students are able to:

- (i) Identify the customer and the needs.
- (ii) Identify and list the design objectives.
- (i) Identify the design constraints.
- (ii) Define the design strategy and methodology.
- (iii) Identify and break down work into subtasks and identify the personnel & deliverables for each.
- (iv) Develop a Gantt chart and critical path analysis for managing the project.
- (v) Establish major milestones for tracking progress and define performance metrics to measure success.

2. Ability to Conduct a Review of the Literature, Generate Ideas and Apply Creativity

Students are able to:

- (i) Identify the types of information needed for a complete understanding of all aspects of the project (Based on task described in the project planning).
- (ii) Gather information on relevant fundamentals, theory / concept (demonstrate technical competence) and relate them to the design.
- (iii) Provide the sources in a list of references properly cited in the literature review section and relevant sections of the report.
- (iv) Define functional requirements for design (Specific required actions needed to be performed for the design to be achieved).
- (v) Transform functional requirements into candidate solutions / mathematical modeling.
- (vi) Evaluate candidate solutions to arrive at feasible designs.

3. Ability to Perform Preliminary and Detailed Design

Students are able to:

- (i) Identify applicable codes and standards for the design
- (ii) Perform relevant detailed analysis (engineering, mathematical, economic) in accord with applicable codes and standards.
- (iii) Develop final design specifications
- (iv) Do the design within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (v) Select materials/components/software/test equipment.
- (vi) Fabricate a prototype or a model (physical, software, hardware) of the design.
- (vii) Test or simulate the design and make necessary changes to obtain optimum design.

Course Outcome 3

To teach students the ability to identify, formulate, and solve engineering problems (*ABET outcome e*)

Performance Criteria/Objectives

1. Identify engineering/technical/computing problems

Given a problem, the student is able to:

- (i) Understand the given problem and identify the subject area and concept involved.
- (ii) Convert the problem into a well labeled sketch (such as free body diagram, flow chart, functional block diagram, schematic diagram).
- (iii) Identify the system of units applicable to the problem.

2. Formulate/analyze engineering/technical/computing problems

Given a problem, the student is able to:

- (i) Define the known and the unknown variables in the problem.
- (ii) State relevant laws and equations needed for the problem.
- (iii) List and apply assumptions to the relevant laws and equations to obtain the specific equations appropriate to the problem.

3. Solve engineering/technical/computing problems

Given a problem, the student is able to:

- (i) Implement strategy to solve the problem.
- (ii) Solve the problem (showing consistent units throughout).
- (iii) Evaluate and interpret the result.

Course Outcome 4

To teach students to function in a multidisciplinary design team (*ABET outcome d will be assessed*)

Performance Criteria/Objectives

1. Manage themselves as a team by following good team management practices and resolve conflicts

- (i) Plan group meetings and time management, assign team roles (leader, recorder, etc).
- (ii) Assign and keep good record of team meetings and activities.
- (iii) Distribute project tasks evenly to team members, and evaluate performance of team members on a regular basis.
- (iv) Resolve conflicts professionally within the group (*Example will be an assignment to identify potential problems and indicate how they will resolve them*).

2. Track and meet project schedule

- (i) Track progress of team members to ensure project is on schedule (through submission of progress reports).
- (ii) Share ideas, complete assigned task on time, help others, and be professional to each other (through peer evaluation of team members on these characteristics).

Course Outcome 5

Understanding of professional and ethical responsibility (ABET outcome (f) will be assessed)

Performance Criteria/Objectives

1. Students understand and demonstrate ethical responsibilities

- (i) Students are able to demonstrate the knowledge of professional code of ethics (*Review code of ethics from your specific professional society and from your State board of professional Engineers. Students may be tested on these*).
- (ii) Students are able to evaluate case studies and make ethical decisions (*Instructor may present a case study and request students to identify and provide professional and ethical considerations for addressing the problem posed in the case study*).
- (iii) Students acknowledge the work of others they use through proper permission and citation.
- (iv) Students apply ethics in the academic environment and desist from cheating, plagiarism, and report such unethical practices to proper authorities.

2. Students understand and demonstrate professional responsibilities

- (i) Apply professional standards (use of handbooks, codes, standards) in obtaining, reporting, analyzing data or in design.
- (ii) Attend classes on regular basis and informs professor when excused absence situation occurs (use attendance policy and the professionalism of students in informing and getting excuse for being absent).
- (iii) Students demonstrate high academic standards, personal responsibilities (continually looks for own mistakes and opportunities/methods for improvement), and exercises good judgment and discretion (make decisions based upon a defined body of acquired knowledge).

Course Outcome 6

Student becomes proficient in written, oral and technical communication (ABET outcome g)

Performance Criteria/Objectives

Oral Communication

1. Ability to Organize, Plan, Design/Prepare and Use Appropriate Visual Aids for communication/Presentation

- (i) Students are able to organize presentation in well structured logical sequence making it easy for audience to follow the content with clear understanding.
- (ii) Students are able to prepare effective slides (*adequate and relevant technical content and viewgraphs that are legible, completely labeled/annotated/dimensioned to illustrate important features of the work being presented*).
- (iii) Students are able to use modern presentation techniques (*may include visually enhanced transitions, animations, video, and sound clips*).
- (iv) Students are able to stay within time limits

2. Ability to Articulate Subject Knowledge (Technical Content)

- (i) Students demonstrate knowledge and understanding of the subject. (*This may be demonstrated by presenting literature review, originality, creativity, required standards, constraints, and other appropriate considerations such as economics, environmental, and societal impact*)
- (ii) Students are able to prepare and display prototypes or models when they are necessary to support the presentation.
- (iii) Students respond clearly to questions in a professional manner after restating questions to audience.

3. Appearance and Ability to Provide Good Oral Delivery

Students are able to:

- (i) Use correct grammatical English and technical terms appropriate to technical area and audience; speak with clarity and confidence.
- (ii) Maintain good posture and eye contact with the audience (should not read from prepared notes) and elicit the attention of the audience.

- (iii) Dress appropriately for the occasion.

Instructor may record the presentation for assessment display purpose, and must ensure to get consent for witness protection from the students.

Written Communication (Senior Project Report Writing)

4. Ability to organize, plan and properly format a written technical report

- (i) Students are able to organize report by categorizing ideas for the report into well and logically organized chapters, major sections, subsections and paragraphs blended within the larger units.
- (ii) Students provide Title Page, Abstract, and Table of Contents, list of Figures, and List of Tables properly formatted.
- (iii) Students provide figure number and title for each figure in the report, reference each figure, and completely discuss each figure in the report in accord with standards in the project manual.
- (iv) Students provide table number and title for each table in the report in accord with standards in the project manual, reference each table, and completely discuss each table in the report.
- (v) Students properly cite references in the report and provide well formatted reference list at the end.
- (vi) Students prepare the written report in accord with standard report formatting provided in the Senior Projects Report Manual.

5. Ability to compose original texts and properly apply the conventions of written language.

Students are able to

- (i) Properly apply capitalization, punctuation, and penmanship, to communicate clearly
- (ii) Spell proficiently
- (iii) Apply standard grammar and usage to communicate clearly and effectively in writing including
 - using complete sentences, varying the types such as compound and complex to match meanings and purposes
 - properly employing standard English usage in writing for audiences, including subject-verb agreement, pronoun referents, and parts of speech
 - properly using adjectives (comparative and superlative forms) and adverbs appropriately to make writing vivid or precise
 - properly using prepositional phrases to elaborate written ideas
 - properly using conjunctions to connect ideas meaningfully
- (iv) Use available technology to support aspects of creating, revising, editing, spell checking, and publishing the report.

6. Ability to provide appropriate discussion, conclusions and recommendations

Students are able to clearly

- (i) Summarize the goals, objectives, and indicate whether they were met.
- (ii) Summarize the results.
- (iii) Summarize constraints and codes and indicate whether they were met.
- (iv) Provide logical conclusions and recommendations (including strengths and weaknesses).

Course Outcome 7

The broad education necessary to understand the impact of engineering solution in a global and societal context (ABET outcome h)

Performance Criteria/Objectives

Students are able to investigate a given engineering problem and are able to analyze the short and long term impact (political, economic, environmental, health, safety, cultural) of proposed solutions on society (local, regional or global context).

- *Instructor poses a problem (case study), and asks students to propose solution and indicate how proposed solution will impact society*
- *Instructor poses a problem, provides solutions, and asks students to analyze solutions and determine their impact on society.*
- *Students working on projects are required to analyze and determine the effects of their proposed solution on society*

Course Outcome 8

A recognition of the need for, and ability to engage in life long learning (*ABET outcome i*).

Performance Criteria/Objectives

1. Students are aware of the need for lifelong learning

- (i) Given an open ended problem, students are aware of the need and are able to independently acquire additional knowledge and data needed for solving the problem. (*Instructor may give an assignment that requires students to learn additional information not covered in class for successful completion of the assignment*).
- (ii) Students join and participate in activities of local student chapters of professional or other organizations and are aware of or make use of programs provided by the professional organizations in the areas of training and continuing education.

2. Students engage in life-long learning activities

- (i) Students are able to effectively use library and online resources for research and are abreast with current developments in their discipline. (*Instructor can give an assignment requiring students to use other resources to study on their own and use the information studied to solve the problem, or give a library assignment*)
- (ii) Students are able to identify and take advantage of learning opportunities available on internet and elsewhere such as seminars, webinars, conferences, workshops and tutorials. (*The instructor should direct the students to identify some of these activities and require them to show documentation of their involvement*).

Course Outcome 9

A recognition of contemporary issues (*ABET outcome j*)

Performance Criteria/Objectives

1. Students display knowledge in a variety of contemporary issues or topics

- (i) Students are able to identify current issues (socio-economic, political, environmental, cultural, health and safety) in engineering and technology. *Some examples are global warming, population, depletion of natural resources, alternative energy; outsourcing, security, ecology, engineering/technology workforce development, human rights and environmental pollution.*
- (ii) Students are aware of contemporary issues in industry such as corporate culture, industry-academia-government collaboration, industrial competition, etc.

Instructor may require the student to identify and discuss several of the contemporary issues; recognize consequences; take and defend a position and/or write a report.

Instructor may assign topics or issues and require the students to discuss these issues; recognize consequences; take and defend a position and/or write a report.

Course Outcome 10

Use of techniques, skills, and modern engineering tools to complete a final design project (*ABET outcome k* will not be assessed)

Performance Criteria/Objectives

1. Students are able to use techniques and skills acquired in their studies necessary for engineering practice.

- (i) Students are able to utilize the latest problem solving and design techniques/methods in their discipline (such as unified modeling language (UML), numerical techniques, process simulators, and the design process).

2. Students are able to use modern engineering tools necessary for engineering practice

- (i) Students are able to solve problems using current software used in the discipline (such as Matlab, AutoCAD, EES, Ansys, Multisim, Pspice, .NET, C++ compiler, etc)
- (ii) Students are able to utilize the latest available hardware/equipment used in the discipline (such as NC machine, signal generators, oscilloscope, strength testing machine, computer hardware)

Course Requirements & Evaluation Methods

This course will utilize the following instruments to determine student grades and proficiency of the learning outcomes

for the course.

Class Participation - daily attendance and participation in class discussions; attend guest speaker talks.

Outside Class Participation - Field visits, 'Short call' late afternoon or evening sessions, Weekly team work, Pre-scheduled weekend team work; Utilization of campus computing resources.

Initiative - Personal and team initiative to keep track of project needs, develop relationship with team members and leaders, start and complete project tasks on schedule and meet deadlines.

Leadership - Execute leadership roles as need be to complete task, maintain regular correspondence with team members and troubleshoot scenarios with Instructor's help. **Keep track of Deadlines.**

Professionalism and Ethics - The Sr. Design Course is a mock run of what the graduates will expect in the industry. Professionalism and ethics in getting work done on time through communication and teamwork is vital for ultimate success in ELEG 4482.

Teamwork - Develop and maintain solid teamwork mindset; show enthusiasm and be positive to changes and deadlines.

Communication - Be alert to the needs of the group. Communicate individual needs to the team leader and/or team manager, as appropriate under the protocols discussed in class by the Instructor.

Quality Control - Practice clear documentation of computer and hand calculations, generate clean, crisp, to-the-point reports, presentation slides, assignments, AutoCAD drawings, and project model.

Grading Matrix

Numerical score	Letter grade
90 or more	A
80-89	B
70-79	C
60-69	D
Less than 60	F
<u>Grading Summary</u>	
Attendance, Punctuality, Mid Term Team Project Status	10%
Papers/Presentations/Reports	30%
Final Oral Presentation	30%
Final Written Presentation	30%
Demonstrate a Working Final Design	

Grade Determination:

A: 90 – 100%

B: 80 – 90%

C: 70 – 79%

D: 60 – 69%

F: 0 – 59%

Submission of Assignments:

Follow the instructors' requirements.

Formatting Documents:

Microsoft Word is the standard word processing tool used at PVAMU. Please use "Times New Roman" style with Font

12 and 1.5 line spacing. Microsoft Excel 2007 should be used for all spreadsheet calculations. Legible hand calculations with necessary sketches must support Excel spreadsheet. Spreadsheet must contain list of assumptions (if any), and all equations used in respective columns.

NOTES:

- No Cell phones in the Classroom, They must be turned off while in the classroom or in an emergency you should keep it in silence (vibration) mode. It is a distraction for other students and faculty.
- **Students will be required to work at hours beyond the set time because of the nature of this course.**
- **Weekly report will be true to accomplishments and setbacks.**
- **PowerPoint slides will have to dynamic with animation. Details will be discussed.**
- **Professional caliber blue prints with scales are expected.**
- Students with disabilities, who believe they may need an adjustment in this class, are encouraged to contact the Office of Disabilities Services at (936) 261-3581/3582 as soon as possible. Once you receive a letter of adjustment from the office, kindly make an appointment with me to discuss appropriate adjustments for this class.
- Grading/class related Appeals (see undergraduate catalog)

REMOVAL OF TEAM MEMBER:

In the event that it becomes necessary to remove a member from a team, the following procedure must be followed:

1. The team minus the affected member must meet to discuss the action to be taken.
2. The team must then meet with the affected student and discuss the action to be taken.
3. A letter must be submitted to the instructor giving justification for the action to be taken. The letter must be signed by all team members and a copy must be sent to the affected student.
4. The instructor will then schedule a meeting with the team members and the affected student for final discussion and appropriate action.

UTILIZATION OF CLASS TIME

Wednesday 10:00am – 10:50am – Meeting and discussions with course instructors

Thursday 1:00pm – 4:50 pm: Lecture, Workshops, Presentations, Team Meetings, Other Issues

Team collaboration/communication to stay focused and on track for timely completion of tasks.

TOPICS TO BE COVERED

REVIEW OF THE DESIGN PROCESS

- Review of the Design Process
- Review of Comments from Project I Final Report

PROJECT PLANNING FOR SEMESTER

- Planning Concepts, Tasks and GANTT Charts

DETAILED DESIGN COMPONENTS AND SUBSYSTEMS TESTING

- Testing of Components for Functionality & Efficiency
- Modification of Design for Improvement
- Re-Testing of New Designs

MODERN ENGINEERING TOOLS & PRACTICES

APPLICATION OF CODES & STANDARDS

PROFESSIONALISM & ETHICS

GLOBAL & SOCIAL CONSIDERATIONS

COVID-19 Campus Safety Measures [NOTE: Delete this section when the COVID-19 pandemic is over]

To promote public safety and protect students, faculty, and staff during the COVID-19 pandemic, Prairie View A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring** - Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
- **Face Coverings** - Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain.
- **Physical Distancing** - Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- **Classroom Ingress/Egress** - Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Students should leave classrooms promptly after course activities have concluded, should not congregate in hallways and should maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- **Face-to-face Class** - To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Office for Student Conduct for adjudication. Additionally, the faculty member may choose to teach that day's class remotely for all students.
- **COVID-19 Guidelines for Student Conduct Adjudication** - The mandatory COVID-19 Training/Certification taken by all students serves as the 1st Warning for violation of COVID-19 Guidelines.
 - 1st incident: upon review of Incident Report and finding of responsibility — Conduct Probation
 - 2nd incident: upon review of Incident Report and finding of responsibility — Suspension
- **Personal Illness and Quarantine** - Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities. Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence. To receive an excused absence, students must provide appropriate documentation to the Office for Student Conduct, studentconduct@pvamu.edu.

OUTCOME 1

Ability to Solve Complex engineering problems (CEP) are engineering problems having one or more of the seven characteristics below:

- i. wide-ranging or conflicting technical issues,
- ii. having no obvious solution, addressing
- iii. problems not encompassed by current standards and codes
- iv. involving diverse groups of stakeholders
- v. including many component parts or sub-problems
- vi. involving multiple disciplines, or
- vii. having significant consequences in a range of contexts

1. Identify and Formulate engineering/technical/computing problems using principles of engineering/mathematics/science

Given a complex engineering problem, the students are able to:

- i. Understand the given problem and identify the subject area and concepts involved.
- ii. Convert the problem into a well labeled sketch (such as free body diagram, flow chart, a. functional block diagram, schematic diagram).
- iii. Formulate the CEP into a mathematical model [using basic, intermediate and advanced mathematics ranging from algebra & trigonometry, calculus, probability & statics, complex analysis to Fourier transform & LaPlace transforms] or experimental framework stating all relevant assumptions.
- iv. Formulate the CEP into an engineering model [using relevant laws and equations from engineering and science areas) stating all relevant assumptions.

2. Solve CEP/computing problems

Given a CEP that has been formulated, students are able to:

- i. Solve the resulting engineering/mathematical/science formulations analytically, numerically, experimentally or through the use of appropriate software or computer program.
- ii. Evaluate and interpret the result.

OUTCOME 2

Ability to apply the engineering design through a systematic design process that includes

1. Ability to identify the specific needs to be met by defining/understanding the Problem and developing plans for the project to satisfy the need

Students are able to:

- (i) Identify the customer and the specific needs to be met by the design
- (ii) Identify and list the design objectives.
- (iii) Identify the design constraints.
- (iv) Define the design requirements, strategy and methodology.
- (v) Identify and break down work into tasks and subtasks and identify the personnel and deliverables for each.
- (vi) Develop a project management plan using Gantt charts and critical path analysis.
- (vii) Establish major milestones for tracking progress and define performance metrics to measure success.

2. Ability to Conduct a Review of the Literature and perform preliminary design by generation of ideas and applying creativity

Students are able to:

- i. Identify the types of information needed for a complete understanding of all aspects of the project (Based on task described in the project planning).
- ii. Gather information on relevant fundamentals, theory / concept (demonstrate technical competence) and relate them to the design.
- iii. Provide the sources in a list of references properly cited in the literature review section and relevant sections of the report
- iv. Define functional requirements for design (Specific required actions needed to be performed for the design to be achieved).
- v. Transform functional requirements into candidate multiple solutions / mathematical models.
- vi. Evaluate multiple candidate solutions against requirements to arrive at feasible final designs.

3. Ability to perform detailed engineering design

Students are able to:

- (i) Perform relevant detailed analysis (engineering, mathematical, economic)
- (ii) Consider and address issues relating to public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- (iii) Develop final design specifications
- (iv) Select materials/components/software/test equipment.
- (v) Fabricate a prototype or a model (physical, software, hardware) of the design.
- (vi) Test or simulate the design and make necessary changes to obtain optimum design.

OUTCOME 3-Oral

An ability to communicate effectively with a range of audiences, orally

1. Ability to Organize, Plan, Design/Prepare and Use Appropriate Visual Aids for communication/Presentation to a range of audiences (executives, technical and non-technical).

- i. Students are able to organize presentation in well-structured logical sequence making it easy for technical or non-technical or the appropriate audience to follow the content with clear understanding.
- ii. Students are able to prepare effective slides (adequate and relevant technical content and viewgraphs that are legible, completely labeled/annotated/dimensioned to illustrate important features of the work being presented)
- iii. Students are able to use modern presentation techniques (may include visually enhanced transitions, animations, video, and sound clips).
- iv. Students are able to stay within time limits

2. Ability to Articulate Subject Knowledge (Technical Content)

- i. Students demonstrate technical knowledge and understanding of the subject. (This may be demonstrated by presenting literature review, originality, creativity, required standards, constraints, and other appropriate considerations such as economics, environmental, and societal impact)
- ii. Students are able to prepare and display prototypes or models when they are necessary to support the presentation.
- iii. Students respond clearly to questions in a professional manner (after restating questions to audience if necessary).

3. Appearance and Ability to Provide Good Oral Delivery to a range of audiences

Students are able to:

- (i) Use correct grammatical English and technical terms appropriate to technical area and audience type; speak with clarity and confidence;
- (ii) Maintain good posture and eye contact with the audience (should not read from prepared notes) and elicit the attention of the audience.
- (iii) Dress appropriately for the occasion.

OUTCOME 3-Written

An ability to communicate effectively with a range of audiences (Written Technical Communication)

1. Ability to prepare an executive summary for the report

Students are able to prepare an executive summary of 5 to 8 pages.

2. Ability to organize, plan and properly format a written technical report

- i. Students are able to organize report by categorizing ideas for the report into well and logically organized chapters, major sections, subsections and paragraphs blended within the larger units.
- ii. Students provide Title Page, and Table of Contents, list of Figures, and List of Tables properly formatted.
- iii. Students provide figure number and title for each figure in the report, reference each figure, and completely discuss each figure in the report in accord with standards in the project manual.
- iv. Students provide table number and title for each table in the report in accord with standards in the project manual, reference each table, and completely discuss each table in the report.
- v. Students properly cite references in the report and provide well formatted reference list at the end.
- vi. Students prepare the written report in accord with standard report formatting provided in the Senior Projects Report Manual.

3. Ability to compose original texts and properly apply the conventions of written language.

Students are able to

- (i) properly apply capitalization, punctuation, and penmanship, to communicate clearly
- (ii) Spell proficiently
- (iii) Apply standard grammar and usage to communicate clearly and effectively in writing including
 - using complete sentences, varying the types such as compound and complex to match meanings and purposes
 - properly employing standard English usage in writing for audiences, including subject-verb agreement, pronoun referents, and parts of speech
 - properly using adjectives (comparative and superlative forms) and adverbs appropriately to make writing vivid or precise
 - properly using prepositional phrases to elaborate written ideas
 - properly using conjunctions to connect ideas meaningfully
- (iv) Use available technology to support aspects of creating, revising, editing, spell checking, and publishing the report.

4. Ability to provide appropriate discussion, conclusions and recommendations

Students are able to clearly

- (i) Summarize the goals, objectives, and indicate whether they were met.
- (ii) Summarize the project design chapter by chapter
- (iii) Summarize constraints and codes and indicate whether they were met.
Summarizes how issues relating to public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors were considered/addressed. in the design.
- (iv) Provide logical conclusions and recommendations (including strengths and weaknesses).

OUTCOME 4

An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

1. an ability to recognize ethical and professional responsibilities in engineering situations involving global, and societal contexts.

Students are able to demonstrate the knowledge of professional code of ethics (Review code of ethics from your specific professional society and from your State board of professional Engineers. Students may be tested on these).

2. an ability to make informed judgements on ethical and professional responsibilities in engineering while considering the impact of engineering solutions in global, economic, environmental, and societal contexts.

Students will study several ethics case studies and make informed judgements on them with regard to the impact of engineering solutions on (a) global, (b) economic, (c) environmental, and (d) societal contexts. (There should be enough case studies that cover all the four areas of global, economic, environmental and societal context)

Global Impact: The student is able to investigate a given engineering problem, and explain how proposed engineering solutions to similar problems may be adopted in different parts of the world.

Societal Impact: The student is able to investigate a given engineering problem, and develop engineering solutions that take into account societal factors.

Economic Impact: The student is able to investigate a given engineering problem, and develop solutions that take into account economic factors.

Environmental Impact: The student is able to investigate a given engineering problem, and develop solutions that take into account environmental impact.

OUTCOME 5

An ability to (1) function effectively on a team whose members together (2) provide leadership, create a collaborative and inclusive environment, (3) establish goals, plan tasks, and meet objectives.

1. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment

- i. Organize and assign team roles
- ii. Plan and keep good record of team meetings including documentation of individual contributions
- iii. Share ideas, complete assigned task on time, help others, and be professional to each other (through peer evaluation of team members on these characteristics).
- iv. Resolve conflicts professionally within the group with the view of creating an inclusive and collaborative environment

2. Establish goals, plan tasks, and meet objectives.

- i. List goals and objectives
- ii. Identify and break down work into tasks and subtasks and identify the personnel and deliverables for each.
- iii. Develop a Gantt chart and critical path analysis for managing the project.
- iv. Establish major milestones for tracking progress and define performance metrics to measure success.
- v. Track progress of team members to ensure project is on schedule and meets objectives (through submission of progress reports).

End of Semester Course Assessment Report

This summary contains the following Information

1. Performance Statistics

- Total number of students in class
- The class average performance (**stated as %**) in each course outcome assessed in this class and the **two previous times course was assessed**.
- The acceptable class average for the class in each outcome area as set by your Department. **You cannot use any number of your choice**
- Percentage of students who scored below the expected average in each outcome.

2. Implementation Summary

- Brief summary of plans implemented during the semester based on last assessment report

3. Perceived Problems

- Instructor's critical **evaluation** of perceived problems that affected students' performance. **Realistic problems should be identified throughout the semester and summarized in this section of the report.**

4. New Plans for Addressing Problems

- Instructor's plans for addressing the perceived problems the next time the class is taught. **These should be specific enough for another instructor to implement. Most of these should be things that, you, the instructor can implement to help students to improve. Be creative.**

5. Overall Trend over last three assessment periods

- Instructor's summary of overall performance trend for each outcome measured over the last three periods.

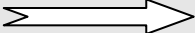
5. Were Expectations Met?

- Answer **YES** if the **class average was above the expected average** and the **stated percentage of students** scored at or above the expected average, else answer **NO**.

END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT
ELEG 4248-P01 SENIOR DESIGN & PROFESSIONALISM II / SPRING 2022 SEMESTER
(COMPUTER ENGINEERING STUDENTS)

Report Prepared by: VJ Turner & Sarhan Musa

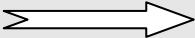
Report Date: MAY 17, 2022

Semester	Analysis Type	Number of Students	Outcome 1 An ability to identify, formulate, and solve complex engineering problems (CEP) by applying principles of engineering, science, and mathematics.			Outcome 2 An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.		
			Expected Average	Class Average	% Students Above Expected Average	Expected Average	Class Average	% Students Above Expected Average
Spring 2019	Direct	9 - CE	80	89	100%	80	87	100%
Spring 2020	Direct	6- CE	80	95	100%	80	95	100%
Spring 2021	Direct	12- CE	80	93	100%	80	92	100%
Spring 2022	Direct	14-CE	80	94	100%	80	91	100%
Implementation Summary	Items implemented from previous report or after meeting previous instructor		Each project had an ECE faculty sponsor with helped the successful deliverable for a final design. Each team was able to have a working design project.			Lecture on public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors was held early in the design process to ensure appropriate consideration of these factors.		
Perceived Problems	Perceived problems are directly related to the PC and the sub items under them		Main issue is getting the projects assigned early in the semester and having faculty or graduate assistant available to give timely technical advice and direction.			We want students to have data to back up their findings and for the students to fully grasp, so we had to discuss and give examples on several lectures to them to get it. Some students' teams still do not provide any data or statistics to support their analysis.		
Plans for Addressing Problems	Plans for address specific measures to address PC and their sub areas		Compile project list from faculty and or company sponsors in August so students can have access and decide on projects very early in the semester. In addition, need to have access to budget and procurement card to ensure parts are ordered and delivered in a timely fashion. Goal is to order parts before Thanksgiving break and have on site by January semester start.			We now have good examples from previous classes to show and use in the lecture. We will continue to stress the need for data to support their findings.		
Overall Trend over Periods	Ascertain if there were improvements over previous semesters		We made progress and we will continue in moving in right direction.			We made progress and we will continue in moving in right direction.		
Were Expectations Met?			YES			YES		

END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT
ELEG 4248-P01 SENIOR DESIGN & PROFESSIONALISM II / SPRING 2022 SEMESTER
(COMPUTER ENGINEERING STUDENTS)

Report Prepared by: VJ Turner & Sarhan Musa

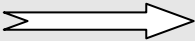
Report Date: MAY 17, 2022

Semester	Analysis Type	Number of Students	Outcome 3 An ability to communicate effectively with a range of audiences (Oral Communication)			Outcome 3 An ability to communicate effectively with a range of audiences (Written Communication)		
			Expected Average	Class Average	% Students Above Expected Average	Expected Average	Class Average	% Students Above Expected Average
Spring 2019	Direct	9 - CE	80	93	100%	80	91	100%
Spring 2020	Direct	6- CE	80	92	100%	80	94	100%
Spring 2021	Direct	12- CE	80	94	100%	80	92	100%
Spring 2022	Direct	14-CE	80	90	100%	80	91	100%
Implementation Summary	Items implemented from previous report or after meeting previous instructor		We had several interim oral presentations before mid-term and finals oral presentation which provided tips and adjustments to ensure students had training.			We follow the standard COE outline for the written final report. We had provided feedback and examples for written presentations so teams can see examples of higher quality products from previous classes.		
Perceived Problems	Perceived problems are directly related to the PC and the sub items under them		We got good feedback from industrial attendees about this year presentations. Not all students are comfortable on public speaking.			Overall, the final reports are pretty good. However, some students do not understand Gantt charts and struggle to make details project timeline. Primary reason for minor change in class average is that two teams turned in their assignments late which automatically reduce their scores.		
Plans for Addressing Problems	Plans for address specific measures to address PC and their sub areas		We will continue to hold oral practice sessions for students who are uncomfortable speaking. Also, we will stress the professional importance of turning assignments on time.			We now have good writing examples from previous classes to show and use in the lecture. This will speed up the understanding. Also, we may start giving lectures sooner on the final product so students can start to see earlier in the semester what the expectations are for a final written report. We will show more examples of Gantt chart.		
Overall Trend over Periods	Ascertain if there were improvements over previous semesters		We got good feedback from the industry attendees about the quality of our projects and the oral presentations.			The students are getting accustom and more comfortable and we will continue in moving in right direction.		
Were Expectations Met?			YES			YES		

END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT
ELEG 4248-P01 SENIOR DESIGN & PROFESSIONALISM II / SPRING 2022 SEMESTER
(COMPUTER ENGINEERING STUDENTS)

Report Prepared by: VJ Turner & Sarhan Musa

Report Date: MAY 17, 2022

Semester	Analysis Type	Number of Students	Outcome 4 An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts			Outcome 5		
			Expected Average	Class Average	% Students Above Expected Average	Expected Average	Class Average	% Students Above Expected Average
Spring 2019	Direct	9 - CE	80	99	100%	80	81	100%
Spring 2020	Direct	6 - CE	80	94	100%	80	92	100%
Spring 2021	Direct	12 - CE	80	96	100%	80	90	100%
Spring 2022	Direct	14 - CE	80	94	100%	80	90	100%
Implementation Summary	Items implemented from previous report or after meeting previous instructor		In the Spring 2022, each team was given a real Ethics scenario that they presented results, observations etc. in class. By presenting the scenario to the whole class we were able to have classroom learning about each scenario.			For this outcome, we leverage Team Contracts and Weekly Team Progress. Students pick their own teams – we do not force them into a team.		
Perceived Problems	Perceived problems are directly related to the PC and the sub items under them		We do not see any major problem with this topic, all seems to understand the values and importance of ethics.			We like to see students have more details experience with GANTT type charts before coming to senior design.		
Plans for Addressing Problems	Plans for address specific measures to address PC and their sub areas		We will continue to do more classroom discussion on ethics and may be have outside industry speaker on this topic.			Will have to give students good GANTT charts examples of previous teams to ensure we can meet this outcome for project task planning.		
Overall Trend over Periods	Ascertain if there were improvements over previous semesters		Classroom presentation is good for group learning.			We made progress using the weekly progress report.		
Were Expectations Met?			YES			YES		

Grade Sheet Showing
(FOR COMPUTER ENGINEERING STUDENTS)

Student and Class Performance in Outcomes
The computed semester average in each outcome
as stated in the Assessment report are
highlighted in boldface

Grade Sheet Showing Student and Class Performance in Course Outcomes
ELEG 4248-P01- Senior Design & Professionalism II Spring 2022
(Computer Engineering Students)

CRN:

27837

Student #	Outcome 1	Outcome 2	Outcome 3 (Oral Communication-Final)	Outcome 3 (Written Communication-Final)	Outcome 4 (Ethics Scenario)	Outcome 5 (Contracts and Reports)
1	92	93	88	91	94	90
2	95	91	95	94	98	90
3	98	94	92	96	97	90
4	95	95	96	97	97	90
5	87	85	72	83	85	90
6	93	76	92	74	97	90
7	95	95	96	97	97	90
8	95	95	96	97	97	90
9	99	99	97	98	97	90
10	87	85	72	82	85	90
11	87	85	72	82	85	90
12	95	91	95	94	98	90
13	99	99	97	98	97	90
14	95	95	96	97	97	90
Class Average	94	91	90	91	94	90

**OUTCOME SPECIFIC ASSIGNMENTS
USED TO ASSESS OUTCOMES**

ASSIGNMENTS FOR OUTCOME “1”

An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematic.

**ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II
SPRING 2022**

Instructor: VJ Turner & Sarhan Musa

Title of Assignment

Written Final Report used to evaluate this outcome

Outcome Measured Using this Assignment

Outcome 1

An ability to identify, formulate, and solve **complex engineering problems** by applying principles of engineering, science, and mathematic.

Check the complex engineering problem characteristics related to this assignment

Assignment problem	
X	involves wide-ranging or conflicting technical issues, has no obvious solution
	Addresses problems not encompassed by current standards and codes
	involves diverse groups of stakeholders
	includes many component parts or sub-problems
	includes many component parts or sub-problems
	involves multiple disciplines
	has significant consequences in a range of contexts
Assignment problem involves the application of the principles of	
X	engineering
	science
	mathematics

Brief justification of the suitability of assignment for the outcome

This section will demonstrate students' ability to define the project and project scope. Along with some key deliverables.

ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II SPRING 2022

Title of Presentation: Outcome 1						
Team Number and Members:						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Identify and Formulate						
Able to understand the given problem and identify the subject area and concepts involved						
Able to identify what information is known and what needs to be determined						
Able to convert the problem into a well labeled sketch or appropriate representation (free body diagram, flow chart, functional block diagram, schematic diagram, etc.)						
Able to formulate the complex engineering problem into an engineering model or design – showing any math or science or technology needed to validate the design						
Solve Complex Problem						
Able to design a practical solution to address the problem.						
Able to identify parts and other needed capability (like coding) to solve the problem or proposal						
Able to deliver a final solution that integrates all aspects of the design from hardware to software						
The final solution should be consistent with project deliverables and able to demonstrate the objective has been achieved						

Electrical and Computer Engineering Department

ELEG 4248 Senior Design D

Spring Semester

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- 1.1 Problem Statement, Business Objective and Target Audience or Your Project
- 1.2 Client identification and recognition of need
- 1.3 Project Goals and Objectives
- 1.4 Contemporary issues relevant to project
- 1.5 Potential impact of project on society (Safety, Env, Tech, Eco)
- 1.6 Initial Project Constraints

2. PROJECT PLANNING AND TASK DEFINITION

- 2.1 Task Definition
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3. LITERATURE REVIEW

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- 5.5 Economic Analysis
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6. RESULTS & DISCUSSION

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- 6.2 Summary of Constraints and Codes met by Design ..
- 6.3 Discussion of Results and Other Use Cases ..

7. CONCLUSIONS AND RECOMMENDATIONS

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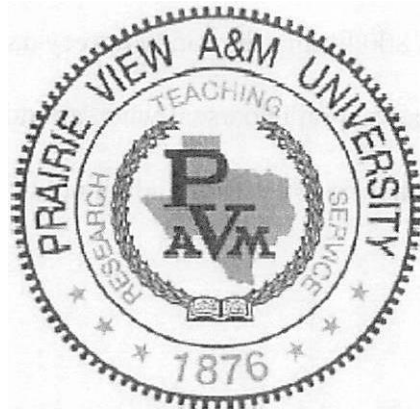
ITEMS IN RED are informational only – do not include the comments in red in your submission

Complex Engineering Problem Evaluation Form
ECE Senior Design & Professionalism
Outcome 1

Title of Presentation:						
Team 5 - Object Detection						
Joshua Littleton, Xavier Dukes, Arthur Quinney, Tri'Heem Neville, Christopher Rollerson						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Identify and Formulate						
Able to understand the given problem and identify the subject area and concepts involved	/					Identify and Formulate Able to understand the given problem and identify the subject area and concepts involved Able to identify what information is known and what needs to be determined Able to convert the problem into a well labeled sketch or appropriate representation (free body diagram, flow chart, functional block diagram, schematic diagram, etc.) Able to formulate the complex engineering problem into an engineering model or design - showing any math or science or technology needed to validate the design
Able to identify what information is known and what needs to be determined						
Able to convert the problem into a well labeled sketch or appropriate representation (free body diagram, flow chart, functional block diagram, schematic diagram, etc.)	/					
Able to formulate the complex engineering problem into an engineering model or design - showing any math or science or technology needed to validate the design						
Solve Complex Problem						
Able to design a practical solution to address the problem.	/					Solve Complex Problem Able to design a practical solution to address the problem. Able to identify gaps and other needed capability (like coding) to solve the problem or proposal Able to deliver a final solution that integrates all aspects of the design from hardware to software The final solution should be consistent with project deliverables and able to demonstrate the objective has been achieved
Able to identify gaps and other needed capability (like coding) to solve the problem or proposal	/					
Able to deliver a final solution that integrates all aspects of the design from hardware to software	/					
The final solution should be consistent with project deliverables and able to demonstrate the objective has been achieved	/					

Avg 99

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Object Detection on Raspberry Pi

ELEG 4247: Senior Design & Professionalism II

Topic: Final Report

Team Number 5

Submitted by:
Joshua Littleton (Team Lead)
Tri'Heem Neville
Arthur Quinney
Xavier Dukes
Christopher Rollerson

Instructor: Professor Turner
Faculty Sponsor: Dr. Dong

Date of Submission: May 1, 2022

Excellent
+

Project Executive Summary

J

Problem Statement

On average, approximately 4,800 burglaries happen every day. One-third of all robberies result in injury and 39% of the time a weapon is present when an individual is harmed. Arrest rates for Weapon offenses have doubled since 1965 including unlawful possession and trespassing.

Proposed Deliverables

We will be using a Raspberry Pi attached with a camera to survey the area and identify potential threats

The machine learning (ML) algorithm we implement detects the threatening objects on an individual such as weapons in real-time

- Once an object defined as a threat is detected, a text notification is sent to the owner/operator's phone allowing them to determine the course of action

Budget

- The total budget for our project is \$600.00
- The total amount spent on our project is \$340.00

Project Executive Summary (continued)

Customer requirements And Engineering solutions

Mass producible by using easily obtainable/cost-effective parts

Lightweight parts for mounting purposes

Train machine learning algorithm to detect various weapons

The camera needs a resolution of 1080p for increasing the range of detection

Text notification alerts of potential threats

The algorithm classifies threats and non-threats

Detect threats in real-time

j

Major Constraints

- The housing for the Raspberry Pi and camera must be mountable

The camera resolution affects detection accuracy and distance

The limited frame rate of the Raspberry Pi camera

Benefits

Societal: This project will offer greater security to those that cannot afford other options.

Businesses will be capable of guaranteeing the safety of customers without infringing upon a customer's 2nd amendment right to carry while within the public space.

Safety: The primary goal of this project is to create an affordable security system for small businesses and homeowners to proactively respond to potential threats however they see fit.

Technical: Machine learning has not been utilized within security systems to this day.

Our project will pioneer a smart security system that will inform you of potential dangers

Project Executive Summary (continued)

at the first sighting of a weapon that would provide a danger to security or the owner.

Recommendations

We recommend that the unit is mounted to a stable elevated surface, ensure there is nothing blocking the camera lens, make sure the Raspberry Pi is located in a well-insulated area to prevent overheating the unit, provide a power source for the Raspberry to connect to, and lastly to get the best usages of our product do not forget to set up a Twilio account for all alerts and notifications.

Conclusion

Our design will identify active threats by revealing displayed weapons. This artificial intelligent threat detection system will impact many from universities and church organizations to businesses and homeowners.

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Perfect ✓

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List of Team Members and Roles

Joshua Littleton	Team Lead
Arthur Quinney	Parts Procurement Lead
Christopher Rollerson.....	Design Analysis Lead
Tri'Heern Neville	Scribe and Presentation Manager
Xavier Dukes.....	Software Developer

Section 1 - Project Scope

1.1 Problem Statement, Business Objective and Target Audience

Across the United States, a burglary happens every 15 seconds. This equates to a staggering 4800 burglaries a day on average. A burglary is defined as an unlawful entry of a structure to commit a felony or theft. Two-thirds of these burglaries affect residential properties while the remaining third affect small businesses. In 2020, 33,296 robberies involved a handgun, and an additional 8,641 involved a knife. A robbery can be more severe than a burglary, as it must involve threats or actual violence. Arrest rates for weapon offenses have doubled since 1965 including unlawful possession and trespassing. However, according to the U.S. Department of Justice, Bureau of Justice Statistics, a substantial portion of violent crimes that take place in homes have taken place during a burglary incident.

The goal of this project is to design an intelligent monitoring system that will enhance our ability to survey public and private spaces by using object detection to identify various threats that could potentially lead to security risks and/or bodily harm.

The target audience for this project is small businesses, homeowners, hospitals, schools/universities, and churches.

1.2 Client Identification and Recognition of Need

1. The device should be mass-producible; to achieve this we plan to use easily obtainable parts that are cost-effective. Due to the target audience being homeowners and small businesses, we want to make this device available to everyone at a reasonable price.
11. The final product must be mountable and lightweight; this will be achieved by using lightweight materials and cheaper parts. This will ensure that it can be mounted on a wall for extended periods of time without any complications. The final product will be placed in conventional security camera locations, to survey the area.
- iii. This device must detect a variety of potential threats as weapons come in various shapes, sizes, and calibers. This is a perfect application for machine learning (M.L.) as there is not any set of definite rules to classify the myriad of types of weapons there are. The flexibility required for this particular use case lends itself very well to the use of artificial intelligence (A.I.).
- iv. The detection of potential threats at a distance is imperative to the preemptive Smart Detection System. A high degree of accuracy is required to minimize false positives. Poor resolution can affect accuracy and may not give an adequate warning since the potential threat will have to be closer to the camera when compared to a higher resolution camera. The camera will have a minimum resolution of 1080p to accomplish the goal of high accuracy, but we are also limited by the processing power of the Raspberry Pi.
- v. The device needs to be able to communicate with other devices such as a phone or monitor to deliver the alert notification system. A text message should be sent

1.2 Client Identification and Recognition of Need (continued)

immediately, via Twilio, to the home or business owner for appropriate action to be taken.

- vi. Object detection must be able to distinguish between a threat and a non-threat entity. The Raspberry Pi has limited processing power and should not waste valuable CPU power on low-risk or non-threatening individuals. The M.L. algorithm should focus on items that are deemed as potentially dangerous.
- vii. Real-time tracking is essential as the camera will give real-time data for the environment it is monitoring. The delay between the image processing and the time the data is received should be minimized for the most effective results. Raspberry Pis are particularly suited for real-time environments as they are often used in robotics due to their real-time clock (RTC) functionalities.

Marketing Requirements	Engineering Requirements	Justification
Mass Producible	Easily obtainable and cost-effective parts	Target audience is homeowners and small business owners
Mountable/Lightweight	Lightweight parts sturdy enough to be mounted for extended periods	Will be placed in conventional security camera locations
Detect a variety of potential threats	Train machine learning (M.L.) algorithm for weapon detection	Threats come in various forms, and this is an abstract problem with no clear formula. Requiring the flexibility of Artificial Intelligence
Detect potential threats at a distance	Camera has minimum resolution of 1080p	Poor resolution images are more difficult to decipher and can cause inaccuracies
Alert Notification System	Send an alert through a text message	Alerts the home/business owner of the potential threat near the camera
Distinguishable between threat and no threat	M. L. model will be trained to detect items deemed as threats	Camera's tracking will not focus on low-risk individuals and will dismiss them
Real Time Tracking	Use Raspberry Pi for its real time clock (RTC) capabilities	Raspberry Pi utilizes RTC which is essential for real time environments

Table 1: 1v/atri.r

1.3 Project Goals and Objectives

The goal of this project is to design an intelligent monitoring system that will enhance our ability to survey both public and private spaces by using object detection to identify various threats. These threats could lead to security risks and or bodily harm. Utilizing machine learning (M.L.) within the Raspberry Pi, we will monitor and detect any potential threats and non-threats that would enter the surveyed area. Once an object is determined to be a threat, the homeowner or business owner will be alerted so that they may take action that they deem as necessary. The notification will be sent before any violent action takes place, making the system more proactive rather than reactive. The warning that is received is essential to the safety of the occupants of the property and any type of warning in a potentially dangerous situation can aid in the mitigation of severe bodily harm.

1.4 Contemporary Issues Relevant to the Project

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Security is an essential part of our society, and our project is aimed at providing better security to small businesses, homeowners, hospitals, schools/universities, and churches. In our society, we have seen a drastic increase in gun violence and gun violence rates. In 2020, there was a 34% increase in gun violence deaths from the previous year, this also results in a 75% increase over the previous decade. Another important statistic to point out is that 79% of murders were carried out with a gun. If our project were to be implemented in our society these rates would start to decrease because people would be notified when there is a weapon present in their area.

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1.5.1 Societal Impact: 1.5 Potential Impacts of the Project

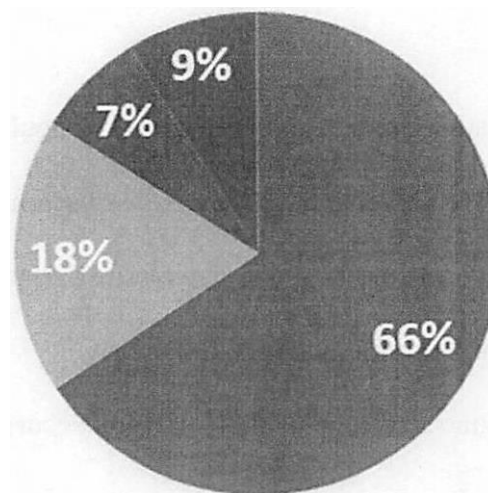
- I. Open and constitutional carry in several states could be impacted by this technology, as of September 1, 2021, Texas became a constitutional carry state, and its residents could openly display firearms without a permit. These weapons and their visibility in society will increase
- II. Home and business owners will have greater security due to the threat detection services
- III. 30% of U.S. households have home security our system would grant greater security

1.5.2 Safety Impact:

- I. In 2019, there were an estimated 1,117,696 burglaries in the United States. 62.8% of those burglaries were residential properties, 37.2% of those burglaries were businesses.
- II. According to Statista, there were a total of 124,381 robberies that involved weapons in 2019. 66% of those robberies involved a firearm and 34% involved a knife or some other weapon.
- III. Statistics show that someone is present 27.6% of the time when a burglary is taking place, 7.2% of these burglaries result in someone being injured.
- IV. Graph 1 shows the percentage of a certain type of weapon is used in robberies. This influenced our decision on what weapons our device will detect.

1.5 Potential Impacts of the Project (continued)

Number of Robberies



■ Firearm Knife ■ Blunt Object ■ Other

Graph, I: Percentages of Weapons used in Robberies

1.5.3 Technical Impact:

- I. Our project utilizes machine learning algorithms for the smart detection of weapons. The benefit of using M.L. is that our system will be able to learn on its own with the ability to detect new weapons
- II. Weapon detection using M.L. will be done in real-time, which has not yet been implemented in conventional home and small business security systems, some examples of weapon detection are in Figures 2.1 and 2.2
- III. Weapon detection allows for the security system to be more proactive rather than reactive. This will help the homeowner/business owner to prevent the possibility of injury to themselves or others
- IV. The figures below what a weapon detection interface would look like.

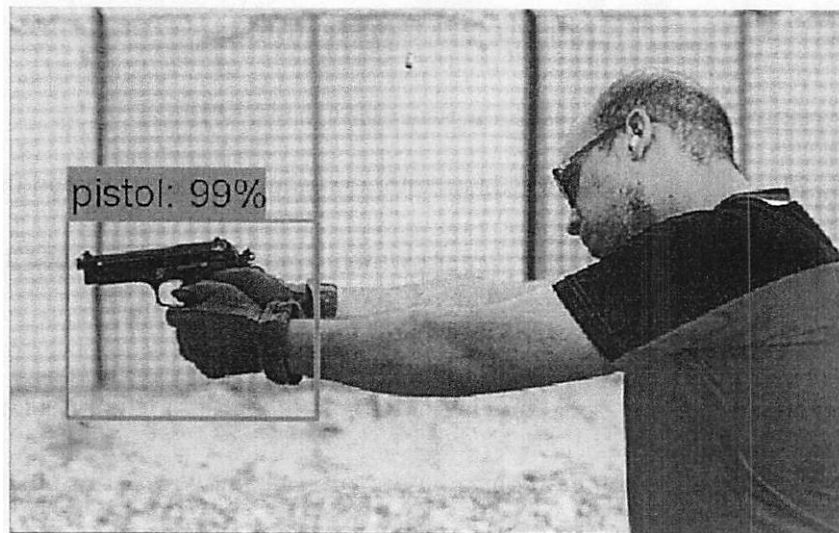


Figure 1.1: Example of Weapon Detection of a Firearm

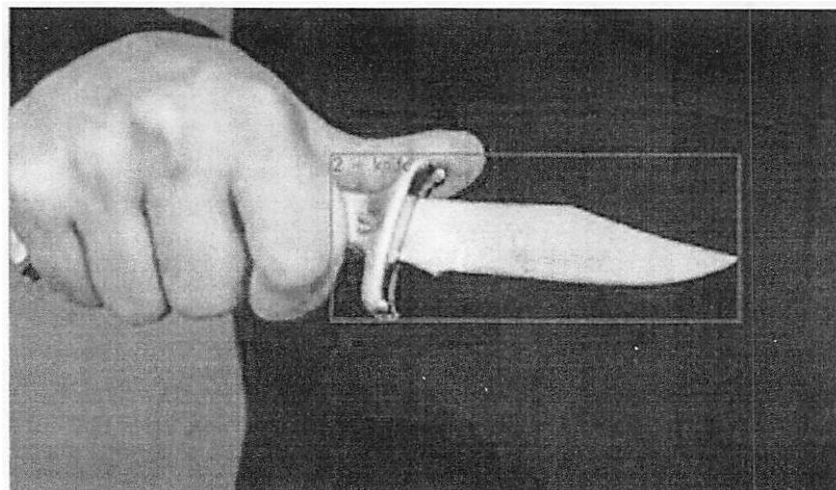


Figure 1.2: Example of Weapon Detection of a Knife

1.6 Initial Project Constraints

There are a few constraints that will influence the success of our project.

- The first is that the housing for the Raspberry Pi and camera must be mountable. This is due to our project acting as a security camera which is normally mounted to the wall in an unreachable location.
- The second constraint for our project is the camera resolution, which affects detection accuracy and distance. If our camera has a bad resolution, we will not be able to clearly detect the weapons at a distance and will have inaccurate readings.

Our final constraint is the limited frame rate of the Raspberry Pi camera, which will also affect our detection accuracy and has an impact on our alert notification system.

Section 2 - Project Planning and Task Definition

2.1 Task Identification

The team began planning first by conversing with the faculty sponsor to choose the specialization for object detection we would implement. This built a foundation on what type of research will be needed, as well as how much data is necessary for the project to start, beginning with the understanding of object detection and the procurement of parts. The research period allowed for each group member to learn about Raspberry Pi and the operating system interface that went along with it making for the future steps to have a smoother transition.

The design and coding phase of the project allowed the group to learn the coding language, Python, and design the script for the project to run. While designing the project we began early-stage testing to determine if the code worked as expected and find if there were any errors that needed to be fixed before moving to the next step. After testing the code and determining it works as intended, the next phase was to specialize the project in weapon detection instead of just object detection. To accomplish this, an edit to the code is necessary as well as training for the machine learning model to be capable of learning and recognizing set weapons that would appear before the camera. After changing the code and training, the first prototype was complete; however, the next step was to solve the framerate issues and implement a notification system to the code.

The final phase was completing the notification system for the Raspberry Pi and solving the framerate constraint to accomplish real time tracking and provide accurate detection for when a weapon appeared on camera. These tasks ranged between being completed within a day and taking weeks, so the delegation of time and work needed to be allocated appropriately so that the project is capable of being completed before the allotted due date.

2.2 Gantt Chart

Excellent

Throughout the year, time management is important for guaranteeing the project will be completed within a timely manner and that each member is working on their respective part by delegating the workload for the team to work as efficiently as possible. The following images are the complete Gantt chart displaying the detailed time delegation for each task to ensure the project progressed smoothly within the time limit.

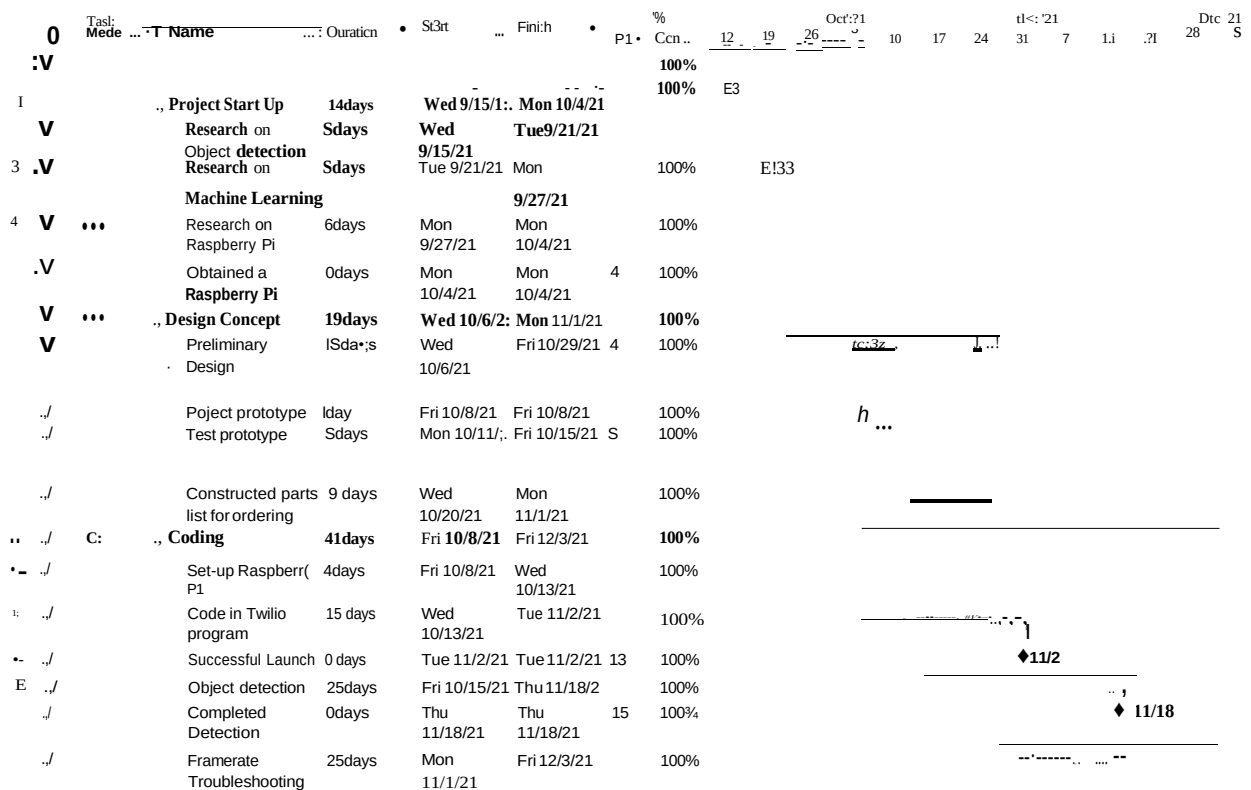


Figure 2.2: Gantt Chart (part 1)

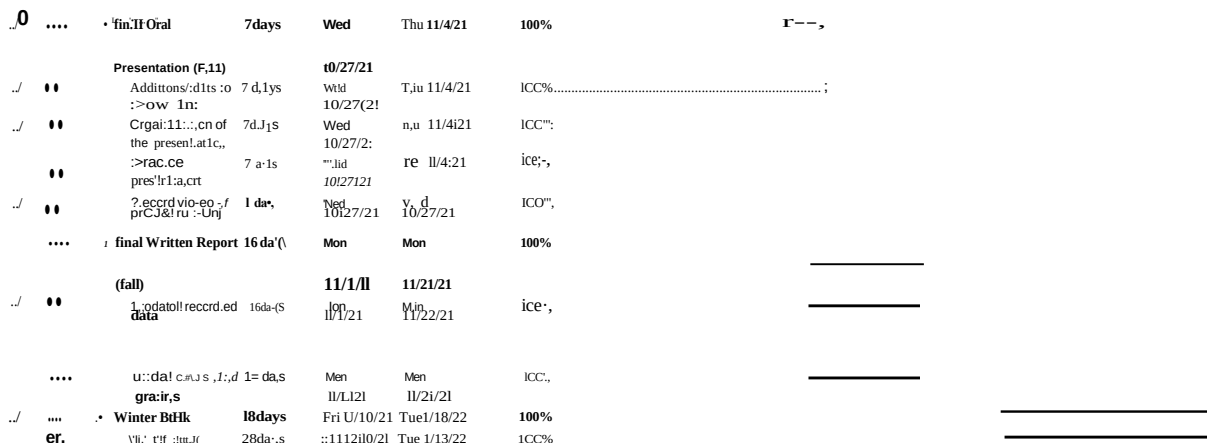


Figure 2.2: Gantt Chart (part 2)

2.2 Gantt Chart (continued)

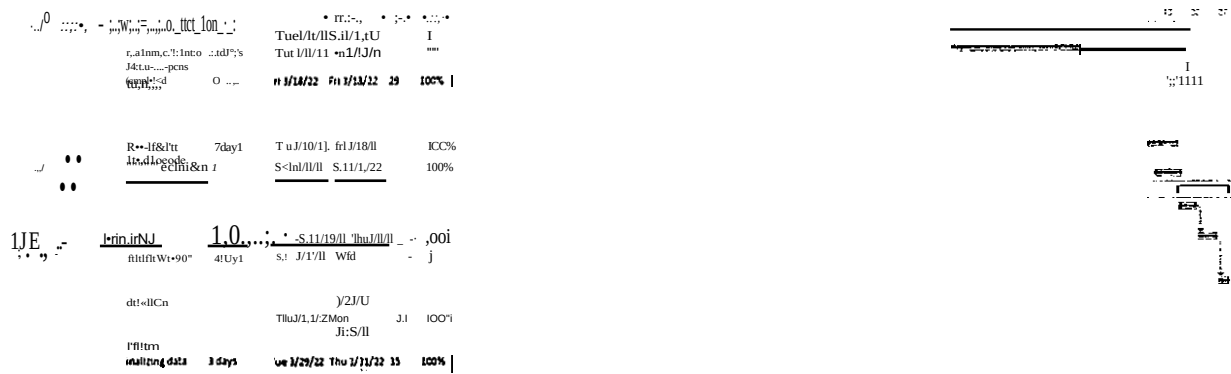


Figure 2.3: Gantt Chart (part 3)

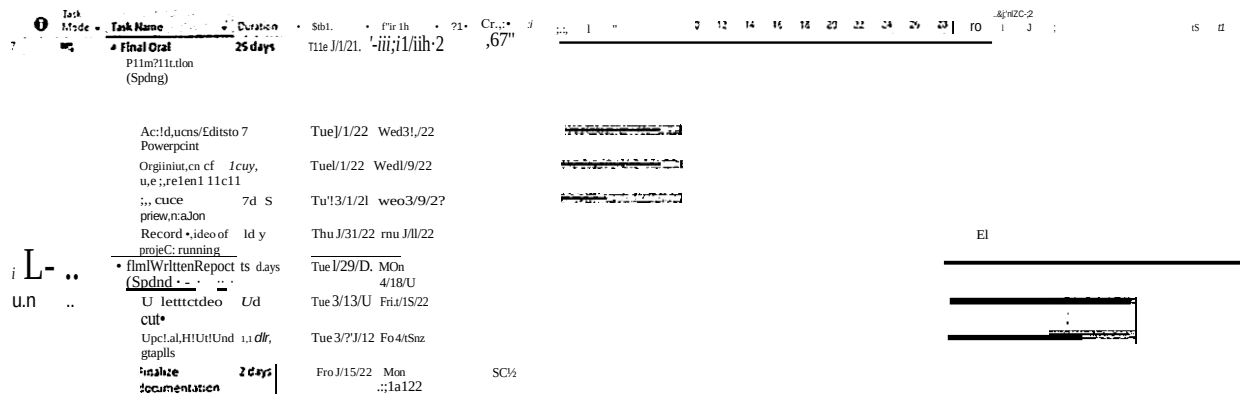


Figure 2.4: Gantt Chart (part 4)

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Section 3 - Literature Review

3.1 List of All Sources

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3.2 Statement of Learning from Each Source

1. Reference to another security device for monitoring of area; Deep Sentinel device
2. Break-in and burglary statistics regarding injuries and the presence of weapons provided via FBI Uniform Crime Reporting Statistics
3. Economic significance and statistics regarding the presence of small businesses
4. Project comparison to SimpliSafe products
5. How to integrate and set up a web client via python to send message to Twilio messaging service
6. Discussion of crime statistics and how ML can be used in burglary prevention and identification
7. Implementation of Vaak's AI theft-detection system and the methods of training
8. Project comparison to GW security camera products and their various prices and capabilities
9. Various SimpliSafe products for comparison to our product
10. Bureau of Justice Statistics Weapons Offenses and Offenders statistics on firearm related criminal offense over the years and its growth
11. The victimology of burglary victims according to the Department of Justice statistics, rates of burglary and harming of victims
12. Exploring the possibility of infrared cameras and object detection, for this project to detect concealed weapons
13. How to detect concealed weapons against the human body and when direct sightlines are obstructed

32 Statement of Learning from Each Source (continued)

14. The possibility of using infrared and heat sensitive wavelengths of light with various photo processing techniques to detect concealed weapons
15. 18+ homeowner statistics, touches on various aspects of homeownership such as reports on increasing cost, less overall homeowners, and disparities in the housing market
16. Cove Smart products and how they potentially compare to our product sensitive wavelengths of infrared light
17. Visual data and statistics regarding the number of times a weapon was present during robberies and the types of weapons during these occurrences
18. Stats on the number of burglaries, how often homes had security measures preinstalled and the economic effect such acts have on the victims
19. Statistics regarding the type of locations affected by burglaries

Section 4 - Preliminary Design

4.1 Concept Generation

There are several applications that machine learning can be used for such as object detection, image classification, natural language processing, facial recognition, and much more. As a group, we decided to focus on a specific implementation of object detection in relation to threat detection. The project shifted more into the development of a pre-emptive warning and threat detection system with associated hardware and third-party text notification alert system.

4.2 Concept Evaluation and Selection

As a company, we have a favorable position to produce our goods and services at a differential value. We have demonstrated a greater comparative value than that of our / competitors and conveyed this information to our target market. Production of our unique technology that offers features our competitors are not marketing paired with a lower production cost will ensure our competitive advantages.

Our technology includes a weapon detection algorithm whereas our rivals offer a general object detection algorithm. We have machine learning and real-time tracking software whereas some of our rivals only offer machine learning software. Our organization will not charge a continuous monthly service charge as many of our rivals include in their packages. Our single unit product is remarkably simple, easy to install, and lightweight, whereas our rivals have multiple heavier hardware devices and equipment to install.

With every great invention comes a challenge, and for our system to be complete, we must rely on a third-party notification company by the name of Twilio. Twilio plays a large factor in our equation as to when a threat is determined by our system. Twilio is responsible for sending out the proper notifications to the selected entities. Twilio is an independent company that the consumer will need to purchase a package plan from for our product to be utilized to its fullest capacity.

4.2 Concept Evaluation and Selection (continued)

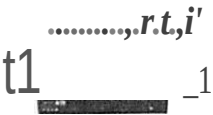
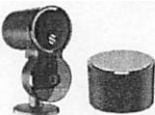
Design Options	Initial Cost	Continuous Fees	Pros	Cons	References
Smart Threat Detection System (Our Design)	\$340	No Monthly Fee	- Weapon Detection - Machine Learning (ML) - Real Time Tracking - Light Weight - Text Notifications	- No remote monitoring - Twilio subscription needed	N/A
GW Security 	Starts at \$1400 to \$6000	No Monthly Fee	- 4k Resolution - Uses ML - Night Vision	- No Remote Viewing - Heavy Camera Equipment - No Weapon Detection	
Deep Sentinel 	\$400 to \$1200	Monitoring Fee \$60 to \$200 per month	- Uses ML - Motion Detection - Wi-Fi or Ethernet connection	- No Weapon Detection	Decpsemi nel.com
SimpliSafe 	Starts at \$700	Monitoring Starts at \$15 per month	- Smoke, water, carbon & motion sensors - Smart home integration	- No ML feature to enhance system	
Cove Smart 	Starts at \$1200	Monitoring \$26 per month	- A+ rating - Environmental Sensors - Text Notifications	- No smart ML features available	CoYesman.com BBB.com

Table 2: Pl"(jocr Co1111Jariso11 Chun

4.3 Constraints and Applicable Codes and Standards Used in Preliminary Design

One of the major design constraints for our project was the frame rate of the Raspberry Pi camera. The frame rate affects Twilio alert times as it works via a counter of frames with a weapon present. Frame rates are essential to our project because we need to be able to detect weapons clearly and accurately before an individual is harmed. To fix this issue we implemented the Google Coral USB Accelerator, this allowed our system to go from one to two frames a second to around 30 frames a second.

The following Codes and Standards were used in implementing our preliminary design:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision - This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

After determining the deliverables for our project, we were then able to research and investigate ways to complete our project. We decided that we should start with object detection on our Raspberry Pi 3b+, object detection is to detect instances of visual objects within a certain class in digital images. With object detection, we were able to detect preprogrammed objects such as chairs, cellphones, laptops, a person, and many other objects. Next, we would test object detection on our Raspberry Pi 3b+ and investigate the machine learning code so that we could determine how to go from object detection to weapon detection, which is the basis of our project. The way to do this was by "labeling", labeling is the process of identifying raw data and adding meaningful and informative labels to provide context so that a machine learning model can learn from it. This will be addressed later in the paper. Referring to our object detection tests, we noticed that we were only getting around 1.1 to 2.5 frames per second, this would cause a delay in the timing of our text message alert system. This issue is due to the Raspberry Pi 3b+ being an older model machine that could not handle the video processing that we needed it to do. Therefore, we had to do more research to find a solution to address this problem, we arrived at the Google Coral USB Accelerator which can be plugged into our Raspberry Pi to give us a higher frame rate. The accelerator would then bring our frame rate from a maximum of 2.5 frames per second to around a maximum of 30 frames per second. We also found a newer model Raspberry Pi that was more powerful than the current one we were given; the new model was the Raspberry Pi 4b. We decided to purchase these new products that had a greater benefit on our overall project success.

4.5 Preliminary Design

Once we were given our project at the start of the fall semester, we began to consider ways that we could create the design of our project. We knew that we would need a Raspberry Pi and the associated camera, because that was the required hardware specification for our project and the camera allows us to monitor the area. Aside from the hardware of our project we also decided that we would have an alert notification system set up to alert the owner of the device that a weapon has been identified in their area. The alert notification comes through a third-party company known as Twilio that users will have to subscribe to and provide a phone number to send an alert message.

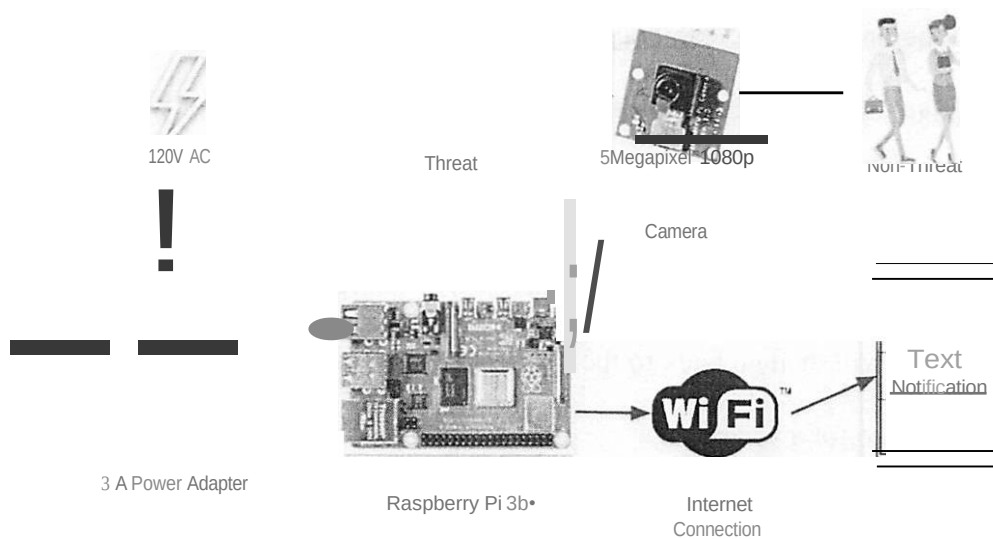


Figure 3: Preliminary Design

Once we obtained the hardware for our preliminary design, we put it together so that we could test it; the preliminary design can be seen in figure 3 above. The Raspberry Pi 3b+ is plugged in via a 3-amp power adapter, the camera is attached to the Raspberry Pi to detect threat and non-threats, and once a threat is detected an alert text message is sent over a Wi-Fi internet connection.

4.5 Preliminary Design (continued)

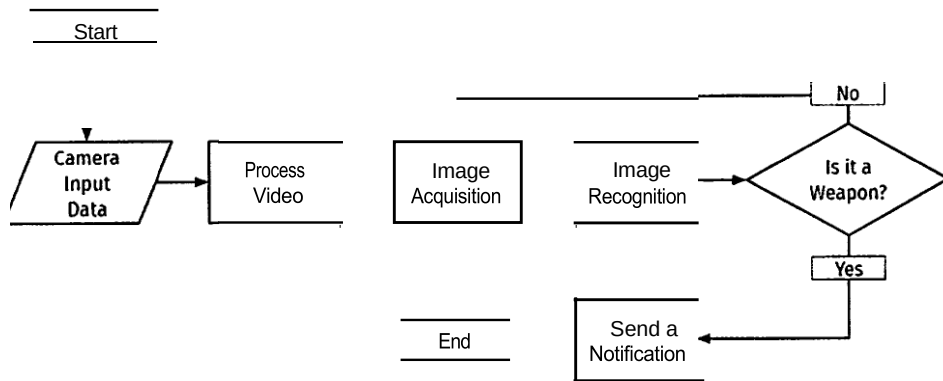


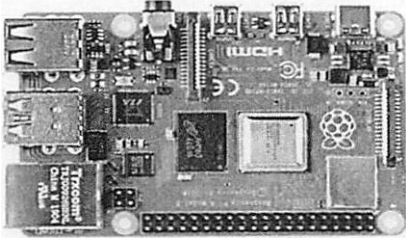
Figure 4: Software Flow Chart

In figure 4, we show the software flow chart on how the detection and notification system works. The software begins when the camera is turned on, the camera will then receive input data and will process the video. During image acquisition the system checks for weapons frame by frame, which then goes to image recognition \where it will determine if a weapon has been identified in that frame. If a weapon was detected then it will send the notification to the user, if no weapon is detected it will then go back to the image acquisition stage and continue to check the next frame in the video for a weapon.

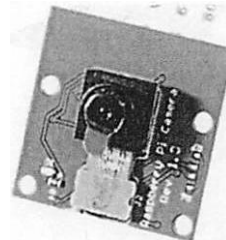
Section 5 - Detailed System Design

5.1 Project Parts Summary

All parts used in the final system design are listed below in Figures 5.1 to 5.8.



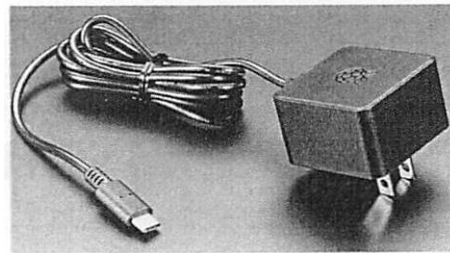
5.1: Raspberry Pi 4 Model B



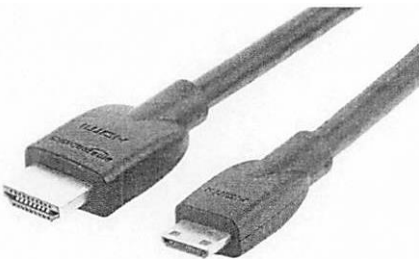
5.2: Raspberry Pi Camera Rev 1.3



5.3: Google Coral USB Accelerator



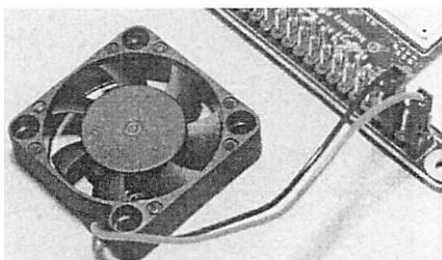
5.4: USB-C Power Supply



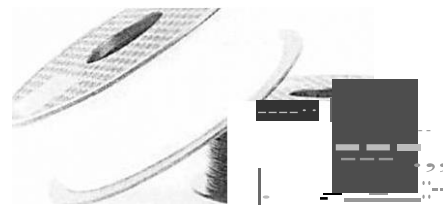
5.5: Micro HDMI to HDMI Cord



5.6 : Micro SD Card



5.7 : Raspberry Pi Fan



5.8: Polylactic Acid

Figures 5.1-5.8: Images of Parts

S.2 Engineering Analysis

Labeling and Training:

In order to train the model to detect weapons, we first had to label images that contained weapons. This was done using a software called Labellmg. A bounding box is drawn on the portion of the image that contains the weapon and you attach a label to that box. An example of this is shown in the figure below.

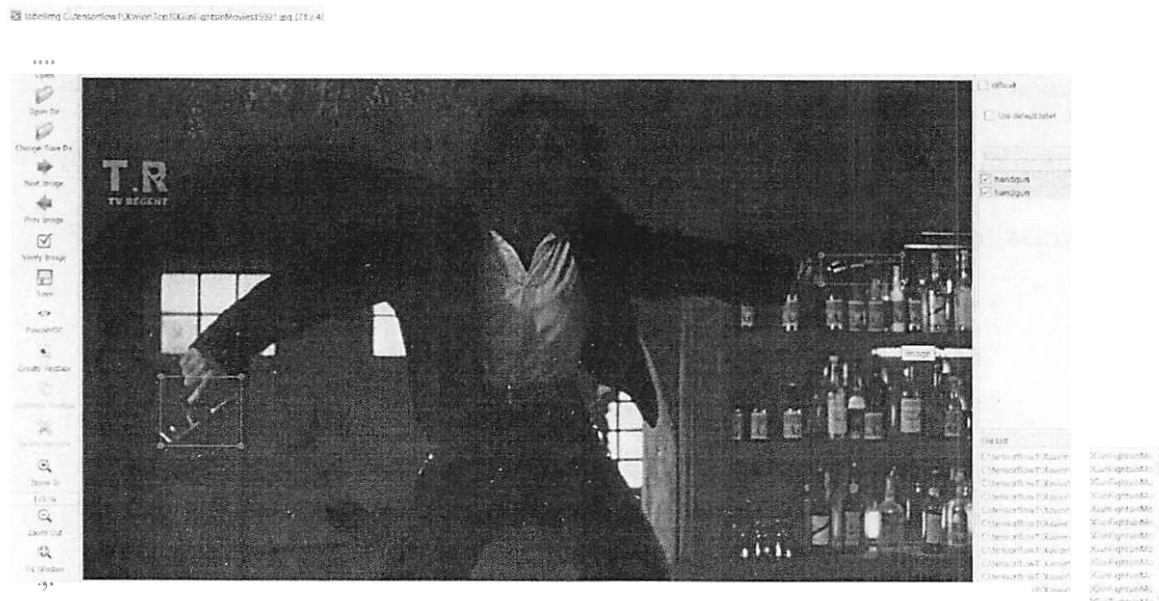


Figure 6: Lobel/mg Software

Here you can see that two handguns have been boxes and labeled as handguns. This had to be clone for over 5000 images.

After the entire dataset is labeled, it is used to train the model. The model uses the information provided by the labeled images to recognize patterns and make predictions.

Quantization:

Quantization is the act of constraining an input and representing its value as a smaller value. Each node, or tensor, of the model is represented by some numerical value. Usually, a 64-

5.2 Engineering Analysis (continued)

bit floating-point value can represent an absurdly broad range of values and is computationally intensive to decipher or to use in other operations. This large computational load slows the processing of frames and therefore the frame rate. Shrinking the representation of these nodes to 8-bit unsigned integers can greatly improve the frame rate, as operations on simpler values are faster and take up significantly less space in memory.

Quantization can be applied to the model on a per tensor basis or to the outputs of individual layers which only partially optimizes the model. This process can decrease the overall size of the model when it is totally quantized by a factor of 4 times. Quantization is also essential for the implementation of the Coral USB Accelerator Tensor Processing Unit (TPU) produced by Google which will maximize the frame rate on the Raspberry Pi upwards of 25-30 frames per second (fps).

Model:

The model used for object detection was the SSD MobileNet V2 COCO model. The SSD acronym at the beginning of the model's name stands for Single Stage Detection, meaning that this algorithm for identification goes straight from pixels of an image directly to bounding box coordinates and class probabilities to be displayed around the object. This model was chosen because of its compatibility with TFlite as only a select pool of lightweight operators is available with this framework and not all models can be converted to this version. This model is also one of the few quantizable models which is necessary for frame rate solutions to be implemented such as the Coral USB accelerator.

5.2 Engineering Analysis (continued)

Notification System:

Short Message Service or SMS is used as our notification system. A third-party software called Twilio is integrated into our design. Whenever a weapon is seen for a set number of frames, the notification is sent to warn anyone in danger. This type of notification was used because of its easy implementation, as well as its ability to send out notifications to any number of people with any type of phone. The messages are very quick and reliable.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications

Hardware Layout

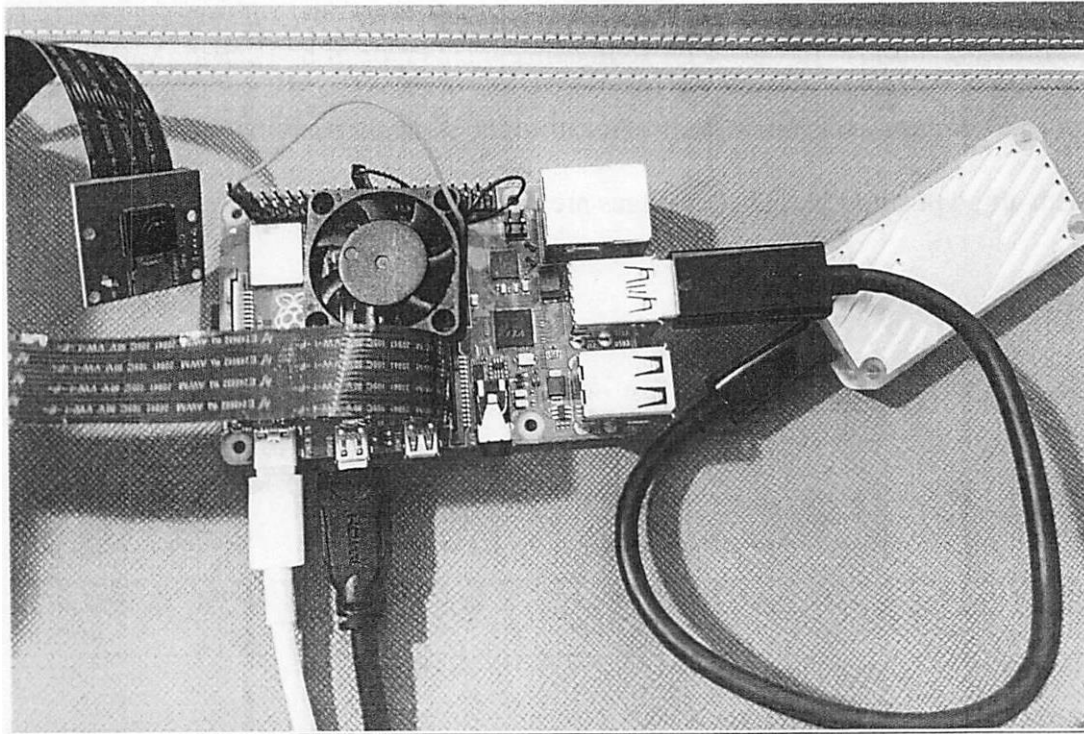


Figure 7: Hardware Layout

In the figure above, it is shown that the Raspberry Pi is connected to power via the 3-amp power supply and the Pi Camera is connected via a ribbon cable. The USB accelerator is connected to the Raspberry Pi via a USB-A to USB-C cable. The fan is connected to the 5V and ground pin on the Raspberry Pi and the Raspberry Pi is connected to the monitor via the Micro HDMI to HDMI cable.

Detailed Drawings

In this section, the schematic for the housing will be shown and described. After the housing was designed, it was 3D printed out of PLA. The housing is encasing the Raspberry Pi.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.) /"

fan, Coral USB, camera, and the camera ribbon cable. The full housing can be seen in the figure below.

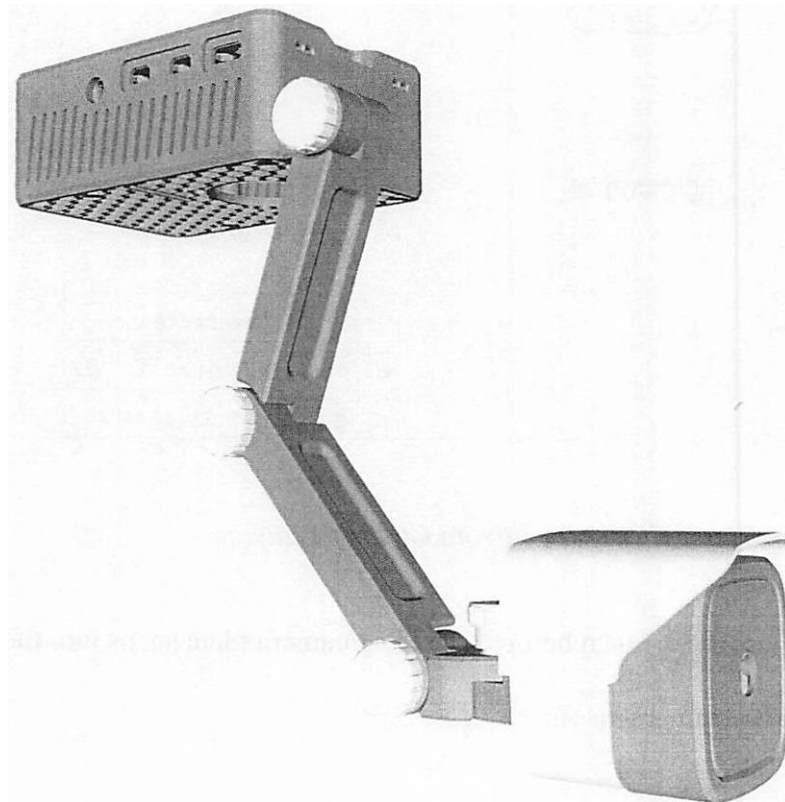


Figure 8: *Housing Design*

Listed below will be detailed drawing of the individual pieces of the housing. To start with we have the front camera plate. The Pi Camera snaps into place via the 4 pins that stick out on the inside. The lens of the camera sits in the whole in the center.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

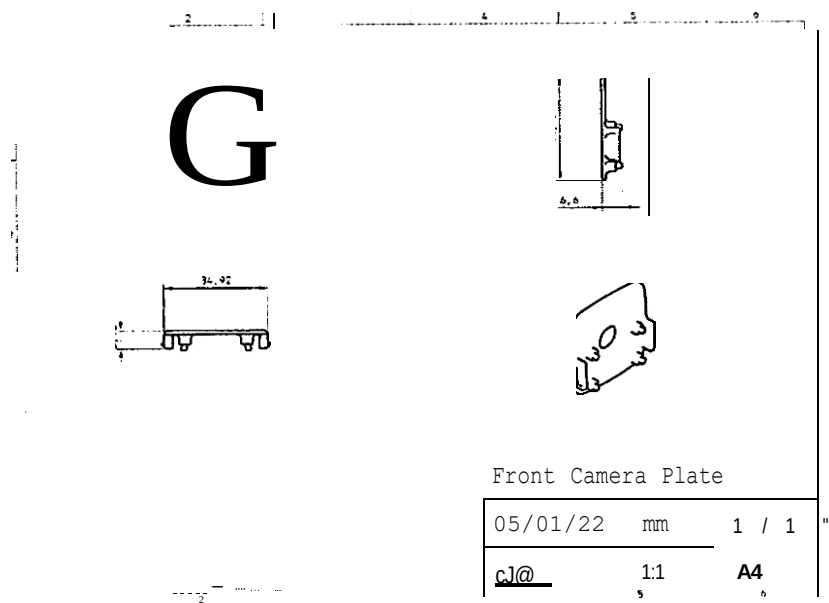


Figure 9.1: Front Camera Plate

The side camera cover is shown below. The front camera plate snaps into the side camera cover and his snaps into the camera visor.

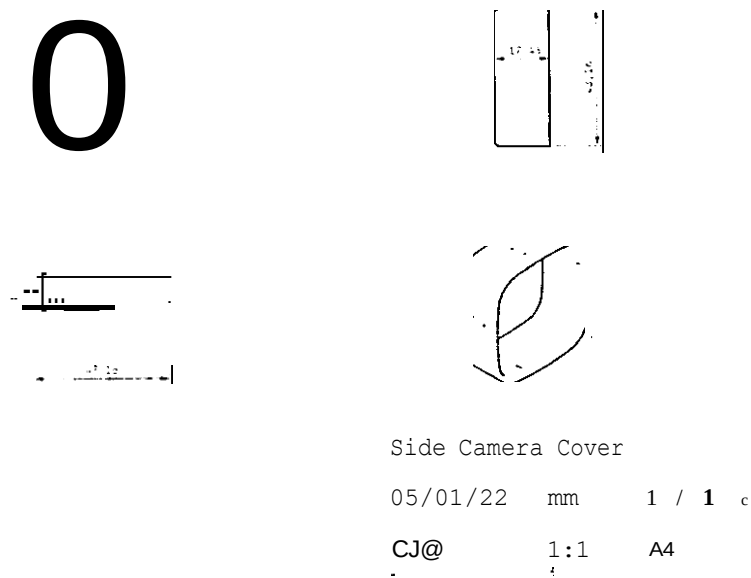


Figure 9.2: Side Camera Cover

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The camera visor is shown below. The visor snaps together with the side camera cover. There is a slot on the back to allow the ribbon cable of the camera to pass through as well as a larger slot that connects the back camera plate.

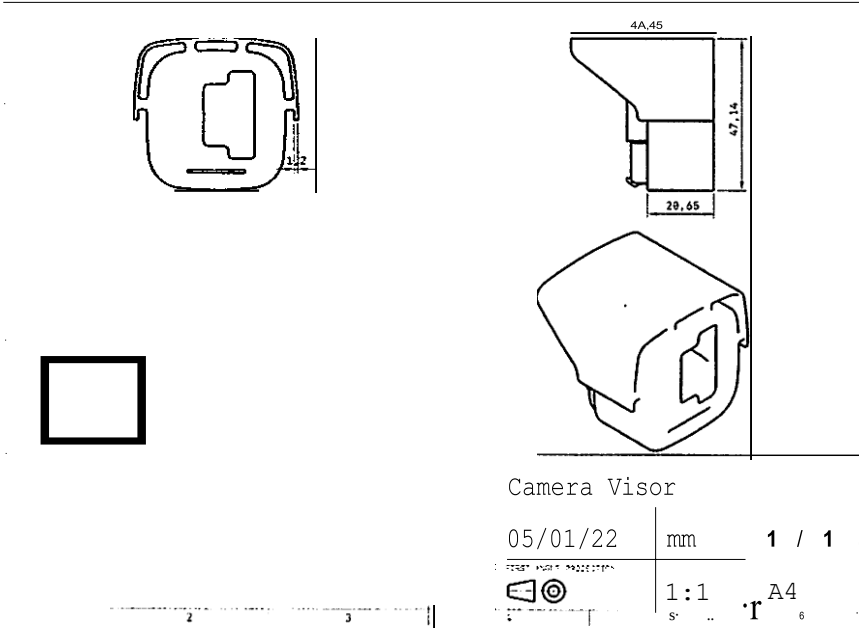


Figure 9.3: Camera Visor

The back camera plate is shown below. The interior side of the back camera plate has a notch that slides into the opening on the camera visor. There is a threaded hole to allow for a short screw attachment to the hinge.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

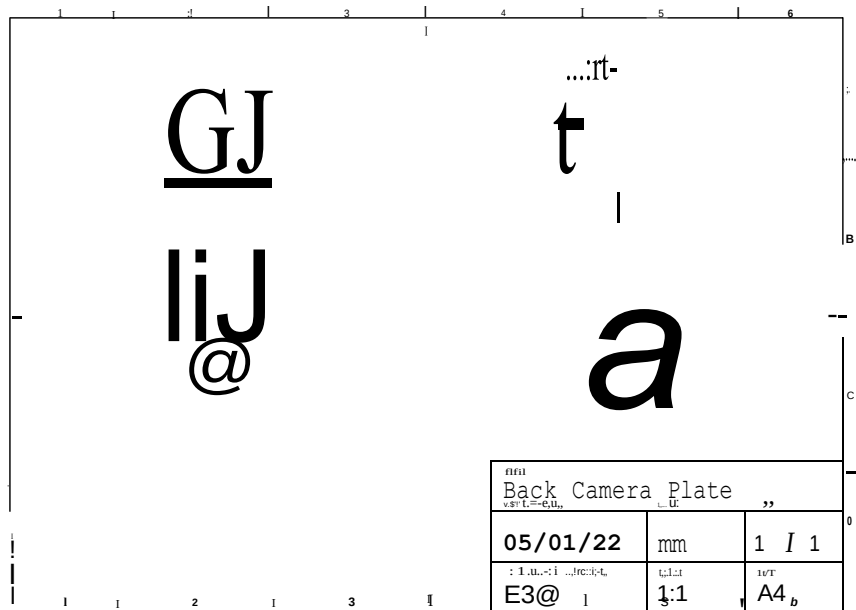


Figure 9.4: Back Camera Plate

The hinge is shown below. The hinge allows for the camera to pan left and right. The hinge is connected to the lower arm via a long screw.

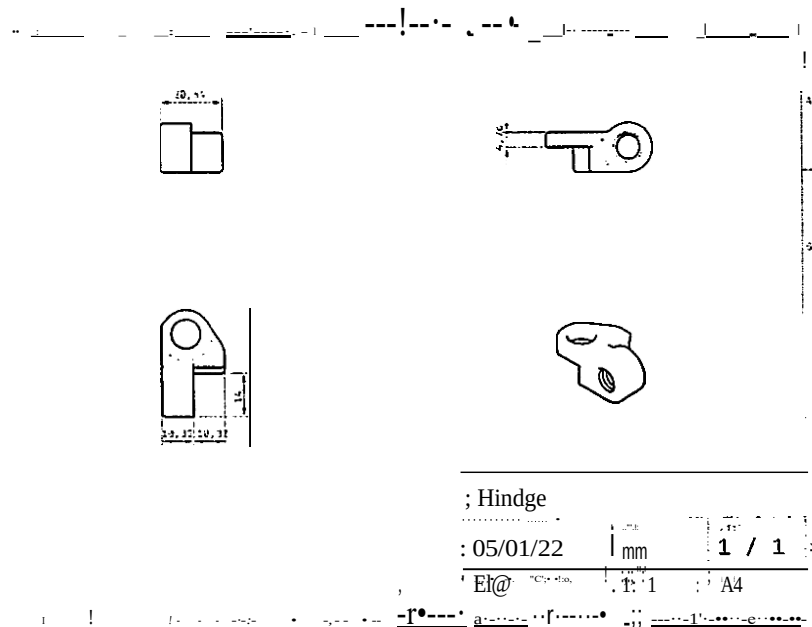


Figure 9.5: Hinge

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The lower arm and upper arm are identical and shown below. They are connected via 2 long screws at either end. They have a slit that allows for the ribbon cable to run through the interior of the arm.

I

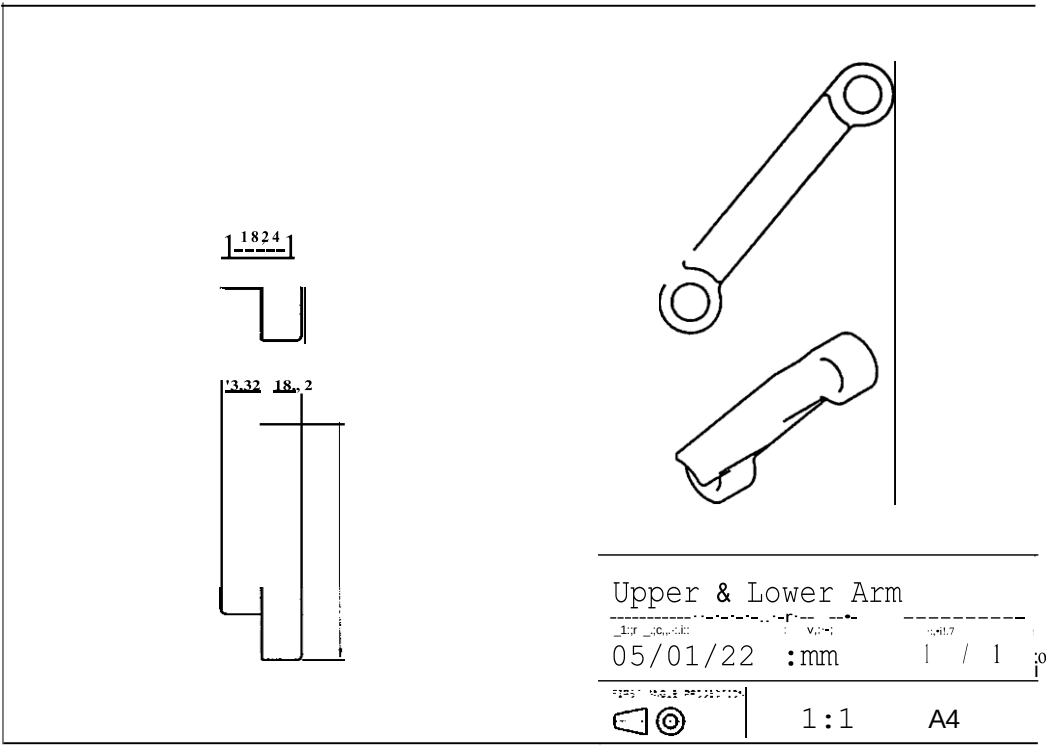


Figure 9.6: Upper & Lower Arm

The long and short screws are threaded the same way. The long screw is shown below. The short screw is $\frac{3}{4}$ the length of the long screw.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

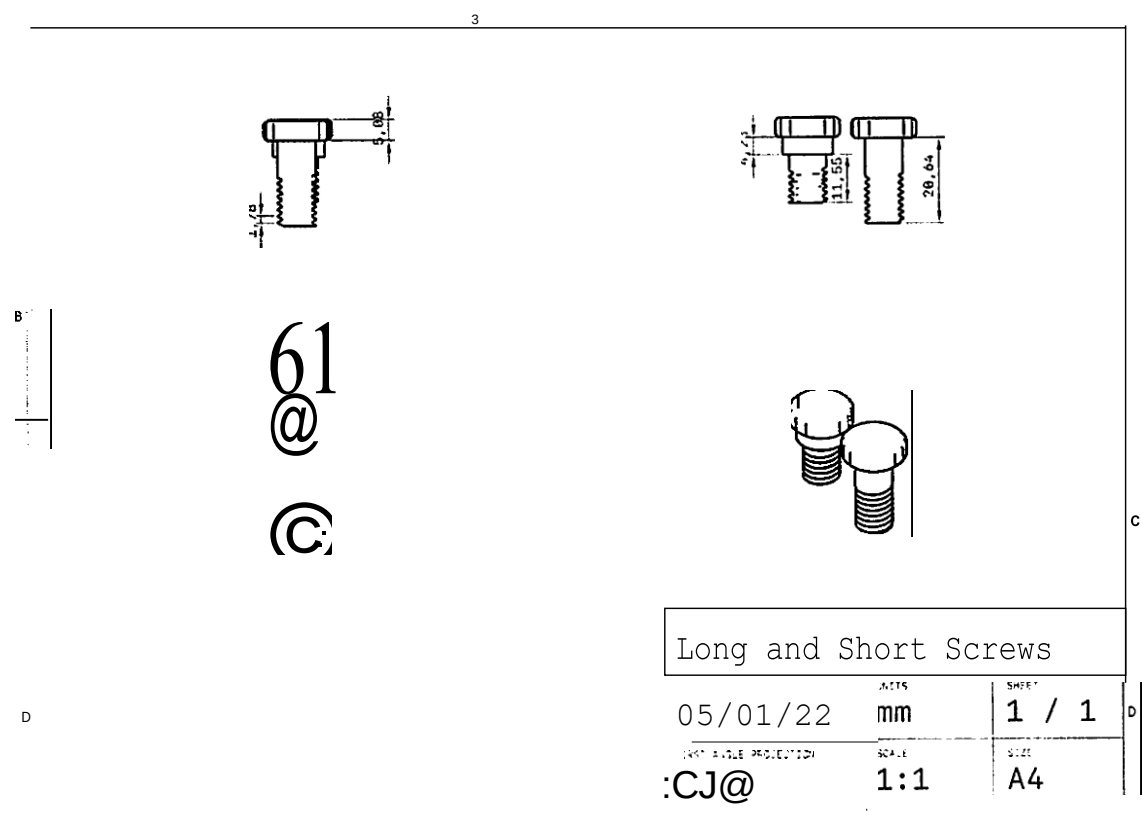


Figure 9.7: Long & Short Screws

The Raspberry Pi case top is shown below. It is the portion of the case that would face downwards if mounted to a ceiling despite being named the top. It has a cut out for the fan to sit on and has enough space to hold the Coral USB Accelerator. It also has a slit cut out for the camera ribbon cable and 3 large notches for the USB Ports and the Ethernet port. The hexagonal shape on the top and slits on the sides allow for adequate air flow as overheating used to be an issue.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

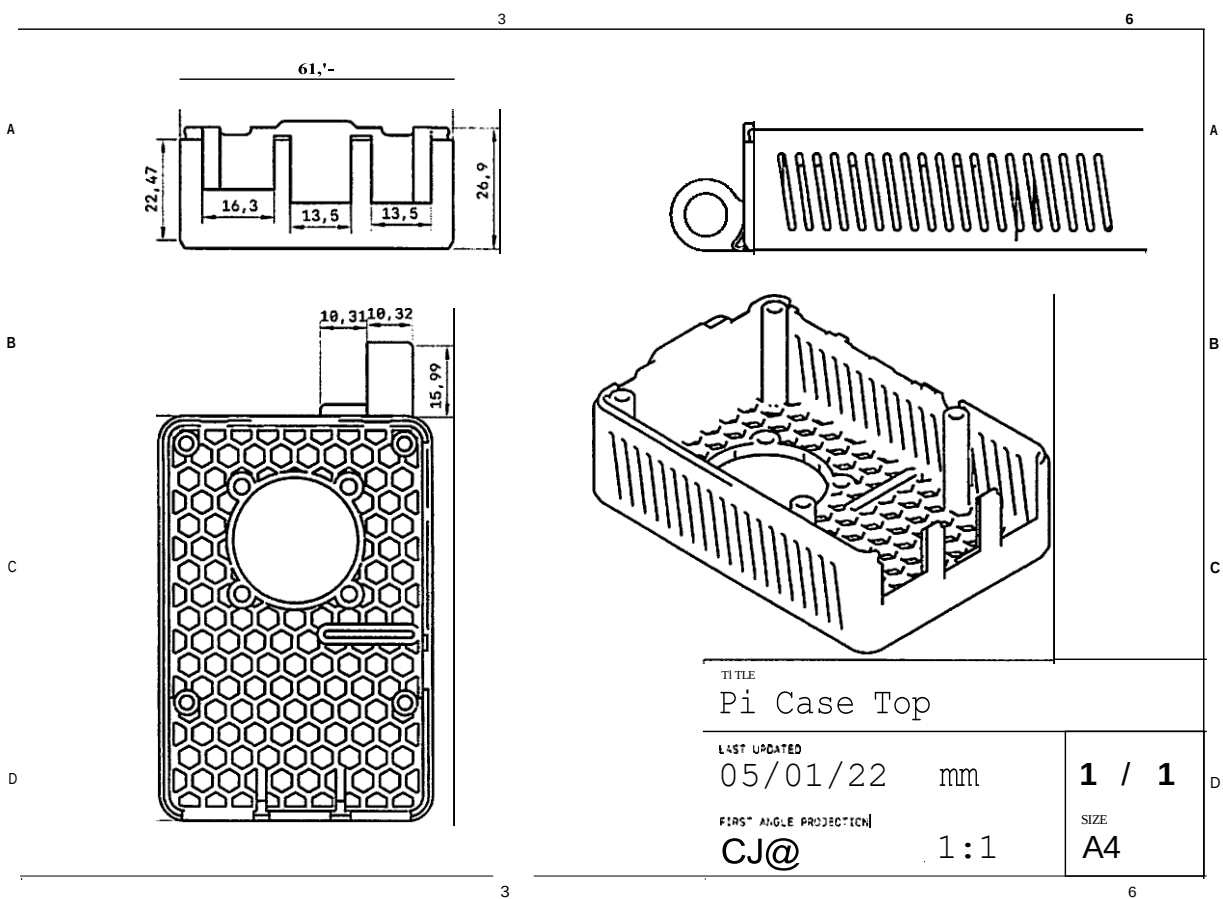


Figure 9.8: Pi Case Top

The Raspberry Pi case bottom can be seen below. It is the portion of the case that would be touching the surface in which the device is being mounted. The case has 4 cut outs for the power, HDMI ports, and the audio port. The two case pieces snap into one another with the Raspberry Pi, fan and Coral USB accelerator fixed in place on the inside.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

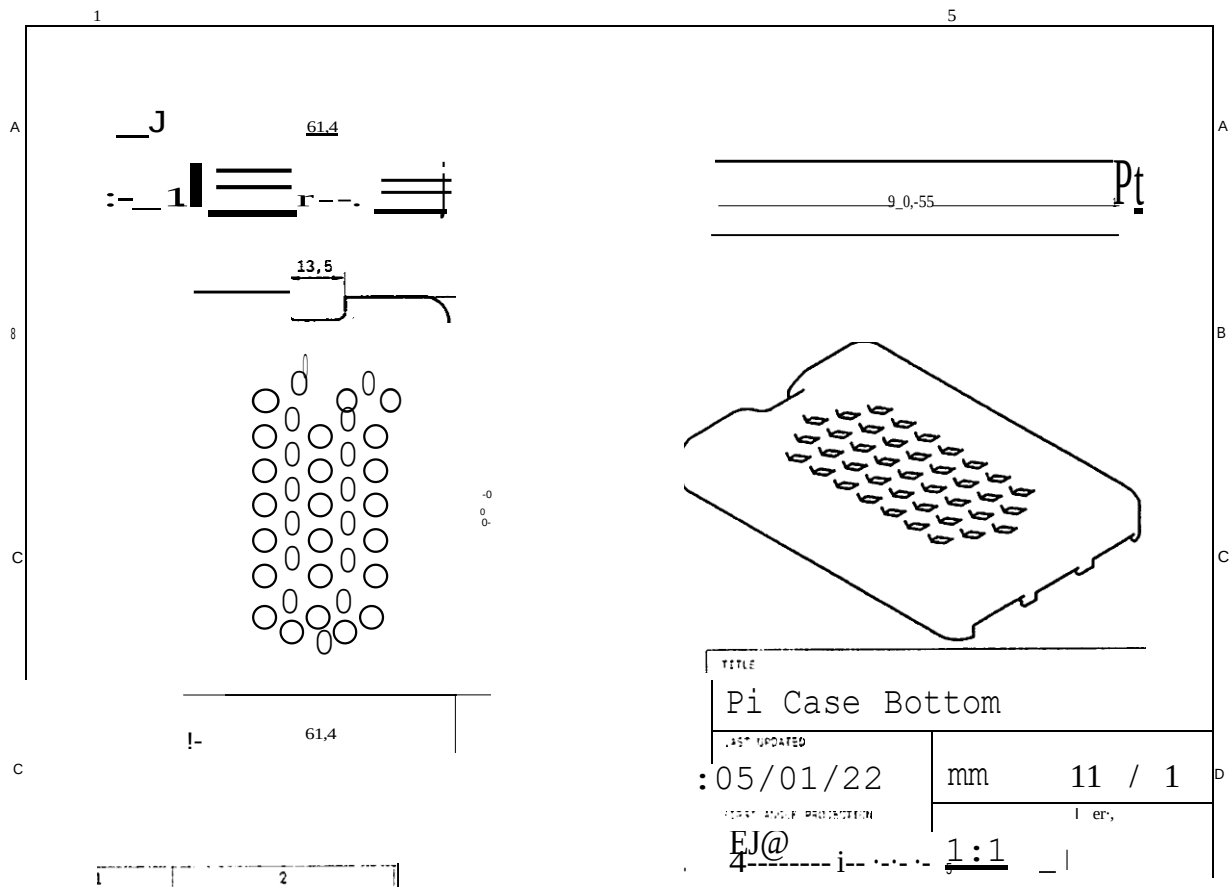


Figure 9.9: Pi Case Bottom

The parts are all 3D printed from PLA including the screws. This allows for the housing to be very lightweight.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

Equipment Selection and Specifications

The Raspberry Pi 4 Model B was selected due to it being the most up to date Raspberry Pi to be released. It has a much better performance than the other Raspberry Pi models. A LINPAC benchmark test showed that the Raspberry Pi 4 B almost tripled the score of the Raspberry Pi 3B+. The specifications of the Raspberry Pi 4 Model Bare shown in the table below.

Raspberry- 4 Model B	
Processor	Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Ram	8GB LPDDR4-3200 SDRAM (depending on model)
Wi-Fi/Bluetooth	2.4 GHz and 5.0 GHz IEEE 802.11ac wireless, Bluetooth 5.0, BLE
Ethernet Port	Gigabit Ethernet
USB Ports	2 USB 3.0 ports; 2 USB 2.0 ports.
GPIO	Raspberry Pi standard 40 pin GPIO header (fully backwards compatible with previous boards)
Display Ports	2 x micro-HDMI ports (up to 4Kp60 supported) 2-lane MIPI DSI display port
Camera Port	2-lane MIPI CSI camera port
Audio Port	4-pole stereo audio and composite video port
Video Encoder	H.265 (4Kp60 decode), H.264 (1080p60 decode, 1080p30 encode)
Graphics	OpenGL ES 3.1, Vulkan 1.0
Storage	Micro-SD card slot for loading operating system and data storage
Power	5V DC via USB-C connector (minimum 3A*) 5V DC via GPIO header (minimum 3A*) Power over Ethernet (PoE) enabled (requires separate PoE HAT)
Operating Temperature	0 - 50 degrees C ambient

Table 3.1: Raspberry Pi 4 Model B Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.))

The Raspberry Pi Camera was selected due to its easy compatibility with the Raspberry Pi 4 Model B. The specifications of the Raspberry Pi Camera are shown below.

Raspberry Pi Camera Rev 1.3	
Still Resolution	5 Megapixels
Video Modes	1080p30, 720p60 and 640 x 480p60/90
Linux Integration	1080p30, 720p60 and 640 x 480p60/90
C Programming API	OpenMAX IL and others available
Sensor	OmniVision OV5647
Sensor Resolution	2592 x 1944 pixels
Sensor Image Area	3.76 x 2.74 mm
Pixel Size	1.4 μ m x 1.4 μ m
Optical Size	1/4"
Full-frame SLR Lens Equivalent	35 mm
S/N Ratio	36 dB
Dynamic Range	67 dB @ 8x gain
Sensitivity	680 mV/lux-sec
Dark Current	16 mV/sec@ 60 C
Well Capacity	4.3 Ke-
Depth of Field	approx. 1 m to infinity
Focal Length	3.60 mm +/- 0.01
Horizontal Field of View	53.50 +/- 0.13 degrees
Vertical Field of View	41.41 +/- 0.11 degrees
Focal Ratio (F-Stop)	2.9

Table 3.2: Raspberry Pi Camera Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.) .J

The Google Coral USB Accelerator was selected due to its easy compatibility with the Raspberry Pi 4 Model B. This device aided in increasing the frame rate by approximately 20 frames per second. The specifications of the Google Coral USB Accelerator are shown below.

Google Coral USB Accelerator	
ML accelerator	Google Edge TPU coprocessor: 4 TOPS (int8); 2 TOPS per watt
Connector	USB 3.0 Type-C* (data/power)
Dimensions	65 mmx30mm

Table 3.3: Coral USB Accelerator Specifications

The Raspberry Pi 4 Official Power Supply Unit was selected due to it being built specifically to meet the requirements for the Raspberry pi 4 Model B. The specifications of the Raspberry Pi 4 Official Power Supply Unit are shown below.

Raspberry Pi 4 Official Power Supply Unit	
Power	15.3-Watt output
Voltage	5.1-Volt output
Current	3.0-Amp output
Length	1.5-m cable

Table 3.4: Power Supply Specifications

The QVS Micro-HDMI to HDMI Cable was selected because it fit the Raspberry Pi 4 B and the monitor we used. The specifications of the cable are shown below.

QVS Micro-HDMI to HDMI Cable	
Supports	15W output
Length	2-m 1.8m, 3m, 5m, 10m
Connectors	HDMI 1.4b (Type A) to Micro-HDMI (Type B) Cable

Table 3.5: Micro-HDMI to HDMI Cable Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The Samsung 32GB EVO Plus UHS-I microSDHC Memory Card was selected due to it having enough storage capacity and a fast enough speed for the project. The specifications of the Raspberry Pi 4 Official Power Supply Unit are shown below.

Samsung 32GB EVO Plus UHS-I microSDHC Memory Card	
Card Type	microSDHC
Storage Capacity	32GB
Bus Type	UHS-I
Speed Class	10
UHS Speed Class	U1
Read Speed	Maximum: 95 MB/s
Write Speed	Maximum: 20 MB/s Minimum: 10 MB/s
Durability	10-year warranty, Temperature Extremes, Waterproof, X-Ray Proof, etc.
Operating Temperature	-13 to 105 °F (-20 to 40 °C)
Storage Temperature	-13 to 105 °F (-20 to 40 °C)
Wireless Capability	None

Table 3.6: microSD Card Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The Pi-FAN was selected due to its easy compatibility with the Raspberry Pi. The specifications of the Pi-FAN are shown below.

Pi-FAN	
Operating Voltage	5 Volts
Current	0.2 Amps
Motor	Brushless DC fan
Dimensions	30mm x 30mm x 8mm
Wire Length	3.25" 180mm
Weight	6.2g / 0.22oz

Table 3.7: Pi-FAN Specifications

The OVERTURE Polylactic (PLA) ACID Filament was selected due to its easy compatibility with the 3D printer that was used. It was also ideal for its biodegradability and was already readily available. The specifications of the OVERTURE PLA Filament are shown below.

OVERTURE Polylactic ACID Filament	
Diameter	1.75 mm diameter
Dimensional Accuracy	Accuracy+/- 0.03 mm
Material	Polylactic Acid (PLA)
Extrusion Temperature	190°C - 220°C (374°F~ 428 °F)
Heated Bed Temperature	1YT - 60 °C (77 F~ 110: T)
Color	Black

Table 3.8: Polylactic Acid Specifications

5.4 Overview of Code

There are three main portions of the code. The first section handles training the model to detect weapons. The second section contains everything that deals with the process of running the camera and detecting objects. The third section handles the logic behind how and when to send the notification. The main portions of these three sections will be explained below; however, to see the full-length code, see appendix page A2

Training the Model

When training the model, we used over 5000 images that we labeled as a specific category of weapon. These images became our dataset. The model is then trained on this data set by running the training executable. This code, along with instructions on how to configure the training job can be found in the appendix on page A8. This section calls many different files to aid in the training process. To summarize what is happening during training, the algorithm takes an image that looks at where the bounding box for the weapon is and looks for certain patterns and similarities throughout the various images.

Running the Camera

The code that runs the camera and weapon detection starts with the camera constraints. The dimensions of the camera must be defined because the bounding box location for the \Weapons is calculated using the image height and width. Below it is shown that the image width for our camera is 1280 and the height is 720.

```
IM_WIDTH  
IM_HEIGHT
```

Figure 10.1: Camera Dimensions

5.4 Overview of Code (continued)

The output of the model includes the detection boxes, scores, classes, and number of objects detected. In the figure below, these are seen as `detection_boxes`, `detection_scores`, `detection_classes`, and `num_detections`. The detection boxes give the coordinates of the top left and bottom right points of the bounding box. The score is the confidence level this is displayed as a percentage. The classes are the names of the object being detected and the number of detections keeps track of how many of the detected objects are in the view of the camera.

```
It Output tensors are the detection boxes, scores, and classes
Each box represents a part of the image where a particular object was detected
detection_boxes = detection_graph.get_tensor_by_name('detection_boxes:0', dtype=tf.float32)

# Each score represents its level of confidence for each of the objects.
# The score is displayed on the result image, together with the class label.
detection_scores = detection_graph.get_tensor_by_name('detection_scores:0', dtype=tf.float32)

detection_classes = detection_graph.get_tensor_by_name('detection_classes:0', dtype=tf.int32)
num_detections = detection_graph.get_tensor_by_name('num_detections:0', dtype=tf.int32)
```

Figure 10.4: Boxes, Scores, Classes, and Number of Boxes

The live value of the frame rate is calculated by checking the tick frequency. This is shown in the figure below. It is important to have the exact frame rate of the camera as this directly affects the speed at which the notification is sent.

```
frame_rate = 1 / (time.time() - start_time)

cv2.putText(image, 'Frame Rate: %f' % frame_rate, (10, 10), cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 255, 0), 2)
```

Figure 10.5: Frame Rate Calculation

5.4 Overview of Code (continued)

The model is run and uses each frame from the camera as its input. This code is shown below.

```
Perform the actual detection by running the model with the image as input
boxes scores classes num sess
detection_boxes detection_scores detection_classes num_detections
feed_dict image_tensor frame_expanded
```

Figure 10.6: Running Detection Model

The results from the detection model are displayed over the actual live footage from the camera. This is done by drawing the boxes, showing the classes, and updating the scores for each frame. The figure below demonstrates this process.

```
# Draw the results of the detection (aka 'visualize the results')
vis_util
    fig = plt.figure()
    np_boxes = boxes
    np_classes = classes
    np_scores = scores
    category_index = category_index
    use_normalized_coordinates = True
    line_thickness = 4
    plt.imshow(image)
```

Figure 10.7: Visualization of Results

Notification System

For our notification system, we used Twilio. To code in the Twilio information we first import the Twilio client. Then the account SID number, authorization number, the phone number of who needs to receive the notification, and the number the message is being sent from are all defined. In the figure below, it is shown where these values are defined as the specific variables: account_sid, auth_token, my_number, and twilio_number, respectively. The numbers are covered for privacy purposes.

5.4 Overview of Code (continued)

```
Set up Twilio  
t  
  
r11illo SID, authentication token, my_phone_number, a J t le Twilio phone number  
account_sid [REDACTED]  
auth_token [REDACTED]  
my_number [REDACTED]  
twilio_number '19352510045'  
  
count_sid .Jth o
```

Figure 11.1: Twilio Setup

The way the program knows when to send the notification is a series of "if" statements. It determines if a weapon is on the screen. The weapons are defined by their ID classes; 1 for rifle, 2 for handgun, 3 for knife, 4 for blunt object. A predetermined area of detection is defined if it is not wanted to detect weapons in the camera's full field of view. [f one of the weapons is located within that area for 300 frames, it sends the mcs.;;age .. A weapon has been detected on your camera.. to the numbers previously defined. The program then pauses for a set amount of time to prevent messages being spammed. This can all be seen in the snapshot of the code below.

```
in: IM_WIDTH  
IM HEIGHT
```

Figure 11.2: SJIS Notifirntion Execution

5.5 Application of Engineering Codes and Standards used in Final Design /

The following IEEE Codes and Standards were used in the final design of our project:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision -This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

5.6 Economic Analysis

The economic analysis of our project can be separated into two phases. There were different components that were used in each phase which we will outline below. During phase one we were given the parts that we needed to start a preliminary design of our project. The parts that we used in our phase one design were given to us by the school and can be seen in table 4.1.

Item Name	Quantity	Total
Raspberry Pi 3b+	1	Pre-owned
Raspberry Pi Camera Rev 1.3	1	Pre-owned
	Total:	\$0

Table 4.1: Phase 1 Cost

After completing the testing of phase one with the given parts, we were able to identify which parts needed updating and investigate ways that we can improve our design. We needed to update our Raspberry Pi 3b+ to the Raspberry Pi 4b which is a more powerful and faster model, we also upgraded our MicroSD card so that our Raspberry Pi can hold more storage. Another upgrade to our project was the addition of the Google Coral Accelerator, which increases the frame rate of our camera and video processing. To connect the Raspberry Pi 4b to a monitor and observe an area we had to purchase a Micro HDMI to HDMI cord. The updated cost of our project can be seen in table 4.2.

Item Name	Quantity	Total
Raspberry Pi 4b	1	\$134
Raspberry Pi Camera Rev 1.3	1	Pre-owned
Google Coral USS Accelerator	1	\$174.58
Micro HDMI to HDMI cord	1	\$16.95
Micro SD card	1	\$20
	Total:	\$345.53

Table 4.2: Snzun Threar Dt'fection System Cost

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 12.1 - 12.3 depict a rifle being detected by our camera. The yellow box and word "rifle" are specific to that class of weapon. In various orientations, including partially covered, the rifle is detected with remarkably high confidence.



Figure 12.1: Rifle Detected with 95% Confidence

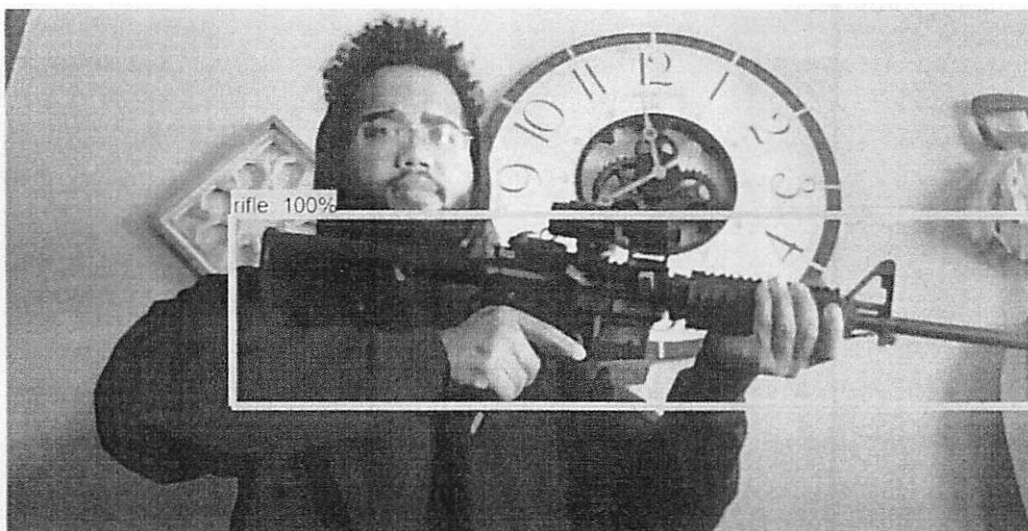


Figure 12.2: Rifle Detected with 100% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

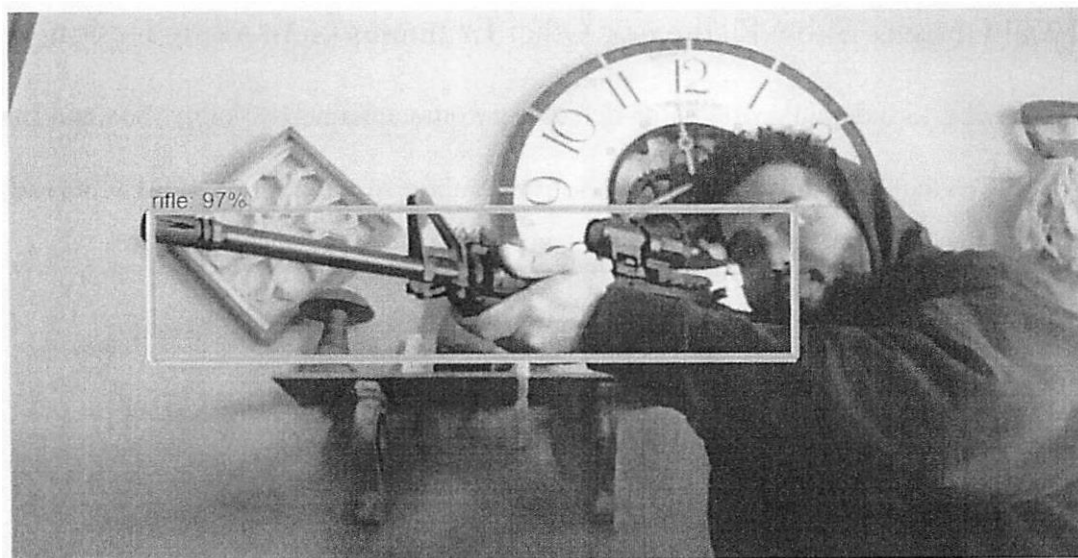


Figure 12.3: Covered Rifle Detected with 97% Confidence

Figures 13.1 - 13.5 below depict a handgun being detected by our camera. The green box and word "handgun" are specific to that class of weapon. In various orientations, including the barrel pointed towards the camera and a black gun on a black background, the handgun is detected with high confidence.

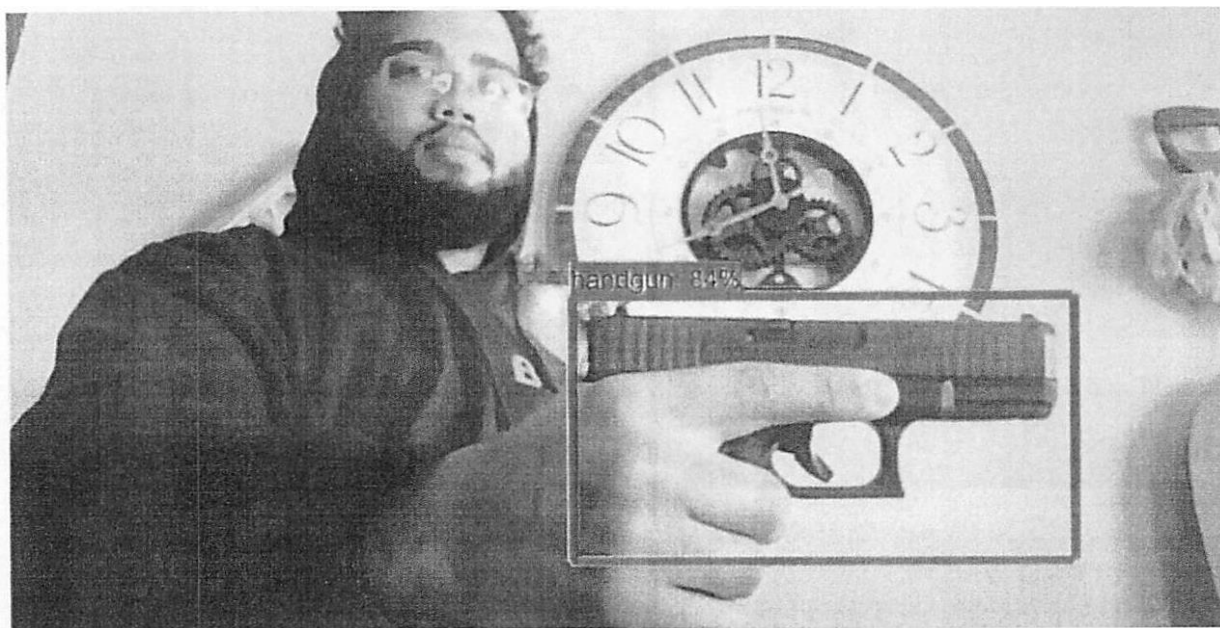


Figure 13.1: Handgun Detected with 84% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

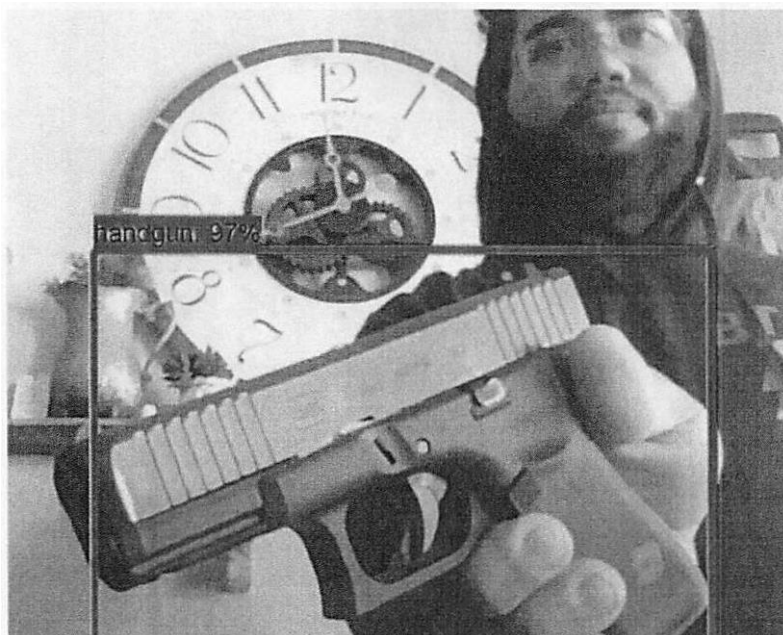


Figure 13.2: Handgun Detected with 97% Confidence

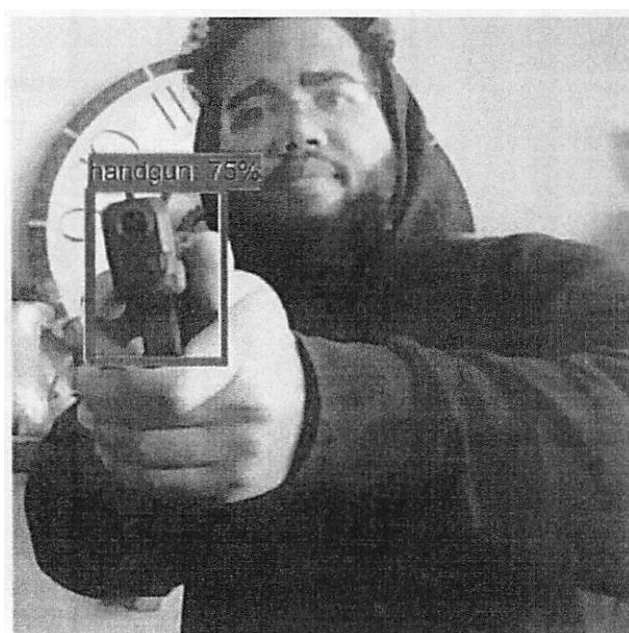


Figure 13.3: Barrel Pointed at Camera Detected with 75% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

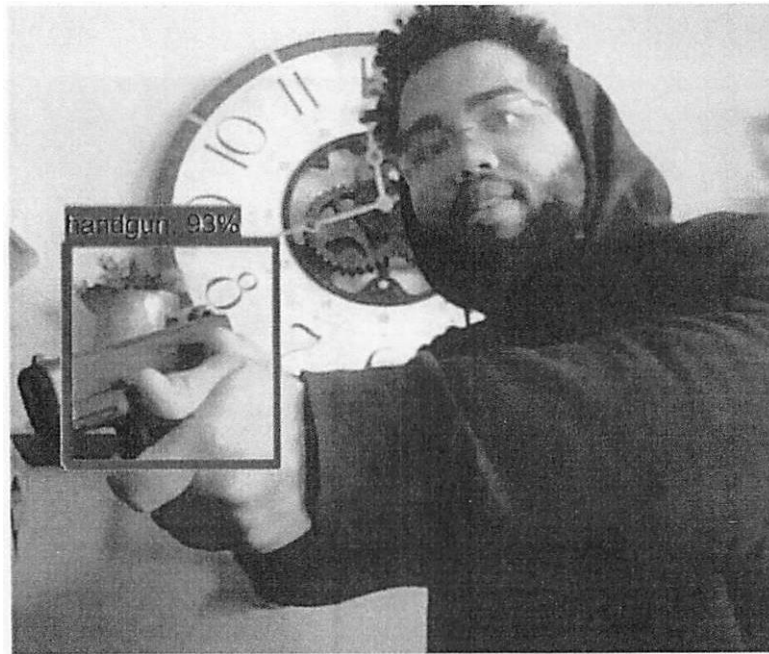


Figure 13.4: Partially Colored Handgun Detected with 93% Confidence



Figure 13.5: Black Handgun Detected with 99% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 14.1 - 14.3 below depict a blade being detected by our camera. The greenish yellow box and word "blade" are specific to that class of weapon. The blade is detected with high confidence. However, the algorithm is less than 60% confident in categorizing the blade when its narrow profile is facing the camera. Objects with a confidence level less than 60% are not displayed on the screen.

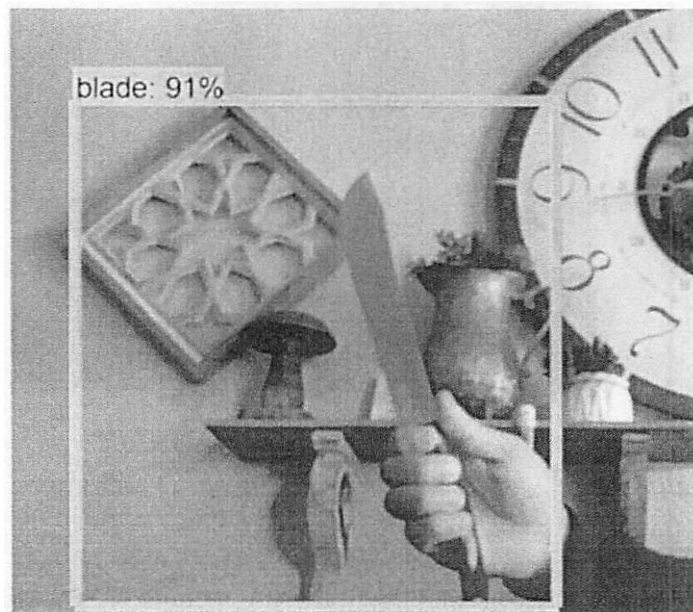


Figure 14.1: Blade Detected with 91% Confidence

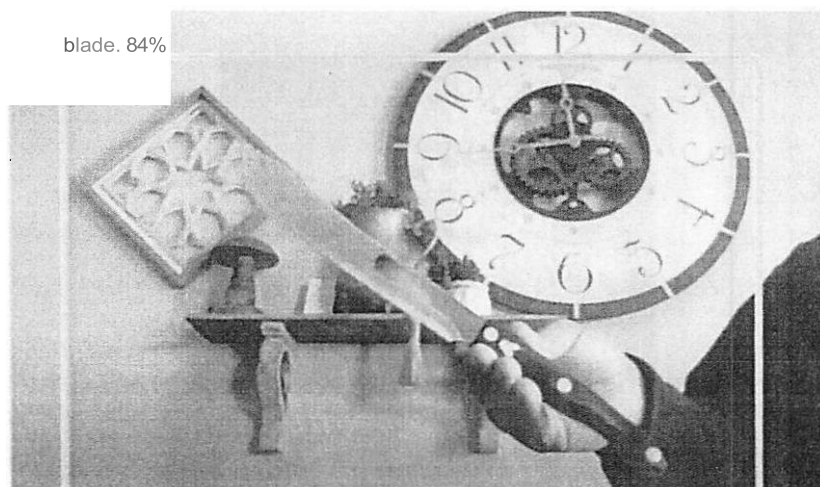


Figure 14.2: Blade Detected with 84% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design



Figure 14.3: *Narrm, Pnfile of Blade 110! Detected*

Figure 15 shows an example of what the notification could read when a weapon is detected. The 'Sent from your Twilio trial account' portion does not appear when the small messaging fee is paid.

Today 7:59 PM

Sent from your Twilio
trial account - A
weapon has been
detected on your
camera!

Figure 15: *Example Norificatioll*

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 16.1 & 16.2 demonstrate how the algorithm does not accidentally depict a similar looking object as a weapon. In this case, the phone is being held in a way a handgun would be held and no box is ever displayed. This shows that there are very few false positives.

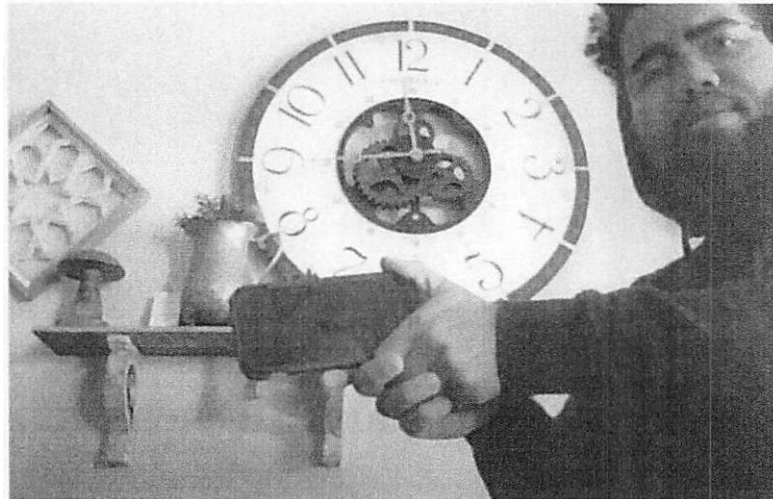


Figure 16.1: Cell Phone False-Positive Test (part 1)



Figure 16.2: Cell Phone False-Positive Test (part 2)

Section 6 - Results and Discussion

6.1 Summary of Goals and Objectives

The main objective was to implement object detection onto Raspberry Pi. We ran a mobile deep learning model, SSD-MobileNet, on Raspberry Pi to detect various objects. Our experimental results demonstrated the effectiveness of this implementation. Moreover, the ongoing work was to extend this implementation to weapon detection, which was used to detect different weapons in a real-time manner. Upon completing and validating this extension in different testing scenarios our results were successful. In order to complete the smart security system a notification system was integrated into the object detector once the new categories of objects were trained to be detected. This ensured that once a weapon was detected in the frame a text notification was sent to the appropriate authorities warning them of the potential threat.

6.2 Summary of Constraints and Codes met by Design

The main constraints we have observed with this project are creating a durable housing kit for the raspberry pi with a mountable camera that is capable of staying in place for an extended duration of time. The next constraint was the camera resolution impacting the accuracy of the weapon detection, as well as the distance that the camera is able to view, to fix this having a camera that has a minimum resolution of 1080p will ensure a clear quality to have the highest accuracy. The final notable constraint with our project was the frame rate of the real time tracking with the raspberry pi. Due to the severity of this issue we needed to increase the frame rate of the hardware, and after thorough research on how to solve the issue, the best solution to the situation was changing our software to TFlite and quantizing the data as well as utilizing a USB accelerator device in order to aid in speeding up the frame rates of the overall system.

The following codes were used in our final design:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision - This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology

6.2 Summary of Constraints and Codes met by Design

for software Based Intelligent Process Automation

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IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

6.3 Discussion of Results and Other Use Cases

This project allowed us to design a completely unique security system by utilizing a machine learning algorithm capable of detecting weapons and immediately notifying the owner of the potential danger that is within the area. Designing this system granted us the opportunity to offer a more advanced security system to consumers at a lower cost compared to competitors. Machine learning has not been introduced to security systems easily and with the introduction of our device, we would be offering a continuously learning security system that will offer greater results as time goes on while also being capable to notify the owners of the home or establishment of a potential threat.

The use of this system can be expanded into being capable of finding concealed weapons with the implementation of an infrared camera, with this feature the number of areas this system would be able to be set up will drastically increase due to the uncertainty of if there is a weapon on a person. Taking into consideration that weapon detection is a specialization of object detection, the other uses of object detection can be implemented into several types of trackers, such as a people tracker, a vehicle tracker, or even an animal tracker. These would also easily be able to be used to notify when any object, not just a weapon, is detected in a certain area.

Section 7 - Conclusions and Recommendations

Section 7 - Conclusions and Recommendations (continued)

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It is observed that a large population reconciles violence related to various weapons such as guns and knives all over the world. Therefore, it is a good proactive solution to detect these weapons in public areas to defend against this violence. Our Weapon Detection on Raspberry Pi design identifies active threats by revealing displayed weapons. These weapons can be either a rifle, a handgun, or a blade and the weapon must be in view of the camera. Our alert notification system provides additional time for actions to be taken to minimize casualties.

We recommend having a mountable dry surface for the Raspberry Pi platform. Wi-Fi and or data service are needed for text notifications. Electricity to run power to the Raspberry Pi system is also required. In the event of power failure, the possibility of having a backup generator is convenient to prevent system interruption. This artificially intelligent threat detection system will impact many from universities and church organizations to businesses and homeowners.

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Appendix

Code to Run Camera and Send Notification:

```
##### Webcam Object Detection Using TensorFlow-trained Classifier #####
"""
# Description:
# This program uses a TensorFlow-trained classifier to perform object detection.
# It loads the classifier and uses it to perform object detection on a webcam
feed.
# It draws boxes, scores, and labels around the objects of interest in each frame
# from the webcam.

# Import packages
import ctypes
import os
import
import  as np
import  as tf
import sys

# This is needed since the notebook is stored in the object_detection folder.
sys.path

# Import utilites
from utils import label_map_util
from utils import visualize_objects Explain why this would be the case and the benefits of
such an
implementation? Do you expect the performance of suboptimal choice of the
parameter triplet
to dramatically impact the link throughput performance?
from utils import visualize_objects

;; set up %utilio
from  import
```



```
# Twilio SID, authentication token, my phone number, and the Twilio phone number
account_sid , 'AG7Ei4e@&9J-9-f94e€•3b3r::+rJfb+7a8fl£1434'
auth_token , '-4% oo+-2:@8- -=14b99b-fb33-:ie &e-E-E-1-&e-
my_number , '+5428-5-1+@2_:-
twilio number , '19362510045'
```

```
client ,,, ,: : \, -i, ,: account_sid, auth_tol<en:
```

```
## get Screen Size
user32, ctypes.windll.. --
screen_width, screen_height , user32 , 0:
user32. '1:: , , [1,
frame_height, frame_1,,,idth
```

```
scale •Jidth float screen width .float frame_width.
scaleHeight float screen_height float frame_height
```

```
if scaleHeight scaleWidth
    i.ir gscale s ca le •Jid th
```

```
else
    imgScale| sc::lerieight
```

```
newX newY imgScale| imgScale|
frame cv2 int n2,,,: int n2..Y
WINDOW_NAME all Integration|
```

```
;; Set up cam2r-a cc,-;stants
H•U,JIDTH
IM_HEIGHT
```

```
# Name of the directory containing the object detection module we're using
MODEL_NANE
```

```
,,, Grab path to current ,,,orking d ir'2C tory
Cli•ID_PATH os
```

Path to folder detection graph .co file, contains the that is used

r

t

Appendix (cont.)

```
# for object detection.
PATH_TO_CKPT, os.path.join(GD_PATH, MODEL_NAME, 'frozen_inference_graph.pb') :
```

```
# Path to label map file
PATH_TO_LABELS = os.path.join(CWD_PATH, 'training', 'labelmap.pbtxt')
```

```
# Number of classes the object detector can identify
NUM_CLASSES = 4
```

```
## Load the label map.
# Label maps map indices to category names, so that when our convolution
# network predicts '5', we know that this corresponds to 'king'.
# Here we use internal utility functions, but anything that returns a
# dictionary mapping integers to appropriate string labels would be fine
label_map_util.load_label_map(PATH_TO_LABELS)
categories = label_map_util.get_category_dict(label_map_util)
max_num_classes = NUM_CLASSES
use_display_name = True
category_index = label_map_util.create_category_index(categories)
```

```
# Load the TensorFlow model into memory.
```

```
detection_graph = tf.nn.Graph()
with tf.Session(graph=detection_graph):
```

```
    od_graph_def = tf.nn.Graph()
    with tf.Session(graph=od_graph_def):
        # Load the model
        serialized_graph = tf.nn.Graph()
        od_graph_def.ParseFromString(serialized_graph.SerializeToString())
        tf.nn.Graph().AddOperation(od_graph_def.Operation(0))
```

```
tf.nn.Graph().AddOperation(od_graph_def.Operation(0))
```

Define input and output tensors (i.e. data) for the object detection classifier

```
Input tensor is the image
image_tensor = detection_graph.get_tensor_by_name('input_image_tensor:0')
```

```
# Output tensors are the detection boxes, scores, and classes
```

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Appendix (cont.)

```
# Each box represents a part of the image where a particular object was detected
detection_boxes = detection_graph.get_boxes()
fig = plt.figure()
ax = fig.add_subplot(1, 1, 1)
ax.imshow(image)
ax.set_title('detection_boxes:{}'.format(detection_boxes))
```

```
# Each score represents level of confidence for each of the objects.
# The score is shown on the result image, together with the class label.
detection_scores = detection_graph.get_scores()
detection_classes = detection_graph.get_classes()
fig = plt.figure()
ax = fig.add_subplot(1, 1, 1)
ax.imshow(image)
ax.set_title('detection_scores:{}'.format(detection_scores))
ax.set_title('detection_classes:{}'.format(detection_classes))
```

```
# Number of objects detected
num_detections = detection_graph.get_num_detections()
fig = plt.figure()
ax = fig.add_subplot(1, 1, 1)
ax.imshow(image)
ax.set_title('num_detections:{}'.format(num_detections))
```

```
#### Initialize other parameters #####
```

```
# Initialize frame rate calculation
frame_rate_calc = 0
freq = cv2.FONT_HERSHEY_SIMPLEX
font = cv2.FONT_HERSHEY_SIMPLEX
```

```
;; Define inside box coordinates (top left and bottom right)
iL inside = int(IM_WIDTH * 0.46)
iR inside = int(IM_WIDTH * 0.54)
jL inside = int(IM_HEIGHT * 0.25)
jR inside = int(IM_HEIGHT * 0.75)
```

```
# Define outside box coordinate5 (top left and bottom right)
#TL_outside = (int(IM_WIDTH * 0.46), int(IM_HEIGHT * 0.25))
#tR_outside = (int(IM_WIDTH * 0.54), int(IM_HEIGHT * 0.75))
```

```
Initialize control variables used for weapon detector
iL = 0
iR = 0
jL = 0
jR = 0
detected_outside = False
```

```
inside_counter = 0
outside_counter = 0
```

```
pause = 0
counted = 0
```

```
# Initialize frame rate calculation
```

AS


```

frame_rate_calc 1
freq cv2 ,..; ...
font cv2

# Initialize webcam feed
video_, cv2 ,..j_!?:r.<!\pi!...,i::0
ret " video,:-::< i_3 1280_
ret ° video.-:-:: _4_,720;

def (frame.:

    # Use globals for the control variables so they retain their value after
function exits
    global detected_inside
    global inside_counter
    global pause pause_counter

    frame_expanded np frame axis (

-1hile Trlle

    # Acquire frame and expand frame dimensions to have shape: [1, None, None, 3]
    # i.e. a single-column array, where each item in the column has the pixel RGB
value
    ret Frame video
    frame_rgb cv2 frame cv2
    frame_expanded np frame_rgb axis

    # Perform the actual detection by running the model with the image as input
    boxes scores classes num sess
    detection_boxes detection_scores detection_classes detections
    feed_dict image_tensor frame_expanded

    # Draw the results of the detection (aka 'visulaize the results')
vis_util

```

```

np.ndarray, dtype=np.int32, shape=(1, 1, 1, 1), boxes
np.ndarray, dtype=np.int32, shape=(1, 1, 1, 1), classes
np.ndarray, dtype=np.int32, shape=(1, 1, 1, 1), scores
category_index
use_normalized_coordinates True.
line_thickness 3
min_score_thresh, 0.58\

# Draw boxes defining "outside" and "inside.. locations.
#cv2.rectangle(frame, TL_outside, BR_outside, (255, 20, 20), 3)
#cv2.putText(frame, "Outside #box", (TL_outside[0]+10, TL_outside[1]-
10), font, 1, (255, 20, 255), 3, cv2.LINE_AA)
cv2.imshow('frame', frame)
cv2.waitKey(1)
cv2.destroyAllWindows()
cv2.imshow('frame', frame)
cv2.waitKey(1)
cv2.destroyAllWindows()
cv2.imshow('frame', frame)
cv2.waitKey(1)
cv2.destroyAllWindows()

# Check the class of the top detected object by looking at classes[0][0].
# If the top detected object is a weapon (1-4)
# find its center coordinates by looking at the boxes[0][0] variable.
# boxes[0][0] variable holds coordinates of detected objects as (ymin, xmin,
ymax, xmax)

if int(classes[0][0]) == 1 or int(classes[0][0]) == 2 or
int(classes[0][0]) == 3 or int(classes[0][0]) == 4:
    x = int(boxes[0][0] + boxes[0][2]) / 2
    y = int(boxes[0][1] + boxes[0][3]) / 2
    # Draw a circle at center of object
    cv2.circle(frame, (x, y), 10, (255, 255, 255), 2)
    # If object is in inside box, increment inside counter variable
    if x > TL_inside[0] and x < BR_inside[0] and y > TL_inside[1] and
y < BR_inside[1]:
        inside_counter = inside_counter + 1

if inside_counter == 3:
    detected_inside = True
    message = "Weapon detected"
    body = "Weapon detected"
    from_twitter_number = "123456789"
    to_twitter_number = "987654321"

    inside_counter = 0
    outside_counter = 0
    # Pause weapon detection by setting 'pause' flag
    pause = True

```



```

# All the results have been drawn on the frame, so it's time to display it.
cv2.imshow('Object detector' frame)

# Press 'q' to quit
if cv2.waitKey(1) >= ord('q'):
    break

#Cleanup
cv2.destroyAllWindows()

```

Code for the Training of the Model

1) Training executable for detection models.

This executable is used to train DetectionModels. There are two ways of configuring the training job:

1) A single pipeline_pb2.TrainEvalPipelineConfig config file can be specified by --pipeline_config_path.

Example usage:

```

./train.py \
  --logtostderr \
  --train_dir=path/to/train \
  --pipeline_config_path=

```

Three configuration files can be provided: a model_pb2.DetectionModel configuration file to define what type of DetectionModel is being trained, an input_reader_pb2.InputReader file to specify what training data will be used, and a train_pb2.TrainConfig file to configure training parameters.

```

--logtostderr \
--train_dir=pach/to/train_dir \
--model_config_path=model_config.pbtxt \
--train_config_path=train_config.pbtxt \
--input_config_path=train_input_config.pbtxt

```

```

import functools
import json

```

```

import os
import tensorflow as tf
from tensorflow import

```

```

from object_detection import object_detection_builder
from object_detection.builders import
from object_detection.builders import
from object_detection.builders import
from object_detection.builders import

```

```

tf
tf

```

```

flags = tf
flags = tf
flags = tf
flags = tf
master = '' 'Name of the TensorFlow master to use.'
task = 0 'task id'
num_clones = 1 'Number of clones to deploy per worker.'
clone_on_cpu = False
'Force clones to be deployed on CPU. Note that even if
set to False (allowing ops to run on gpu), some ops may
still be run on the CPU if they have no GPU kernel.'
worker_replicas = 1 'Number of worker-replica.'
replicas =
'pa_tasks' =
'Number of parameter server tasks. If None, does not use
a parameter server.'

```

```

directory =
(points and training summaries)

```

```

tf.nn

```

```

tf.nn

```


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```

model_builder.build
model_config:model_config.
is_training ;True.

def
    ,_config,:
    return dataset_builder.make_(*tf.nn.parallel
        dataset_builder.build(config)).get

create_input_dict_fn = functools.partial(
    input_config

env = json
: os.environ
' TF_CONFIG ' {} '
cluster_data = env.
'cluster'. None,
cluster_.. tf.L=-- ;_..
:.. :.. cluster_data if cluster_data else None
task_data = env. :.. = 'task'_ None.. or 'type'
'master'_.. 'index': 0'-
task_info = type.. 'TaskSpec' . object, , task_data

# Parameters for a single worker.
ps_tasks
worker_replicas
worker_job_name = 'lonely_worker'
task = 0
is_c1J.2/ True
master

if cluster_data and .. in cluster- c1ti
    t; Number of total ..-erker replicas include ..-orker"s and the "master".
    worker_replicas = cluster_data 'worker'
if cluster_data and 'ps' in cluster_data
    ps_tasks = cluster_data 'ps'

if worker_replicas == 1 and ps_L;sk...
    raise ValueError 'At least 2 workers are needed for distributed training.

if worker_replicas == 1 and ps_tasks
    Setup distributed training.
    tf
    tf
    cluster_protocol

```

```

if task_info.type == 'ps':
    server = server_factory(task_info)
    return

worker_job_name = '%s/task:%d' % (task_info.job_id, task_info.task_id)
task = task_info.task_id
is_chief = (task_info.task_id == 0)
master = server_factory(task_info)

graph_rewriter_fn = None
if 'graph_rewriter_config' in confs:
    graph_rewriter_fn = graph_rewriter_factory(confs['graph_rewriter_config'],
                                                is_training)

confs = {'graph_rewriter_config': graph_rewriter_config, 'is_training': is_training}

def create_input_dict_fn():
    model_fn = model_fn_factory
    train_config = train_config
    master = master
    task = task
    FLAGS = FLAGS
    worker_replicas = worker_replicas
    FLAGS = FLAGS
    ps_tasks = ps_tasks
    worker_job_name = worker_job_name
    is_chief = is_chief
    FLAGS = FLAGS
    graph_hook_fn = graph_rewriter_fn

if __name__ == '__main__':
    tf

```

ASSIGNMENTS FOR OUTCOME “2”

An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

**ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II
SPRING 2022
Instructor: VJ Turner & Sarhan Musa**

Title of Assignment

Final Written Report Used to Evaluate this Outcome

Outcome Measured Using this Assignment

Outcome 2

An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Check the engineering design characteristics related to this assignment

X	Involves identifying the specific needs to be met by defining/understanding the problem and developing plans for the project to satisfy the need
X	Involves conducting a review of the literature and performing preliminary design by generating alternative ideas/solutions and applying creativity
X	Involves performing detailed engineering design leading to specification and fabrication/selection of components for system being designed.
X	Involves consideration of one or more of the following (Please check those involved in this assignment.)
	Public health
	Safety and welfare
	Global factors
	Cultural factors
	Social factors
	Environmental factors
	Economic factors
X	Involves fabrication and testing of model or prototype

Brief justification of the suitability of assignment for the outcome

This section will demonstrate student ability to plan their project in detail and to demonstrate early analysis to delivery a preliminary project design.

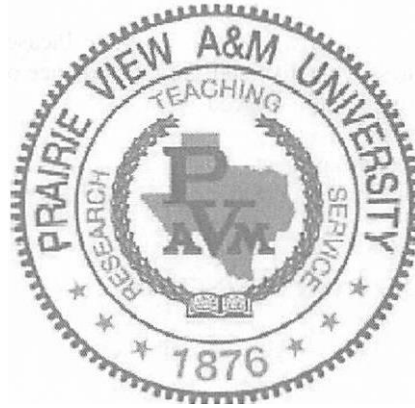
ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II

SPRING 2022

Title of Presentation: Outcome 2 – Produce Solutions						
Team Number and Members:						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Define/Understand and plan						
Able to identify the business case and the specific needs to be met by the design						
Able to identify and list the design objectives, customer/marketing requirements and constraints						
Able to develop a project management plan using, Gantt type charts - and break down work into tasks/ subtasks and identify the deliverables for each person. Also, establish milestones to track progress.						
Literature and perform preliminary design						
Able to identify and gather the types of information needed for a complete understanding of all aspects of the project						
Able to provide the sources in a list of references properly cited in the literature review section and relevant sections of the report and then define functional requirements						
Able to transform functional requirements into candidate solutions / and then able to evaluate candidate solutions to arrive at feasible designs.						
Detailed engineering design						
Able to perform relevant detailed analysis and to consider/ address issues relating to public health, safety, and welfare., global, cultural, social, environmental, and economic factors						
Able to develop final design specifications, select materials/components/software/test equipment and fabricate a prototype.						

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Senior Design & Professionalism II
ELEG4248

Final Exam Report

Due Date Sunday May 1 by 5:00pm (Central Time)

Upload to Final Exam Written Report Assignment On Canvas

Due date is firm: early is ok and late is (- 10 points)

Upload only a word document - do not upload a PDF or PowerPoint

This document will serve as your final exam report

Instructions:

- Avoid unexplained acronyms
- Word Document Only - No PDF or other formats
- There is no page limit and number all pages
- OK to use diagrams or pies but they must be explained clearly
- The formatting for this document must be precisely followed

Electrical and Computer Engineering Department

ELEG 4248 Senior Design II

Spring Semester

TABLE OF CONTENTS

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List of Tables and Graphs	v
List of Team Members and Roles	

1. PROJECT SCOPE Please Number All Pages

- 1.1 Problem Statement, Business Objective and Target Audience of your Project
- 1.2 Client identification and recognition of need
- 1.3 Project goals and objectives
- 1.4 Contemporary issues relevant to project
- 1.5 Potential impact of project on society (Safety, Env, Tech, Eco)
- 1.6 Initial Project constraints

2. PROJECT PLANNING AND TASK DEFINITION

- 2.1 Task identification
- 2.2 Gantt Chart - detailed chart not a high level summary

3. LITERATURE REVIEW

- 3.1 List of all sources of information
- 3.2 Statement of Learning from each source

4. PRELIMINARY DESIGN

- 4.1 Concept Generation - describe other designs you considered
- 4.2 Concept Evaluation and selection (evaluation other designs you considered/ selection criteria)
- 4.3 Design Constraints and Applicable Codes and Standards
Used in the Preliminary Design
- 4.4 Preliminary Analysis - must show the science/math
- 4.5 Preliminary Design

5. DETAILED SYSTEM DESIGN

- 5.1 Project Parts Summary
- 5.2 Engineering Analysis and/or Simulation must show the science/math
- 5.3 Hardware Layout/Detailed Drawings/Equipment selection
and specifications (Coding only projects replace Hardware with Software and skip 5.3.1)
- 5.3.1 Show Overview of Code Developed to Support 5.3 (only if you developed any code)
- 5.4 Application of Engineering Codes and Standards used in Final Design
- 5.5 Economic Analysis
- 5.6 Final Design - show pictures or other example of working design

6. RESULTS & DISCUSSION

- 6.1 Summary of Goals and Objectives - show design and compare final deliverables with original
- 6.2 Summary of Constraints and Codes met by Design - explain rate on codes/how you used in your project
- 6.3 Discussion of Results and Other Use Cases - results summary and address other risks/use cases

7. CONCLUSIONS AND RECOMMENDATIONS

LIST OF REFERENCES

APPENDIX (Include user manual or coding documentation if appropriate)

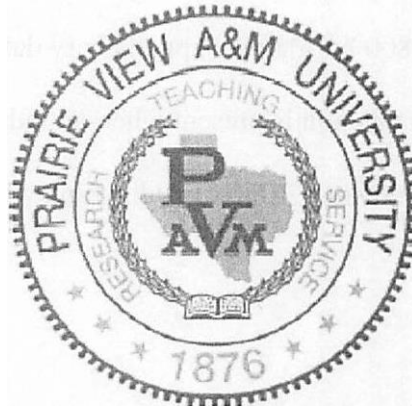
ITEMS in RED are Informational only - do not include the comments in red in your submission

Solution Productions Evaluation Form
ECE Senior Design & Professionalism
Outcome 2

Team 5 - Object Detection						
Joshua Littleton, Xavier Dukes, Arthur Quinney, Tri'Heem Neville, Christopher Rollerson						
Date of Presentation:						
Name Of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Define/Understand and plan						See Chapter 2 Project Planning & Task Definition
Able to identify the business case and the specific needs to be met by the design						See Chapter 2 Project Planning & Task Definition
Able to identify and list the design objectives, customer/marketing requirements and constraints						
Able to develop a project management plan using Gantt type charts - and break down work into tasks/subtasks and identify the deliverables for each person. Also, establish milestones to track progress.	/					
Literature and perform preliminary design						See Chapter 3 Literature Review and Chapter 4 Preliminary Design
Able to identify and gather the types of information needed for a complete understanding of all aspects of the Project	/					See Chapter 3 Literature Review and Chapter 4 Preliminary Design
Able to provide the sources in a list of references properly cited in the Literature review section and relevant sections of the report and then define functional requirements	./					
Able to transform functional requirements into candidate solutions/ and then able to evaluate candidate solutions to arrive at feasible designs.						
Detailed engineering design						See Chapter 5 Detailed Systems Design
Able to perform relevant detailed analysis and to consider/ address issues relating to public health, safety, and welfare, global, cultural, social, environmental, and economic factors						See Section 11.1.5
Able to develop final design specifications, select materials/components/software/test equipment and fabricate a prototype.	/					

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PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Object Detection on Raspberry Pi

ELEG 4247: Senior Design & Professionalism II

Topic: Final Report

Team Number 5

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Instructor: Professor Turner
Faculty Sponsor: Dr. Dong

Date of Submission: May 1, 2022

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Report
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Project Executive Summary

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Problem Statement

On average, approximately 4,800 burglaries happen every day. One-third of all robberies result in injury and 39% of the time a weapon is present when an individual is harmed. Arrest rates for Weapon offenses have doubled since 1965 including unlawful possession and trespassing.

Proposed Deliverables

We will be using a Raspberry Pi attached with a camera to survey the area and identify potential threats

The machine learning (ML) algorithm we implement detects the threatening objects on an individual such as weapons in real-time

Once an object defined as a threat is detected, a text notification is sent to the owner/operator's phone allowing them to determine the course of action

Budget

- The total budget for our project is \$600.00
- The total amount spent on our project is \$340.00

Project Executive Summary (continued)

Customer requirements And Engineering solutions

Mass producible by using easily obtainable/cost-effective parts

Lightweight parts for mounting purposes

Train machine learning algorithm to detect various weapons

The camera needs a resolution of 1080p for increasing the range of detection

Text notification alerts of potential threats

The algorithm classifies threats and non-threats

Detect threats in real-time

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Major Constraints

- The housing for the Raspberry Pi and camera must be mountable
- The camera resolution affects detection accuracy and distance
- The limited frame rate of the Raspberry Pi camera

Benefits

Societal: This project will offer greater security to those that cannot afford other options.

Businesses will be capable of guaranteeing the safety of customers without infringing upon a customer's 2nd amendment right to carry while within the public space.

Safety: The primary goal of this project is to create an affordable security system for small businesses and homeowners to proactively respond to potential threats however they see fit.

Technical: Machine learning has not been utilized within security systems to this day.

Our project will pioneer a smart security system that will inform you of potential dangers

Project Executive Summary (continued)

at the first sighting of a weapon that would provide a danger to security or the owner.

Recommendations

We recommend that the unit is mounted to a stable elevated surface, ensure there is nothing blocking the camera lens, make sure the Raspberry Pi is located in a well-insulated area to prevent overheating the unit, provide a power source for the Raspberry to connect to, and lastly to get the best usages of our product do not forget to set up a Twilio account for all alerts and notifications.

Conclusion

Our design will identify active threats by revealing displayed weapons. This artificial intelligent threat detection system will impact many from universities and church organizations to businesses and homeowners.

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List of Team Members and Roles

Joshua Littleton.....	Team Lead
Arthur Quinney.....	Parts Procurement Lead
Christopher Rollerson.....	Design Analysis Lead
Tri'Heem Neville.....	Scribe and Presentation Manager
Xavier Dukes	Software Developer

Section 1 - Project Scope

1.1 Problem Statement, Business Objective and Target Audience

Across the United States, a burglary happens every 15 seconds. This equates to a staggering 4800 burglaries a day on average. A burglary is defined as an unlawful entry of a structure to commit a felony or theft. Two-thirds of these burglaries affect residential properties while the remaining third affect small businesses. In 2020, 33,296 robberies involved a handgun, and an additional 8,641 involved a knife. A robbery can be more severe than a burglary, as it must involve threats or actual violence. Arrest rates for weapon offenses have doubled since 1965 including unlawful possession and trespassing. However, according to the U.S. Department of Justice, Bureau of Justice Statistics, a substantial portion of violent crimes that take place in homes have taken place during a burglary incident.

The goal of this project is to design an intelligent monitoring system that will enhance our ability to survey public and private spaces by using object detection to identify various threats that could potentially lead to security risks and/or bodily harm.

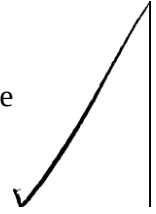
The target audience for this project is small businesses, homeowners, hospitals, schools/universities, and churches.

1.2 Client Identification and Recognition of Need

- i. The device should be mass-producible; to achieve this we plan to use easily obtainable parts that are cost-effective. Due to the target audience being homeowners and small businesses, we want to make this device available to everyone at a reasonable price.
- 11. The final product must be mountable and lightweight; this will be achieved by using lightweight materials and cheaper parts. This will ensure that it can be mounted on a wall for extended periods of time without any complications. The final product will be placed in conventional security camera locations, to survey the area.
- iii. This device must detect a variety of potential threats as weapons come in various shapes, sizes, and calibers. This is a perfect application for machine learning (M.L.) as there is not any set of definite rules to classify the myriad of types of weapons there are. The flexibility required for this particular use case lends itself very well to the use of artificial intelligence (A.I.).
- iv. The detection of potential threats at a distance is imperative to the preemptive Smart Detection System. A high degree of accuracy is required to minimize false positives. Poor resolution can affect accuracy and may not give an adequate warning since the potential threat will have to be closer to the camera when compared to a higher resolution camera. The camera will have a minimum resolution of 1080p to accomplish the goal of high accuracy, but we are also limited by the processing power of the Raspberry Pi.
- v. The device needs to be able to communicate with other devices such as a phone or monitor to deliver the alert notification system. A text message should be sent

1.2 Client Identification and Recognition of Need (continued)

immediately, via Twilio, to the home or business owner for appropriate action to be taken.



- vi. Object detection must be able to distinguish between a threat and a non-threat entity. The Raspberry Pi has limited processing power and should not waste valuable CPU power on low-risk or non-threatening individuals. The M.L. algorithm should focus on items that are deemed as potentially dangerous.
- vii. Real-time tracking is essential as the camera will give real-time data for the environment it is monitoring. The delay between the image processing and the time the data is received should be minimized for the most effective results. Raspberry Pis is particularly suited for real-time environments as they are often used in robotics due to their real-time clock (RTC) functionalities.

1.2 Client Identification and Recognition of Need (continued)

Marketing Requirements	Engineering Requirements	Justification
Mass Producible	Easily obtainable and cost-effective parts	Target audience is homeowners and small business owners
Mountable/Lightweight	Lightweight parts sturdy enough to be mounted for extended periods	Will be placed in conventional security camera locations
Detect a variety of potential threats	Train machine learning (M.L.) algorithm for weapon detection	Threats come in various forms, and this is an abstract problem with no clear formula. Requiring the flexibility of Artificial Intelligence
Detect potential threats at a distance	Camera has minimum resolution of 1080p	Poor resolution images are more difficult to decipher and can cause inaccuracies
Alert Notification System	Send an alert through a text message	Alerts the home/business owner of the potential threat near the camera
Distinguishable between threat and no threat	M.L. model will be trained to detect items deemed as threats	Camera's tracking will not focus on low-risk individuals and will dismiss them
Real Time Tracking	Use Raspberry Pi for its real time clock (RTC) capabilities	Raspberry Pi utilizes RTC which is essential for real time environments

Table I: Matrix

1.3 Project Goals and Objectives

The goal of this project is to design an intelligent monitoring system that will enhance our ability to survey both public and private spaces by using object detection to identify various threats. These threats could lead to security risks and or bodily harm. Utilizing machine learning (M.L.) within the Raspberry Pi, we will monitor and detect any potential threats and non-threats that would enter the surveyed area. Once an object is determined to be a threat, the homeowner or business owner will be alerted so that they may take action that they deem as necessary. The notification will be sent before any violent action takes place, making the system more proactive rather than reactive. The warning that is received is essential to the safety of the occupants of the property and any type of warning in a potentially dangerous situation can aid in the mitigation of severe bodily harm.

1.4 Contemporary Issues Relevant to the Project

Security is an essential part of our society, and our project is aimed at providing better security to small businesses, homeowners, hospitals, schools/universities, and churches. In our society, we have seen a drastic increase in gun violence and gun violence rates. In 2020, there was a 34% increase in gun violence deaths from the previous year, this also results in a 75% increase over the previous decade. Another important statistic to point out is that 79% of murders were carried out with a gun. If our project were to be implemented in our society these rates would start to decrease because people would be notified when there is a weapon present in their area.

1.5.1 Societal Impact:

1.5 Potential Impacts of the Project

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- I. Open and constitutional carry in several states could be impacted by this technology, as of September 1, 2021, Texas became a constitutional carry state, and its residents could openly display firearms without a permit. These weapons and their visibility in society will increase
- II. Home and business owners will have greater security due to the threat detection services
- III. 30% of U.S. households have home security our system would grant greater security

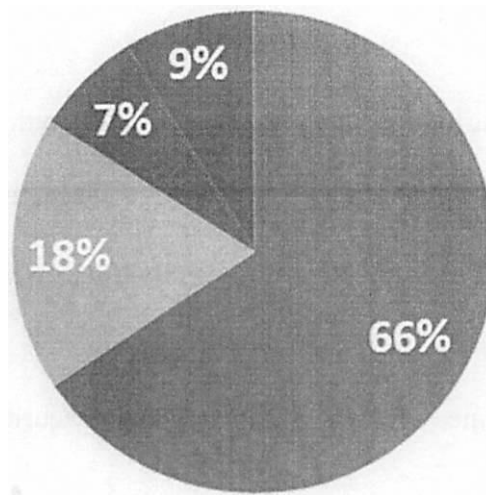
1.5.2 Safety Impact:

- I. In 2019, there were an estimated 1,117,696 burglaries in the United States. 62.8% of those burglaries were residential properties, 37.2% of those burglaries were businesses.
- II. According to Statista, there were a total of 124,381 robberies that involved weapons in 2019. 66% of those robberies involved a firearm and 34% involved a knife or some other weapon.
- III. Statistics show that someone is present 27.6% of the time when a burglary is taking place, 7.2% of these burglaries result in someone being injured.
- IV. Graph 1 shows the percentage of a certain type of weapon is used in robberies. This influenced our decision on what weapons our device will detect.

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1.5 Potential Impacts of the Project (continued)

Number of Robberies



■ Firearm Knife ■ Blunt Object ■ Other

Graph 1: Percentages of Weapons used in Robberies

1.5.3 Technical Impact:

- I. Our project utilizes machine learning algorithms for the smart detection of weapons. The benefit of using M.L. is that our system will be able to learn on its own with the ability to detect new weapons
- II. Weapon detection using M.L. will be done in real-time, which has not yet been implemented in conventional home and small business security systems, some examples of weapon detection are in Figures 2.1 and 2.2
- III. Weapon detection allows for the security system to be more proactive rather than reactive. This will help the homeowner/business owner to prevent the possibility of injury to themselves or others
- IV. The figures below what a weapon detection interface would look like.

1.5 Potential Impacts of the Project (continued)

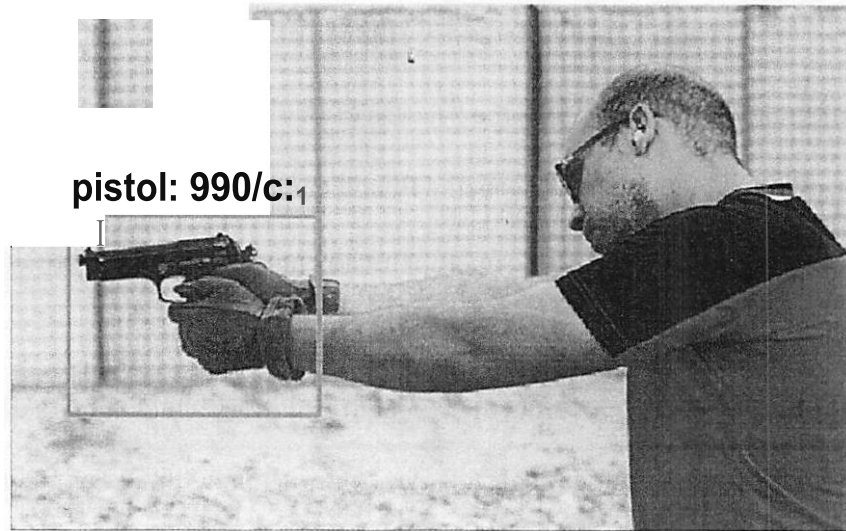


Figure 1.1: Example of Weapon Detection of a Firearm

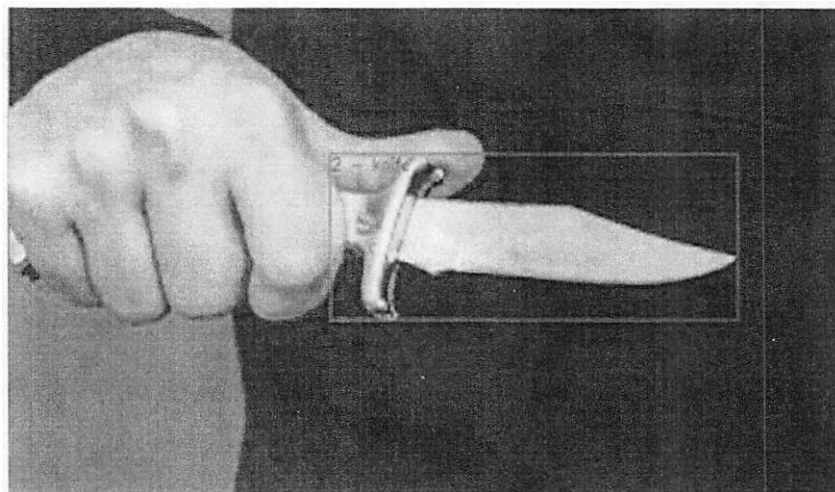


Figure 1.2: Example of Weapon Detection of a Knife

1.6 Initial Project Constraints

There are a few constraints that will influence the success of our project.

- The first is that the housing for the Raspberry Pi and camera must be mountable. This is due to our project acting as a security camera which is normally mounted to the wall in an unreachable location.
- The second constraint for our project is the camera resolution, which affects detection accuracy and distance. If our camera has a bad resolution, we will not be able to clearly detect the weapons at a distance and will have inaccurate readings.
- Our final constraint is the limited frame rate of the Raspberry Pi camera, which will also affect our detection accuracy and has an impact on our alert notification system.

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Section 2 - Project Planning and Task D.e finition

2.1 Task Identification

The team began planning first by conversing with the faculty sponsor to choose the specialization for object detection we would implement. This built a foundation on what type of research will be needed, as well as how much data is necessary for the project to start, beginning with the understanding of object detection and the procurement of parts. The research period allowed for each group member to learn about Raspberry Pi and the operating system interface that went along with it making for the future steps to have a smoother transition.

The design and coding phase of the project allowed the group to learn the coding language, Python, and design the script for the project to run. While designing the project we began early-stage testing to determine if the code worked as expected and find if there were any errors that needed to be fixed before moving to the next step. After testing the code and determining it works as intended, the next phase was to specialize the project in weapon detection instead of just object detection. To accomplish this, an edit to the code is necessary as well as training for the machine learning model to be capable of learning and recognizing set weapons that would appear before the camera. After changing the code and training, the first prototype was complete; however, the next step was to solve the framerate issues and implement a notification system to the code.

The final phase was completing the notification system for the Raspberry Pi and solving the framerate constraint to accomplish real time tracking and provide accurate detection for when a weapon appeared on camera. These tasks ranged between being completed within a day and taking weeks, so the delegation of time and work needed to be allocated appropriately so that the project is capable of being completed before the allotted due date.

2.2 Gantt Chart

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Throughout the year, time management is important for guaranteeing the project will be completed within a timely manner and that each member is working on their respective part by delegating the workload for the team to work as efficiently as possible. The following images are the complete Gantt chart displaying the detailed time delegation for each task to ensure the project progressed smoothly within the time limit.

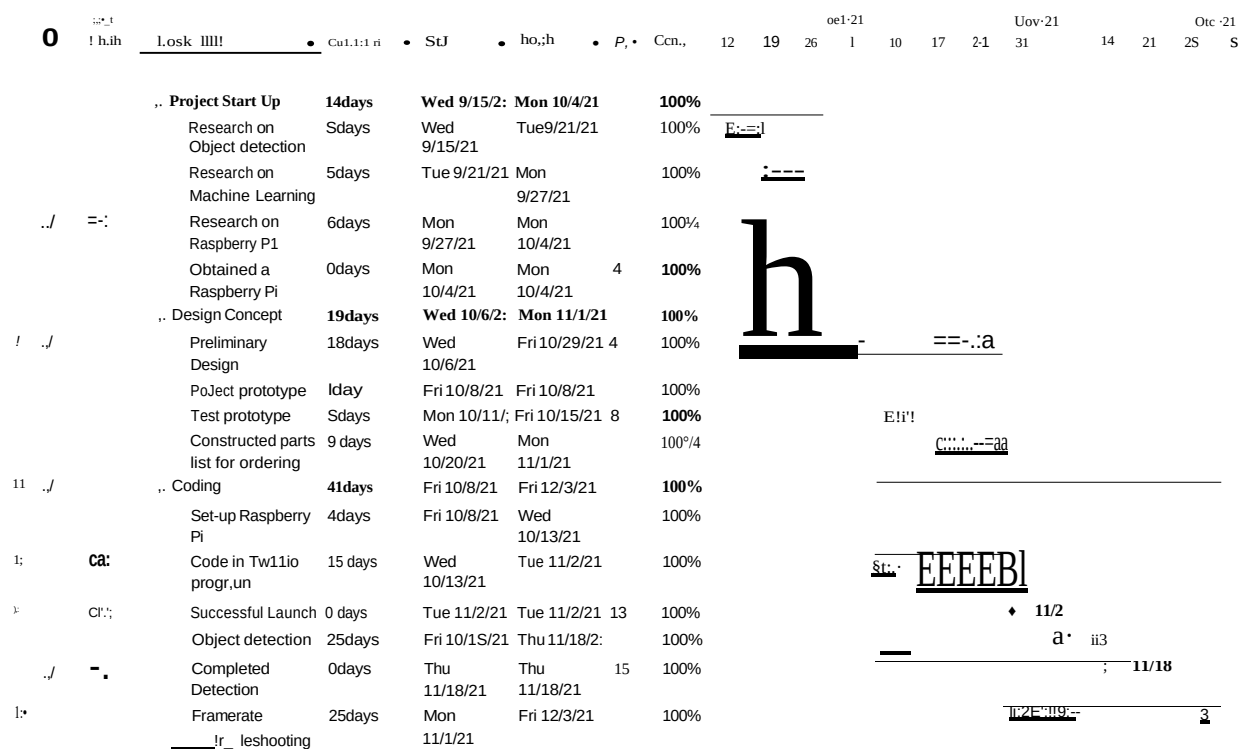


Figure 2.2: Gantt Chart (part 1)

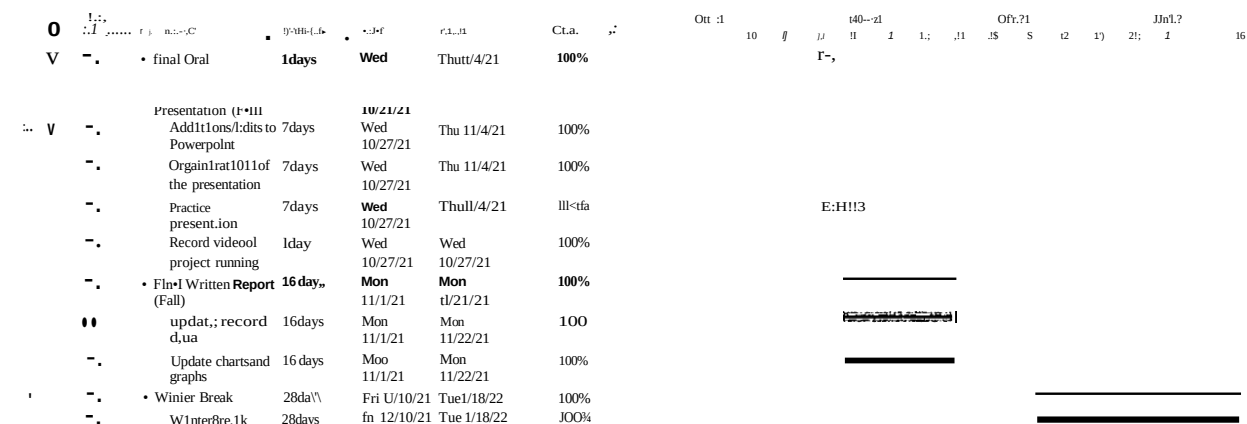


Figure 2.2: Gantt Chart (part 2)

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2.2 Gantt Chart (continued)



Figure 2.3: Gantt Chart (part 3)

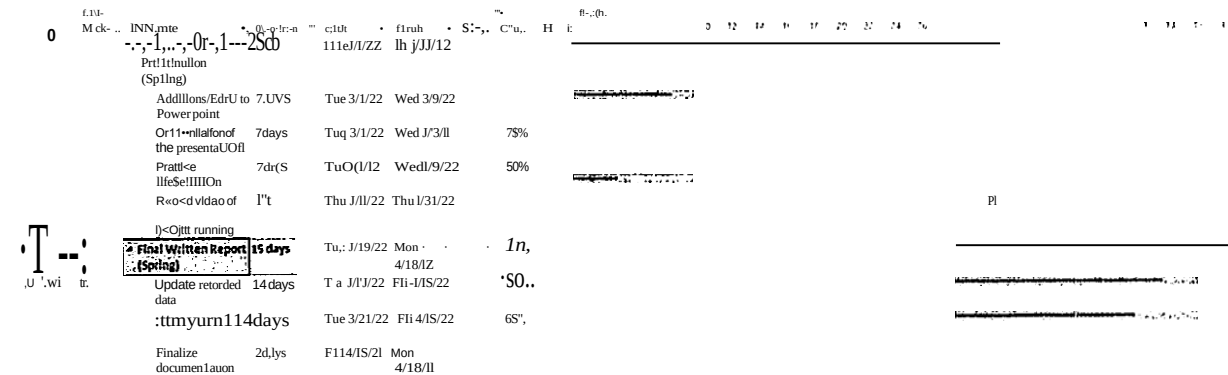


Figure 2.4: Gantt Chart (part 4)

Section 3 - Literature Review

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3.2 Statement of Learning from Each Source

1. Reference to another security device for monitoring of area; Deep Sentinel device
2. Break-in and burglary statistics regarding injuries and the presence of weapons provided via FBI Uniform Crime Reporting Statistics
3. Economic significance and statistics regarding the presence of small businesses
4. Project comparison to SimpliSafe products
5. How to integrate and set up a web client via python to send message to Twilio messaging service
6. Discussion of crime statistics and how ML can be used in burglary prevention and identification
7. Implementation of Vaak's AI theft-detection system and the methods of training
8. Project comparison to GW security camera products and their various prices and capabilities
9. Various SimpliSafe products for comparison to our product
10. Bureau of Justice Statistics Weapons Offenses and Offenders statistics on firearm related criminal offense over the years and its growth
11. The victimology of burglary victims according to the Department of Justice statistics, rates of burglary and harming of victims
12. Exploring the possibility of infrared cameras and object detection, for this project to detect concealed weapons
13. How to detect concealed weapons against the human body and when direct sightlines are obstructed

3.2 Statement of Learning from Each Source (continued)

14. The possibility of using infrared and heat sensitive wavelengths of light with various photo processing techniques to detect concealed weapons
15. 18+ homeowner statistics, touches on various aspects of homeownership such as reports on increasing cost, less overall homeowners, and disparities in the housing market
16. Cove Smart products and how they potentially compare to our product sensitive wavelengths of infrared light
17. Visual data and statistics regarding the number of times a weapon was present during robberies and the types of weapons during these occurrences
18. Stats on the number of burglaries, how often homes had security measures preinstalled and the economic effect such acts have on the victims
19. Statistics regarding the type of locations affected by burglaries

Section 4 - Preliminary Design

4.1 Concept Generation

There are several applications that machine learning can be used for such as object detection, image classification, natural language processing, facial recognition, and much more. As a group, we decided to focus on a specific implementation of object detection in relation to threat detection. The project shifted more into the development of a pre-emptive warning and threat detection system with associated hardware and third-party text notification alert system.

4.2 Concept Evaluation and Selection

As a company, we have a favorable position to produce our goods and services at a differential value. We have demonstrated a greater comparative value than that of our / competitors and conveyed this information to our target market. Production of our unique technology that offers features our competitors are not marketing paired with a lower production cost will ensure our competitive advantages.

Our technology includes a weapon detection algorithm whereas our rivals offer a general object detection algorithm. We have machine learning and real-time tracking software whereas some of our rivals only offer machine learning software. Our organization will not charge a continuous monthly service charge as many of our rivals include in their packages. Our single unit product is remarkably simple, easy to install, and lightweight, whereas our rivals have multiple heavier hardware devices and equipment to install.

With every great invention comes a challenge, and for our system to be complete, we must rely on a third-party notification company by the name of Twilio. Twilio plays a large factor in our equation as to when a threat is determined by our system. Twilio is responsible for sending out the proper notifications to the selected entities. Twilio is an independent company that the consumer will need to purchase a package plan from for our product to be utilized to its fullest capacity.

4.2 Concept Evaluation and Selection (continued)

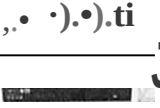
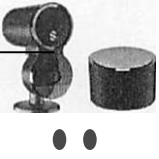
Design Options	Initial Cost	Continuous Fees	Pros	Cons	References
Smart Threat Detection System (Our Design)	\$340	No Monthly Fee	- Weapon Detection - Machine Learning (ML) - Real Time Tracking - Light Weight -Text Notifications	- No remote monitoring -Twilio subscription needed	NIA
GW Security 	Starts at \$1400 to \$6000	No Monthly Fee	- 4k Resolution - Uses ML - Night Vision	- No Remote Viewing -Heavy Camera - Equipment - No Weapon Detection	GWsecurityusa.com BBB.com Amazon.com
Deep Sentinel 	\$400to \$1200	Monitoring Fee \$60 to \$200 per month	- Uses ML - Motion Detection - Wi-Fi or Ethernet connection	- No Weapon Detection	Dccpsentincl.com
SimpliSafe 	Starts at \$700	Monitoring Starts at \$15 per month	- Smoke, water, carbon & motion sensors - Smart home integration - A+ rating	- No ML feature to enhance system	Simpli,arc.com
Cove Smart 	Starts at \$1200	Monitoring \$26 per month	- Environmental Sensors - Text Notifications	- No smart ML features available	C1wcs111ar1.co111 BBB.com

Table 2: Pu jec1 Co111poriso11 Chor/

4.3 Constraints and Applicable Codes and Standards Used in Preliminary Design

One of the major design constraints for our project was the frame rate of the Raspberry Pi camera. The frame rate affects Twilio alert times as it works via a counter of frames with a weapon present. Frame rates are essential to our project because we need to be able to detect weapons clearly and accurately before an individual is harmed. To fix this issue we implemented the Google Coral USB Accelerator, this allowed our system to go from one to two frames a second to around 30 frames a second.

The following Codes and Standards were used in implementing our preliminary design:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision -This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

4.4 Preliminary Analysis

After determining the deliverables for our project, we were then able to research and investigate ways to complete our project. We decided that we should start with object detection on our Raspberry Pi 3b+, object detection is to detect instances of visual objects within a certain class in digital images. With object detection, we were able to detect preprogrammed objects such as chairs, cellphones, laptops, a person, and many other objects. Next, we would test object detection on our Raspberry Pi 3b+ and investigate the machine learning code so that we could determine how to go from object detection to weapon detection, which is the basis of our project. The way to do this was by "labeling", labeling is the process of identifying raw data and adding meaningful and informative labels to provide context so that a machine learning model can learn from it. This will be addressed later in the paper. Referring to our object detection tests, we noticed that we were only getting around 1.1 to 2.5 frames per second, this would cause a delay in the timing of our text message alert system. This issue is due to the Raspberry Pi 3b+ being an older model machine that could not handle the video processing that we needed it to do. Therefore, we had to do more research to find a solution to address this problem, we arrived at the Google Coral USB Accelerator which can be plugged into our Raspberry Pi to give us a higher frame rate. The accelerator would then bring our frame rate from a maximum of 2.5 frames per second to around a maximum of 30 frames per second. We also found a newer model Raspberry Pi that was more powerful than the current one we were given; the new model was the Raspberry Pi 4b. We decided to purchase these new products that had a greater benefit on our overall project success.

4.5 Preliminary Design



Once we were given our project at the start of the fall semester, we began to consider ways that we could create the design of our project. We knew that we would need a Raspberry Pi and the associated camera, because that was the required hardware specification for our project and the camera allows us to monitor the area. Aside from the hardware of our project we also decided that we would have an alert notification system set up to alert the owner of the device that a weapon has been identified in their area. The alert notification comes through a third-party company known as Twilio that users will have to subscribe to and provide a phone number to send an alert message.

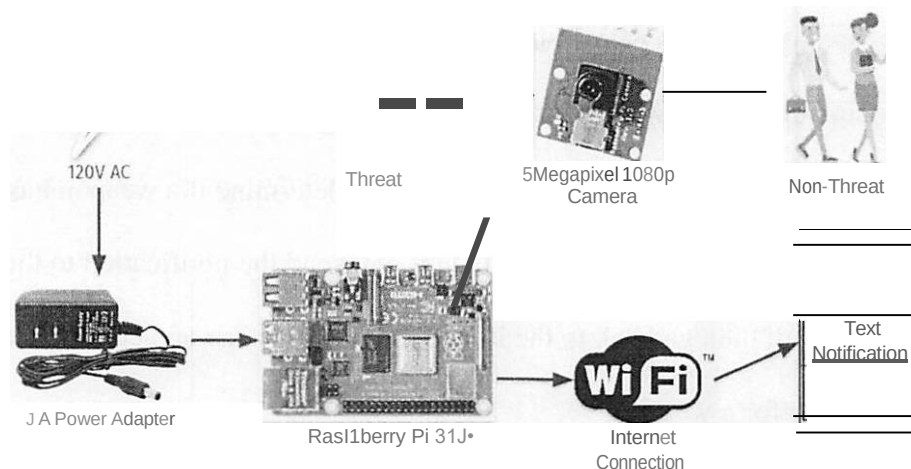


Figure 3: Preliminary Design

Once we obtained the hardware for our preliminary design, we put it together so that we could test it; the preliminary design can be seen in figure 3 above. The Raspberry Pi 3b+ is plugged in via a 3-amp power adapter, the camera is attached to the Raspberry Pi to detect threats and non-threats, and once a threat is detected an alert text message is sent over a Wi-Fi internet connection.

4.5 Preliminary Design (continued)

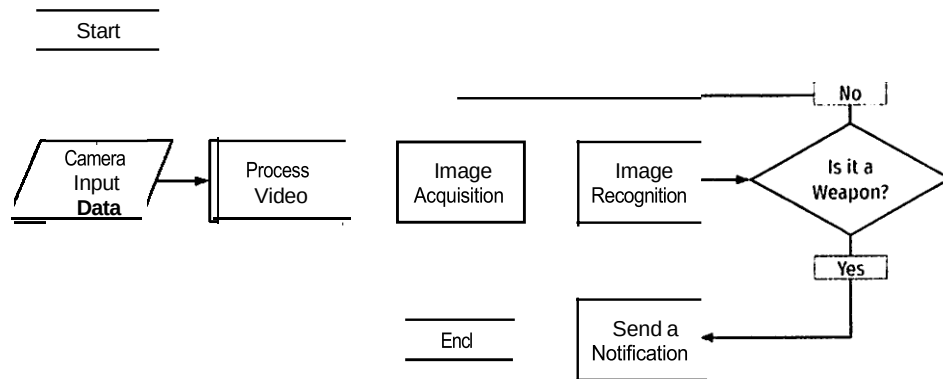


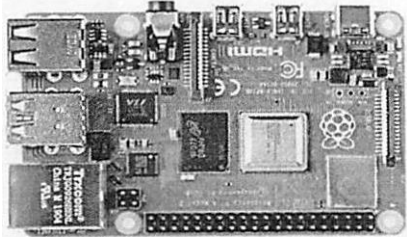
Figure 4: *Software Flow Chart*

In figure 4, we show the software flow chart on how the detection and notification system works. The software begins when the camera is turned on, the camera will then receive input data and will process the video. During image acquisition the system checks for weapons frame by frame, which then goes to image recognition where it will determine if a weapon has been identified in that frame. If a weapon was detected then it will send the notification to the user, if no weapon is detected it will then go back to the image acquisition stage and continue to check the next frame in the video for a weapon.

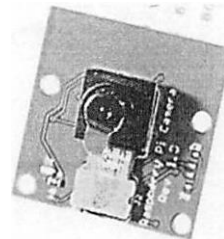
Section 5 - Detailed System Design

5.1 Project Parts Summary

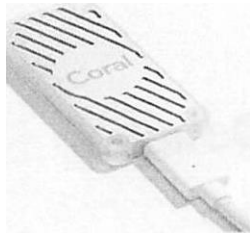
All parts used in the final system design are listed below in Figures 5.1 to 5.8.



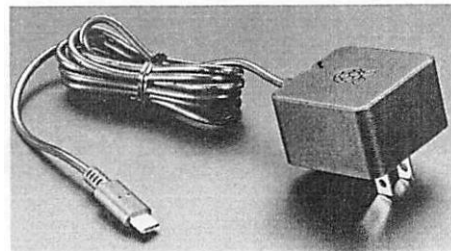
5.1: Raspberry Pi 4 Model B



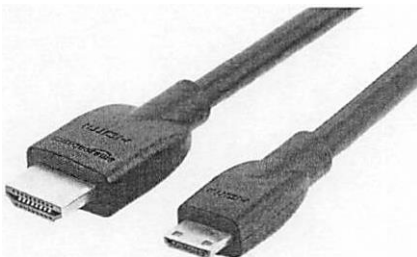
5.2: Raspberry Pi Camera Rev 1.3



5.3: Google Coral USB Accelerator



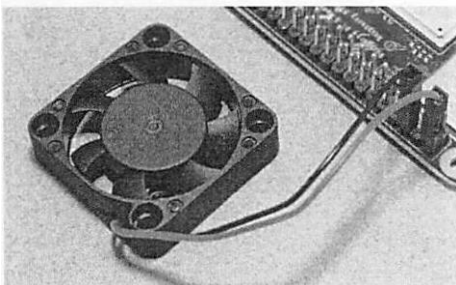
5.4: USB-C Power Supply



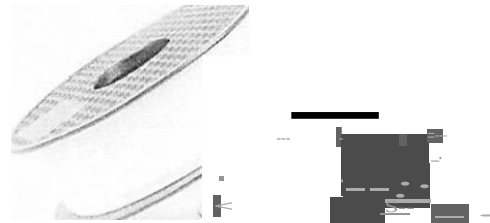
5.5: Micro HDMI to HDMI Cord



5.6 : Micro SD Card



5.7 : Raspberry Pi Fan



5.8: Polylactic Acid

Figures 5.1-5.8: 1111C1ges qf"PC1rls

5.2 Engineering Analysis

Labelirnz and Trainin2:

In order to train the model Lo detect weapons, we first had to label images that contained weapons. This was done using a software called Labellmg. A bounding box is drawn on the portion of the image that contains the weapon and you attach a label to that box. An example of this is shown in the figure below.

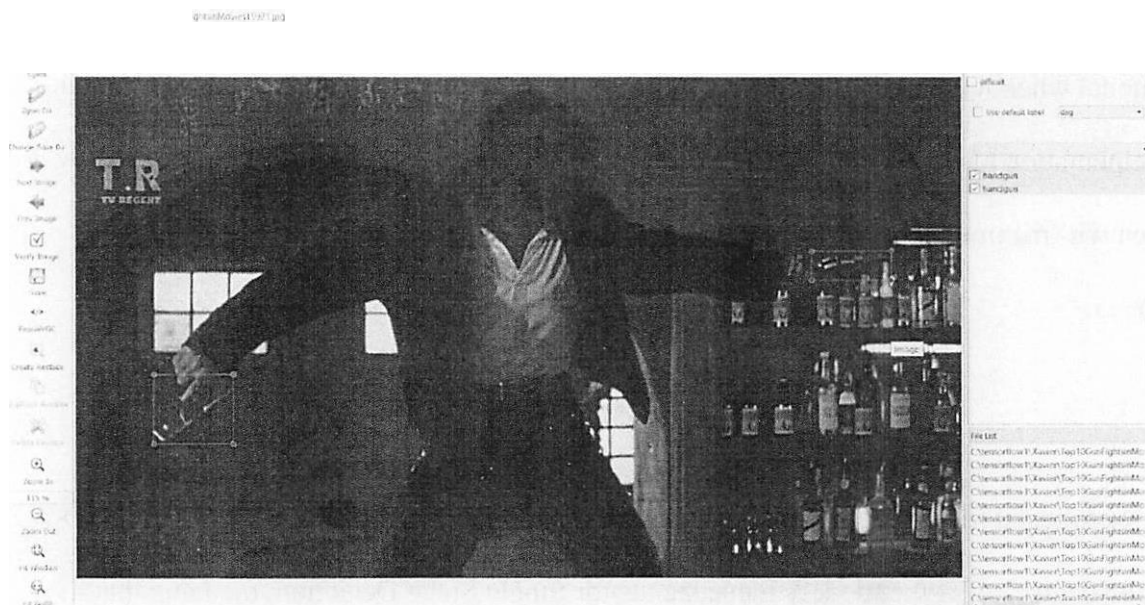


Figure 6: Labellmg SoFware

Here you can see that two handguns have been boxes and labeled as handguns. This had Lo be done for over 5000 images.

After the entire dataset is labeled, it is used to train the model. The model uses the information provided by the labeled images to recognize patterns and make predictions.

Quantization:

Quantization is the act of constraining an input and representing its value as a smaller value. Each node, or tensor, of the model is represented by some numerical value. Usually, a 64-

5.2 Engineering Analysis (continued)

bit floating-point value can represent an absurdly broad range of values and is computationally intensive to decipher or to use in other operations. This large computational load slows the processing of frames and therefore the frame rate. Shrinking the representation of these nodes to 8-bit unsigned integers can greatly improve the frame rate, as operations on simpler values are faster and take up significantly less space in memory.

Quantization can be applied to the model on a per tensor basis or to the outputs of individual layers which only partially optimizes the model. This process can decrease the overall size of the model when it is totally quantized by a factor of 4 times. Quantization is also essential for the implementation of the Coral USB Accelerator Tensor Processing Unit (TPU) produced by Google which will maximize the frame rate on the Raspberry Pi upwards of 25-30 frames per second (fps).

Model:

The model used for object detection was the SSD MobileNet V2 COCO model. The SSD acronym at the beginning of the model's name stands for Single Stage Detection, meaning that this algorithm for identification goes straight from pixels of an image directly to bounding box coordinates and class probabilities to be displayed around the object. This model was chosen because of its compatibility with TFlite as only a select pool of lightweight operators is available with this framework and not all models can be converted to this version. This model is also one of the few quantizable models which is necessary for frame rate solutions to be implemented such as the Coral USB accelerator.

5.2 Engineering Analysis (continued)

Notification System:

Short Message Service or SMS is used as our notification system. A third-party software called Twilio is integrated into our design. Whenever a weapon is seen for a set number of frames, the notification is sent to warn anyone in danger. This type of notification was used because of its easy implementation, as well as its ability to send out notifications to any number of people with any type of phone. The messages are very quick and reliable.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications

Hardware Layout

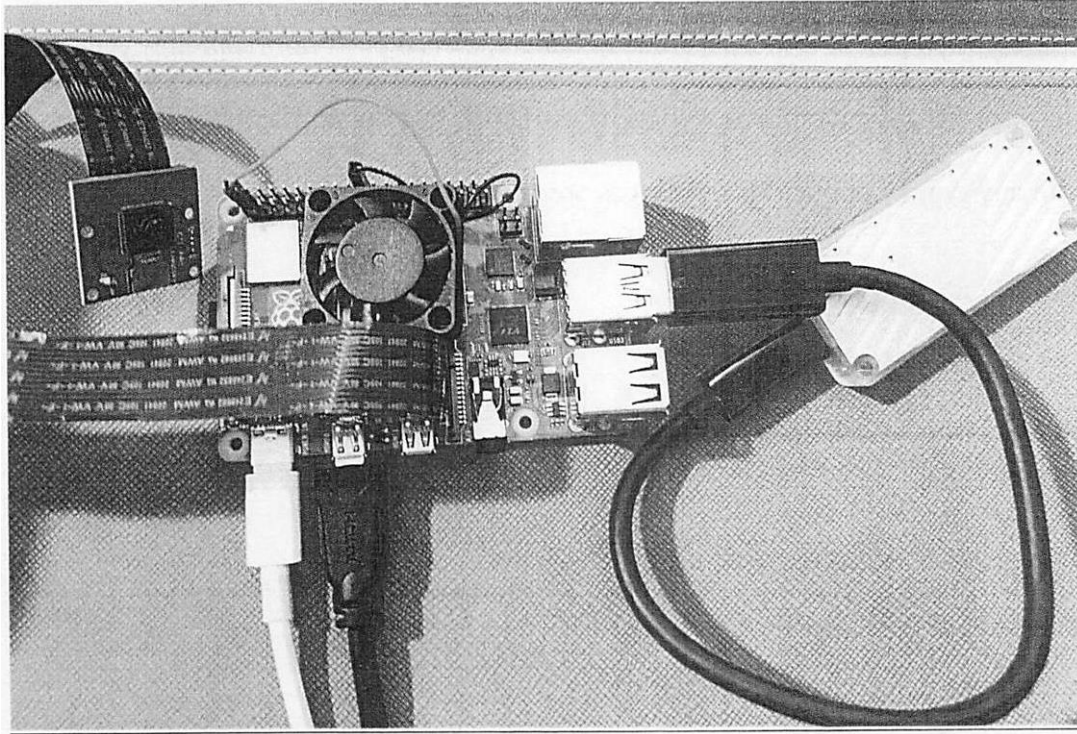


Figure 7: Hardware Layout

In the figure above, it is shown that the Raspberry Pi is connected to power via the 3-amp power supply and the Pi Camera is connected via a ribbon cable. The USB accelerator is connected to the raspberry Pi via a USB-A to USB-C cable. The fan is connected to the 5V and ground pins on the Raspberry Pi and the Raspberry Pi is connected to the monitor via the Micro HDMI to HDMI cable.

Detailed Drawings

In this section, the schematics for the housing will be shown and described. After the housing was designed. It was 3D printed out of PLA. The housing is encasing the Raspberry Pi,

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.) /

fan, Coral USB, camera, and the camera ribbon cable. The full housing can be seen in the figure below.

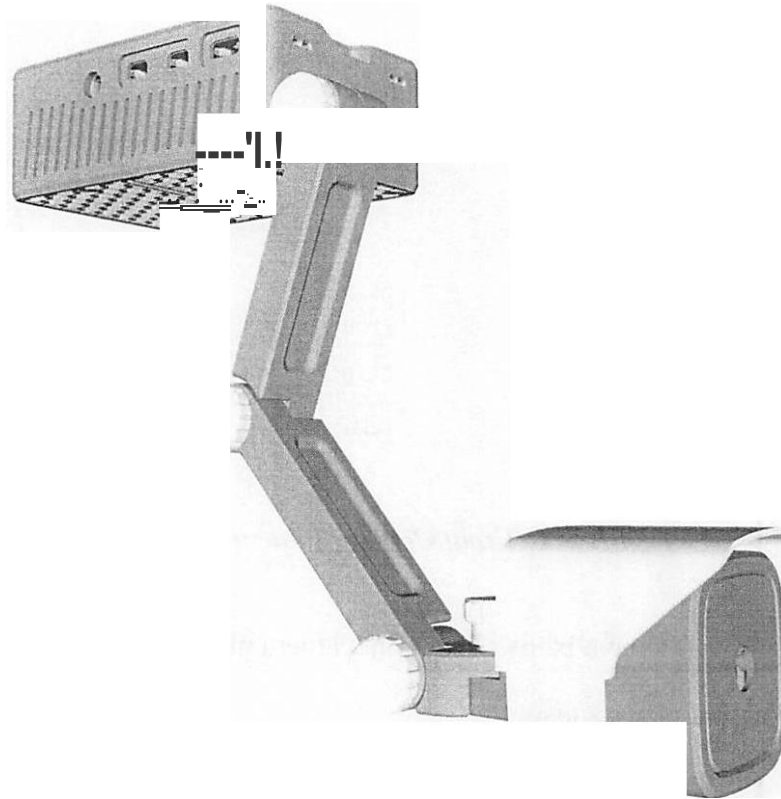


Figure 8: Housing Design

Listed below will be detailed drawings of the individual pieces of the housing. To start with we have the front camera plate. The Pi Camera snaps into place via the 4 pins that stick out on the inside. The lens or the camera sits in the hole in the center.

1



5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The camera visor is shown below. The visor snaps together with the side camera cover.

There is a slot on the back to allow the ribbon cable of the camera to pass through as well as a larger slot that connects the back camera plate.

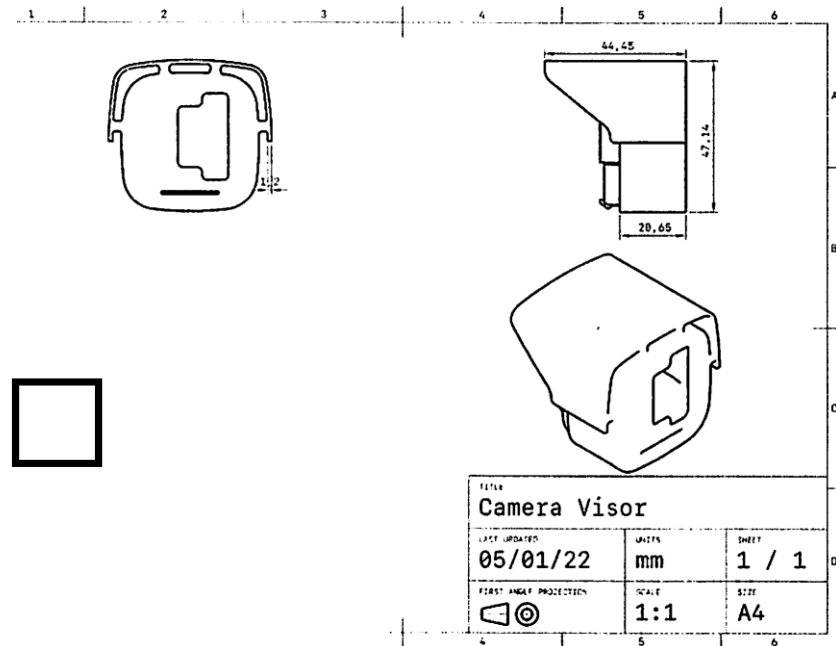


Figure 9.3: Camera Visor

The back camera plate is shown below. The interior side of the back camera plate has a notch that slides into the opening on the camera visor. There is a threaded hole to allow for a short screw attachment to the hinge.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

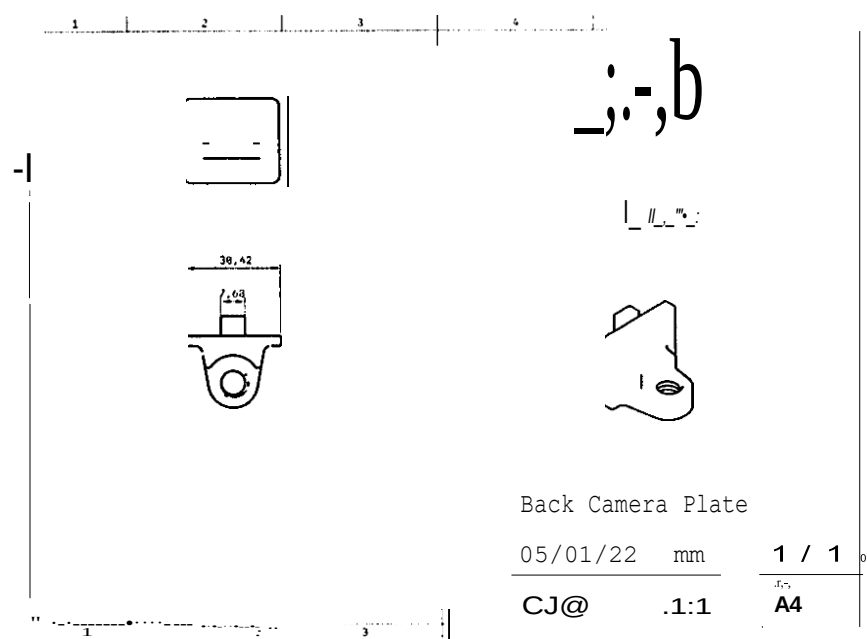


Figure 9.4: Back Camera Plate

The hinge is shown below. The hinge allows for the camera to pan left and right. The hinge is connected to the lower arm via a long screw.



Figure 9.5: Hinge

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The lower arm and upper arm are identical and shown below. They are connected via 2 long screws at either end. They have a slit that allows for the ribbon cable to run through the interior of the arm.

I

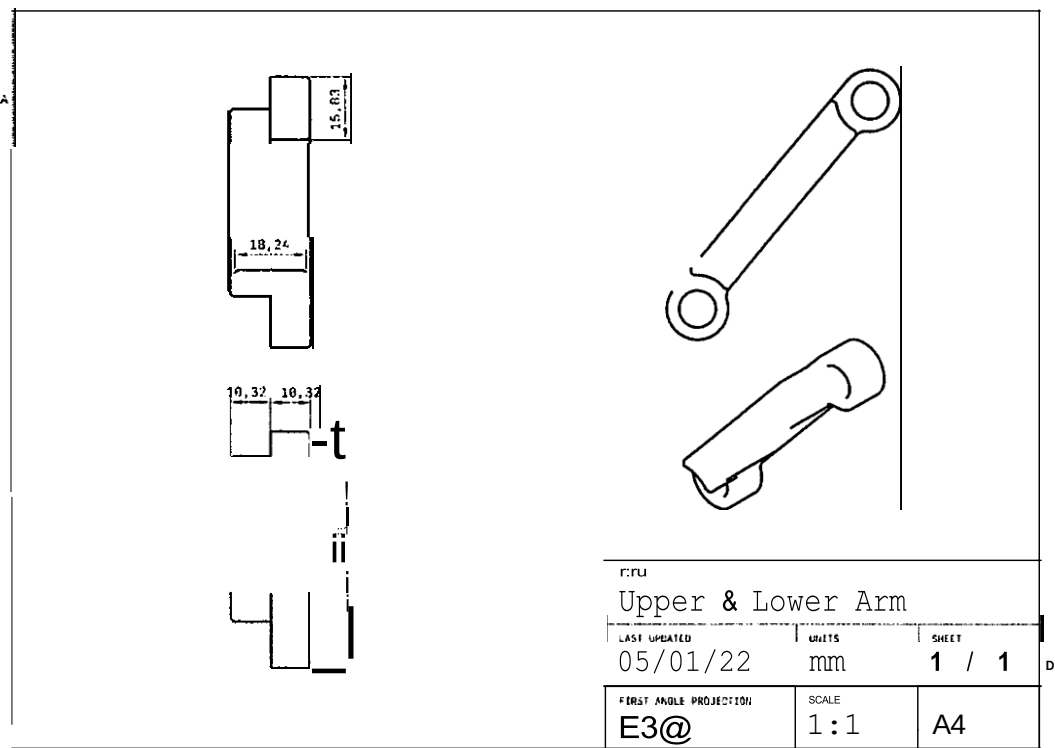


Figure 9.6: Upper & Lower Arm

The long and short screws are threaded the same way. The long screw is shown below.
The short screw is $\frac{3}{4}$ the length of the long screw.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

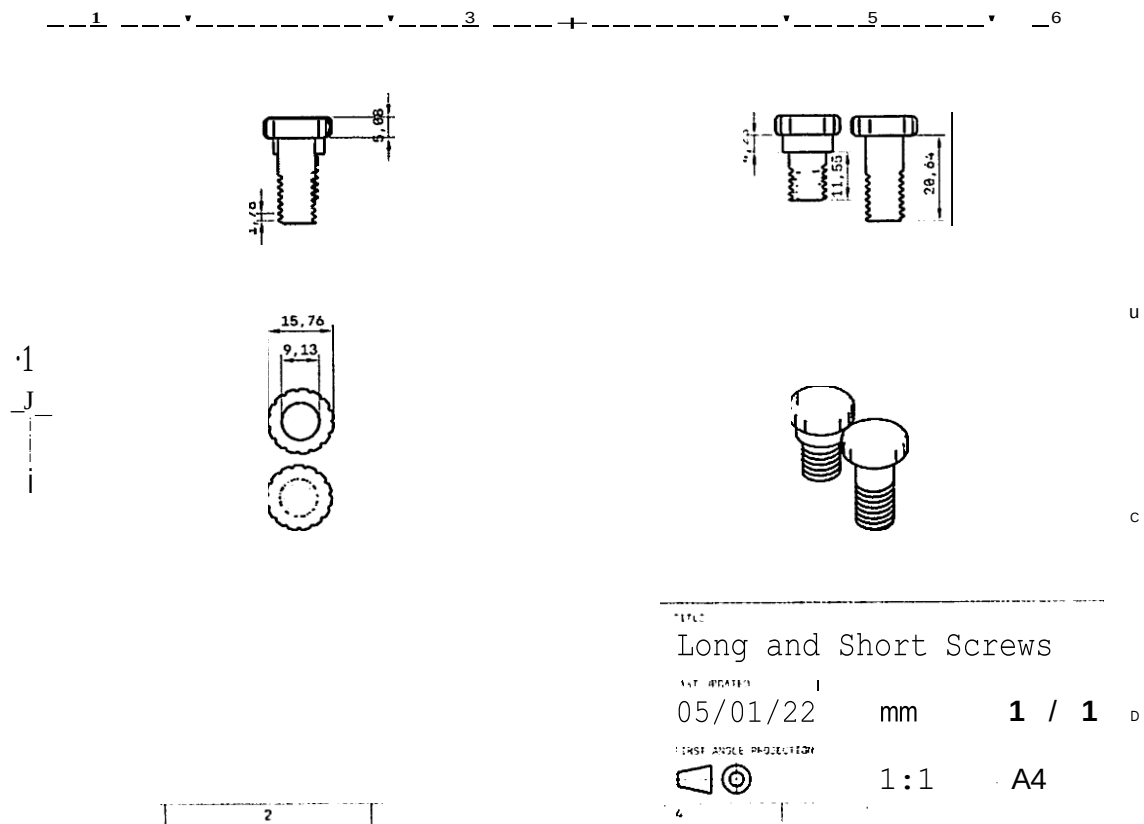


Figure 9.7: Long & Short Screws

The Raspberry Pi case top is shown below. It is the portion of the case that would face downwards if mounted to a ceiling despite being named the top. It has a cut out for the fan to sit on and has enough space to hold the Coral USB Accelerator. It also has a slit cut out for the camera ribbon cable and 3 large notches for the USB Ports and the Ethernet port. The hexagonal shape on the top and slits on the sides allow for adequate air flow as overheating used to be an issue.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

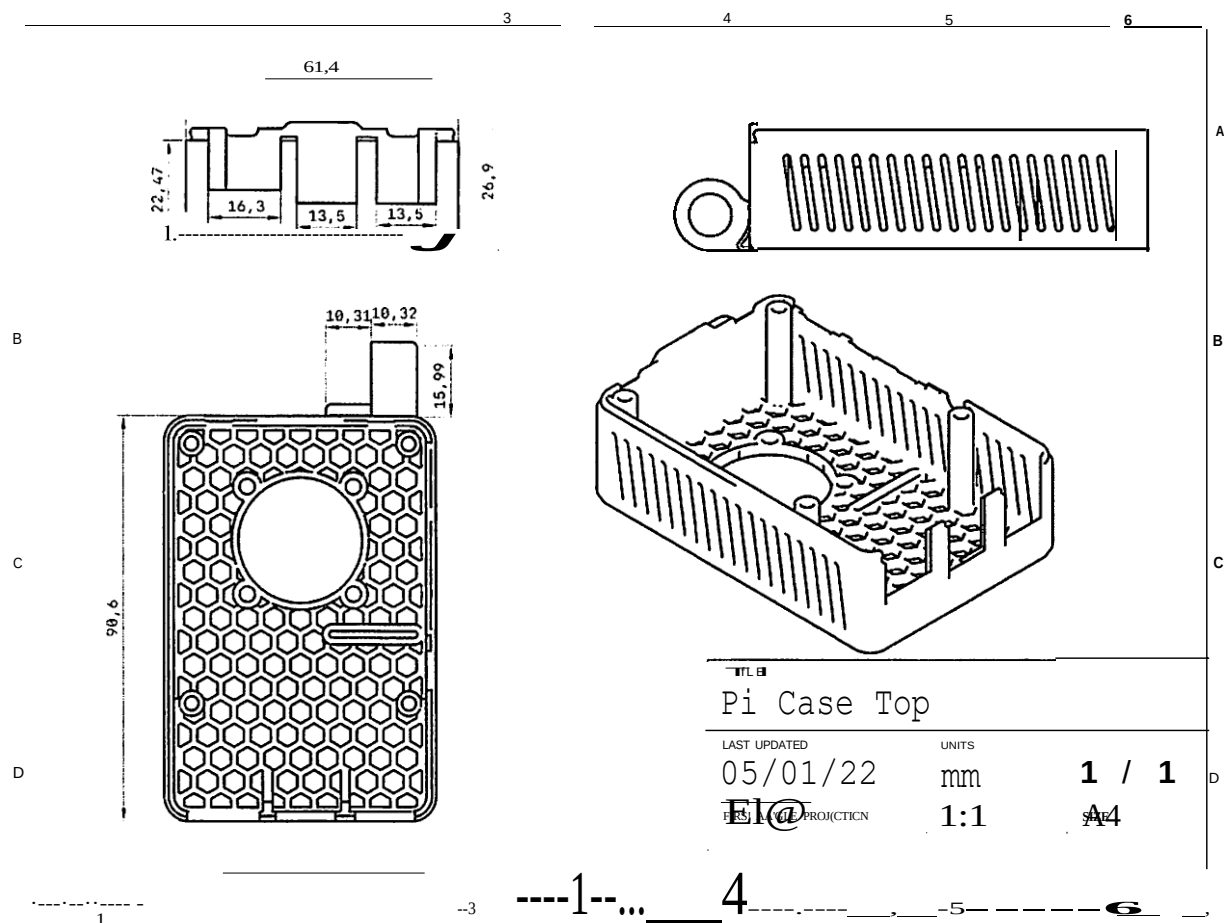


Figure 9.8: Pi Case Top

The Raspberry Pi case bottom can be seen below. It is the portion of the case that would be touching the surface in which the device is being mounted. The case has 4 cut outs for the power, HDMI ports, and the audio port. The two case pieces snap into one another with the Raspberry Pi, fan and Coral USB accelerator fixed in place on the inside.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

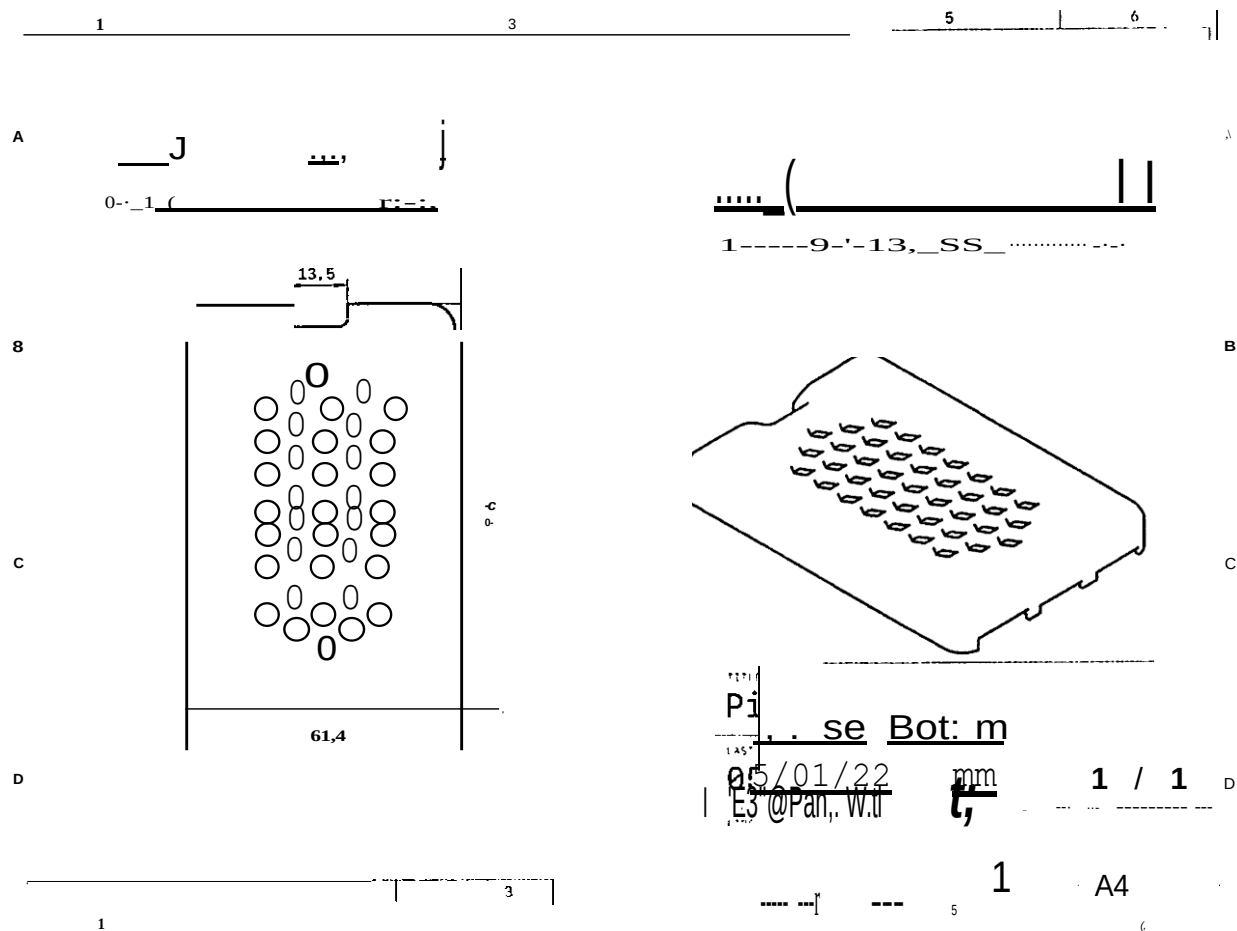


Figure 9.9: Pi Case Bottom

The parts are all 3D printed from PLA including the screws. This allows for the housing to be very lightweight.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

Equipment Selection and Specifications

The Raspberry Pi 4 Model B was selected due to it being the most up to date Raspberry Pi to be released. It has a much better performance than the other Raspberry Pi models. A LINPAC benchmark test showed that the Raspberry Pi 4 B almost tripled the score of the Raspberry Pi 3B+. The specifications of the Raspberry Pi 4 Model B are shown in the table below.

Raspberry Pi 4 Model B.	
Processor	Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Ram	8GB LPDDR4-3200 SDRAM (depending on model)
Wi-Fi/Bluetooth	2.4 GHz and 5.0 GHz IEEE 802.11ac wireless, Bluetooth 5.0, BLE
Ethernet Port	Gigabit Ethernet
USB Ports	2 USB 3.0 ports; 2 USB 2.0 ports.
GPIO	Raspberry Pi standard 40 pin GPIO header (fully backwards compatible with previous boards)
Display Ports	2 x micro-HDMI ports (up to 4k60 supported) 2-lane MIPI CSI display port
Camera Port	2-lane MIPI CSI camera port
Audio Port	4-pole stereo audio and composite video port
Video Encoder	H.265 (4k60 decode), H264 (1080p60 decode, 1080p30 encode)
Graphics	OpenGL ES 3.1, Vulkan 1.0
Storage	Micro-SD card slot for loading operating system and data storage
Power	5V DC via USB-C connector (minimum 3A*) 5V DC via GPIO header (minimum 3A*) Power over Ethernet (PoE) enabled (requires separate PoE HAT)
Operating Temperature	0 - 50 degrees C ambient

Table 3.1: Raspberry Pi 4 Model B Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.) ¹

The Raspberry Pi Camera was selected due to its easy compatibility with the Raspberry Pi 4 Model B. The specifications of the Raspberry Pi Camera are shown below.

Raspberry Pi Camera Rev 1.3	
Still Resolution	5 Megapixels
Video Modes	1080p30, 720p60 and 640 x 480p60/90
Linux Integration	1080p30, 720p60 and 640 x 480p60/90
C Programming API	OpenMAX IL and others available
Sensor	OmniVision OV5647
Sensor Resolution	2592 x 1944 pixels
Sensor Image Area	3.76 x 2.74 mm
Pixel Size	1.4 μm x 1.4 μm
Optical Size	1/4"
Full-frame SLR Lens Equivalent	35mm
SIN Ratio	36 dB
Dynamic Range	67 dB @ 8x gain
Sensitivity	680 mV/lux-sec
Dark Current	16 mV/sec@ 60 C
Well Capacity	4.3 Ke-
Depth of Field	approx. 1 m to infinity
Focal Length	3.60 mm+/- 0.01
Horizontal Field of View	53.50 +/- 0.13 degrees
Vertical Field of View	41.41 +/- 0.11 degrees
Focal Ratio (F-Stop)	2.9

Table 3.2: Raspberry Pi Camera Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.) /

The Google Coral USB Accelerator was selected due to its easy compatibility with the Raspberry Pi 4 Model B. This device aided in increasing the frame rate by approximately 20 frames per second. The specifications of the Google Coral USB Accelerator are shown below.

Google Coral USB Accelerator	
ML accelerator	Google Edge TPU coprocessor: 4 TOPS (int8); 2 TOPS per watt
Connector	USB 3.0 Type-C* (data/power)
Dimensions	65 mm x 30 mm

Table 3.3: Coral USB Accelerator Specifications

The Raspberry Pi 4 Official Power Supply Unit was selected due to it being built specifically to meet the requirements for the Raspberry pi 4 Model B. The specifications of the Raspberry Pi 4 Official Power Supply Unit are shown below.

Raspberry Pi 4 Official Power Supply Unit	
Power	15.3-Watt output
Voltage	5.1-Volt output
Current	3.0-Amp output
Length	1.5-m cable

Table 3.4: Power Supply Specifications

The QVS Micro-HDMI to HDMI Cable was selected because it fit the Raspberry Pi 4 B and the monitor we used. The specifications of the cable are shown below.

QVS Micro-HDMI to HDMI Cable	
Supports	15.3-Watt output
Length	2-m cable
Connectors	HDMI Male to Micro HDMI Male

Table 3.5: Micro-HDMI to HDMI Cable Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The Samsung 32GB EVO Plus UHS-I microSDHC Memory Card was selected due to it having enough storage capacity and a fast enough speed for the project. The specifications of the Raspberry Pi 4 Official Power Supply Unit are shown below.

Samsung 32GB EVO Plus UBS-I microSDHC Memory Card	
Card Type	microSDHC
Storage Capacity	32GB
Bus Type	UHS-I
Speed Class	10
UHS Speed Class	U1
Read Speed	Maximum: 95 MB/s
Write Speed	Maximum: 20 MB/s Minimum: 10 MB/s
Durability	Magneti-ProoL Tcrnp r.ttute Ex.lrcmes. Walerproor. X-Ray Proof
Operating Temperature	-13 lo IX5°F I -25 to 85°C
Storage Temperature	-40 In I s..r: /-40 to 85°C
Wireless Capability	None

Table 3.6: *MicroSD Card Specifications*

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The Pi-FAN was selected due to its easy compatibility with the Raspberry Pi. The specifications of the Pi-FAN are shown below.

Pi-FAN	
Operating Voltage	5 Volts
Current	0.2 Amps
Motor	Brushless DC fan
Dimensions	30mm x 30mm x 8mm
Wire Length	3.25" / 80mm
Weight	6.2g / 0.22oz

Table 3.7: Pi-FAN Specifications

The OVERTURE Polylactic (PLA) ACID Filament was selected due to its easy compatibility with the 3D printer that was used. It was also ideal for its biodegradability and was already readily available. The specifications of the OVERTURE PLA Filament are shown below.

OVERTURE Polylactic ACID Filament	
Diameter	1.75 mm diameter
Dimensional Accuracy	Accuracy +/- 0.03 mm
Material	Polylactic Acid (PLA)
Extrusion Temperature	190°C - 220°C (374°F~ 428 °F)
Heated Bed Temperature	25°C - 60°C (77°F~ 140°F)
Color	Black

Table 3.8: Polylactic Acid Specifications

5.4 Overview of Code

There are three main portions of the code. The first section handles training the model to detect weapons. The second section contains everything that deals with the process of running the camera and detecting objects. The third section handles the logic behind how and when to send the notification. The main portions of these three sections will be explained below; however, to see the full-length code, see appendix page A2

Training the Model

When training the model, we used over 5000 images that we labeled as a specific category of weapon. These images became our dataset. The model is then trained on this data set by running the training executable. This code, along with instructions on how to configure the training job can be found in the appendix on page A8. This section calls many different files to aid in the training process. To summarize what is happening during training, the algorithm takes an image that looks at where the bounding box for the weapon is and looks for certain patterns and similarities throughout the various images.

Running the Camera

The code that runs the camera and weapon detection starts with the camera constraints. The dimensions of the camera must be defined because the bounding box location for the weapons is calculated using the image height and width. Below it is shown that the image width for our camera is 1280 and the height is 720.

```
# Set up Ci-1"1Pf,, CDFISI,Int_*,
IM_WIDTH
IM_HEIGHT
```

Figure 10.1: Camera DimellSIONs

j

J

5.4 Overview of Code (continued)

The output of the model includes the detection boxes, scores, classes, and number of objects detected. In the figure below, these are seen as `detection_boxes`, `detection_scores`, `detection_classes`, and `num_detections`. The detection boxes give the coordinates of the top left and bottom right points of the bounding box. The score is the confidence level this is displayed as a percentage. The classes are the names of the object being detected and the number of detections keeps track of how many of the detected objects are in the view of the camera.

```
tf Output tensors are the detection boxes, scores, classes, and number of
# Each box represents a part of the image with a probability of being detected
detection_boxes = detection_graph.get_tensor_by_name('detection_boxes:0', dtype=tf.float32)

# Each score represents level of confidence
# The score is shown on the result image as a percentage, e.g. '0.91: class'
detection_scores = detection_graph.get_tensor_by_name('detection_scores:0', dtype=tf.float32)

detection_classes = detection_graph.get_tensor_by_name('detection_classes:0', dtype=tf.int32)

# Number of objects detected
num_detections = detection_graph.get_tensor_by_name('num_detections:0', dtype=tf.float32)
```

Figure 10.4: Boxes, Scores, Classes, and Number of Boxes

The live value of the frame rate is calculated by checking the tick frequency. This is shown in the figure below. It is important to have the exact frame rate of the camera as this directly affects the speed at which the notification is sent.

```
# Initialize frame rate calculation
frame_rate_calculator = FrameRateCalculator()
frame_rate_calculator.start()
font = cv2.FONT_HERSHEY_SIMPLEX
```

Figure 10.5: Frame Rate Calculation

The model is run and uses each frame from the camera as its input. This code is shown below.

Figure 10.6: Running Detection Model

Figure 10.7: Visualization of Results

For our notification system, we used Twilio. To code in the Twilio information we first import the Twilio client. Then the account SID number, authorization number, the phone number of who needs to receive the notification, and the number the message is being sent from are all defined. In the figure below, it is shown where these values are defined as the specific variables: `account_sid`, `auth_token`, `my_number`, and `twilio_number`, respectively. The numbers are covered for privacy purposes.

5.4 Overview of Code (continued)

```
II Set up Twilio
ro

II Twilio SID, authentication token, my phone number, Twilio ph
account_sid = 'XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX'
auth_token = 'XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX'
my_number = 'XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX'
twilio_number = '19362510045'

client = Twilio(account_sid, auth_token)
```

Figure 11.1: Twilio Setup

The way the program knows when to send the notification is a series of "if" statements. It determines if a weapon is on the screen. The weapons are defined by their ID classes; 1 for rifle, 2 for handgun, 3 for knife, 4 for blunt object. A predetermined area of detection is defined if it is not wanted to detect weapons in the camera's full field of view. If one of the weapons is located within that area for 300 frames, it sends the message: "A weapon has been detected on your camera." to the numbers previously defined. The program then pauses for a set amount of time to prevent messages being spammed. This can all be seen in the snapshot of the code below.

```
int
inl or int 1 j
    inl P\ 1:111
    int I H.
// Draw a circle at center of object
cv2
// Object is in inside increment
if (x > TL_inside and
    inside)
    inside_counter

inside_counter = 300
detected_inside = True
message = client
    body = 'A weapon has
    from_twilio_number =
    to_my_number

inside_counter = 0
outside_counter = 0
# Pause weapon detection
```

Figure 11.2: SMS Notification Execution

5.5 Application of Engineering Codes and Standards used in Final Design /

The following IEEE Codes and Standards were used in the final design of our project:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision - This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

3) To be honest and realistic in stating claims or estimates based on available data

5) To improve the understanding of technology, its appropriate application, and potential consequences

5.6 Economic Analysis

The economic analysis of our project can be separated into two phases. There were different components that were used in each phase which we will outline below. During phase one we were given the parts that we needed to start a preliminary design of our project. The parts that we used in our phase one design were given to us by the school and can be seen in table 4.1.

Item Name	Quantity	Total
Raspberry Pi 3b+	1	Pre-owned
Raspberry Pi Camera Rev 1.3	1	Pre-owned
	Total:	\$0

Table 4.1: Phase I Cost

After completing the testing of phase one with the given parts, we were able to identify which parts needed updating and investigate ways that we can improve our design. We needed to update our Raspberry Pi 3b+ to the Raspberry Pi 4b which is a more powerful and faster model, we also upgraded our MicroSD card so that our Raspberry Pi can hold more storage. Another upgrade to our project was the addition of the Google Coral Accelerator, which increases the frame rate of our camera and video processing. To connect the Raspberry Pi 4b to a monitor and observe an area we had to purchase a Micro HDMI to HDMI cord. The updated cost of our project can be seen in table 4.2.

Item Name	Quantity	Total
Raspberry Pi 4b	1	\$134
Raspberry Pi Camera Rev 1.3	1	Pre-owned
Google Coral USB Accelerator	1	\$174.58
Micro HDMI to HDMI cord	1	\$16.95
Micro SD card	1	\$20
	Total:	\$345.53

Table 4.2: Smart Threat Detection System Cost

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures L2.1 - 12.3 depict a rifle being detected by our camera. The yellow box and word "rifle" are specific to that class of weapon. In various orientations, including partially covered, the rifle is detected with remarkably high confidence.



Figure 12.1: Rifle Detected with 95% Confidence

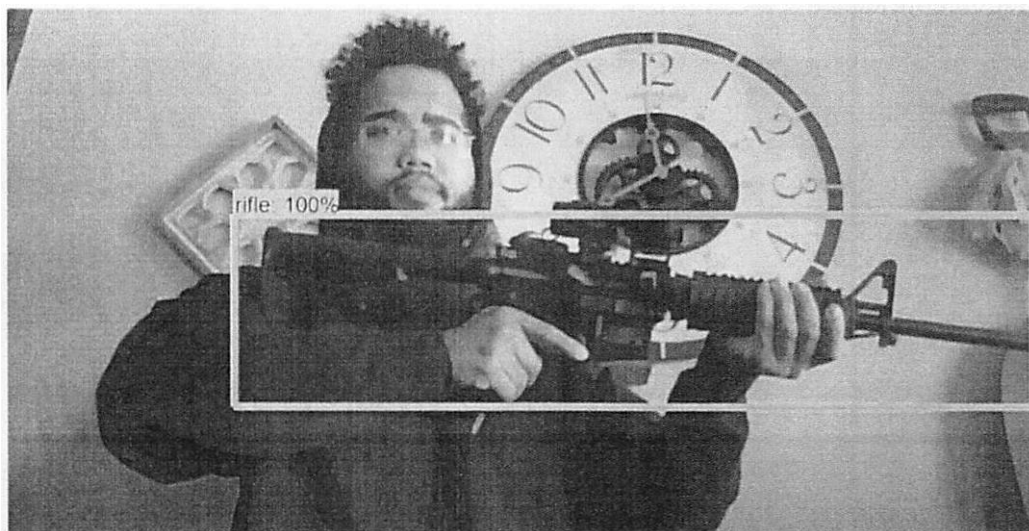


Figure 12.2: Rifle Detected with 100% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

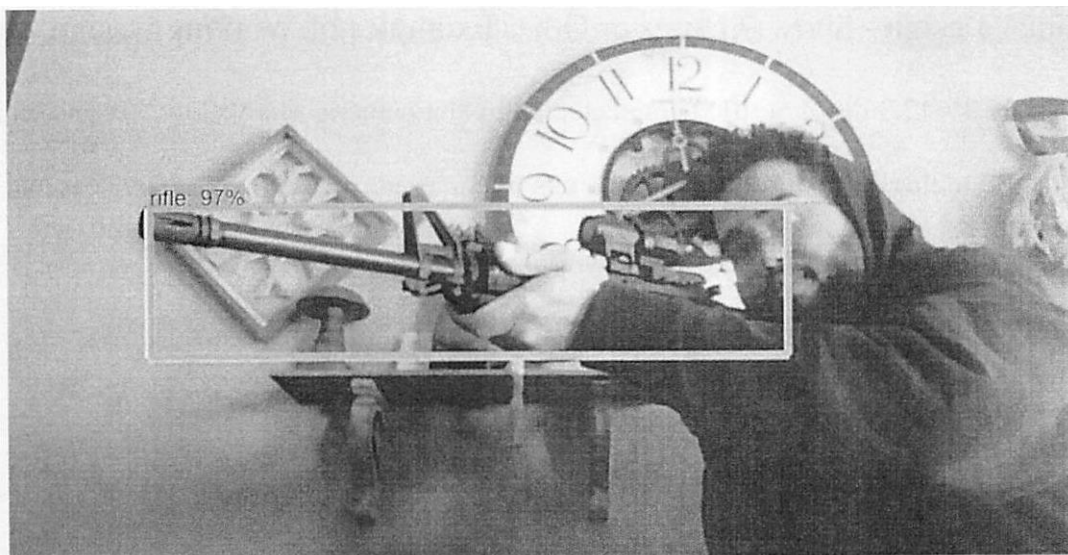


Figure 12.3: *Covered Rifle Detected with 97% Conjhle11.ce*

Figures 13.1 - 13.5 below depict a handgun being detected by our camera. The green box and word "handgun" are specific to that class of weapon. In various orientations, including the barrel pointed towards the camera and a black gun on a black background, the handgun is detected with high confidence.

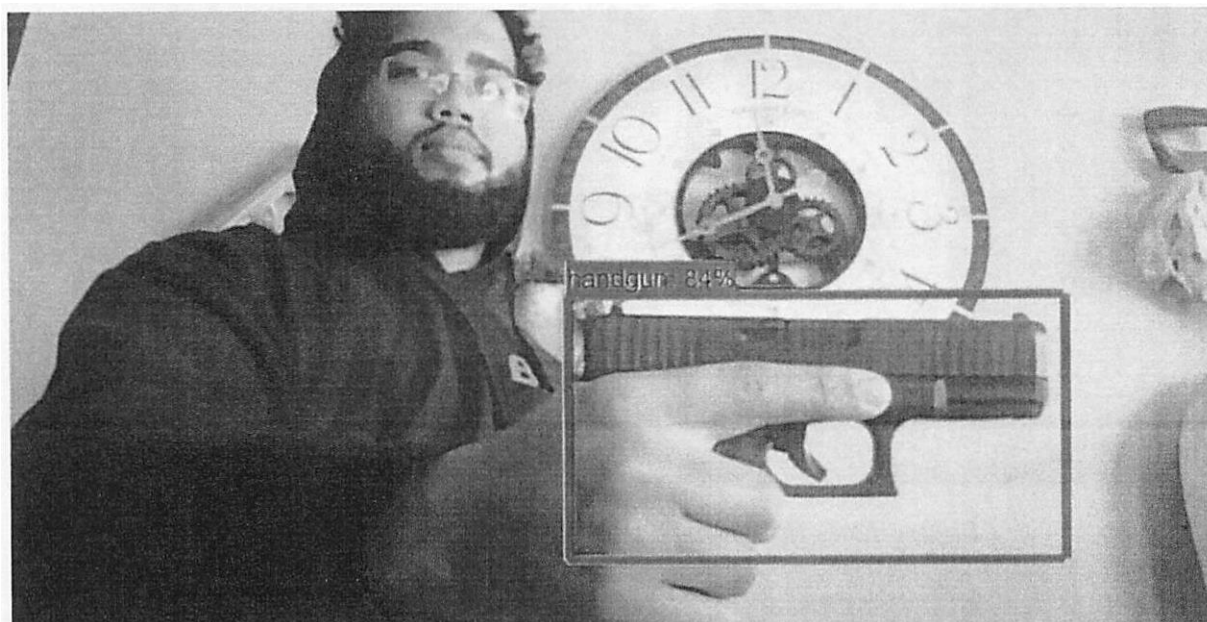


Figure 13.1: *f1011dgu11 Detected rith 84o/cCm1/frle11ce*

5. 7 Final Design - Show Pictures or Other Examples of Working Design

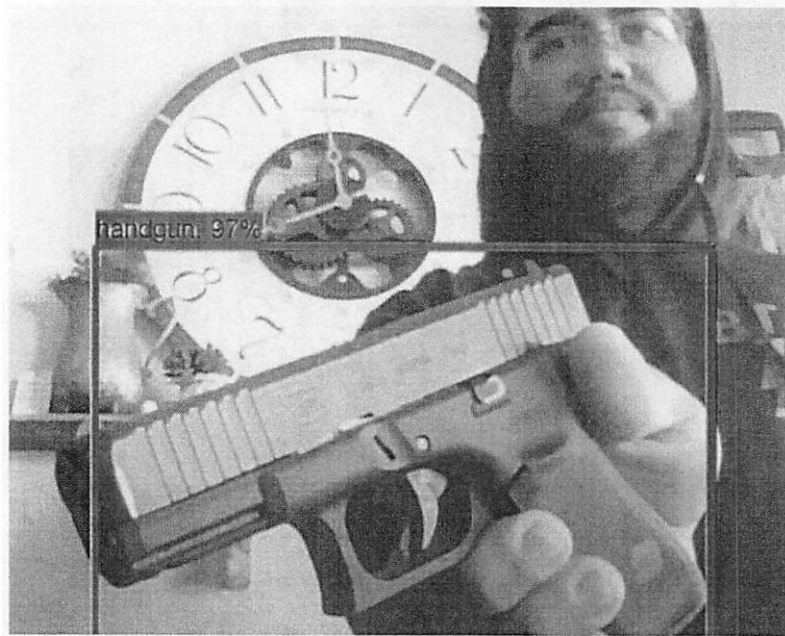


Figure 13.2: HaHdg1111Detected with 97% Confidence

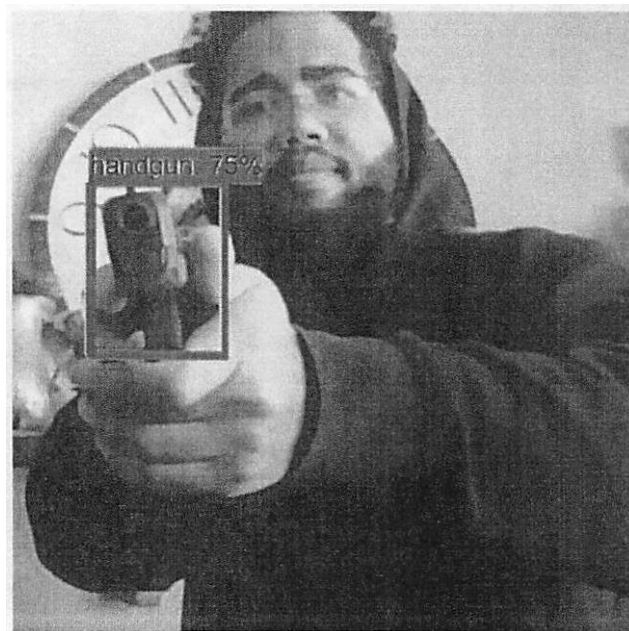


Figure 13.3: Barrel Poillfed at Camera Detected with 75% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

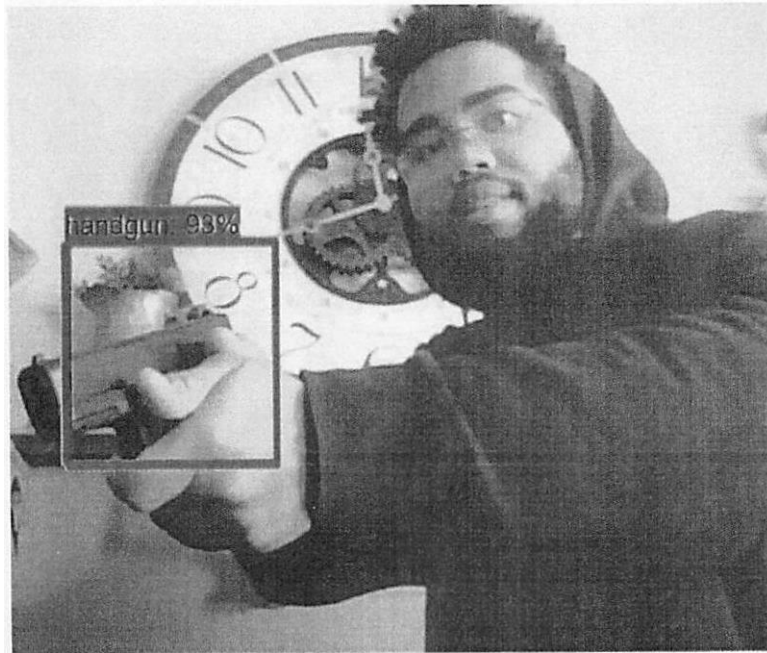


Figure 13.4: *Partially Covered Handgun Detected with 93% Co11/fre11ce*

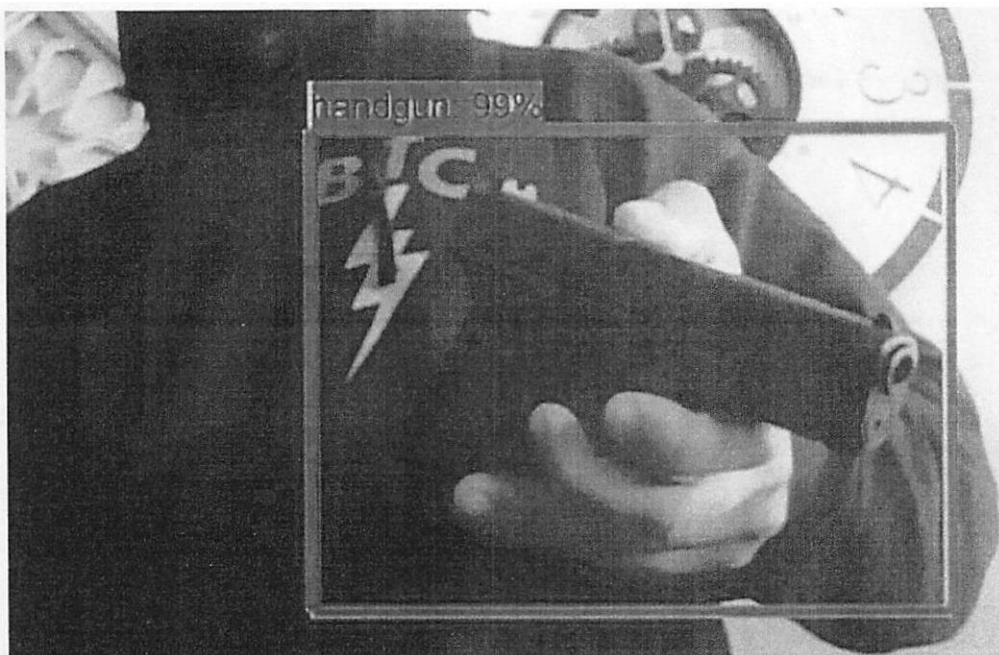


Figure 13.5: *Black Handgun Detected 011 Black Jacket with, 99% CQJlidence*

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 14.1 - 14.3 below depict a blade being detected by our camera. The greenish yellow box and word "blade" are specific to that class of weapon. The blade is detected with high confidence. However, the algorithm is less than 60% confident in categorizing the blade when its narrow profile is facing the camera. Objects with a confidence level less than 60% are not displayed on the screen.

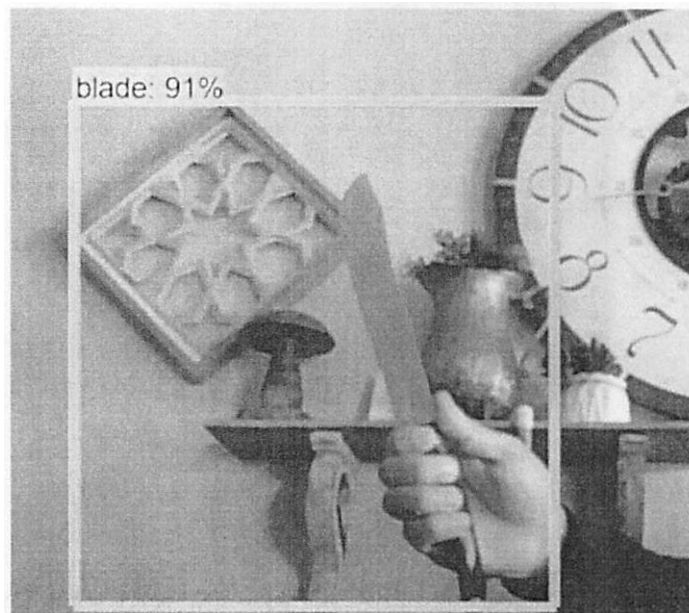


Figure 14.1: Blade Detected with 91% Confidence

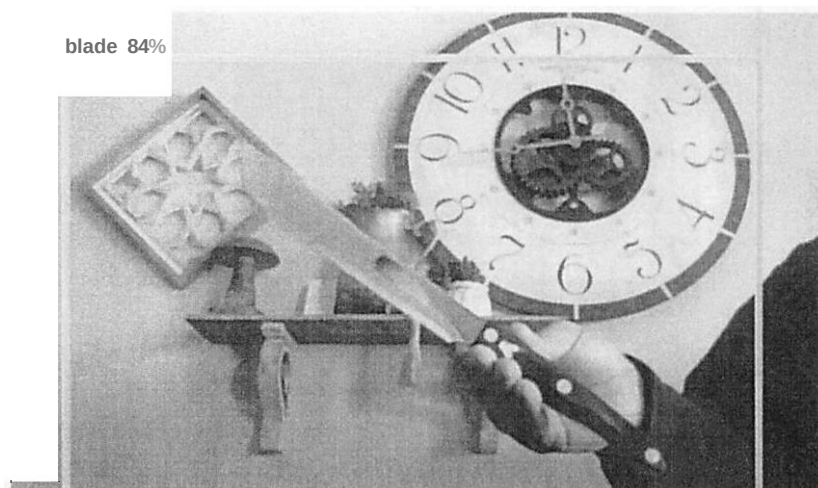


Figure 14.2: Blade Detected with 84% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design



Figure 14.3: *Narro11· Prrfile r!f 8/ude not Detec!ed*

Figure 15 shows an example of what the notification could read when a weapon is detected. The "Sent from your Twilio trial account" portion does not appear when the small messaging fee is paid.

Today 7:59 PM

Sent from your Twilio
trial account - A
weapon has been
detected on your
camera!

Figure 15: *Exa111ple No1ificatio11*

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 16.1 & 16.2 demonstrate how the algorithm does not accidentally depict a similar looking object as a weapon. In this case, the phone is being held in a way a handgun would be held and no box is ever displayed. This shows that there are very few false positives.



Figure 16.1: *Cell Phone False-Positive Test (part 1)*

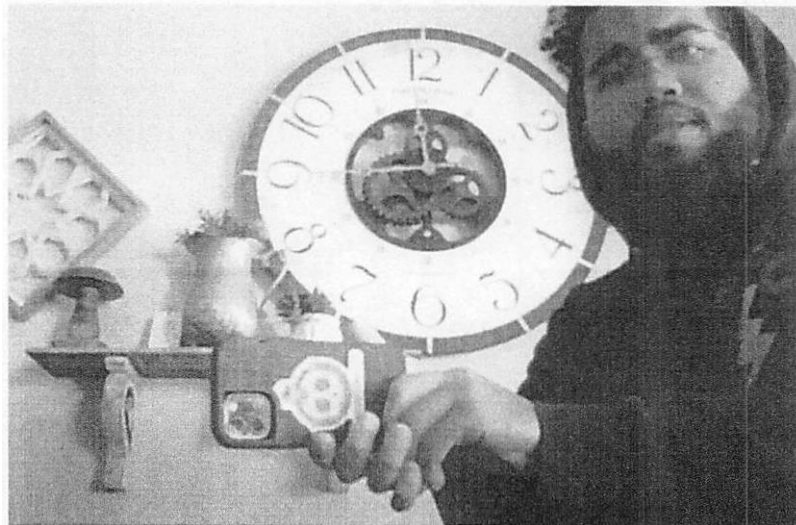


Figure 16.2: *Cell Phone False-Positive Test (part 2)*

Section 6 - Results and Discussion

6.1 Summary of Goals and Objectives

The main objective was to implement object detection onto Raspberry Pi. We ran a mobile deep learning model, SSD-MobileNet, on Raspberry Pi to detect various objects. Our experimental results demonstrated the effectiveness of this implementation. Moreover, the on-going work was to extend this implementation to weapon detection, which was used to detect different weapons in a real-time manner. Upon completing and validating this extension in different testing scenarios our results were successful. In order to complete the smart security system a notification system was integrated into the object detector once the new categories of objects were trained to be detected. This ensured that once a weapon was detected in the frame a text notification was sent to the appropriate authorities warning them of the potential threat.

6.2 Summary of Constraints and Codes met by Design

The main constraints we have observed with this project are creating a durable housing kit for the raspberry pi with a mountable camera that is capable of staying in place for an extended duration of time. The next constraint was the camera resolution impacting the accuracy of the weapon detection, as well as the distance that the camera is able to view, to fix this having a camera that has a minimum resolution of 1080p will ensure a clear quality to have the highest accuracy. The final notable constraint with our project was the frame rate of the real time tracking with the raspberry pi. Due to the severity of this issue we needed to increase the frame rate of the hardware, and after thorough research on how to solve the issue, the best solution to the situation was changing our software to TFJite and quantizing the data as well as utilizing a USB accelerator device in order to aid in speeding up the frame rates of the overall system.

The following codes were used in our final design:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision - This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology

for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

6.3 Discussion of Results and Other Use Cases

This project allowed us to design a completely unique security system by utilizing a machine learning algorithm capable of detecting weapons and immediately notifying the owner of the potential danger that is within the area. Designing this system granted us the opportunity to offer a more advanced security system to consumers at a lower cost compared to competitors. Machine learning has not been introduced to security systems easily and with the introduction of our device, we would be offering a continuously learning security system that will offer greater results as time goes on while also being capable to notify the owners of the home or establishment of a potential threat.

The use of this system can be expanded into being capable of finding concealed weapons with the implementation of an infrared camera, with this feature the number of areas this system would be able to be set up will drastically increase due to the uncertainty of if there is a weapon on a person. Taking into consideration that weapon detection is a specialization of object detection, the other uses of object detection can be implemented into several types of trackers, such as a people tracker, a vehicle tracker, or even an animal tracker. These would also easily be able to be used to notify when any object, not just a weapon, is detected in a certain area.

Section 7 - Conclusions and Recommendations

Section 7 - Conclusions and Recommendations (continued)

[!]
-j

It is observed that a large population reconciles violence related to various weapons such as guns and knives all over the world. Therefore, it is a good proactive solution to detect these weapons in public areas to defend against this violence. Our Weapon Detection on Raspberry Pi design identifies active threats by revealing displayed weapons. These weapons can be either a rifle, a handgun, or a blade and the weapon must be in view of the camera. Our alert notification system provides additional time for actions to be taken to minimize casualties.

We recommend having a mountable dry surface for the Raspberry Pi platform. Wi-Fi and or data service are needed for text notifications. Electricity to run power to the Raspberry Pi system is also required. In the event of power failure, the possibility of having a backup generator is convenient to prevent system interruption. This artificially intelligent threat detection system will impact many from universities and church organizations to businesses and homeowners.

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.Appendix.

Code to Run Camera and Send Notification:

```

## Webcam Object Detection Using TensorFlow-trained Classifier #####
ti
## Description:
u This program uses a TensorFlow-trained classifier to perform object detection.
u It loads the classifier and uses it to perform object detection on a webcam
feed.
# It draws boxes, scores, and labels around the objects of interest in each frame
it from the webcam.

```

```

## Import packages
import ctypes
import os
import
import as np
import cv2 as tf
import sys

```

```

## This is needed since the notebook is stored in the object_detection folder.
sys.path

```

```

import utilites
from utils import label_map_util
from utils import visualization_utils as vis_util

## Explain why this would be the case and the benefits of
such an
implementation? Do you expect the performance of suboptimal choice of the
parameter triplet
to dramatically impact the link throughput performance?
visualization_utils import vis_util

```

```

## Set up TensorFlow
import

```

Appendix (cont.)

```
# Twilio SID, authentication token, my phone number, and the Twilio phone number
account_sid    'AC7-d4e089-79-f94ee3b3b40f177a::: k 143,1'
auth_token     '-49-5-2-8bcU-208-:J14b99bfba8-:,6666ccJ.81::'
```

```
my_number = -2-542 5-1-102-'
twilio_number '19362510045'
```

```
client          :account_sid auth_token
```

```
## get Screen Size
user32, ctypes.windll
screen_width screen_height user32
user32,.,,,:-. ..~. >:..--: _..il;;
frame_height. frame_width.
```

```
scaleWidth float, screen_width .*. 'float. frame_..Jicldth
scaleHeight float screen_height float- frame_h'2ight
```

```
if scaleHeight scaleWidth
    imgScale scaleWidth
```

```
else
    imgScale scaleHeight
```

```
newX newY .          J.. imgScale          t' imgScale
frame cv2          int newX int newY
WINDOW_NAME 'Full Integration'
```

```
#Setup camera constants
IM_WIDTH 1280
IM_HEIGHT 720
```

```
// Name of the directory containing the object detection module we're using
MODEL_NAME 'in_Ferenc':_graph'
```

```
# Grab path to current working directory
CWD_PATH os
```

```
# Path to frozen detection graph .pb file, which contains the model that is used
```



```

n for object detection.
PATH_TO_CKPT = os.path.join(CWD_PATH, MODEL_NAME, 'frozen_inference_graph.pb')

# Path to label map file
PATH_TO_LABELS = os.path.join(CWD_PATH, training, 'labelmap.pbtxt')

# Number of classes the object detector can identify
NUM_CLASSES

it1t Load the Label map.
# Label maps map indices to category names, so that when our convolution
# network predicts '5', we know that this corresponds to 'king'.
# Here we use internal utility functions, but anything that returns a
# dictionary mapping integers to appropriate string labels would be fine
label_map_util = load_label_map_util(PATH_TO_LABELS)

categories = label_map_util.get_categories()
num_classes = NUM_CLASSES
use_dj_splay_name = True

category_index = label_map_util.get_category_index(categories)

# Load the TensorFlow model into memory.
detection_graph = tf.Graph()
with detection_graph.as_default():
    op_def = tf.GraphDef()
    with tf.gfile.FastGFile(PATH_TO_CKPT, 'rb') as fid:
        serialized_graph = fid.read()
        op_def.ParseFromString(serialized_graph)
    detection_graph.as_default()
    tf.nn.conv2d

tf.nn.conv2d = graph_detections_graph

# Define input and output tensors (i.e. data) for the object detection classifier

# Input tensor is the image
image_tensor = tf.placeholder(tf.float32, [1, None, None, 3], name='image_tensor:0')

```

†† Output tensors are the detection boxes, scores, and classes

Appendix (cont.)

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J

Appendix (cont.)

```
# Each box represents a part of the image where a particular object was detected
detection_boxes = detection_graph
```

```
# Each score represents level of confidence for each of the objects.
# The score is shown on the result image, together with the class label.
detection_scores = detection_graph
detection_classes = detection_graph
```

```
# Number of objects detected
num_detections = detection_graph
```

Initialize other parameters

```
# Initialize frame rate calculation
frame_rate_calc1
freq = cv2.
-font = cv2
```

n Define inside box coordinates (top left and bottom right)

```
TL_inside = (int(IM_WIDTH*0.008), int(IM_HEIGHT*0.008))
```

```
BR_inside = (int(IM_WIDTH*0.99), int(IM_HEIGHT*0.99))
```

~~####~~ outside box coordinates (top left and bottom right)

```
#TL_outside = (int(IM_WIDTH*0.46),int(IM_HEIGHT*0.25))
```

```
#BR_outside = (int(IM_WIDTH*0.8),int(IM_HEIGHT*0.85))
```

ff: Initialize control variables used for weapon detector

```
detected_inside = False
```

```
#detected_outside = False
```

```
inside_counter = 0
```

```
#outside_counter = 0
```

```
pause = 0
```

```
pause_counter = 0
```

```
# Initialize frame rate calculation
```



```

frame = r'tt_cal(
    irEl1 = cv2
    t orrr: = cv2

# Initialize webcam feed
video = cv2.VideoCapture(0)
    video.set(3, 1280)
    video.set(4, 720)

def process_frame(frame):

    # Use globals for the control variables so they retain their value after
function exlts
    global clet<:Tted_inside
    global .insicJe countPr
    global pau.;, pause_counter

    frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
    frame = frame[0:1000, 0:1000]

    # Acquire frame and expand frame dimensions to have shape: [1, None, None, 3]
    # i.e. a single-column array, where each item in the column has the pixel RGB
value
    ret, frame = video.read()
    frame_rgb = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
    frame_expanded = np.expand_dims(frame_rgb, axis=0)

    # Perform the actual detection by running the model with the image as input
    boxes, scores, classes, num_detections = model.predict(frame_expanded)

    # Draw the results of the detection (aka 'visualize the results')
vis_util
    frame = frame_rgb[boxes[:, 0]:boxes[:, 1], boxes[:, 2]:boxes[:, 3]]

```

```

np. ....: (boxes.
np. ....: ' ', ..classes .. np
np. ....: ..: .., .scores
category_index.
use_normalized_coordinates. True
line_thickness 8.
min_score_thresh 0.50

# Draw boxes defining "outside" and "inside" locations.
#cv2.rectangle(frame, TL_outside, BR_outside, (255, 20, 20))
#cv2.putText(frame, "Outside #box", (TL_outside[0]+10, TL_outside[1]-
10), font, 1, (255, 20, 255), 3, cv2.LINE_AA)
cv2.:: frame TL inside BR_insideP .. ,,,,
cv2.: - -frame. "Detection Area" BR inside
..: TL_inside:1, JS-Font. 1, 20 hS :S: : cv2
    Check the class of the top detected object by looking at classes[0][0].
    # If the top detected object is a weapon (1-4)
    # find its center coordinates by looking at the boxes[0][0] variable.
    # boxes[0][0] variable holds coordinates of detected objects as (ymin, xmin,
ymax, xmax)
    if int classes[0][0] == 1 or int classes[0][0] == 2 or
int classes[0][0] == 3 or int classes[0][0] == 4 and pJuse
        x = int. boxes[0][0] + boxes[0][2] / 2 IM_WIDTH
        y = int. boxes[0][0] + boxes[0][3] / 2 IM_HEIGHT
        # Draw a circle at center of object
        cv2. frame, (x, y), 5, (0, 0, 255), 2
        # If object is in inside box, increment inside counter variable
        if x > TL_inside and x < BR_inside and y > TL_inside and
y < BR_inside
            inside_counter = inside_counter + 1

if inside_counter == 300
    detected = True
    message = client
        body = 'A 1r-leapon has been detected!.' + 'CH1:~ r :nwtr:!'
        from twilio_number
        to my_number

inside_counter = 0
outside_counter = 0
# Pause weapon detection by setting "pause" flag
pause = 1

```

```

# All the results have been drawn on the frame, so it's time to display it.
cv2.imshow('Object detector')

# Press 'q' to quit
if cv2.waitKey(1) < 0:

# Clean up

cv2.destroyAllWindows()

```

Code for the Training of the Model

```

r"""Training executable for detection models

This executable is used to train DetectionModels. There are two ways of
configuring the training job:

1) A single pipeline_pb2.TrainEvalPipelineConfig configuration file
can be specified by --pipeline_config_path.

Example usage:
./train \
  --log_to5 tderr \
  --cnn_dir==path/to/train_dir \
  --pipeline_config_path=... \
  --model_dir=... \
  --input_reader=... \
  --train_pb2=train_config.pbtxt

2) Three configuration files can be provided: a model_pb2.DetectionModel
configuration file to define the type of DetectionModel is being trained, an
input_reader_pb2.InputReader file to specify what training data will be used and
a train_pb2.TrainConfig file to specify training parameters.

Example usage:
./train \
  --model_dir=... \
  --input_reader=... \
  --train_config=... \
  --model_config=... \
  --input_reader=... \
  --train_pb2=train_config.pbtxt \
  --model_pb2=model_config.pbtxt \
  --input_reader_pb2=input_reader.pbtxt

```



```
--logtostderr \
--train_dir=path/to/train_dir \
--model_config_path=model_config.pbtxt \
--train_config_path=train_config.pbtxt ,
--input_config_path=train_input.config.pbtxt
```

```
###
```

```
import functools
import json
import os
import tensorflow as tf
from tensorflow.python.ops import
```

```
from object_detection.builders import data_loader
from object_detection.builders import
from object_detection.builders import
from object_detection.builders import
from object_detection.builders import
```

```
tf tf
```

```
flags tf
flags 'master'. 'Name of the tensorflow master to use.'
flags 'task' tf 'task id'
flags 'num_clones' J 'Number of clones to create. If set to 0, clones will be created on the CPU. Note that if
flags 'clone_on_cpu' False
'Force clones to be deployed on CPU. Note that if set to True (all training operations will be run on the CPU. If you have no GPU kernel,
flags 'worker_replicas' 1 'Number of worker replicas. If set to 0, the training will be run on the CPU. If you have no GPU kernel,
flags 'replicas.'
'ps_tasks' }
'Number of parameter server tasks. If None, does not run a parameter server.'
flags.. 'train_dir'
'Directory to save the checkpoints, and training snapshots.'
```

```
flags 'pipeline_config_path'
'Path to a pipeline_pb2.pbtxt or pipeline_config.pbtxt file.'
```

Appendix '(cont.)

```

·fj lE=: If p(•ovided, other"" configs are ignored·>

flags · ·train_con fig_path ·

·Path to a train_pb2.TrainConfig config file.'·1
flags 'input..con+ig_path' . ' '
·Patl1 to n input_reader_pb2.InputReader config file.)
f.lags. · 'model_conf.ig_path' .

; PzrU-, to a nio(fol pb2.DetectionModel config -file.' :

FLAGS Hags

, None. 'Use obj(;;Ct _cletec t:ion/model_main. py. ')
def

assert FLAGS · 'train_clir' is·missing.'
if FLAGS r,; tf FLAGS.:_.,.t; d r)
if FLAGS
    configs line(file(
        FLAGS
    H FLAGS ·.
    tf FLAGS

    os path FLAGS 'pipeline.config'
    overwrite True

else
    configs
        model_config_path FLAGS
        train_config_pa th FLAGS

        train_input_config_path -FLAGS
if FLAGS 8

·for· name con-fig in ·,noth J.config' FLAGS ·,·_
        'crain. con+ig' FLAGS
        'lnput.config' FLAGS
    tf config os path FLAGS name
        over'\nrite True

model_config con-figs 'model'

train_con-fig configs 'train_config'
input_config configs 'train_input_config'

```

model fn functools partial

AIO


```

model_builder.ModelBuilder
model_config model_config
is_training=True,

def __init__(self, config):
    return super().__init__(config)

create_input_dict_fn = functools.partial(input_dict_fn, input_config)

env = os.environ.get('TF_CONFIG')
cluster_data = env.get('cluster', None)
cluster_spec = {} if cluster_data else None

task_data = env.get('task', None) or {'type': 'master', 'index': 0}

task_info = type('TaskSpec', (object,), {'task_data': task_data})

# Parameters for a single worker.
ps_tasks = 0
worker_replicas = 1
worker_job_name = 'loneJy10:kr:1'
task_index = 0
is_chief = True
master = ''

if cluster_data and 'worker' in cluster_data:
    # Number of total worker replicas include "worker"s and the "master".
    worker_replicas = cluster_data['worker'] + 1
if cluster_data and 'ps' in cluster_data:
    ps_tasks = cluster_data['ps']

if worker_replicas == 1 and ps_tasks == 0:
    raise ValueError('At least 1 ps task is needed for distributed training.')

if worker_replicas == 1 and ps_tasks == 0:
    # Setup distributed training.
    server = tf.train.Server(
        tf.train.ReplicaSpec(
            job_name=task_info.job_name,
            task_index=task_info.task_index,

```

cluster, term protocol, group

```

if task_info['ps']
    server
    return

```

```

worker_job_name = '%s/task:%d' % (task_info.type, task_info.index)
task = task_info,
is_chief, task_info['master'],
master, server.

```

```

graph_rewriter_fn = None
H['graph_rev_iterator_config'] in configs:

```

```

graph_rev_iterator_fn = create_iterator_fn(
    config['graph_rev_iterator_config'], is_training=True;

```

```

create_input_dict_fn
model_fn
train_config
master
task
FLAGS.
    worker_replicas
FLAGS.
    ps_tasks
    worker_job_name
    is_chief
FLAGS
    graph_hook_fn = graph_rewrite_fn.

```

```

if __name__ == '__main__':
    tf

```

A12

ASSIGNMENTS FOR OUTCOME “3”

An ability to communicate effectively with a range of audiences (Oral Communication)

**ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II
SPRING 2022**

Instructor: VJ Turner & Sarhan Musa

Title of Assignment

Final Oral Presentation

Outcome Measured Using this Assignment

Outcome 3

**An ability to communicate effectively with a range of audiences
(Oral Communication)**

Check the communication characteristics related to this assignment

X	Involves ability to organize, plan, design/prepare and use appropriate visual aids for communication/presentation to a range of audiences (executives, technical and non-technical).
X	Involves ability to demonstrate technical knowledge and understanding of the subject, prepare and display prototypes or models when they are necessary, respond clearly to questions in a professional manner
X	Requires use of correct grammatical English and technical terms appropriate to technical area and audience type; ability to speak with clarity and confidence, maintain good posture and eye contact with the audience
X	Geared to diverse groups of stakeholders (students and industrial representatives, etc.)

Brief justification of the suitability of assignment for the outcome

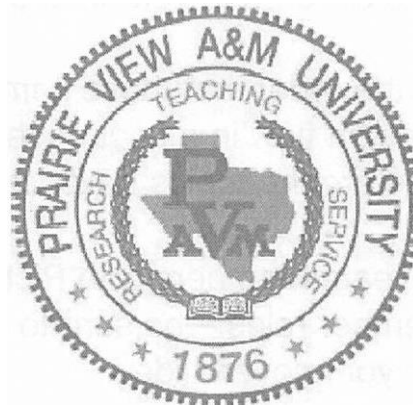
In this assignment the students will demonstrate technical project results and demonstrate their ability to communicate verbal accomplishments.

Outcome 3 - Oral

Outcome 3

Oral Assignment

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Senior Design & Professionalism II
ELEG4287

Final Exam Oral Presentation

Due Date Monday April 18 at 5 pm (Central Time) (Late= minus 10)

Post Final Oral Presentation on Canvas Assignment - One Per Team

You will have 30 minutes to present plus O&A

Note: avoid acronyms or general concepts unfamiliar to those not close to your project - if you must use, they should be explained earlier

Reminder: Everyone on the team must cover some aspect of the final presentation

Each Team will drive their presentation during the final Zoom meeting
(so make sure all your links and videos work)

Practice Practice Practice so you don't embarrass yourself and the College of Engineering

Each Team will have 30 mins plus 15 mins for Q&A

Below are items to be covered in your final presentation.

This does not mean the order that these items are covered. You must put together your present flow in a sequence that makes sense to your project but these are the topics I expect you to cover.

- Project Title, List of Team Members with Picture including academic majors and team member roles - be sure to add Faculty Sponsor and Course Instructor on your cover slide
- Problem Statement - what problem are you trying to solve
- Project Objective and Target Audience of your project
- Marketing and Engineering Requirements
- Proposed Deliverables - what are you actually going to deliver
- Constraints and Assumptions
- Preliminary Design Concept - What is preliminary design/ proposal
- Brief overview of the competitive landscape - what other concepts are you competing with (what you gained/learned from literature review)
- List advantages/disadvantages of your proposed design
- Show broader technical/societal/economic impacts
- Project High Level Schedule showing completion by **April 2022**
- Project Iterations from Preliminary to Final
- Detailed Final System Design (diagram, schematics etc.)
- Project Parts Summary
- List of Engineering Codes and Standards
- Project Demonstrations via pictures and/or video (10 mins max)
- Final Conclusions and Recommendations
- " Questions " Slide at the end of your main presentation
- Back Up Slides Must Include:
 - Executive Summary Slides must be in Back-Up
 - Design Methodology how did you arrive at proposed design
 - Literature Review References
 - Economic Analysis
 - Other Slides you created but didn't have time to show

ASSIGNMENTS FOR OUTCOME “3”

An ability to communicate effectively with a range of audiences (Written Communication)

**ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II
SPRING 2022**

Instructor: VJ Turner & Sarhan Musa

Title of Assignment

Final Written Presentation

Outcome Measured Using this Assignment

Outcome 3

**An ability to communicate effectively with a range of audiences
(Written Communication)**

Check the communication problem characteristics related to this assignment

Ability to prepare an executive summary for the report Requires students to:	
X	Prepare an executive summary of 5 to 8 pages.
Ability to organize, plan and properly format a written technical report Requires students to:	
x	Organize report by chapters, major sections, subsections and paragraphs
x	Provide Title Page, and Table of Contents, list of Figures, and List of Tables properly formatted.
x	Provide figure and table numbers with titles and reference and discuss each table and figure in accord with standard practice.
x	Properly cite references in the report and provide well formatted reference list at the end.
x	Prepare the written report in accord with standard report formatting Manual
Ability to compose original texts and properly apply the conventions of written language. Requires students to:	
X	Properly apply capitalization, punctuation, and penmanship, to communicate clearly and spell proficiently,
X	Apply standard grammar and usage to communicate clearly and effectively in writing using complete sentences , good subject-verb agreement, pronoun referents, and parts of speech, properly using adjectives, adverbs, prepositional phrases appropriately, conjunctions to connect ideas to make writing vivid and precise, and use available technology to support aspects of creating, revising, editing, spell checking, and publishing the report.
Ability to provide appropriate discussion, conclusions and recommendations Requires students to	
X	summarize the goals, objectives, and indicate whether they were met.
X	summarize the report chapter by chapter
	summarize constraints and codes and indicate whether they were met for design reports Summarizes how issues relating to public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors were considered/addressed for design reports.
X	Provide logical conclusions Provide logical conclusions and recommendations (including strengths and weaknesses)

Brief justification of the suitability of assignment for the outcome

The assignment for outcome 3 (written report) will cover all aspects of the project. In this assignment students will demonstrate their ability develop a very thorough written report that anyone familiar or unfamiliar with the project or technology could understand. This final report will service to document every aspect of the project from concept to final design.

ELEG 4482 SENIOR DESIGN & PROFESSIONALISM II

SPRING 2022

Title of Presentation: Outcome 3 – Written Report Rubric						
Team Number and Members:						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Executive Summary						
Able to prepare an executive summary for the report						
Format						
Able to organize the report e.g. Title Page, and Table of Contents, list of Figures, and List of Tables properly formatted						
Charts and Graphs in the report are well documented, easily understood and referenced appropriately						
Able to show appropriate discussion, conclusions and recommendation						
Able to cite references in the report and provide well formatted reference list at the end						
Able to prepare the written report in accord with the Senior Projects Report Manual and instructor guidance						
Written Language						
Able to write the report without grammatical errors						
Report includes appropriate level of detail and analysis						
Able to write the report in excellent professional style – no unexplained technical jargon or acronyms						
Apply approved standard method to cite references used and in literature review						
Conclusion and Recommendation						
Able to summarize goal objective and indicate if they are met						

**Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester**

**PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING**



**Senior Design & Professionalism II
ELEG 4248**

Final Exam Report

Due Date Sunday May 1 by 5:00pm (Central Time)

Upload to Final Exam Written Report Assignment On Canvas

Due date is firm: early is ok and late is (- 10 points)

Upload only a word document – do not upload a PDF or PowerPoint

This document will serve as your final exam report

Instructions:

- Avoid unexplained acronyms
- Word Document Only – No PDF or other formats
- There is no page limit and number all pages
- OK to use diagrams or pics but they must be explained clearly
- The formatting for this document must be precisely followed

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

Report

Your senior design project is intended to be a cumulative effort to produce a product based on a structured design sequence. Please document your project for the academic year by including the following elements in your Final Semester Report per this table of contents that is based on the Senior Design Manual posted on eCourse. All team members should contribute to the writing and technical content of your report.

Your team report will be graded for the design process quality and the writing quality. The sections of the report are to demonstrate the following **technical aspects** of learning for your team:

1. Ability to Define/Understand the Problem and then Plan the Project
 - a. Identify the customer and the needs.
 - b. Identify and list the design objectives.
 - c. Identify the design constraints.
 - d. Define the design strategy and methodology.
 - e. Identify and break down work into tasks and subtasks and identify the personnel and deliverables for each.
 - f. Develop a Gantt chart and critical path analysis for managing the project.
 - g. Establish major milestones for tracking progress and define performance metrics to measure success
2. Ability to Conduct a Review of the Literature, Generate Ideas and Apply Creativity
 - a. Identify the types of information needed for a complete understanding of all aspects of the project (Based on task described in the project planning).
 - b. Gather information on relevant fundamentals, theory / concept (demonstrate technical competence) and relate them to the design.
 - c. Provide the sources in a list of references properly cited in the literature review section and relevant sections of the report.

Formal report writing is also an important component of the senior design course. Your team report should also demonstrate the following process of writing:

1. Ability to organize, plan and properly format a written technical report
 - a. Students are able to organize report by categorizing ideas for the report into well and logically organized chapters, major sections, subsections and paragraphs blended within the larger units.
 - b. Students provide Title Page, Abstract, and Table of Contents, list of Figures, and List of Tables properly formatted.
 - c. Students provide figure number and title for each figure in the report, reference each figure, and completely discuss each figure in the report in accord with standards in the project manual.

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

- d. Students provide table number and title for each table in the report in accord with standards in the project manual, reference each table, and completely discuss each table in the report.
 - e. Students properly cite references in the report and provide well formatted reference list at the end.
 - f. Students prepare the written report in accord with standard report formatting provided in the Senior Projects Report Manual.
2. Ability to compose original texts and properly apply the conventions of written language.
- a. properly apply capitalization, punctuation, and penmanship, to communicate clearly
 - b. Spell proficiently
 - c. Apply standard grammar and usage to communicate clearly and effectively in writing including:
 - i. using complete sentences, varying the types such as compound and complex to match meanings and purposes
 - ii. properly employing standard English usage in writing for audiences, including subject-verb agreement, pronoun referents, and parts of speech
 - iii. properly using adjectives (comparative and superlative forms) and adverbs appropriately to make writing vivid or precise
 - iv. properly using prepositional phrases to elaborate written ideas properly using conjunctions to connect ideas meaningfully
 - i. Use available technology to support aspects of creating, revising, editing, spell checking, and publishing the report.
3. Ability to provide appropriate discussion, conclusions and recommendations
- a. Summarize the goals, objectives, and indicate whether they were met.
 - b. Summarize the results.
 - c. Summarize constraints and codes and indicate whether they were met.
 - d. Provide logical conclusions and recommendations (including strengths and weaknesses).
 - e. Describe the future work that can be done to update and/or extend your project product.

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

ELEG 4248 Sr Design Project Report

Electrical and Computer Engineering Department

ELEG 4248 Senior Design II

Spring Semester

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1. PROJECT SCOPE Please Number All Pages

- 1.1 Problem Statement, Business Objective and Target Audience of your Project
- 1.2 Client identification and recognition of need
- 1.3 Project goals and objectives
- 1.4 Contemporary issues relevant to project
- 1.5 Potential impact of project on society (Safety, Env, Tech, Eco)
- 1.6 Initial Project constraints

2. PROJECT PLANNING AND TASK DEFINITION

- 2.1 Task identification
- 2.2 Gantt Chart- detailed chart not a high level summary

3. LITERATURE REVIEW

- 3.1 List of all sources of information
- 3.2 Statement of Learning from each source

4. PRELIMINARY DESIGN

- 4.1 Concept Generation - describe other designs you considered
- 4.2 Concept Evaluation and selection (evaluation other designs you considered / selection criteria)
- 4.3 Design Constraints and Applicable Codes and Standards
Used in the Preliminary Design
- 4.4 Preliminary Analysis - must show the science/math
- 4.5 Preliminary Design

5. DETAILED SYSTEM DESIGN

- 5.1 Project Parts Summary
- 5.2 Engineering Analysis and/or Simulation must show the science/math
- 5.3 Hardware Layout/Detailed Drawings/Equipment selection
and specifications (Coding only projects replace Hardware with Software and skip 5.3.1)
- 5.3.1 Show Overview of Code Developed to Support 5.3 (only if you developed any code)
- 5.4 Application of Engineering Codes and Standards used in Final Design
- 5.5 Economic Analysis
- 5.6 Final Design - show pictures or other example of working design

6. RESULTS & DISCUSSION

- 6.1 Summary of Goals and Objectives - show deliverables and compare final deliverables with original
- 6.2 Summary of Constraints and Codes met by Design elaborate on codes/how you used in your project
- 6.3 Discussion of Results and Other Use Cases - results summary and add other ideas/use cases

7. CONCLUSIONS AND

RECOMMENDATIONS LIST OF

REFERENCES

APPENDIX (Include user manual or coding documentation if appropriate)

ITEMS in RED are for informational only and do not include the final submission

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester
REFERENCING STYLE

To reference a book, paper, etc. follow IEEE style given below.

Book:

- [1] M. N. O. Sadiku, *Elements of Electromagnetics*. New York: Oxford University Press, 7th edition, 2018, pp. 34-54.
[2] D. F. Beer (ed.), *Writing and Speaking in the Technology Professions: A Practical Guide*. Piscataway, NJ: IEEE Press, 1992.

Paper/article:

- [3] M. N. O. Sadiku and C. Y. Sadiku, "Writing a research report," *IEEE Potentials*, vol. 33, no.4, May 1988, pp. 41-44.

For more than 3 authors, mention only the first author and add et al. (and others)

- [4] J. A.H. Kareem et al., "Social media and consumer awareness toward manufactured food," *Cogent Business & Management*, vol. 3, no. 1, 2016, pp. 1-8.

Conference:

- [5] M. N. O. Sadiku et. al., "Stability criteria for finite difference time-domain algorithm," *Proceedings of IEEE Southeastcon*, April 1990, pp. 48-50.

Internet stuff:

- [6] L. Wijntjes, "Social media in the chemical industry," April 2015,
<https://www.ebcg.com/news/social-media-in-the-chemical-industry/>
-

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

Report Format:

- You must have a table of content with correct page labeling including tables, graphs and pictures
- You must have a cover page
- Double Space
- Number every page
- Title of Each Main Section on Separate Page
- Follow the order listed for each sub section
- You must begin each page with the sub section number and title
- Start a new page for each sub section
- If sub section write up is on more than one page then other pages should say (continued)
- You must cover every sub section do not skip anything
- Grammar and Spelling are critical
- Content please be detailed - show your work and explain it (remember you are not here to explain it so your written explanation must stand on its own)
- There is no word/page maximum
- Font size - do not use small font - if too small it can't be read - use your judgement
- No videos in the report - can use pictures, diagrams, drawings etc
- Include diagrams, flow charts, pictures, drawings and explain everything - be very detailed and thorough

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

Section 1 - Project Scope

Each Main section title should be on its
on page

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

1.1 Problem Statement

Each subsection write up should be on its
on page

**DO NOT COMBINE SUB SECTIONS
ON SAME PAGE**

Electrical and Computer Engineering Department
ELEG 4248 Senior Design II
Spring Semester

1.1 Problem Statement (Continued)

If your write up has several pages per sub section then you should use (Continued) on subsequent slides for that sub section

Electrical and Computer Engineering Department
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Spring Semester

1.2 Client Identification and Recognition of need

Now you should start yours write up for
this sub section on a new page

Written Communications Evaluation Form
ECE Senior Design & Professionalism
Written Communications-Outcome 3

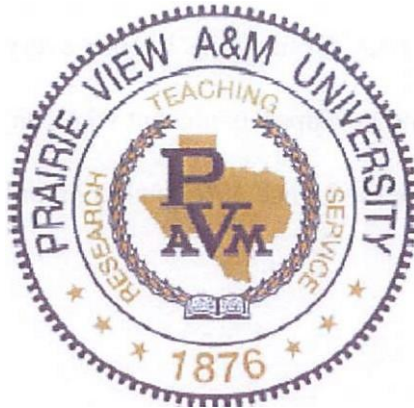
Team 5 - Object Detection Joshua Littleton, Xavier Dukes, Arthur Quinney, Tri'Heem Neville, Christopher Rollerson						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Executive Summary Able to prepare an executive summary for the report	✓					See Executive Summary
Format Able to organize the report e.g. Title Page, and Table of Contents, list of Figures, and List of Tables properly formatted Charts and Graphs in the report are well documented, easily understood and referenced appropriately Able to show appropriate discussion, conclusions and recommendation Able to cite references in the report and provide well formatted reference list at the end Able to prepare the written report in accord with the Senior Projects Report Manual and instructor guidance						See Total Report 5uVll 6 /1 lt. {u!Ot) uv\ c0de Cu?1J1BJ SeJi-0.vA.q lc-u (,1 -t
Written Language Able to write the report without grammatical errors Report includes appropriate level of detail and analysis Able to write the report in excellent professional style - no unexplained technical jargon or acronyms Apply approved standard method to cite references used and in literature review						See Total Report
Conclusion and Recommendation Able to summarize goal objective						See Chapter 7

and indicate if they are met

• /

Aug 90

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Object Detection on Raspberry Pi

ELEG 4247: Senior Design & Professionalism II

Topic: Final Report

Team Number S

Submitted by:

Joshua Littleton (Team Lead)

Tri'Heem Neville

Arthur Quinney

Xavier Dukes

Christopher Rollerson

Instructor: Professor Turner

Faculty Sponsor: Dr. Dong

Date of Submission: May 1, 2022

Excellent
Report
Z

Project Executive Summary



Problem Statement

On average, approximately 4,800 burglaries happen every day. One-third of all robberies result in injury and 39% of the time a weapon is present when an individual is harmed. Arrest rates for Weapon offenses have doubled since 1965 including unlawful possession and trespassing.

Proposed Deliverables

We will be using a Raspberry Pi attached with a camera to survey the area and identify potential threats

The machine learning (ML) algorithm we implement detects the threatening objects on an individual such as weapons in real-time

Once an object defined as a threat is detected, a text notification is sent to the owner/operator's phone allowing them to determine the course of action

Budget

The total budget for our project is \$600.00

The total amount spent on our project is \$340.00

Project Executive Summary (continued)

Customer requirements And Engineering solutions

Mass producible by using easily obtainable/cost-effective parts

Lightweight parts for mounting purposes

Train machine learning algorithm to detect various weapons

The camera needs a resolution of 1080p for increasing the range of detection

Text notification alerts of potential threats

The algorithm classifies threats and non-threats

Detect threats in real-time

j

Major Constraints

The housing for the Raspberry Pi and camera must be mountable

The camera resolution affects detection accuracy and distance

The limited frame rate of the Raspberry Pi camera

Benefits

Societal: This project will offer greater security to those that cannot afford other options.

Businesses will be capable of guaranteeing the safety of customers without infringing upon a customer's 2nd amendment right to carry while within the public space.

Safety: The primary goal of this project is to create an affordable security system for small businesses and homeowners to proactively respond to potential threats however they see fit.

Technical: Machine learning has not been utilized within security systems to this day.

Our project will pioneer a smart security system that will inform you of potential dangers

Project Executive Summary (continued)

at the first sighting of a weapon that would provide a danger to security or the owner.

Recommendations

We recommend that the unit is mounted to a stable elevated surface, ensure there is nothing blocking the camera lens, make sure the Raspberry Pi is located in a well-insulated area to prevent overheating the unit, provide a power source for the Raspberry to connect to, and lastly to get the best usages of our product do not forget to set up a Twilio account for all alerts and notifications.

Conclusion

Our design will identify active threats by revealing displayed weapons. This artificial intelligent threat detection system will impact many from universities and church organizations to businesses and homeowners.

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Perfect ✓

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List of Team Members and Roles

Joshua Littleton	Team Lead
Arthur Quinney	Parts Procurement Lead
Christopher Rollerson	Design Analysis Lead
Tri'Heem Neville	Scribe and Presentation Manager
Xavier Dukes	Software Developer

Section 1 - Project Scope

1.1 Problem Statement, Business Objective and Target Audience

Across the United States, a burglary happens every 15 seconds. This equates to staggering 4800 burglaries a day on average. A burglary is defined as an unlawful entry of a structure to commit a felony or theft. Two-thirds of these burglaries affect residential properties while the remaining third affect small businesses. In 2020, 33,296 robberies involved a handgun, and an additional 8,641 involved a knife. A robbery can be more severe than a burglary, as it must involve threats or actual violence. Arrest rates for weapon offenses have doubled since 1965 including unlawful possession and trespassing. However, according to the U.S. Department of Justice, Bureau of Justice Statistics, a substantial portion of violent crimes that take place in homes have taken place during a burglary incident.

The goal of this project is to design an intelligent monitoring system that will enhance our ability to survey public and private spaces by using object detection to identify various threats that could potentially lead to security risks and/or bodily harm.

The target audience for this project is small businesses, homeowners, hospitals, schools/universities, and churches.

1.2 Client Identification and Recognition of Need

1. The device should be mass-producible; to achieve this we plan to use easily obtainable parts that are cost-effective. Due to the target audience being homeowners and small businesses, we want to make this device available to everyone at a reasonable price.
11. The final product must be mountable and lightweight; this will be achieved by using lightweight materials and cheaper parts. This will ensure that it can be mounted on a wall for extended periods of time without any complications. The final product will be placed in conventional security camera locations, to survey the area.
111. This device must detect a variety of potential threats as weapons come in various shapes, sizes, and calibers. This is a perfect application for machine learning (**M.L.**) as there is not any set of definite rules to classify the myriad of types of weapons there are. The flexibility required for this particular use case lends itself very well to the use of artificial intelligence (A.I.).
- 1v. The detection of potential threats at a distance is imperative to the preemptive Smart Detection System. A high degree of accuracy is required to minimize false positives. Poor resolution can affect accuracy and may not give an adequate warning since the potential threat will have to be closer to the camera when compared to a higher resolution camera. The camera will have a minimum resolution of 1080p to accomplish the goal of high accuracy, but we are also limited by the processing power of the Raspberry Pi.
- v. The device needs to be able to communicate with other devices such as a phone or monitor to deliver the alert notification system. A text message should be sent

1.2 Client Identification and Recognition of Need (continued)

immediately, via Twilio, to the home or business owner for appropriate action to be taken.

- vi. Object detection must be able to distinguish between a threat and a non-threat entity. The Raspberry Pi has limited processing power and should not waste valuable CPU power on low-risk or non-threatening individuals. The M.L. algorithm should focus on items that are deemed as potentially dangerous.
- vii. Real-time tracking is essential as the camera will give real-time data for the environment it is monitoring. The delay between the image processing and the time the data is received should be minimized for the most effective results. Raspberry Pis are particularly suited for real-time environments as they are often used in robotics due to their real-time clock (RTC) functionalities.

Marketing Requirements	Engineering Requirements	Justification
Mass Producing	Easily obtainable and cost-effective parts	Target audience is homeowners and small business owners
Mountable/Lightweight	Lightweight parts sturdy enough to be mounted for extended periods	Will be placed in conventional security camera locations
Detect a variety of potential threats	Train machine learning (M.L.) algorithm for weapon detection	Threats come in various forms, and this is an abstract problem with no clear formula. Requiring the flexibility of Artificial Intelligence
Detect potential threats at a distance	Camera has minimum resolution of 1080p	Poor resolution images are more difficult to decipher and can cause inaccuracies
Alert Notification System	Send an alert through a text message	Alerts the home/business owner of the potential threat near the camera
Distinguishable between threat and no threat	M.L. model will be trained to detect items deemed as threats	Camera's tracking will not focus on low-risk individuals and will dismiss them
Real Time Tracking	Use Raspberry Pi for its real time clock (RTC) capabilities	Raspberry Pi utilizes RTC which is essential for real time environments

Table I: Matrix

1.3 Project Goals and Objectives

The goal of this project is to design an intelligent monitoring system that will enhance our ability to survey both public and private spaces by using object detection to identify various threats. These threats could lead to security risks and or bodily harm. Utilizing machine learning (M.L.) within the Raspberry Pi, we will monitor and detect any potential threats and non-threats that would enter the surveyed area. Once an object is determined to be a threat, the homeowner or business owner will be alerted so that they may take action that they deem as necessary. The notification will be sent before any violent action takes place, making the system more proactive rather than reactive. The warning that is received is essential to the safety of the occupants of the property and any type of warning in a potentially dangerous situation can aid in the mitigation of severe bodily harm.

1.4 Contemporary Issues Relevant to the Project

Security is an essential part of our society, and our project is aimed at providing better security to small businesses, homeowners, hospitals, schools/universities, and churches. In our society, we have seen a drastic increase in gun violence and gun violence rates. In 2020, there was a 34% increase in gun violence deaths from the previous year, this also results in a 75% increase over the previous decade. Another important statistic to point out is that 79% of murders were carried out with a gun. If our project were to be implemented in our society these rates would start to decrease because people would be notified when there is a weapon present in their area.

1.5.1 Societal Impact:

1.5 Potential Impacts of the Project



- I. Open and constitutional carry in several states could be impacted by this technology, as of September 1, 2021, Texas became a constitutional carry state, and its residents could openly display firearms without a permit. These weapons and their visibility in society will increase
- II. Home and business owners will have greater security due to the threat detection services
- III. 30% of U.S. households have home security our system would grant greater security

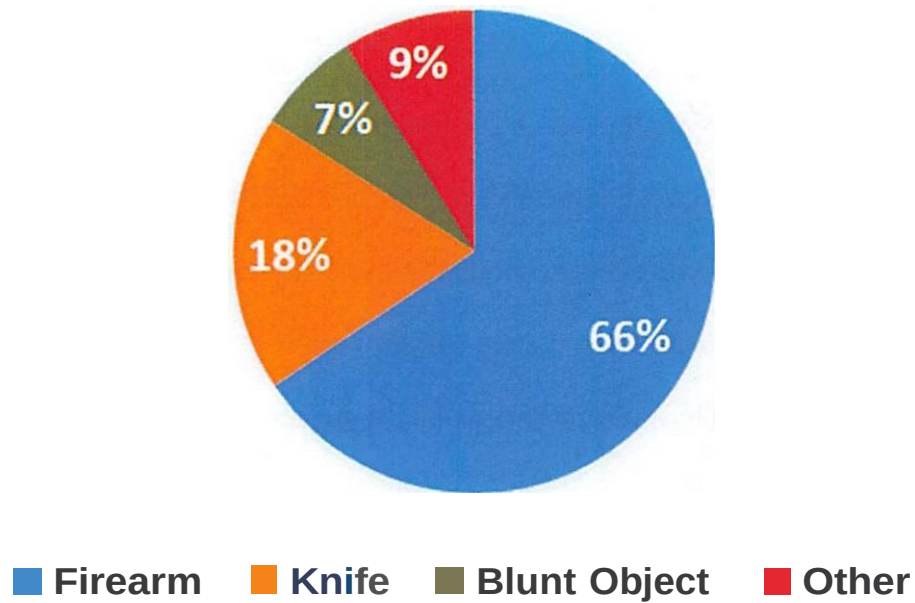
1.5.2 Safety Impact:



- I. In 2019, there were an estimated 1,117,696 burglaries in the United States. 62.8% of those burglaries were residential properties, 37.2% of those burglaries were businesses.
- II. According to Statista, there were a total of 124,381 robberies that involved weapons in 2019. 66% of those robberies involved a firearm and 34% involved a knife or some other weapon.
- III. Statistics show that someone is present 27.6% of the time when a burglary is taking place, 7.2% of these burglaries result in someone being injured.
- IV. Graph 1 shows the percentage of a certain type of weapon is used in robberies. This influenced our decision on what weapons our device will detect.

1.5 Potential Impacts of the Project (continued)

Number of Robberies



Graph 1: Percentages of Weapons used in Robberies

1.5.3 Technical Impact:

- I. Our project utilizes machine learning algorithms for the smart detection of weapons. The benefit of using M.L. is that our system will be able to learn on its own with the ability to detect new weapons
- II. Weapon detection using M.L will be done in real-time, which has not yet been implemented in conventional home and small business security systems, some examples of weapon detection are in Figures 2.1 and 2.2
- III. Weapon detection allows for the security system to be more proactive rather than reactive. This will help the homeowner/business owner to prevent the possibility of injury to themselves or others
- IV. The figures below what a weapon detection interface would look like.

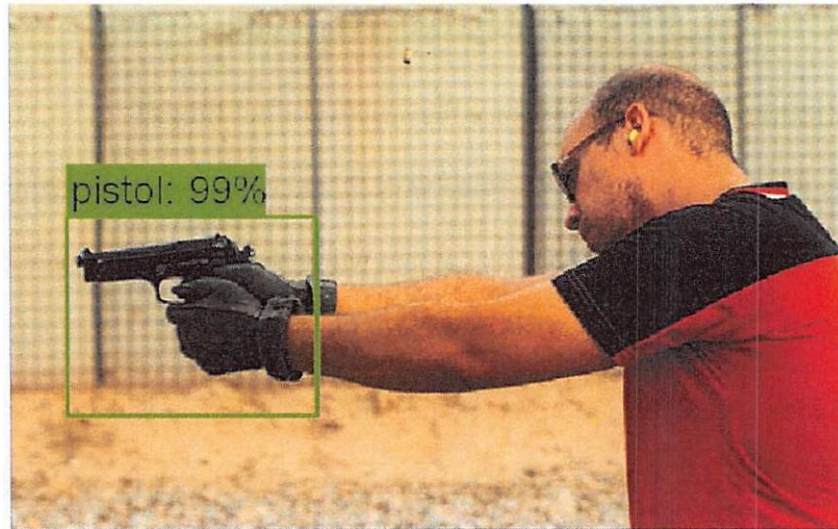


Figure 1.1: Example of Weapon Detection of a Firearm

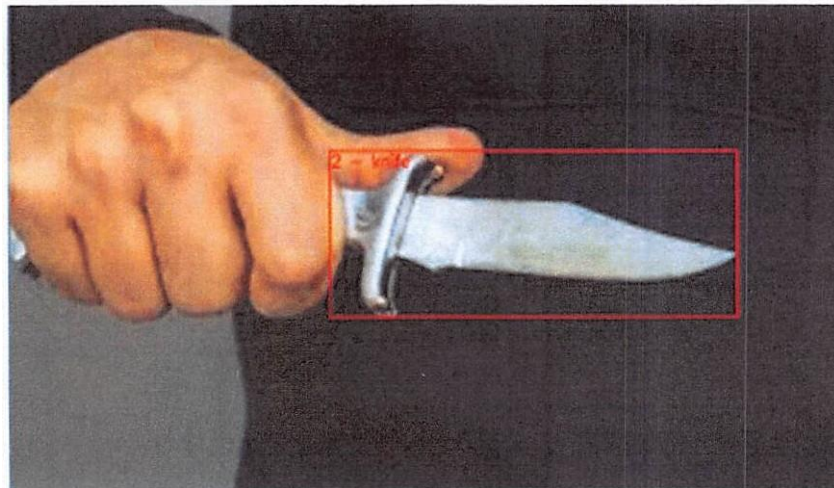


Figure 1.2: Example of Weapon Detection of a Knife

1.6 Initial Project Constraints

There are a few constraints that will influence the success of our project.

- The first is that the housing for the Raspberry Pi and camera must be mountable. This is due to our project acting as a security camera which is normally mounted to the wall in an unreachable location.
- The second constraint for our project is the camera resolution, which affects detection accuracy and distance. If our camera has a bad resolution, we will not be able to clearly detect the weapons at a distance and will have inaccurate readings.
- Our final constraint is the limited frame rate of the Raspberry Pi camera, which will also affect our detection accuracy and has an impact on our alert notification system.

Section 2 - Project Planning and Task Definition

2.1 Task Identification

The team began planning first by conversing with the faculty sponsor to choose the specialization for object detection we would implement. This built a foundation on what type of research will be needed, as well as how much data is necessary for the project to start, beginning with the understanding of object detection and the procurement of parts. The research period allowed for each group member to learn about Raspberry Pi and the operating system interface that went along with it making for the future steps to have a smoother transition.

The design and coding phase of the project allowed the group to learn the coding language, Python, and design the script for the project to run. While designing the project we began early-stage testing to determine if the code worked as expected and find if there were any errors that needed to be fixed before moving to the next step. After testing the code and determining it works as intended, the next phase was to specialize the project in weapon detection instead of just object detection. To accomplish this, an edit to the code is necessary as well as training for the machine learning model to be capable of learning and recognizing set weapons that would appear before the camera. After changing the code and training, the first prototype was complete; however, the next step was to solve the framerate issues and implement a notification system to the code.

The final phase was completing the notification system for the Raspberry Pi and solving the framerate constraint to accomplish real time tracking and provide accurate detection for when a weapon appeared on camera. These tasks ranged between being completed within a day and taking weeks, so the delegation of time and work needed to be allocated appropriately so that the project is capable of being completed before the allotted due date.

2.2 Gantt Chart

Excellent

Throughout the year, time management is important for guaranteeing the project will be completed within a timely manner and that each member is working on their respective part by delegating the workload for the team to work as efficiently as possible. The following images are the complete Gantt chart displaying the detailed time delegation for each task to ensure the project progressed smoothly within the time limit.

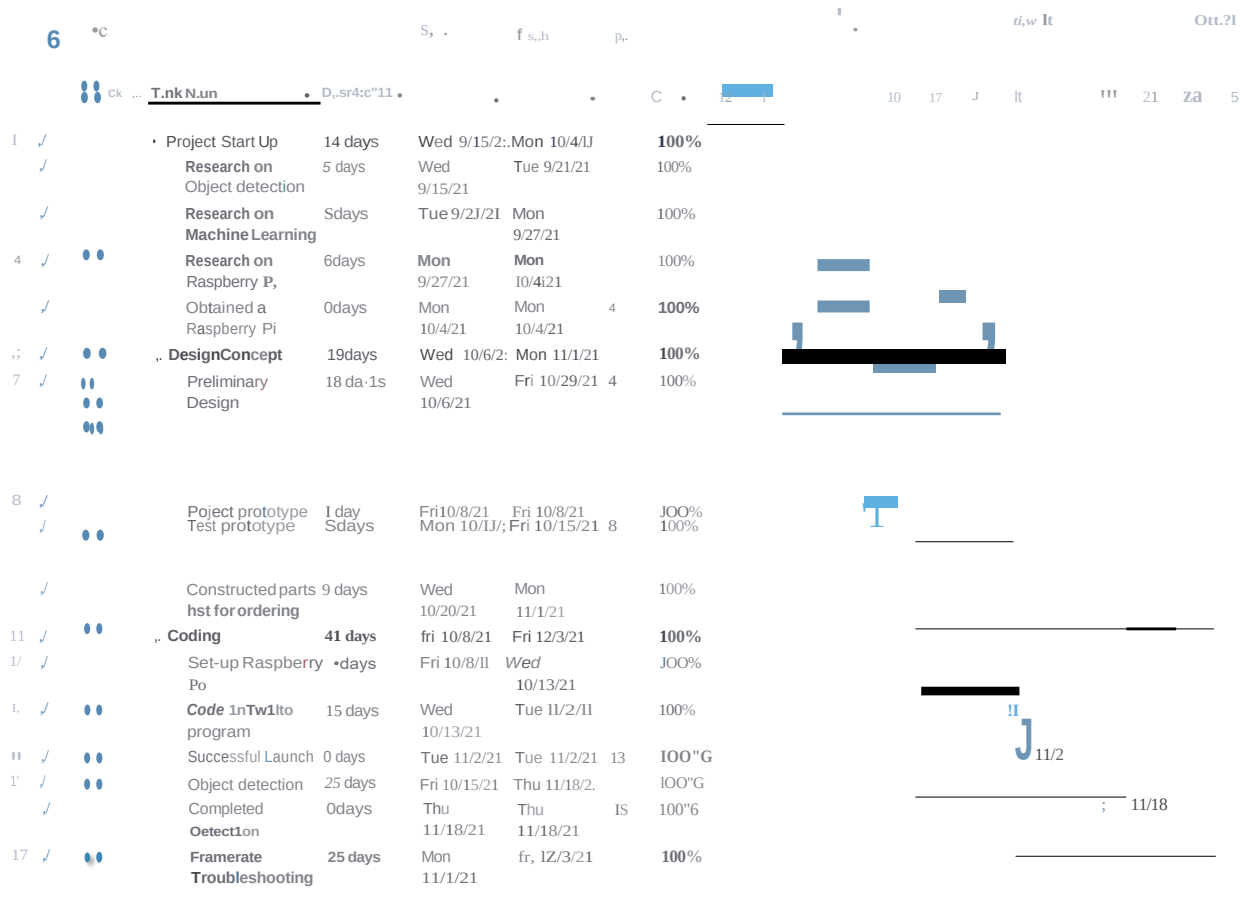
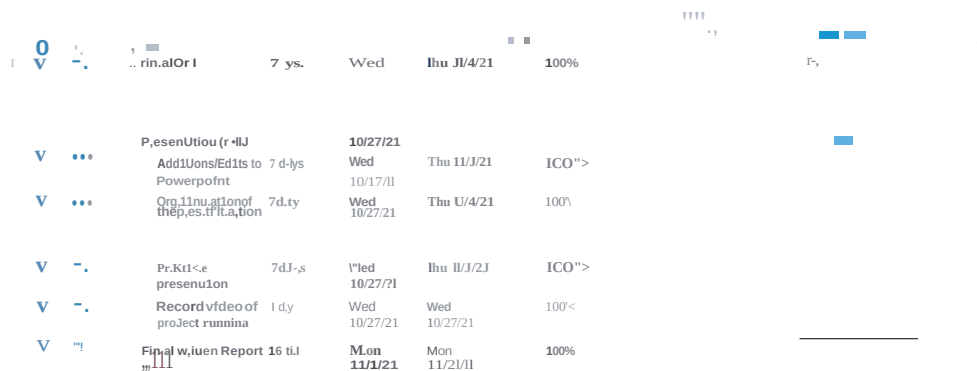


Figure 2.2: Gantt Chart (part 1)



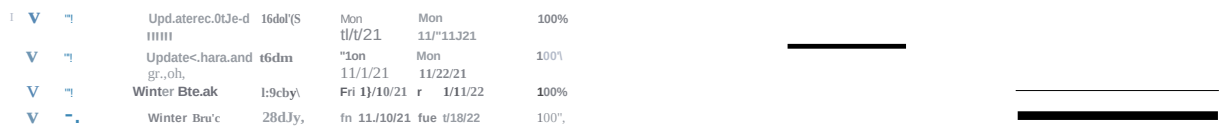


Figure 2.2: Gantt Chart (part 2)

2.2 Gantt Chart (continued)



Figure 2.3: Gantt Chart (part 3)

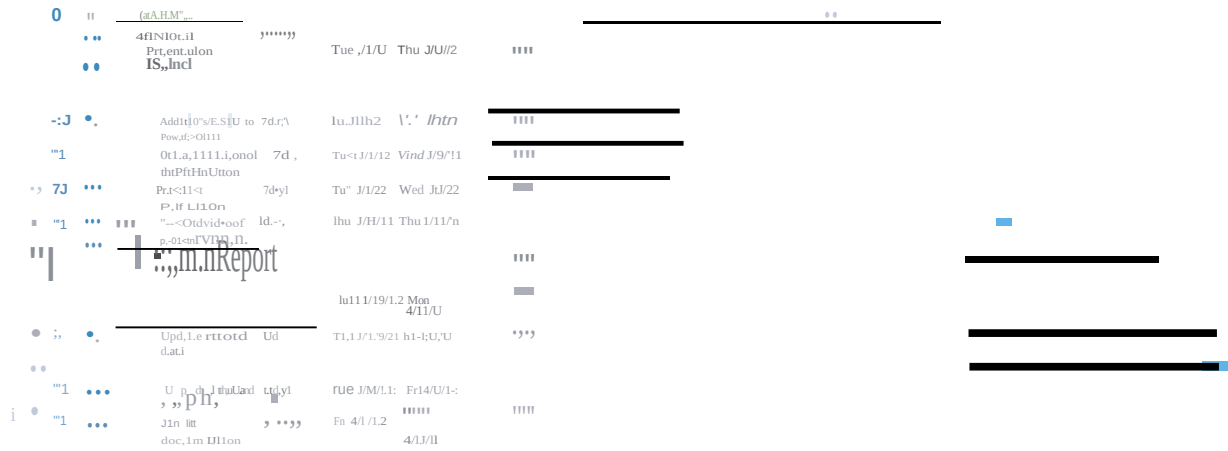


Figure 2.4: Gun/I Chart (part 4)

Section 3 - Literature Review

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3.2 Statement of Learning from Each Source

1. Reference to another security device for monitoring of area; Deep Sentinel device
2. Break-in and burglary statistics regarding injuries and the presence of weapons provided via FBI Uniform Crime Reporting Statistics
3. Economic significance and statistics regarding the presence of small businesses
4. Project comparison to SimpliSafe products
5. How to integrate and set up a web client via python to send message to Twilio messaging service
6. Discussion of crime statistics and how ML can be used in burglary prevention and identification
7. Implementation of Vaak's AI theft-detection system and the methods of training
8. Project comparison to GW security camera products and their various prices and capabilities
9. Various SimpliSafe products for comparison to our product
10. Bureau of Justice Statistics Weapons Offenses and Offenders statistics on firearm related criminal offense over the years and its growth
11. The victimology of burglary victims according to the Department of Justice statistics, rates of burglary and harming of victims
12. Exploring the possibility of infrared cameras and object detection, for this project to detect concealed weapons
13. How to detect concealed weapons against the human body and when direct sightlines are obstructed

3.2 Statement of Learning from Each Source (continued)

14. The possibility of using infrared and heat sensitive wavelengths of light with various photo processing techniques to detect concealed weapons
15. 18+ homeowner_statistics, touches on various aspects of homeownership such as reports on increasing cost, less overall homeowners, and disparities in the housing market
16. Cove Smart products and how they potentially compare to our product sensitive wavelengths of infrared light
17. Visual data and statistics regarding the number of times a weapon was present during robberies and the types of weapons during these occurrences
18. Stats on the number of burglaries, how often homes had security measures preinstalled and the economic effect such acts have on the victims
19. Statistics regarding the type of locations affected by burglaries

Section 4 - Preliminary Design

4.1 Concept Generation

There are several applications that machine learning can be used for such as object detection, image classification, natural language processing, facial recognition, and much more. As a group, we decided to focus on a specific implementation of object detection in relation to threat detection. The project shifted more into the development of a pre-emptive warning and threat detection system with associated hardware and third-party text notification alert system.

4.2-Concept Evaluation and Selection

As a company, we have a favorable position to produce our goods and services at a differential value. We have demonstrated a greater comparative value than that of our competitors and conveyed this information to our target market. Production of our unique technology that offers features our competitors are not marketing paired with a lower production cost will ensure our competitive advantages.

Our technology includes a weapon detection algorithm whereas our rivals offer a general object detection algorithm. We have machine learning and real-time tracking software whereas some of our rivals only offer machine learning software. Our organization will not charge a continuous monthly service charge as many of our rivals include in their packages. Our single unit product is remarkably simple, easy to install, and lightweight, whereas our rivals have multiple heavier hardware devices and equipment to install.

With every great invention comes a challenge, and for our system to be complete, we must rely on a third-party notification company by the name of Twilio. Twilio plays a large factor in our equation as to when a threat is determined by our system. Twilio is responsible for sending out the proper notifications to the selected entities. Twilio is an independent company that the consumer will need to purchase a package plan from for our product to be utilized to its fullest capacity.

4.2 Concept Evaluation and Selection (continued)

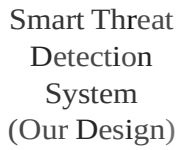
Design Options	Initial Cost	Continuous Fees	Pros	Cons	References
 Smart Threat Detection System (Our Design)	\$340	No Monthly Fee	- Weapon Detection - Machine Learning (ML) - Real Time Tracking - Light Weight - Text Notifications	- No remote monitoring - Twilio subscription needed	N/A
 GW Security	Starts at \$1400 to \$6000	No Monthly Fee	- 4k Resolution - Uses ML - Night Vision	- No Remote Viewing - Heavy Camera Equipment - No Weapon Detection	GWsecurityusa.com BBB.com Amazon.com
 Deep Sentinel	\$400 to \$1200	Monitoring Fee \$60 to \$200 per month	- Uses ML - Motion Detection - Wi-Fi or Ethernet connection	- No Weapon Detection	Deepsentinel.com
 SimpliSafe	Starts at \$700	Monitoring Starts at \$15 per month	- Smoke, water, carbon & motion sensors - Smart home integration	- No ML feature to enhance system	Simplisafe.com
 Cove Smart	Starts at \$1200	Monitoring \$26 per month	- A+ rating - Environmental Sensors - Text Notifications	- No smart ML features available	Covesman.com BBB.com

Table 2: Project Comparison Chart

4.3 Constraints and Applicable Codes and Standards Used in Preliminary Design

One of the major design constraints for our project was the frame rate of the Raspberry Pi camera. The frame rate affects Twilio alert times as it works via a counter of frames with a weapon present. Frame rates are essential to our project because we need to be able to detect weapons clearly and accurately before an individual is harmed. To fix this issue we implemented the Google Coral USB Accelerator, this allowed our system to go from one to two frames a second to around 30 frames a second.

The following Codes and Standards were used in implementing our preliminary design:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision - This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

4.4 Preliminary Analysis

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After determining the deliverables for our project, we were then able to research and investigate ways to complete our project. We decided that we should start with object detection on our Raspberry Pi 3b+, object detection is to detect instances of visual objects within a certain class in digital images. With object detection, we were able to detect preprogrammed objects such as chairs, cellphones, laptops, a person, and many other objects. Next, we would test object detection on our Raspberry Pi 3b+ and investigate the machine learning code so that we could determine how to go from object detection to weapon detection, which is the basis of our project. The way to do this was by "labeling", labeling is the process of identifying raw data and adding meaningful and informative labels to provide context so that a machine learning model can learn from it. This will be addressed later in the paper. Referring to our object detection tests, we noticed that we were only getting around 1.1 to 2.5 frames per second, this would cause a delay in the timing of our text message alert system. This issue is due to the Raspberry Pi 3b+ being an older model machine that could not handle the video processing that we needed it to do. Therefore, we had to do more research to find a solution to address this problem, we arrived at the Google Coral USB Accelerator which can be plugged into our Raspberry Pi to give us a higher frame rate. The accelerator would then bring our frame rate from a maximum of 2.5 frames per second to around a maximum of 30 frames per second. We also found a newer model Raspberry Pi that was more powerful than the current one we were given; the new model was the Raspberry Pi 4b. We decided to purchase these new products that had a greater benefit on our overall project success.

4.5 Preliminary Design



Once we were given our project at the start of the fall semester, we began to consider ways that we could create the design of our project. We knew that we would need a Raspberry Pi and the associated camera, because that was the required hardware specification for our project and the camera allows us to monitor the area. Aside from the hardware of our project we also decided that we would have an alert notification system set up to alert the owner of the device that a weapon has been identified in their area. The alert notification comes through a third-party company known as Twilio that users will have to subscribe to and provide a phone number to send an alert message.

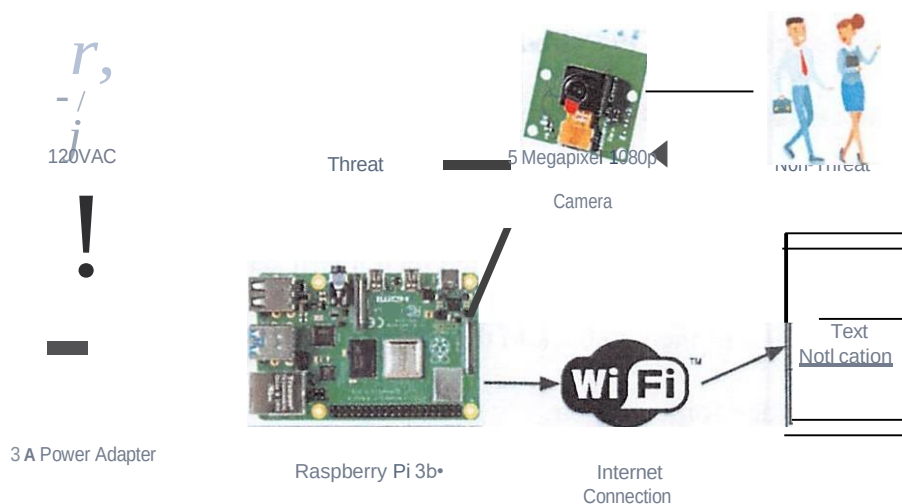


Figure 3: Preliminary Design

Once we obtained the hardware for our preliminary design, we put it together so that we could test it; the preliminary design can be seen in figure 3 above. The Raspberry Pi 3b+ is plugged in via a 3-amp power adapter, the camera is attached to the Raspberry Pi to detect threats and non-threats, and once a threat is detected an alert text message is sent over a Wi-Fi internet connection.

4.5 Preliminary Design (continued)

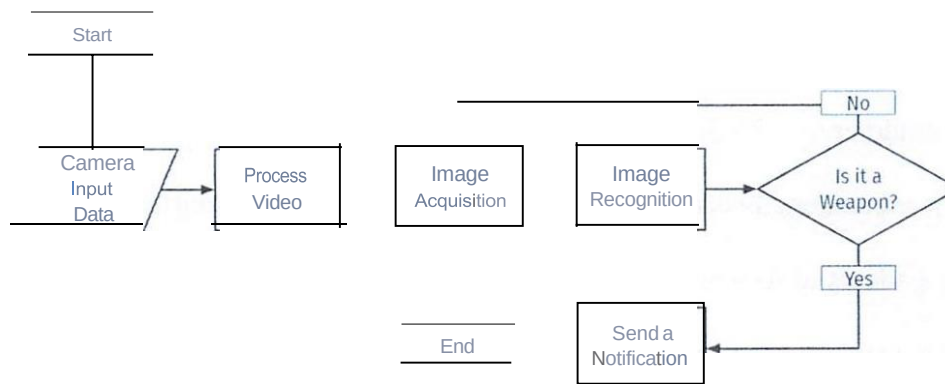


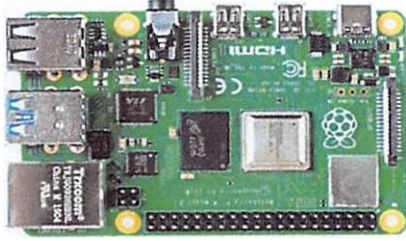
Figure 4: Software Flow Chart

In figure 4, we show the software flow chart on how the detection and notification system works. The software begins when the camera is turned on, the camera will then receive input data and will process the video. During image acquisition the system checks for weapons frame by frame, which then goes to image recognition where it will determine if a weapon has been identified in that frame. If a weapon was detected then it will send the notification to the user, if no weapon is detected it will then go back to the image acquisition stage and continue to check the next frame in the video for a weapon.

Section 5 - Detailed System Design

5.1 Project Parts Summary

All parts used in the final system design are listed below in Figures 5.1 to 5.8.



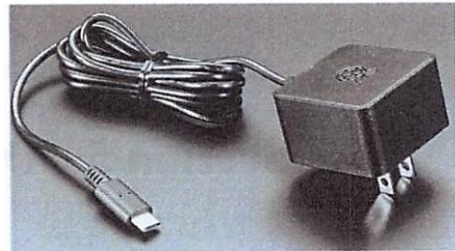
5.1: Raspberry Pi 4 Model B



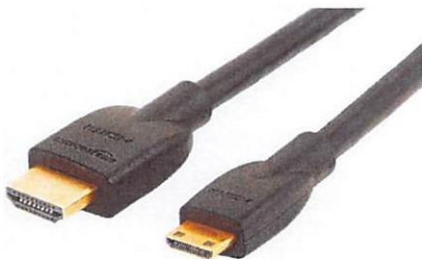
5.2: Raspberry Pi Camera Rev 1.3



5.3: Google Coral USB Accelerator



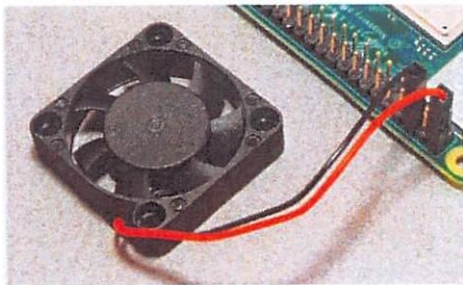
5.4: USB-C Power Supply



5.5: Micro HDMI to HDMI Cord



5.6 : Micro SD Card



5.7 : Raspberry Pi Fan



5.8: Polylactic Acid

Figures 5.1-5.8: Images of Parts

5.2 Engineering Analysis

Labeling and Training:

In order to train the model to detect weapons, we first had to label images that contained weapons. This was done using a software called Labellmg. A bounding box is drawn on the portion of the image that contains the weapon and you attach a label to that box. An example of this is shown in the figure below.



Figure 6: Labellmg Software

Here you can see that two handguns have been boxes and labeled as handguns. This had to be done for over 5000 images.

After the entire dataset is labeled, it is used to train the model. The model uses the information provided by the labeled images to recognize patterns and make predictions.

Quantization:

Quantization is the act of constraining an input and representing its value as a smaller value. Each node, or tensor, of the model is represented by some numerical value. Usually, a 64-

bit floating-point value can represent an absurdly broad range of values and is computationally intensive to decipher or to use in other operations. This large computational load slows the processing of frames and therefore the frame rate. Shrinking the representation of these nodes to 8-bit unsigned integers can greatly improve the frame rate, as operations on simpler values are faster and take up significantly less space in memory.

Quantization can be applied to the model on a per tensor basis or to the outputs of individual layers which only partially optimizes the model. This process can decrease the overall size of the model when it is totally quantized by a factor of 4 times. Quantization is also essential for the implementation of the Coral USB Accelerator Tensor Processing Unit (TPU) produced by Google which will maximize the frame rate on the Raspberry Pi upwards of 25-30 frames per second (fps).

Model:

The model used for object detection was the SSD MobileNet V2 COCO model. The SSD acronym at the beginning of the model's name stands for Single Stage Detection, meaning that this algorithm for identification goes straight from pixels of an image directly to bounding box coordinates and class probabilities to be displayed around the object. This model was chosen because of its compatibility with TFlite as only a select pool of lightweight operators is available with this framework and not all models can be converted to this version. This model is also one of the few quantizable models which is necessary for frame rate solutions to be implemented such as the Coral USB accelerator.

5.2 Engineering Analysis (continued)

Notification System:

Short Message Service or SMS is used as our notification system. A third-party software called Twilio is integrated into our design. Whenever a weapon is seen for a set number of frames, the notification is sent to warn anyone in danger. This type of notification was used because of its easy implementation, as well as its ability to send out notifications to any number of people with any type of phone. The messages are very quick and reliable.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications

Hardware Layout

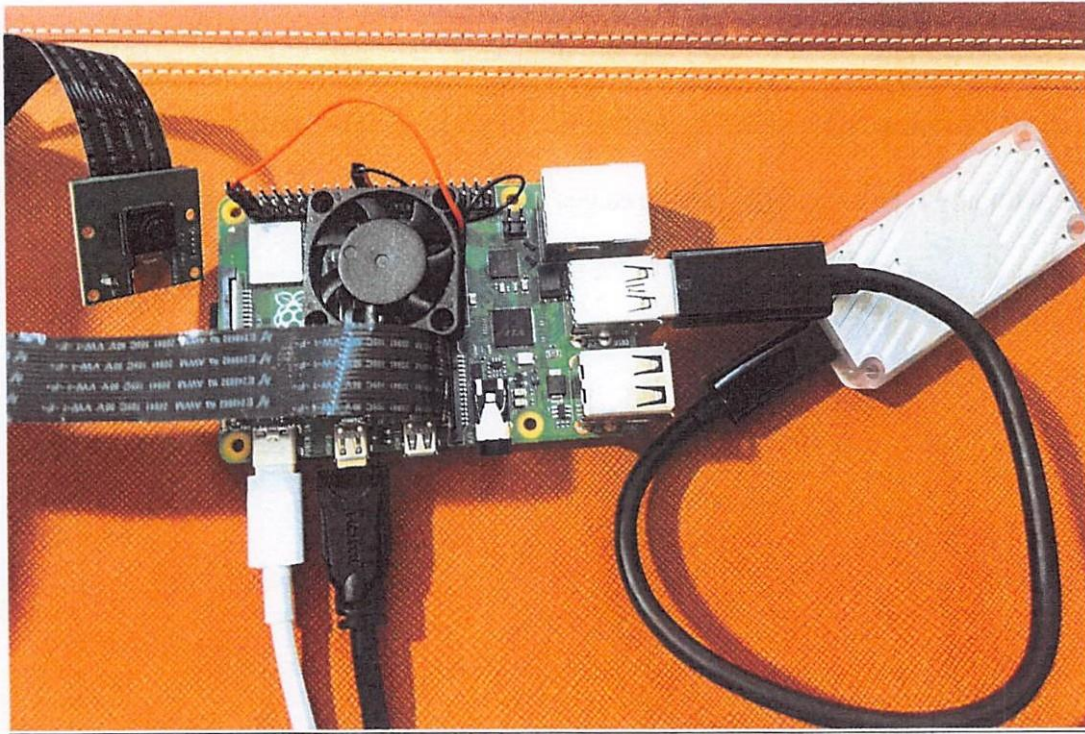


Figure 7: Hardware Layout

In the figure above, it is shown that the Raspberry Pi is connected to power via the 3-amp power supply and the Pi Camera is connected via a ribbon cable. The USB accelerator is connected to the raspberry Pi via a USB-A to USB-C cable. The fan is connected to the SY and ground pins on the Raspberry Pi and the Raspberry Pi is connected to the monitor via the Micro HDMI to HDMI cable.

Detailed Drawings

In this section, the schematics for the housing will be shown and described. After the housing was designed. It was 3D printed out of PLA. The housing is encasing the Raspberry Pi,

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.) /

fan, Coral USB, camera, and the camera ribbon cable. The full housing can be seen in the figure below.

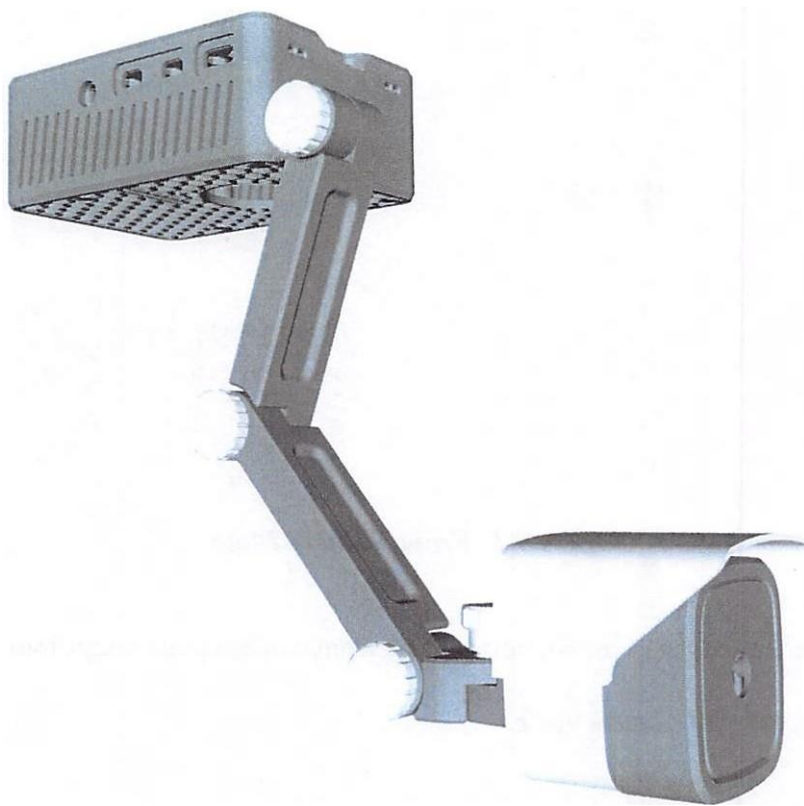


Figure 8: *Housing Design*

Listed below will be detailed drawings of the individual pieces of the housing. To start with we have the front camera plate. The Pi Camera snaps into place via the 4 pins that stick out on the inside. The lens of the camera sits in the whole in the center.

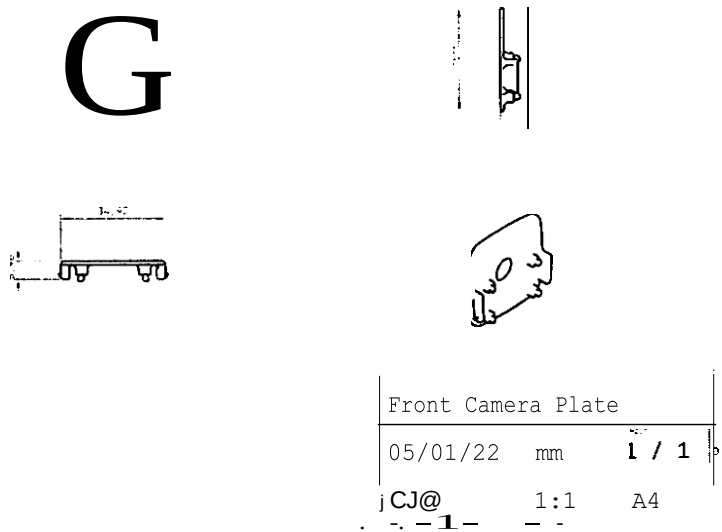


Figure 9.1: Front Camera Plate

The side camera cover is shown below. The front camera plate snaps into the side camera cover and his snaps into the camera visor.

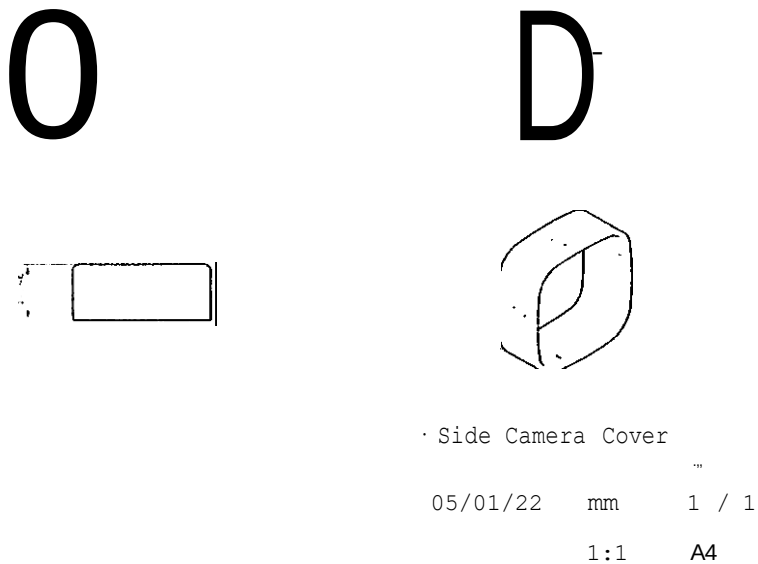


Figure 9.2: Side Camera Cover

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The camera visor is shown below. The visor snaps together with the side camera cover.

There is a slot on the back to allow the ribbon cable of the camera to pass through as well as a larger slot that connects the back camera plate.

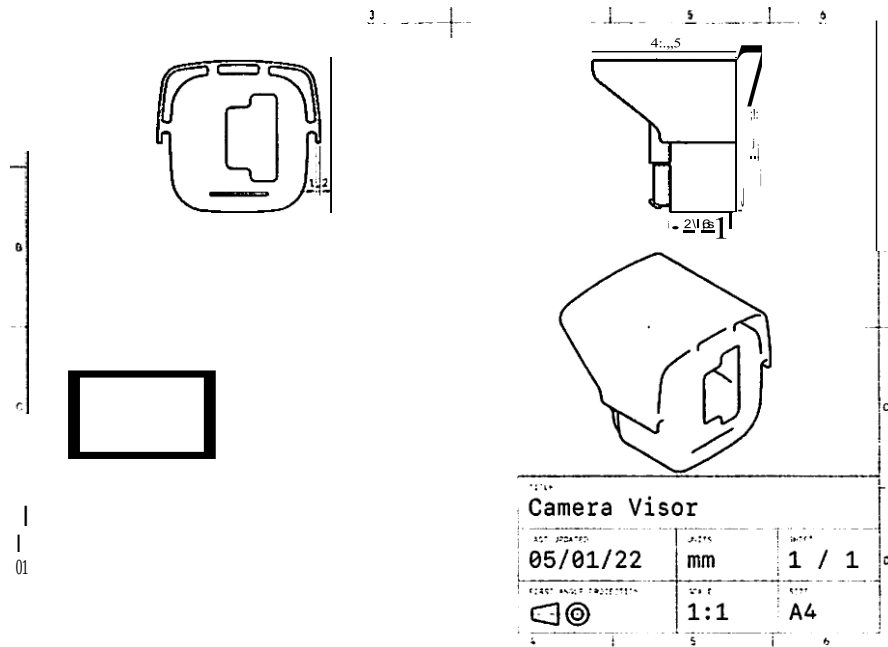


Figure 9.3: Camera Visor

The back camera plate is shown below. The interior side of the back camera plate has a notch that slides into the opening on the camera visor. There is a threaded hole to allow for a short screw attachment to the hinge.

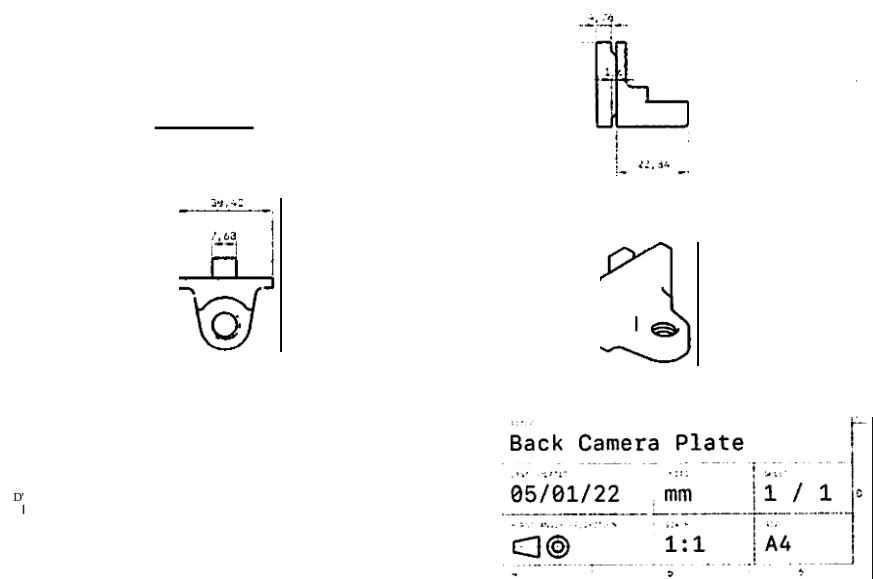


Figure 9.4: Back Camera Plate

The hinge is shown below. The hinge allows for the camera to pan left and right. The hinge is connected to the lower arm via a long screw.

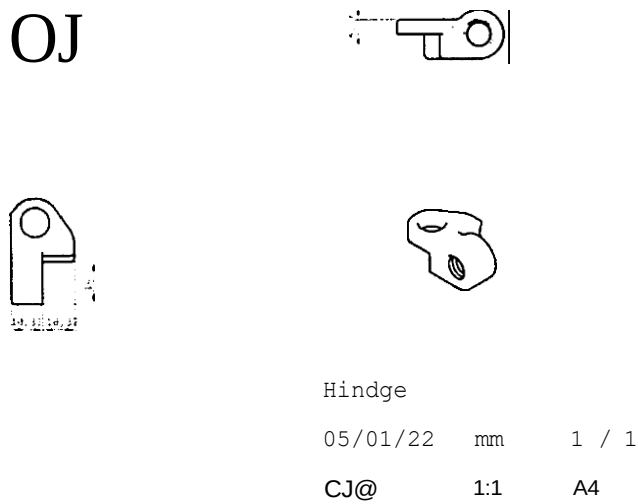


Figure 9.5: Hinge

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The lower arm and upper arm are identical and shown below. They are connected via 2 long screws at either end. They have a slit that allows for the ribbon cable to run through the interior of the arm.

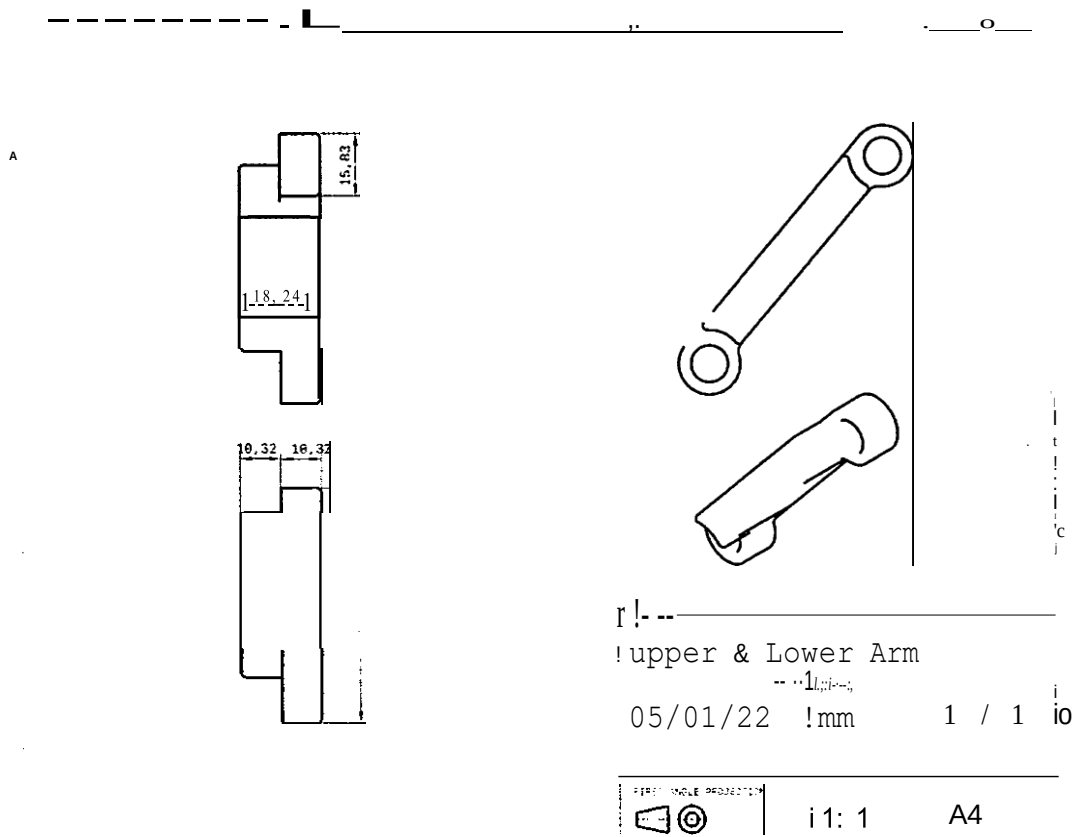


Figure 9.6: Upper & Lower Arm

The long and short screws are threaded the same way. The long screw is shown below. The short screw is $\frac{3}{4}$ the length of the long screw.

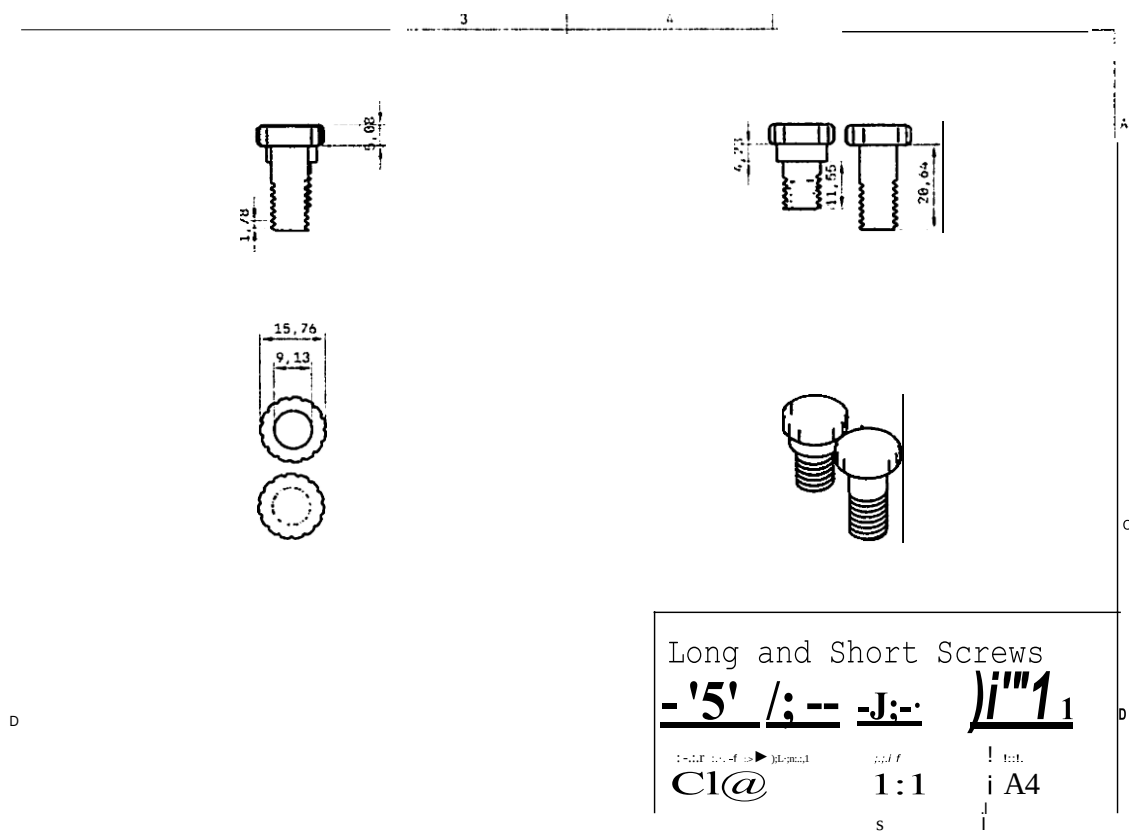


Figure 9.7: long & Short Screws

The Raspberry Pi case top is shown below. It is the portion of the case that would face downwards if mounted to a ceiling despite being named the top. It has a cut out for the fan to sit on and has enough space to hold the Coral USB Accelerator. It also has a slit cut out for the camera ribbon cable and 3 large notches for the USB Ports and the Ethernet port. The hexagonal shape on the top and slits on the sides allow for adequate air flow as overheating used to be an issue.

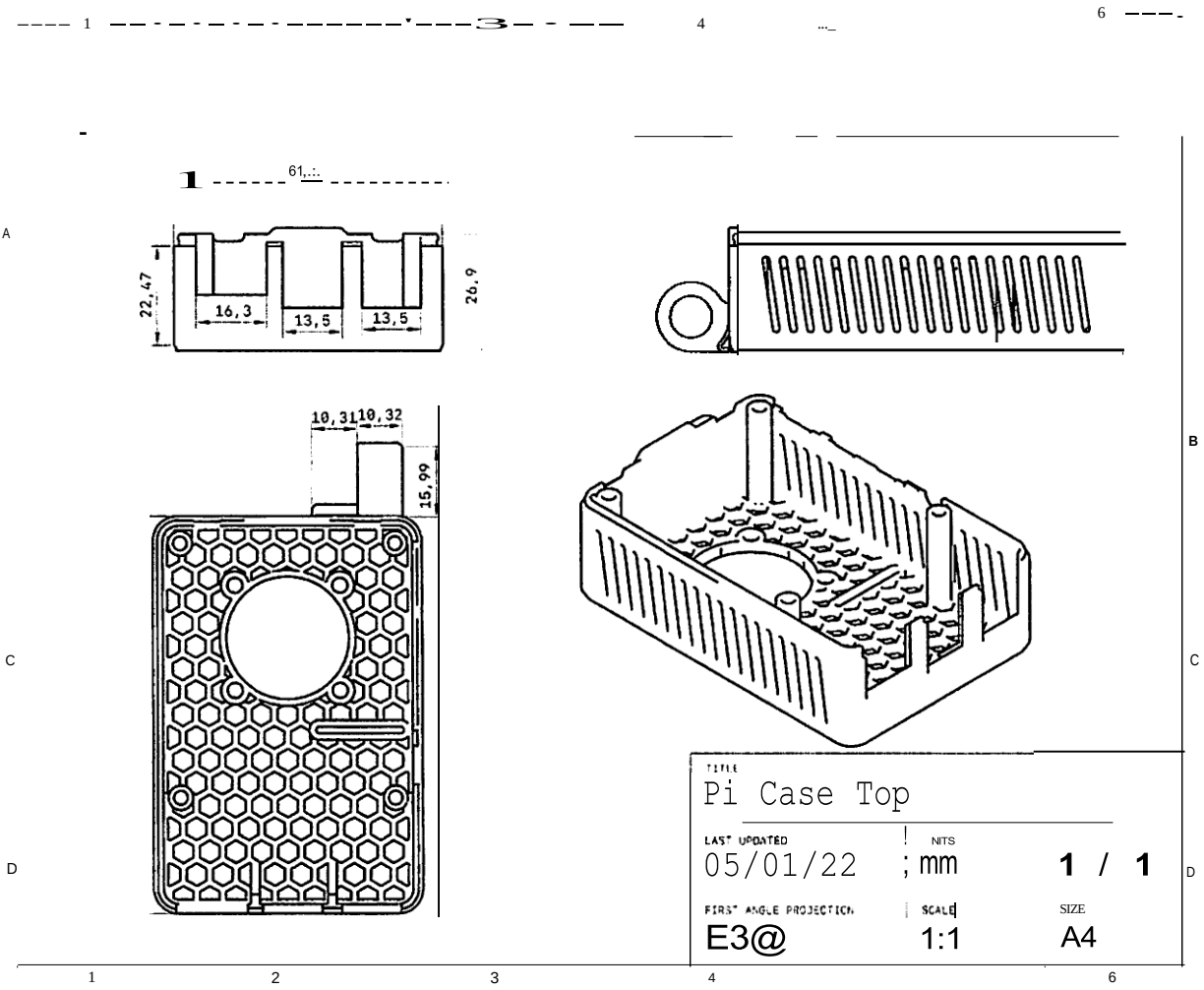


Figure 9.8: Pi Case Top

The Raspberry Pi case bottom can be seen below. It is the portion of the case that would be touching the surface in which the device is being mounted. The case has 4 cut outs for the power, HDMI ports, and the audio port. The two case pieces snap into one another with the Raspberry Pi, fan and Coral USB accelerator fixed in place on the inside.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

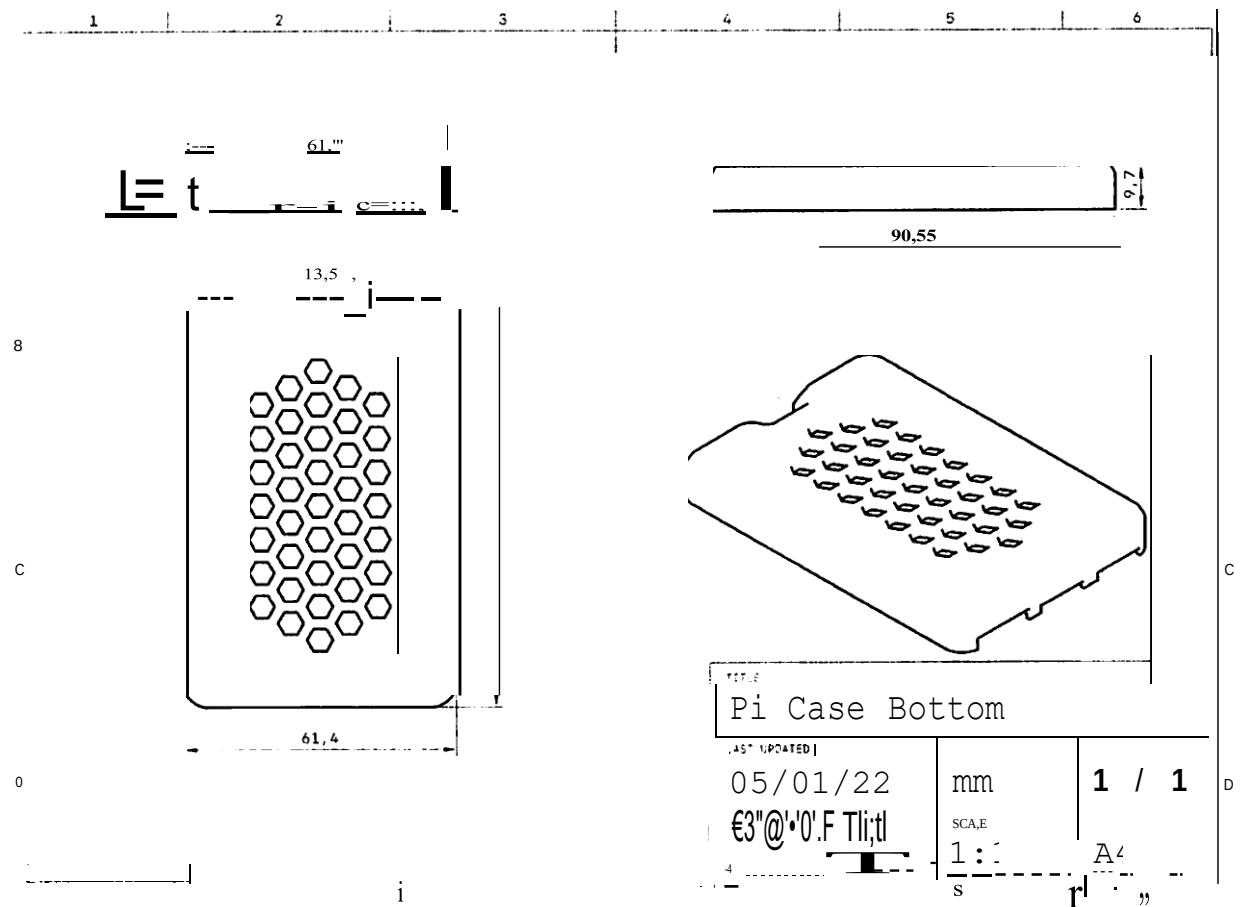


Figure 9.9: Pi Case Bottom.

The parts are all 3D printed from PLA including the screws. This allows for the housing to be very lightweight.

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

Equipment Selection and Specifications

The Raspberry Pi 4 Model B was selected due to it being the most up to date Raspberry Pi to be released. It has a much better performance than the other Raspberry Pi models. A LINPAC benchmark test showed that the Raspberry Pi 4 B almost tripled the score of the Raspberry Pi 3B+. The specifications of the Raspberry Pi 4 Model B are shown in the table below.

Raspberry Pi 4 Model B	
Processor	Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Ram	8GB LPDDR4-3200 SDRAM (depending on model)
Wi-Fi/Bluetooth	2.4 GHz and 5.0 GHz IEEE 802.11ac wireless, Bluetooth 5.0, BLE
Ethernet Port	Gigabit Ethernet
USB Ports	2 USB 3.0 ports; 2 USB 2.0 ports.
GPIO	Raspberry Pi standard 40 pin GPIO header (fully backwards compatible with previous boards)
Display Ports	2 x micro-HDMI ports (up to 4kp60 supported) 2-lane MIPI CSI display port
Camera Port	2-lane MIPI CSI camera port
Audio Port	4-pin stereo audio and composite video port
Video Encoder	H.265 (4kp60 decode), H264 (1080p60 decode, 1080p30 encode)
Graphics	OpenGL ES 3.1, Vulkan 1.0
Storage	Micro-SD card slot for loading operating system and data storage
Power	5V DC via USB-C connector (minimum 3A*) 5V DC via GPIO header (minimum 3A*) Power over Ethernet (PoE) enabled (requires separate PoE HAT)
Operating Temperature	0 - 50 degrees C ambient

Table 3.1: Raspberry Pi 4 Model B Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)^j

The Raspberry Pi Camera was selected due to its easy compatibility with the Raspberry Pi 4 Model B. The specifications of the Raspberry Pi Camera are shown below.

Raspberry Pi Camera Rev 1.3	
Still Resolution	5 Megapixels
Video Modes	1080p30, 720p60 and 640 x 480p60/90
Linux Integration	1080p30, 720p60 and 640 x 480p60/90
C Programming API	OpenMAX IL and others available
Sensor	OmniVision OV5647
Sensor Resolution	2592 x 1944 pixels
Sensor Image Area	3.76 x 2.74 mm
Pixel Size	1.4 μm x 1.4 μm
Optical Size	1/4"
Full-frame SLR Lens Equivalent	35mm
SIN Ratio	36dB
Dynamic Range	67 dB @ 8x gain
Sensitivity	680 mV/lux-sec
Dark Current	16 mV/sec@ 60 C
Well Capacity	4.3 Ke-
Depth of Field	approx. 1 m to infinity
Focal Length	3.60 mm+/- 0.01
Horizontal Field of View	53.50 +/- 0.13 degrees
Vertical Field of View	41.41 +/- 0.11 degrees
Focal Ratio (F-Stop)	2.9

Table 3.2: Raspberry Pi Camera Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.) /

The Google Coral USB Accelerator was selected due to its easy compatibility with the Raspberry Pi 4 Model B. This device aided in increasing the frame rate by approximately 20 frames per second. The specifications of the Google Coral USB Accelerator are shown below.

Google Coral USB Accelerator	
ML accelerator	Google Edge TPU coprocessor: 4 TOPS (int8); 2 TOPS per watt
Connector	USB 3.0 Type-C* (data/power)
Dimensions	65 mmx30mm

Table 3.3: Coral USB Accelerator Specifications

The Raspberry Pi 4 Official Power Supply Unit was selected due to it being built specifically to meet the requirements for the Raspberry pi 4 Model B. The specifications of the Raspberry Pi 4 Official Power Supply Unit are shown below.

Raspberry Pi 4 Official Power Supply Unit	
Power	15.3-Watt output
Voltage	5.1-Volt output
Current	3.0-Amp output
Length	1.5-m cable

Table 3.4: Power Supply Specifications

The QVS Micro-HDMI to HDMI Cable was selected because it fit the Raspberry Pi 4 B and the monitor we used. The specifications of the cable are shown below.

QVS Micro-HDMI to HDMI Cable	
Supports	15.3-Watt output
Length	2-m cable
Connectors	HD H tale to Micrn HOM[ilale

Table 3.5: Micro-HDMI to HDMI Cable Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications (cont.)

The Samsung 32GB EVO Plus UHS-1 microSDHC Memory Card was selected due to it having enough storage capacity and a fast enough speed for the project. The specifications of the Raspberry Pi 4 Official Power Supply Unit are shown below.

Samsung 32GB EVO Plus UBS-I microSDHC Memory Card	
Card Type	microSDHC
Storage Capacity	32GB
Bus Type	UHS-1
Speed Class	10
UBS Speed Class	I/I
Read Speed	maximum: 95 MB/s
Write Speed	maximum: 20 MB/s Minimum: 10 MB/s
Durability	Magnet-Proof, Temperature Extremes, Waterproof, X-Ray Proof
Operating Temperature	-13 to 185 F / -25 to 85°C
Storage Temperature	-40 to 185 F / -40 to 85°C
Wireless Capability	None

Table 3.6: microSD Card Specifications

5.3 Hardware Layout/Detailed Drawings/Equipment Selection and Specifications·(cont.)

The **Pi-FAN** was selected due to its easy compatibility with the Raspberry Pi. The specifications of the **Pi-FAN** are shown below.

Pi-FAN	
Operating Voltage	5 Volts
Current	0.2Amps
Motor	Brushless DC fan
Dimensions	30mm x 30mm x 8mm
\Vire Length	3.25" 180mm
\Veight	6.2g I 0.22oz

Table 3.7: Pi-FAN Specifications

The OVERTURE Polylactic (PLA) ACID Filament was selected due to its easy compatibility with the 3D printer that was used. It was also ideal for its biodegradability and was already readily available. The specifications of the OVERTURE PLA Filament are shown below.

OVERTURE Polylactic ACID Filament	
Diameter	1.75 nun diameter
Dimensional Accuracy	Accuracy+/- 0.03 mm
Material	Polylactic Acid (PLA)
Extrusion Temperature	190°C - 220°C (374°F~ 428 °F)
Heated Beel Temperature	25cc - 6(l1C (7T:JF~ 14(Y'F)
Color	Black

Table 3.8: Polylactic Acid Specifications

5.4 Overview of Code

There are three main portions of the code. The first section handles training the model to detect weapons. The second section contains everything that deals with the process of running the camera and detecting objects. The third section handles the logic behind how and when to send the notification. The main portions of these three sections will be explained below; however, to see the full-length code, see appendix page A2

Training the Model

When training the model, we used over 5000 images that we labeled as a specific category of weapon. These images became our dataset. The model is then trained on this data set by running the training executable. This code, along with instructions on how to configure the training job can be found in the appendix on page A8. This section calls many different files to aid in the training process. To summarize what is happening during training, the algorithm takes an image that looks at where the bounding box for the weapon is and looks for certain patterns and similarities throughout the various images.

Running the Camera

The code that runs the camera and weapon detection starts with the camera constraints. The dimensions of the camera must be defined because the bounding box location for the weapons is calculated using the image height and width. Below it is shown that the image width for our camera is 1280 and the height is 720.

```
#Setup camera constants  
IM_WIDTH  
IM_HEIGHT
```

Figure 10.1: Camera Dimensions



5.4 Overview of Code (continued)

I

A label map is a list of all the objects, or classes, we want to detect. In our case, it is just weapons, so we have a label map with rifle, handgun, blade, and blunt object. We call this label map file and define the number of classes. The figure below shows the code that performs these actions.

```
# Path to label map file
PATH_TO_LABELS os.path.join(CWD_PATH, 'labelmap.pbtxt')

#Number of classes the object detector can identify
NUM_CLASSES

## Load the label map.
# Label maps map indices to category names, so that when our convolution
# network predicts 'S', we know that this corresponds to "king".
# Here we use internal utility functions, but anything that returns a
# dictionary mapping integers to appropriate string labels would be fine
label_map label_map_util.load_labelmap(PATH_TO_LABELS)
categories label_map_util.convert_label_map_to_categories(label_map,
max_num_classes=NUM_CLASSES, use_display_name=True)
category_index label_map_util.create_category_index(categories)
```

Figure 10.2: Loading label Map

The program then loads the TensorFlow model into memory. This is the model that was trained to detect weapons. This can be seen in the figure below.

```
# Load the TensorFlow model into memory.
detection_graph tf.Graph()
with detection_graph.as_default():
    od_graph_def = tf.GraphDef()
    with tf.gfile.FastGFile(PATH_TO_CKPT, 'r') as fid:
        serialized_graph = fid.read()
        od_graph_def.ParseFromString(serialized_graph)

    tf.nn.GraphDef()
    od_graph_def.name

sess = tf.Session(graph=detection_graph)
```

Figure 10.3: Loading in the Model

5.4 Overview of Code (continued)

The output of the model includes the detection boxes, scores, classes, and number of objects detected. In the figure below, these are seen as `detection_boxes`, `detection_scores`, `detection_classes`, and `num_detections`. The detection boxes give the coordinates of the top left and bottom right points of the bounding box. The score is the confidence level this is displayed as a percentage. The classes are the names of the object being detected and the number of detections keeps track of how many of the detected objects are in the view of the camera.

```
Output tensors are the detection boxes, scores, and classes
Each box represents a part of the image where a particular object was detected
detection_boxes  detection_graph              tion boxes:0

; Each score represents level of confidence for each of the objects.
; The score is shown on the result image, together with the class label.
detection_scores  detection_graph            detection_scores:0
detection_classes  detection_graph          'detection_classes

Number of objects detected
num_detections  detection_graph
```

Figure 10.4: Boxes, Scores, Clusses, and Number of Boxes

The live value of the frame rate is calculated by checking the tick frequency. This is shown in the figure below. It is important to have the exact frame rate of the camera as this directly affects the speed at which the notification is sent.

```
# Initialize frame rate calculation
frame_rate_calc
freq  cv2
font  cv2
```

Figure 10.5: Frame Rate Calculation

5.4 Overview of Code (continued)

The model is run and uses each frame from the camera as its input. This code is shown below.

```
# Perform the actual detection by running the model with the image as input
boxes scores classes num sess
detection_boxes detection_scores detection_classes num_detections
feed_dict image_tensor frame_expanded
```

Figure 10.6: Running Detection Model

The results from the detection model are displayed over the actual live footage from the camera. This is done by drawing the boxes, showing the classes, and updating the scores for each frame. The figure below demonstrates this process.

```
# Draw the results of the detection (aka 'visualize the results')
vis_util
frame
np boxes
np classes np
np scores
category_index
use_normalized_coordinates True
line_thickness
min_score_thresh
```

Figure 10.7: Visualization of Results

Notification System

For our notification system, we used Twilio. To code in the Twilio information we first import the Twilio client. Then the account SID number, authorization number, the phone number of who needs to receive the notification, and the number the message is being sent from are all defined. In the figure below, it is shown where these values are defined as the specific variables: account_sid, auth_token, my_number, and twilio_number, respectively. The numbers are covered for privacy purposes.

5.4 Overview of Code (continued)

```
# Set up Tllilio

# Twilio SID, authentication token, my phone number, and the Twilio phone number
account_sid [REDACTED]
autti_token [REDACTED]
my_number [REDACTED]
twilio_number '19362510045'

client [REDACTED] account_sid auth_tokc
```

Figure 11.1: Twilio Setup

The way the program knows when to send the notification is a series of "if" statements. It determines if a weapon is on the screen. The weapons are defined by their ID classes; 1 for rifle, 2 for handgun, 3 for knife, 4 for blunt object. A predetermined area of detection is defined if it is not wanted to detect weapons in the camera's full field of view. If one of the weapons is located within that area for 300 frames, it sends the message "A weapon has been detected on your camera" to the numbers previously defined. The program then pauses for a set amount of time to prevent messages being spammed. This can all be seen in the snapshot of the code below.

```
int cla int classes or int
int cla or int l!s;s and

int boxes es IM_WIDTH
y int boxes taxes IH_HEIGHT
q Draw a circle at center of object
cv2 fra- x y

I If object is in inside bo*, incre cnt inside COInt r v1rl•ble
x Tl inside and x BR inside and y Tl inside and
y BR_lns lde
inside courte" !nsld", .te

In,lde_counte•
de:ecte i slide True
•ssJge cllcet
body
froo "llio n\,;-b r
to my n mo r

inside_counte-
out lde_counte
#Pause weapon detection by setting pause flag
pa se
```

Figure 11.2: SMS Notification Execution

5.5 Application of Engineering Codes and Standards used in Final Design /

The following IEEE Codes and Standards were used in the final design of our project:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision - This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

5.6 Economic Analysis

The economic analysis of our project can be separated into two phases. There were different components that were used in each phase which we will outline below. During phase one we were given the parts that we needed to start a preliminary design of our project. The parts that we used in our phase one design were given to us by the school and can be seen in table 4.1.

Item Name	Quantity	Total
Raspberry Pi 3b+	1	Pre-owned
Raspberry Pi Camera Rev 1.3	1	Pre-owned
	Total:	\$0

Table 4.1: Phase I Cost

After completing the testing of phase one with the given parts, we were able to identify which parts needed updating and investigate ways that we can improve our design. We needed to update our Raspberry Pi 3b+ to the Raspberry Pi 4b which is a more powerful and faster model, we also upgraded our MicroSD card so that our Raspberry Pi can hold more storage. Another upgrade to our project was the addition of the Google Coral Accelerator, which increases the frame rate of our camera and video processing. To connect the Raspberry Pi 4b to a monitor and observe an area we had to purchase a Micro HDMI to HDMI cord. The updated cost of our project can be seen in table 4.2.

Item Name	Quantity	Total
Raspberry Pi 4b	1	\$134
Raspberry Pi Camera Rev 1.3	1	Pre-owned
Google Coral USB Accelerator	1	\$174.58
Micro HDMI to HDMI cord	1	\$16.95
Micro SD card	1	\$20
	Total:	\$345.53

Table 4.2: Smart Threat Defection System Cost

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 12.1 - 12.3 depict a rifle being detected by our camera. The yellow box and word "rifle" are specific to that class of weapon. In various orientations, including partially covered, the rifle is detected with remarkably high confidence.

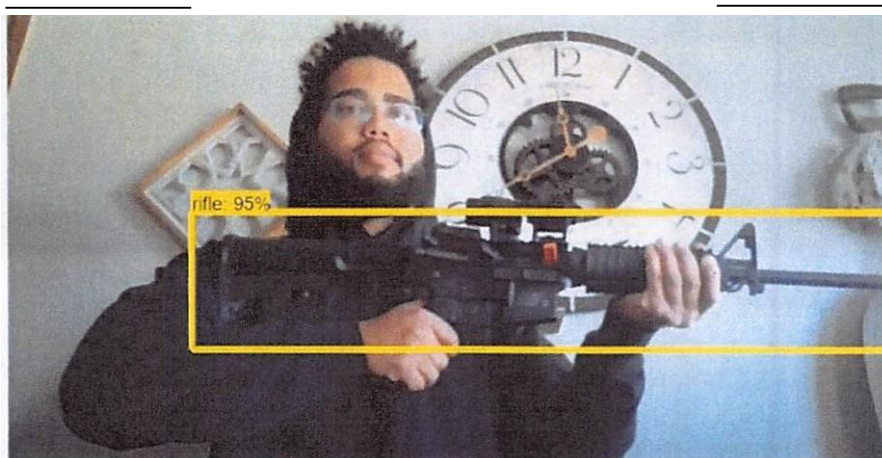


Figure 12.1: Rifle Detected with 95% Confidence

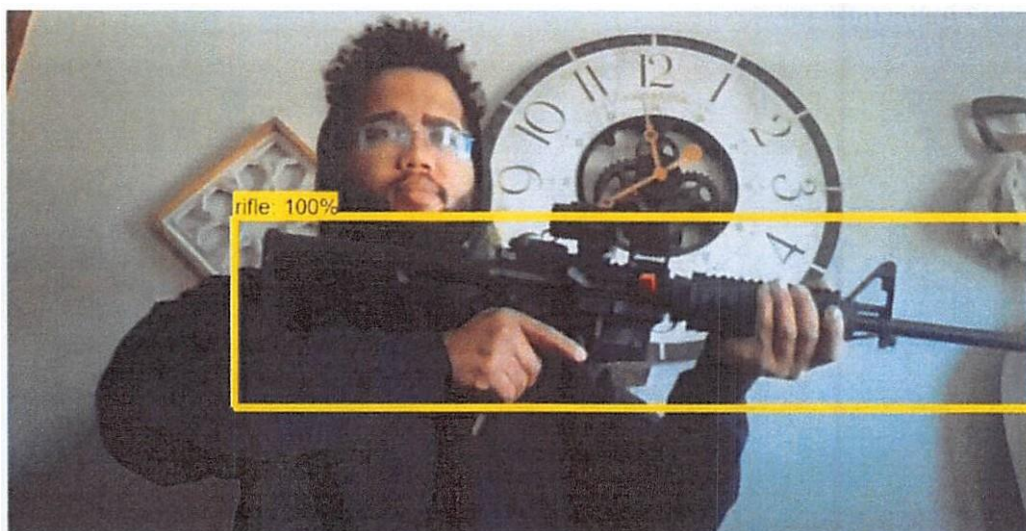


Figure 12.2: Rifle Detected with 100% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

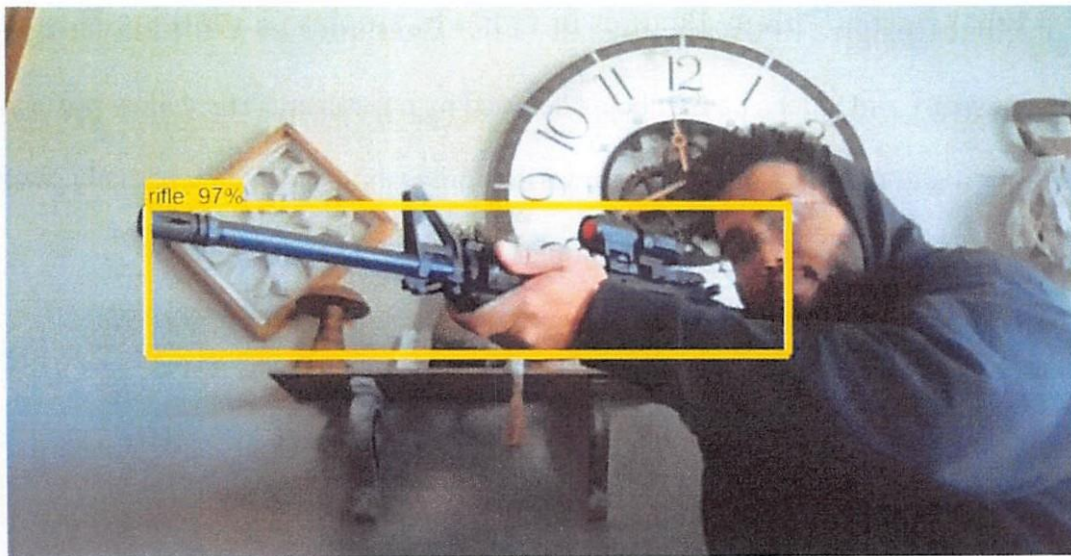


Figure 12.3: Covered Rifle Detected with 97% Confidence

Figures 13.1 - 13.5 below depict a handgun being detected by our camera. The green box and word "handgun" are specific to that class of weapon. In various orientations, including the barrel pointed towards the camera and a black gun on a black background, the handgun is detected with high confidence.

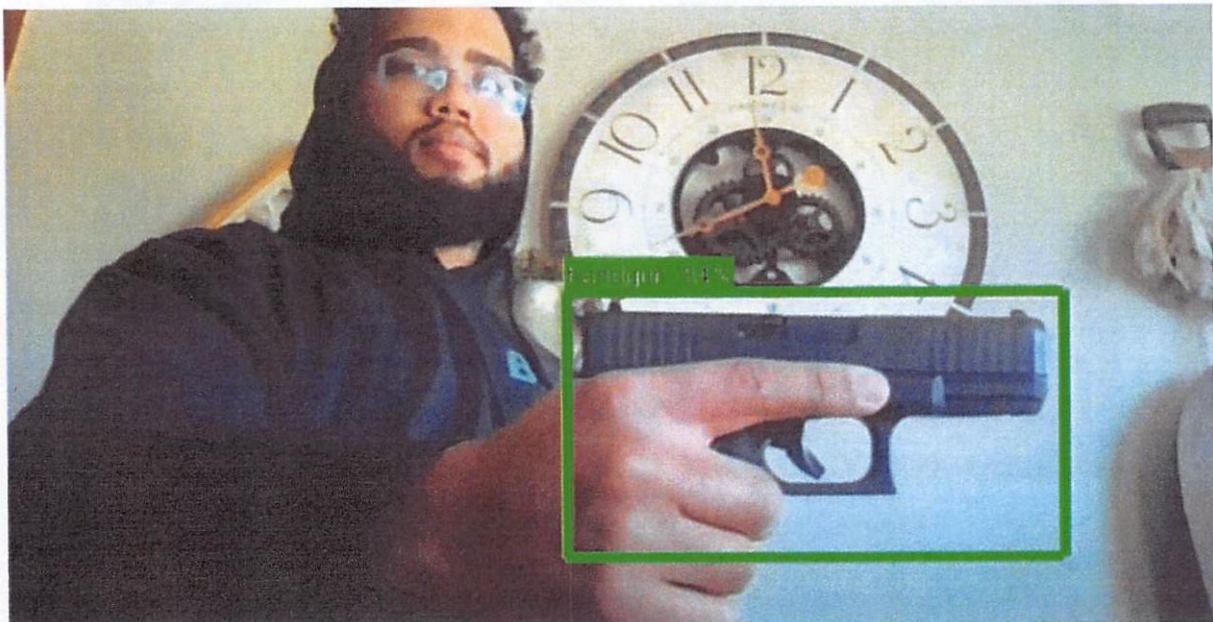


Figure 13.1: Handgun Detected with 84% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design

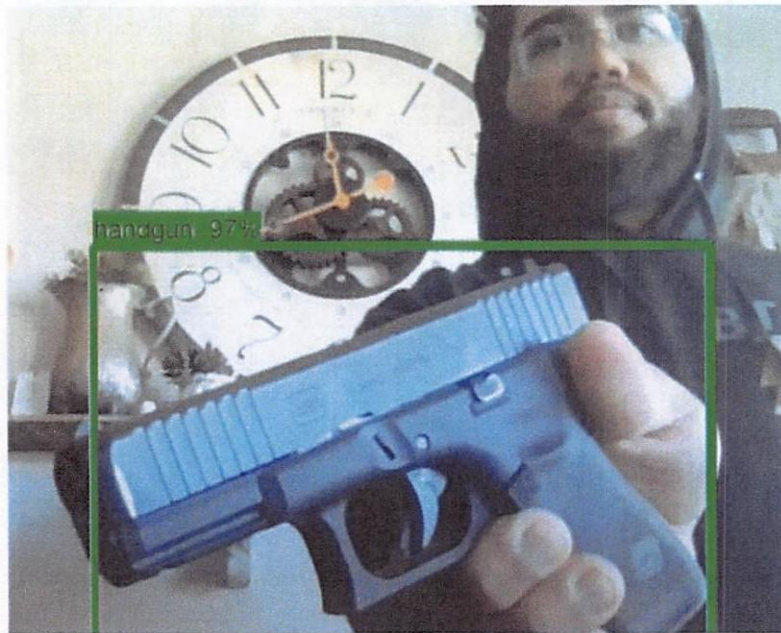


Figure 13.2: *Handgun Detected with 97% Confidence*



Figure 13.3: *Barrel Pointed at Camera Detected with 75% Confidence*

5.7 Final Design - Show Pictures or Other Examples of Working Design

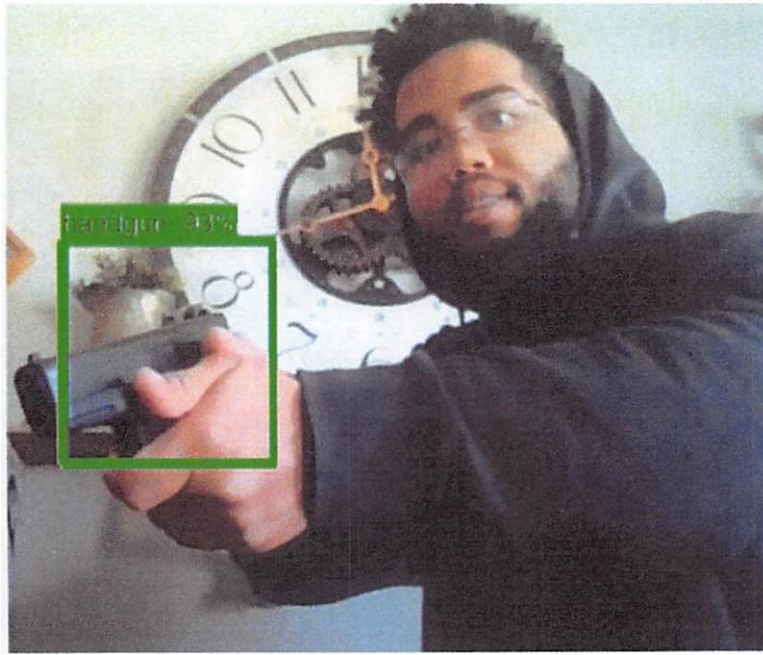


Figure 13.4: *Partially Covered Handgun Detected with 93% Confidence*



Figure 13.5: *Black Handgun Detected on Black Jacket with 99% Confidence*

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 14.1 - 14.3 below depict a blade being detected by our camera. The greenish yellow box and word "blade" are specific to that class of weapon. The blade is detected with high confidence. However, the algorithm is less than 60% confident in categorizing the blade when its narrow profile is facing the camera. Objects with a confidence level less than 60% are not displayed on the screen.

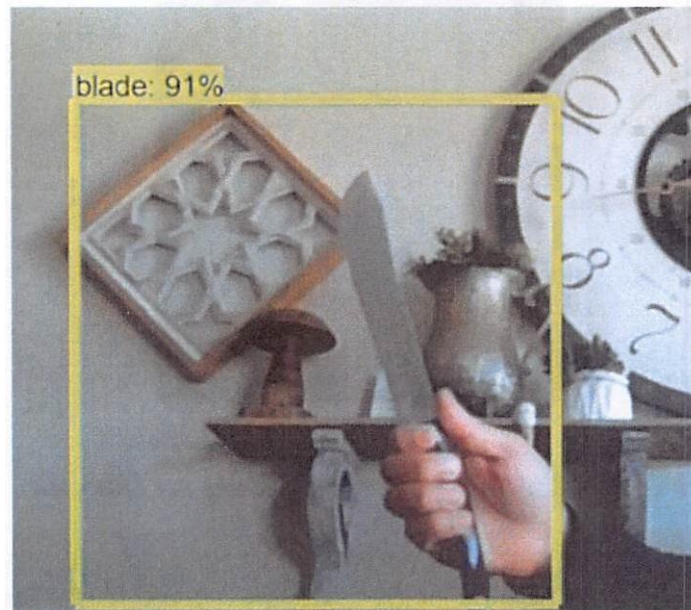


Figure 14.1: Blade Detected with 91% Confidence

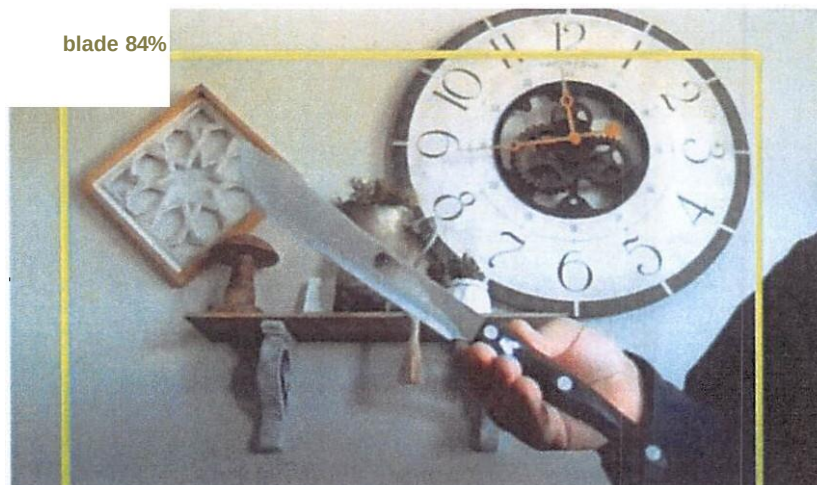


Figure 14.2: Blade Detected with 84% Confidence

5.7 Final Design - Show Pictures or Other Examples of Working Design



Figure 14.3: *Narrmv Profile of Blade not Detected*

Figure 15 shows an example of what the notification could read when a weapon is detected. The "Sent from your Twilio trial account" portion does not appear when the small messaging fee is paid.

Today 7:59 PM

Sent from your Twilio
trial account - A
weapon has been
detected on your
camera!

Figure 15: *Example Notification*

5.7 Final Design - Show Pictures or Other Examples of Working Design

Figures 16.1 & 16.2 demonstrate how the algorithm does not accidentally depict a similar looking object as a weapon. In this case, the phone is being held in a way a handgun would be held and no box is ever displayed. This shows that there are very few false positives.



Figure 16.1: Cell Phone False-Positive Test (part 1)



Figure 16.2: Cell Phone False-Positive Test (part 2)

Section 6 - Results and Discussion

6.1 Summary of Goals and Objectives

The main objective was to implement object detection onto Raspberry Pi. We ran a mobile deep learning model, SSD-MobileNet, on Raspberry Pi to detect various objects. Our experimental results demonstrated the effectiveness of this implementation. Moreover, the ongoing work was to extend this implementation to weapon detection, which was used to detect different weapons in a real-time manner. Upon completing and validating this extension in different testing scenarios our results were successful. In order to complete the smart security system a notification system was integrated into the object detector once the new categories of objects were trained to be detected. This ensured that once a weapon was detected in the frame a text notification was sent to the appropriate authorities warning them of the potential threat.

6.2 Summary of Constraints and Codes met by Design

The main constraints we have observed with this project are creating a durable housing kit for the raspberry pi with a mountable camera that is capable of staying in place for an extended duration of time. The next constraint was the camera resolution impacting the accuracy of the weapon detection, as well as the distance that the camera is able to view, to fix this having a camera that has a minimum resolution of 1080p will ensure a clear quality to have the highest accuracy. The final notable constraint with our project was the frame rate of the real time tracking with the raspberry pi. Due to the severity of this issue we needed to increase the frame rate of the hardware, and after thorough research on how to solve the issue, the best solution to the situation was changing our software to TFlite and quantizing the data as well as utilizing a USB accelerator device in order to aid in speeding up the frame rates of the overall system.

The following codes were used in our final design:

IEEE 3652.1-2020: Federated Machine Learning - Our machine learning model can be constructed from data distributed across various repositories owned by various companies

IEEE P2671: Online detection with machine vision - This standard specifies through the general requirements of online detection based on machine vision

IEEE P2247.3: Recommended Practices for Evaluation of Adaptive Instructional Systems - best practice incorporates and promotes the principles of ethically aligned design for the use of artificial intelligence

IEEE 829-2008: IEEE Standard for Software and System Test Documentation - We used this standard when testing our software for detecting weapons

IEEE 2755.2-2020: Recommended Practice for Implementation and Management Methodology

for software Based Intelligent Process Automation

IEEE 7.8: IEEE: Code of Ethics

- 3) To be honest and realistic in stating claims or estimates based on available data
- 5) To improve the understanding of technology, its appropriate application, and potential consequences

6.3 Discussion of Results and Other Use Cases

This project allowed us to design a completely unique security system by utilizing a machine learning algorithm capable of detecting weapons and immediately notifying the owner of the potential danger that is within the area. Designing this system granted us the opportunity to offer a more advanced security system to consumers at a lower cost compared to competitors. Machine learning has not been introduced to security systems easily and with the introduction of our device, we would be offering a continuously learning security system that will offer greater results as time goes on while also being capable to notify the owners of the home or establishment of a potential threat.

The use of this system can be expanded into being capable of finding concealed weapons with the implementation of an inferred camera, with this feature the number of areas this system would be able to be set up will drastically increase due to the uncertainty of if there is a weapon on a person. Taking into consideration that weapon detection is a specialization of object detection, the other uses of object detection can be implemented into several types of trackers, such as a people tracker, a vehicle tracker, or even an animal tracker. These would also easily be able to be used to notify when any object, not just a weapon, is detected in a certain area.

Section 7 - Conclusions and Recommendations

It is observed that a large population reconciles violence related to various weapons such as guns and knives all over the world. Therefore, it is a good proactive solution to detect these weapons in public areas to defend against this violence. Our Weapon Detection on Raspberry Pi design identifies active threats by revealing displayed weapons. These weapons can be either a rifle, a handgun, or a blade and the weapon must be in view of the camera. Our alert notification system provides additional time for actions to be taken to minimize casualties.

We recommend having a mountable dry surface for the Raspberry Pi platform. Wi-Fi and or data service are needed for text notifications. Electricity to run power to the Raspberry Pi system is also required. In the event of power failure, the possibility of having a backup generator is convenient to prevent system interruption. This artificially intelligent threat detection system will impact many from universities and church organizations to businesses and homeowners.

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Appendix

Code to Run Camera and Send Notification:

```
##### Webca- Object Detection Using TensorFlow-trained Classifier uttn## #ttt

# Description:
# This program uses a TensorFlow-trained classifier to perform object detection.
# It loads the classifier and uses it to perform object detection on a webcam
# feed.
# It draws boxes, scores, and labels around the objects of interest in each frame
# from the webcam.

# Import packages
import ctypes
import os
import cv2
import numpy as np
import tensorflow as tf
import sys

# This is needed since the notebook is stored in the object_detection folder.
sys.path.append('..')

# Import utilites
from object_detection.utils import label_map_util
from object_detection.utils import visualization_utils as viz_utils
import numpy as np
import tensorflow as tf
import sys

# Set up Tflite
or
```

```

Twilio SID, authentication token, my phone number, and the Twilio phone number
account_sid
auth_token 49528hd7208314
my number 4285110
twilio_number

```

```

client account_sid auth_token

```

```

// get Screen Size
user32 ctypes.HI
screen_width = screen_height * user32
user32
frame_height = frame_width

```

```

scale_width = float(screen_width) / float(frame_width)
scale_height = float(screen_height) / float(frame_height)

```

```

scale_width = scale_width
img_scale = scale_height

```

```

img_scale = scale_height

```

```

# ... Scale imgScale
cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
WINDOW_NAME = 'Integration'

```

```

# Set up camera constants
IM_WIDTH
IM_HEIGHT

```

```

# Name of the directory containing the object detection module we're using
MODEL_NAME = 'f',

```

```

# Grab path to current working directory
CWD_PATH = os

```

```

# Path to frozen detection graph .pb file, which contains the model that is used

```



```

    Each box represents a part of the image where a particular object was detected
detection_boxes = detection_graph.get_detections_boxes(image_tensor)

    Each score represents level of confidence for each of the objects.
    The score is shown on the result image, together with the class label.
detection_scores = detection_graph.get_detections_scores(image_tensor)
detection_classes = detection_graph.get_detections_classes(image_tensor)

    Number of objects detected
num_detections = detection_graph.get_detections_number(image_tensor)

    Initialize other parameters
    # Initialize frame rate calculation
    frame_rate = 30
    freq = cv2.FONT_HERSHEY_SIMPLEX
    font = cv2.FONT_HERSHEY_SIMPLEX

    Define inside box coordinate (top left and bottom right)
    tl_inside = (int(IM_WIDTH*0.1), int(IM_HEIGHT*0.1))
    br_inside = (int(IM_WIDTH*0.9), int(IM_HEIGHT*0.9))

    Define outside box coordinates (top left and bottom right)
    tl_outside = (int(IM_WIDTH*0.05), int(IM_HEIGHT*0.05))
    br_outside = (int(IM_WIDTH*0.95), int(IM_HEIGHT*0.95))

    Initialize control variables used for weapon detector
    detected_inside = False
    detected_outside = False

    inside_counter = 0
    outside_counter = 0

    Initialize frame rate calculation

```

A5

4

```

frame1c r t, c ilc
frit?u cv2
fo'lt cv2

μ Initialize webcam feed
video cv2
r'et v. i u
i et video

def frame

    # Use globals for the control variables so they retain their value after
function exits
    global detected_insid0
    global inside_counte'
    global pause pause_counter

    frame_expanded np frzime t1xis

h. True

    # Acquire fra e and expand frame dimensions to have shape: [1, None, None, 3]
    # i.e. a single-column array, where each item in the column has the pixel RGB
value
    re friJre ici 0
    f"a"'2_rgb cv2 frame cv2
    f,..a e exp2 i np frame_rg axis

    # Perform the actual detection by running the model with the image as input
    coxes scores classes num scss
    detection_u xes d tection s ores cietect:o, classes r, _detect10'1s
    feed_dict image tensor frame_expa'lded

    # Draw the results of the detection (aka 'visulaize the results')
vis_util
    fraritc

```

```

np          t.Joxes
np          classes          np
np          scores
czi gory index
use_nor ali ed coo dina s True
line_thicl<ness
mir score thresh

# 10x10 boxes defining "outside" and "inside" locations.
ttcv2.rectangle(frame,TL_outside,BR_outside,(255,20,20),3)
ttcv2.putText(frame,"Outside ttbox",(TL_outside[0]+10,TL_outside[1]-
10),font,1,(255,20,255),3,cv2.LINE_AA)
cv2          frame TL_inside BR_inside
cv2          frame detection
TL_inside    font          cv2
# Check the class of the top detected object by looking at classes[0][0].
# If the top detected object is a weapon (1-4)
# find its center coordinates by looking at the boxes[0][0] variable.
# boxes[0][0] variable holds coordinates of detected objects as (ymin, xmin,
ymax, xmax)
# int classes          1 or int classes          or
int classe          or int classes          and r,aut
x          int          boxes          box s          IM WIDTH
y          int          boxes          box<          IM HEIGHT
# Ora a circle at center of object
cv2          fra e > y

# If object is in inside box, increment inside counter variable
x          TL_inside          and          BR_inside          and y          TL_inside          and
y          BR_inside
inside_counte"          in., de coJlter

inside co,rnter
detected_inside True
message clierit
body '\ weapon has
from cil:o_nu ber
Lo my_number

inside counter
o.ltside_counLer
# Pause 1-weapon detection by setting "pause" flag
pause

```

All the results have been drawn on the frame, so it's time to display it.
cv2

```
# Press 'q' to quit
cv2
```

```
tr Clean up
1 -
cv2
```

Code for the Training of the Model

```
r "Training executable" detection_model s
```

This executable is located in Detecto
configuring the training

1) A single pipeline can be specified by
mainEvalPipe
line config

```
ple usage:
./train \
  --logtostderr \
  --train_dir=path/to
  --pipeline_config
```

2) Three configuration files can be provided: a model_pb2.Detecti
configuration file to define what type of DetectionModel is being
input_reader_pb2.InputReader file to specify what training data w
a train_pb2.TrainConfig file for training

```
5.
/train
```

```

    functools
    json
1    os

    tf

    t

    import
        t
        t

    tf

    tf

    Flag, tf
    flags
    flags
    flags
    flags
        num clones
        clone on cpu False
        set to False
    flags
        'ker_repli
        replicas.
    flags
        • I
        'a parame
    flags
        'train_dir
        'Directory
    flags
        ainEvalP

```

tags

flag

+lags

FLAGS flags

```

def
    None 'Use o
    tion/n

def
    ass FLAGS
    tf FLAGS tf FLAGS
    if FLAGS
        (0 f
            FLAGS
            FLAGS
            tf FLAGS
            os FLAGS pipeli
            w r .irite True

lse
    configs

    model_config_patt FLAGS
    Lr'ain_config_pc1th FLAGS
    r in_input_confir path FLAGS
    FLAGS
    n:ir el co'lfig FLAGS
    FLAGS
    FLAGS
    tf co'ft os r FLAGS
    0:ler •r it True

rmodel_config configs
train_cmfig configs
input_Co'lfig configs

```



```

mode: corfig model_corfig
is_training True

def config

    contig

create_inout_dict_f = functools.partial(inplace config

eriv json OS " viron I {}
clu:. clJ a e v None
cluster tf c J, - _data i.f'. cluster data °' None
task_data c " None or

task info type T '> object task_data

# Parameters for a single worker.
ps_tasks
1,10rker_replicas
1,10rker_iohname 'lonely
task
is_chiet True
masLe"

cluster data and in clu t "'_datd
r. Number of total 1*,0r'ker replicas include "1,10rker"s and the "master".
wo"'ker_replicas clusler_data
clusterE'r data and in cl.1ster_dcltc,
p:,_ta:.ks cluster data

"if 0 k- rcp_iL :, and ps ta:,k:,
ValueError

, f ,,,10rker' r•eplicas and ps_tasks
Setup distributed training.
se"'ver tf tf cluster protocol
JOh_name tas_l.f'.o
tas index task info

```

```
task_i'llfo
server
```

```
worker_job_., e %s %d task: info task i'llfo
task task_irfo
is_chief task i'llfo
raster servc>r
```

```
graph_rewriter_fn None
it config in configs
graph_rewriter_fn
configs is training True
```

```
create_input_dict_fn,
model_fn
train_config
master
```

```
FLAGS
::, _r_replicas;
FLAGS
ps as
\•Worker_job_name
is chief
FLAGS
g r t, c( fr graph_ : e\• .:te" h
```

```
name_
tf
```

ASSIGNMENTS FOR OUTCOME “4”

An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

**ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II
SPRING 2022**

Instructor: VJ Turner & Sarhan Musa

Title of Assignment

Ethics Case Studies

Outcome Measured Using this Assignment

Outcome 4

An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

Check the ethical dimensions related to this assignment

Requires students to	
X	Recognize ethical and professional responsibilities in engineering situations involving global, and societal contexts
X	Make informed judgements on ethical and professional responsibilities in engineering while considering the impact of engineering solutions in
X	global context
	economic context
	and societal context.

Brief justification of the suitability of assignment for the outcome

This assignment will allow students to take actual real world ethical problems/scenarios and discuss possible issues and ramifications of not following sound ethical practices.

ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II SPRING 2022

Title of Presentation: Outcome 4 Ethics Rubric						
Team Number and Members:						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Demonstrate Knowledge/Understanding Professional Code of Ethics						
Able to analyze a situation for potential ethical problems						
Able to demonstrate the knowledge of professional code of ethics (IEEE, ASEE, NSPE, FE etc)						
Able to select/argue the most ethical actions to take						
Awareness of responsibility to work in an ethical and professional manner						
As appropriate ability to reference proper Ethical Cannon to a situation						
Aware of the need and the knowledge the work of others uses by getting proper permission and citation in the work						
Analysis and Informed Judgments						
Able to recognize an ethical issue within engineering profession						
Identify impact on Safety, Environmental, Technical, Global or Cultural as appropriate						
Able to identify alternative solutions regarding an ethical issue						
Formulate practices to try to prevent recurrence of an issue						
Ability to make informed judgment by evaluate both immediate and long-term risks/consequences of a decision						

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



ELEG 4248: Senior Design & Professionalism II

Topic: Ethical Scenario Case Study

Instructions:

Upload to Team Ethics Scenario Assignment

Due no later than 5pm on Monday February 7, 2022

10-point reduction if late

Submit only PowerPoint slides

Each Team will control its own slides on day of presentation
Each person is expected to cover some portion of the presentation

Each Team has 15 mins max to present and 5 mins for Q&A

Ethics Case Studies – Objective

An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

1. an ability to recognize ethical and professional responsibilities in engineering situations involving global, and societal contexts

Students are able to demonstrate the knowledge of professional code of ethics (Review code of ethics from your specific professional society and from your State board of professional Engineers. Students may be tested on these).

2. an ability to make informed judgements on ethical and professional responsibilities in engineering while considering the impact of engineering solutions in global, economic, environmental, and societal contexts

Students will study several ethics case studies and make informed judgements on them with regard to the impact of engineering solutions on (a) global, (b) economic, (c) environmental, and (d) societal contexts. (There should be enough case studies that cover all the four areas of global, economic, environmental and societal context)

Global Impact: The student is able to investigate a given engineering problem, and explain how proposed engineering solutions to similar problems may be adopted in different parts of the world

Societal Impact: The student is able to investigate a given engineering problem and develop engineering solutions that take into account societal factors.

Economic Impact: The student is able to investigate a given engineering problem and develop solutions that take into account economic factors.

Environmental Impact: The student is able to investigate a given engineering problem and develop solutions that take into account environmental impact.

3. Reference the fundamental cannons on last page where applicable in your explanation.

For the Ethical Scenario Assignment

Develop a PowerPoint Presentation to Discuss and Review Your case Study

Your Presentation Deck must include:

- Team Introduction Slide w Picture
- Copy of the actual scenario assigned
- Use Bullet Points to Describe the scenario if needed to make it clear to the audience
- Describe the Ethical Issue
- What are the consequences of the action is carried out?
- What are the correct actions to be taken?
- What did you learn?
- Reference appropriate Fundamental Canon in your discussions

Presentation Deck must include discussion (where appropriate) :

1. Global Impact: The student is able to investigate a given problem, and explain how proposed action could have implications or be adopted in different parts of the world
 2. Societal Impact: The student is able to investigate a problem, and explain any societal factors and issues if the action being questioned is implemented
 3. Economic Impact: Describe any economic factors associated with this ethical scenario.
 4. Environmental Impact: Investigate and describe any a given environmental impact.
 5. Safety Impact: Describe any safety issues you uncovered in the scenario
- Conclusion and Recommendation
 - "Questions" slide at the end of your presentation

Everyone on the Team must cover some portion of the presentation

Source for Different Ethical Scenario

<https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases/>

These cases and others on engineering ethics can be sorted according to the following categories: Academic Ethics

- Bioengineering
- Business Ethics
- Civil Engineering
- Computer/Software Engineering
- Electrical Engineering
- International
- Mechanical Engineering
- Science/Research Ethics

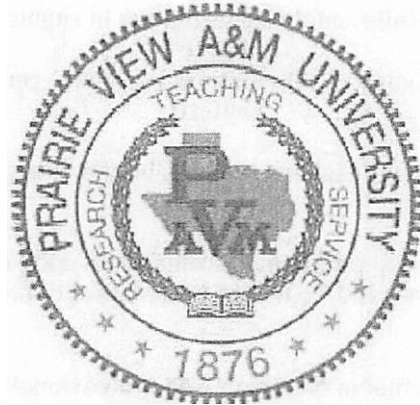
Outcome 4

Outcome 4

Ethics

Assignment

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



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- Mechanical Engineering
- Science/Research Ethics

Title of Presentation:						
Team Number and Members:						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
Please determine a score (e.g. 82) for each criterion and write it in the range for that score	Poor 0 to 54	Below Avg. 55 to 69	Average 70 to 79	Very Good 80 to 89	Excellent 90 to 100	Comments
Demonstrate Knowledge/Understanding Professional Code of Ethics [50%]						
Able to analyze a situation for potential ethical problems						
Able to demonstrate the knowledge of professional code of ethics (IEEE, ASPE, NSPE, FE etc)						
Able to select/argue the most ethical actions to take						
Awareness of responsibility to work in an ethical and professional manner						
As appropriate ability to reference proper Ethical Canon to a situation						
Aware of the need and the knowledge the work of others uses by getting proper permission and citation in the work						
Analysis [25 %]						
Able to recognize an ethical issue within engineering profession						
Identify impact on Safety. Environmental, Technical. Global or Cultural as appropriate						
Able to identify alternative solutions regarding an ethical issue						
Able to evaluate both immediate and long-term risks/consequences of a decision						
Formulate practices to try to prevent recurrence of an issue						
Summarization and Communications [25 %]						
Able to provide appropriate results and conclusions to indicate learnings from an Ethics scenario						
Able to provide appropriate logical conclusions and recommendations						
Summary Presentation includes all team members						

Order of Team Presentations

Spring 2022

Wednesday February 9

Team 6 and Team 7

Thursday February 10

Teams 1, 2, 3, 4, 5, 8,

Ship or Not to Ship

See Example Summary Posted on eCourse

Rachel works as a Quality Assurance Engineer at a large electronics company. She is responsible for the final testing of her company's servers and is part of a team which decides when new products will be shipped to distributors for sale.

Rachel's company has a contract with another company which makes the chips which are incorporated into the servers Rachel's company makes. The business model for this product is to release a new generation server approximately every six months, meaning Rachel has a limited timeframe to conduct her Quality Control tests.

Because there is such a short amount of time between the release of each next new product, the Quality and Assurance department cannot perform every possible test on the servers to ensure they are defect free. Rachel will not ship a product if there is any possibility that the server could malfunction and cause physical harm to the customer. However, she will ship a product that has a higher likelihood of failure resulting in data loss for the customer, because she knows that if she doesn't, her company's competitor will.

Is this an ethical way to conduct business? How should she determine when to ship a product with known defects?

A Violation of Privacy Team 1

Marcus is a computer engineer who has recently developed an app which helps users keep track of medical information, doctor's appointments, and prescriptions.

Information about the user is stored in this app, including what prescriptions they are taking and how frequently they schedule doctor's appointments. As the developers of the app, Marcus and his company have access to this information.

The marketing department requests Marcus supply them with customer-specific information so they can better target ads and app suggestions to the users. Marcus understands that he is part of a company, but also feels that the privacy of the app users should be protected. Additionally, Marcus feels that as an engineer, he should be responsible to those who use his technology.

How does Marcus determine how much of the user's information should be shared with marketing? Is this an ethical use of information or a violation of the user's privacy?

A Sinking Situation Team 2

Roscoe is the head of engineering at a systems engineering company. His company has been contracted by a company, U-sub, to make firing assemblies for torpedoes. This contract calls for additional safety testing to ensure that the systems work properly.

The contract stipulated that it was the responsibility of Roscoe's company to pay for this expensive additional testing. However, the CEO reminds Roscoe that their company is in financial trouble and asks Roscoe to skip the extra testing and falsify the paperwork by saying that the testing had occurred and that the systems passed. He then goes on to tell Roscoe that if he doesn't sign off on the testing, he will be fired.

Roscoe decides he cannot give in to his boss's demands and quits. However he suspects that his former boss will promote someone else who will be willing to sign off on the testing.

Should Roscoe report the ethical violations of his former company?

May The Truth Be With You Team 4

Catherine is a new hire at a startup that produces LCD displays for large venues, such as shopping malls. Part of her job requires her to troubleshoot malfunctioning displays.

One day, a shopping mall reported that two display units out of twelve had stopped working from their installation three months prior. The customer also noted serial and revision numbers on the two units were different from the rest of the units.

At the job site, Catherine inspected the displays and realized her company had sold units that were from a bad batch (i.e. group of displays that did not have over 50% yield during manufacturing). Catherine wanted to tell the site why the units failed, but recognized that if she disclosed this information, the site would be eligible to receive replacement displays at no additional cost. On the other hand, if she blamed the failing units on a weaker cause, such as improper installation, her company would be able to charge the site for replacement units.

Catherine knew her manager would want her to choose the option that would minimize the company's losses; however, she wanted to be honest with the site as they were one of the company's best customers.

What should she do?

After earning a graduate degree in Engineering Management, Ashton began working for PDRC International. This is a company based in the U.S. which offers engineering, design, and construction services to countries all over the world.

Ashton's work is focused on international development; her first assignment is to lead a team to develop a bid for a highway construction project in East Africa. After the engineering proposal is submitted, Ashton is proud of the work her team has accomplished and promises her manager she will do everything possible to make sure that PDRC receives the contract.

PDRC's bid is well-received, and Ashton and her team are flown to East Africa to finish negotiations. Ashton is thrilled when her company receives the bid; the only stipulation is that they build their construction headquarters in a specific region in the country. Ashton then begins scouting the region for a location to build their headquarters.

In order to obtain building permits in the region, Ashton has to negotiate with the local government. As she begins negotiations, she realizes that bribery is both a common and expected practice. If she does not bribe the local officials, she will not be able to build PDRC's headquarters in that region and consequently will lose the contract; her first managerial project will be a failure. However, it is illegal for a U.S. citizen to bribe a foreign official in order to obtain business; if she is caught for bribery, she could face jail time and her company could be fined millions of dollars.

What should she do?

Apathy over Anonymity Team 5

Satomi works in a research facility that provides statistical results for the bioengineering firm TechCureCase. She is one of four interns expected to go through hundreds of samples per day. At her first week on the job, her supervisor informs her that all blood samples are to be completely anonymous. No testing can be done if personal information is revealed-meaning, the samples must be properly disposed of if opened, or returned to the physicians if unopened to be re-anonymized.

For the first five weeks, most of the new interns follow procedures to check that samples were anonymized before testing occurred. However, one of the interns, **Max**, failed to verify whether the samples were anonymized. Halfway through the testing, Satomi discovers the non-anonymized samples. She considers whether they should tell- their supervisor, but the other interns ask her not to speak up so that they won't get in trouble. One of the interns argues that as long as they remove the information from the non-anonymized samples, the batch would otherwise be fine. Max is hesitant to go to their supervisor as it is his fault, but Satomi can see that neither does he like the idea the other interns are suggesting.

What should Satomi do

A Lengthy Dilemma Team 6

Monica has been working at a large medical company that reviews lab procedures on blood samples shipped in weekly. On the first week on the job, her supervisor went over the procedure the company uses that give the institution permission to use blood samples for laboratory testing. One part of the procedure is to collect signed informed consent forms for each sample. Monica knows if a sample does not come with an informed consent sheet, the sample must be returned back to the supplier.

Almost a year after she started, Monica comes across an unsigned consent form fourteen pages long, with incredibly small font. Her initial reaction was to return it to the supplier to obtain the necessary signatures. However, reading through the first few sentences of the form, she wonders if the consent sheet is sufficient to inform a patient about the possible risks involved with consenting to their samples being used even if it were signed. It takes her about an hour to read through the entire form, and at the end of it she is certain no patient would take the same amount of time to read it. Furthermore, the text is complex to read due to all the technical vocabulary, and could put the organization at risk if challenged. She wonders how the draft of the consent form with the company could have been reviewed and approved by the institutional review board.

Monica has serious questions about the ethical basis of using this form, how it was approved and by whom. She wonders whether to bring it up to her boss, in order to see if there's something she hasn't understood. Her coworkers shrug it off, saying they have seen numerous consent forms similar to the one she found, and some that were even longer. Should Monica return the form back for a signature from the supplier without comments, or should she speak with her boss about the process used to accept the forms?

A Positively Negative Response Team 7

Milo recently got hired to work in the technical research department of TechCureCase, a bioengineering firm that develops new medical devices for more accurate diagnostic testing of prostate cancer. Milo performs numerous tests to determine the success rate of a new medical device the company is testing. While nearly 98% of the known samples have produced correct results, a few samples have proven to have incongruous results.

During this longitudinal study, results from one of the negative control samples surprises Milo as it changes from being consistently negative to being consistently positive for early stage prostate cancer. As no device has perfect sensitivity and specificity, he initially believes the change is due to is a false positive result or mislabeling during processing, and therefore dismisses it. However, the next sample from the same negative control patient again produces the same positive result. Milo becomes certain there is either a technical issue going on with the test, or the patient has actually developed prostate cancer. When Milo talks about the issue with his boss, Milo's boss tells him to put the issue aside and focus on the rest of his work.

Unintended Effects Team 8

Jack has been working as a project engineer for a mechanical energy technology firm for a few years now, and has recently been promoted to review projects for in-need communities overseas. He has been put in charge of managing the current company's charity projects, and determining how to distribute the funding for them.

Some of the projects are pretty straightforward in their mission and material requirement, but for one project, Jack isn't sure whether the company should be funding it. The project's mission is to provide new solar panels for an East African community but the project data suggests it is more practical to just install better lighting inside the homes. Jack wonders whether to bring up his doubts with his boss. Based on the company's research on the community, the community desires better lighting system for their homes, and the solar panels would be an expensive and high maintenance project. Not to mention, there was a previous project that (when followed through) resulted in equipment being stolen from the same region to exchange for money.

Jack understands their local sponsor would gain a great advantage in featuring solar panels in the community. It would also foster a good business partnership between the two companies. However, Jack feels it is his responsibility to provide the community with a more simple and efficient solution to their problem, without diving into a large project that could possibly lead to negative side effects. Is Jack's company wrong to provide technology to the community when they don't need it?

Looking for a medical future Team 9

Anthony conducts research on emerging technologies in regenerative medicine. While on the train home from work, he starts chatting with the man sitting next to him. When Anthony mentions that he is researching regenerative medicine, the man becomes very interested and starts asking a lot of questions. Anthony ends up talking to the man for nearly an hour and explains to him the potential therapies which could be developed from his research.

The man then says that he would want to undergo these experimental therapies even if it meant he would only live a couple more years. Anthony then realizes that this man is in a wheelchair (a divider prevented him from seeing this sooner), and that the man is willing to do anything to regain his ability to walk. Anthony explains that his research is many years away from human testing, but the man says he would sign up for any testing, even if it wasn't safe.

As a scientist, what are Anthony's ethical responsibilities when discussing his research? Does a person so desperate for a cure truly understand the consequences associated with experimental treatments? Is it wrong to provide hope for these individuals, especially considering that many therapies are years away from being used in humans?

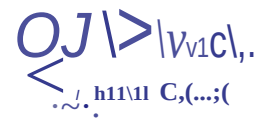
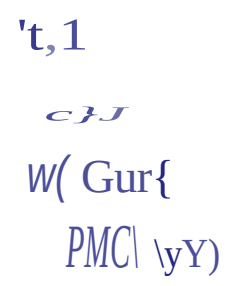
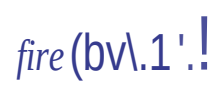
Fundamental Canons

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby

commit ourselves to the highest ethical and professional conduct and agree:

1. to accept responsibility in making decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment.
2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist.
3. to be honest and realistic in stating claims or estimates based on available data.
4. to reject bribery in all its forms.
5. to improve the understanding of technology, its appropriate application, and potential consequences.
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations.
7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others.
8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin.
9. to avoid injuring others, their property, reputation, or employment by false

Ethics Evaluation Form
ECE Senior Design & Professionalism
Ethics-Outcome 4

Title of Presentation:						
Team Number and Members:						
Team 2 Mathew Barnett, Hiram Pouncy, George Polk, Breon Holmes, Bryce Lovejoy						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Demonstrate Knowledge/Understanding Professional Code of Ethics						
Able to analyze a situation for potential ethical problems	11"					
Able to demonstrate the knowledge of professional code of ethics (IEEE, ASPE, NSPE, FE etc)						
Able to select/argue the most ethical actions to take						
Awareness of responsibility to work in an ethical and professional manner						
As appropriate ability to reference proper Ethical Canon 10 a situation	/					
Aware of the need and the knowledge the work of others uses by getting proper permission and citation in the work						
Analysis and Informed Judgments						
Able to recognize an ethical issue within engineering profession	v					
Identify impact on Safety, Environmental, Technical, Global or Cultural as appropriate						
Able to identify alternative solutions regarding an ethical issue	/					
Formulate practices to try to prevent recurrence of an issue	I					
Ability to make informed judgment by evaluate both immediate and long-term risks/consequences of a decision						

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Question slide 4
 Code #8? —
 Good Answer on
 Slide 5

Ethics Evaluation Form
ECE Senior Design & Professionalism
Ethics-Outcome 4

Title of Presentation:

Team Number and Members:

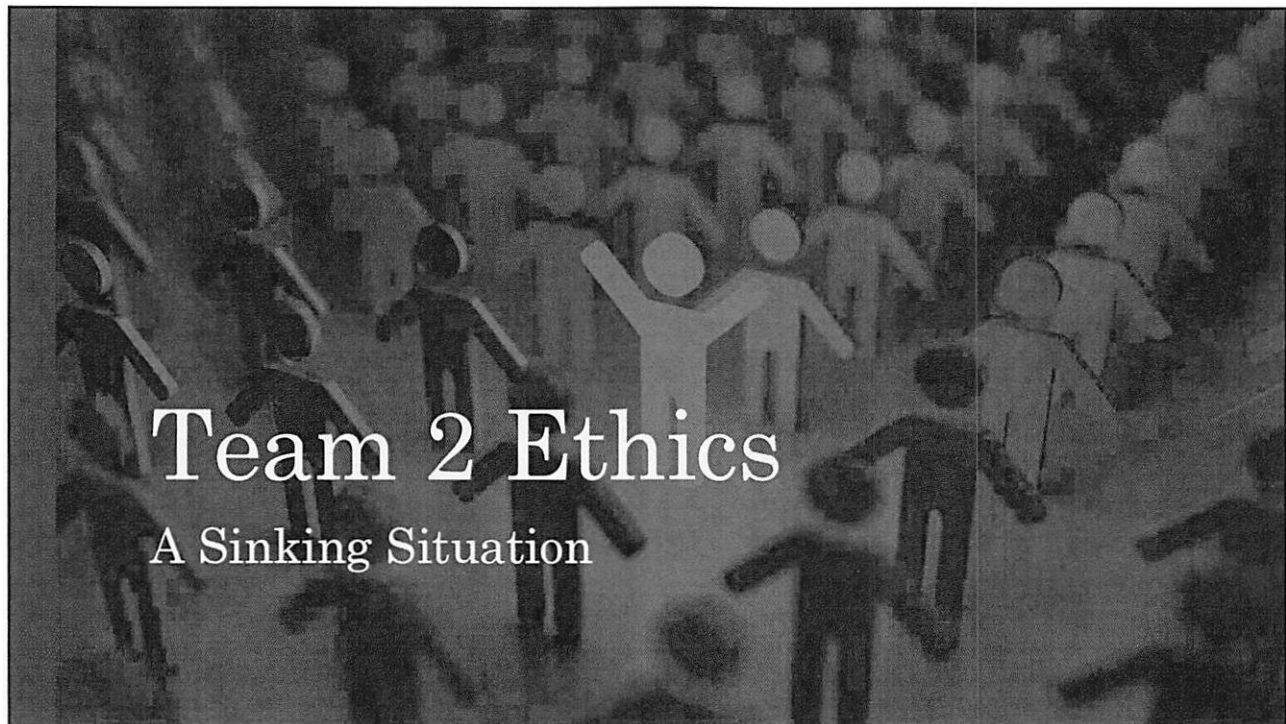
Team 2 Mathew Barnett, Hiram Pouncy, George Polk, Breon Holmes, Bryce Lovejoy

Date of Presentation: 12 / 10 / 2022

Name of Evaluator and Affiliation (University or Company name) **Murphy**

	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
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Able to analyze a situation for potential ethical problems						
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Able to identify alternative solutions to an ethical issue						
Formulate practices to try to prevent recurrence of an issue						
Ability to make informed judgment by evaluate both immediate and long-term risks/consequences of a decision		96				

96



Scenario

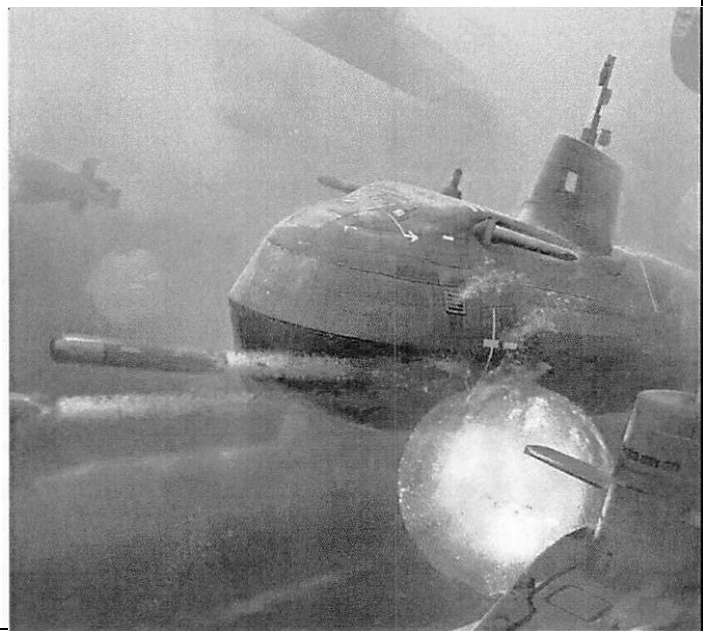
A Sinking Situation

Roscoe is the head of engineering at a systems engineering company. His company has been contracted by a company, U-sub, to make firing assemblies for torpedoes. This contract calls for additional safety testing to ensure that the systems work properly.

The contract stipulated that it was the responsibility of Roscoe's company to pay for this expensive additional testing. However, the CEO reminds Roscoe that their company is in financial trouble and asks Roscoe to skip the extra testing and falsify the paperwork by saying that the testing had occurred and that the systems passed. He then goes on to tell Roscoe that if he doesn't sign off on the testing, he will be fired.

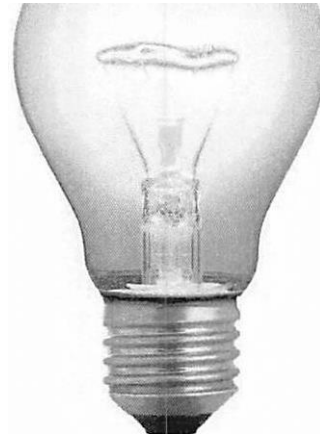
Roscoe decides he cannot give in to his boss's demands and quits. However, he suspects that his former boss will promote someone else who will be willing to sign off on the testing.

Should Roscoe report the ethical violations of his former company?



Simple Breakdown

- Roscoe is the head of engineering
- The contract with U-Sub requires safety testing.
- Roscoe's Company wants to skip safety testing and falsify paperwork with fake test results to save money.
- Roscoe's CEO threatens to fire him if he doesn't sign off on the "testing".
- Roscoe quits and decides not to sign off on the false paperwork but fears his CEO will find someone that will.



Code of Ethics

The situation finds the involved parties in conflict with several of the IEEE fundamental codes of ethic cannons

Each cannons are as followed:

- 1. To hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment.
- 3. To avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist.
- 8. To not engage in harassment of any kind, including sexual harassment or bullying behavior.
- 9. To avoid injuring others, their property, reputation, or employment by false or malicious actions, rumors or any other verbal or physical abuses.



Ethical Concerns

How do the involved parties violate each of the codes mentioned?

1. It is the responsibility of Roscoe's company to pay for expensive additional testing before approving the assembly. By falsifyingly approving without testing the product he would not only be out of compliance with ethical design practices, but he would also be putting the safety of the public in jeopardy.
3. Once the company realized they could not accommodate for the additional testing mentioned in the contract they should have notified their employer, but instead the CEO pushed Roscoe to falsify the paperwork.
8. In this situation Roscoe's CEO threatens Roscoe with the chance of termination if he doesn't falsify the paperwork this can be classified as a threat.
- U. Through falsifying the paperwork the company runs the risk of hurting the employees at U-Sub, their property, and reputation as well.

Impact of Consequences

Global Impact: If Roscoe doesn't report the ethical violation of his former company, not only will they lose trust globally regarding their international customers, but it could also potentially harm the user if the torpedo firing assembly malfunctions and doesn't shoot properly.

Societal Impact: Not only will Roscoe's former company sever their relations with U-sub but also any other future companies who could've possibly wanted to contract them for their services within systems engineering operations such as the torpedo firing assembly.

Economic Impact: By not expressing the fault of the company, U-sub and other companies will no longer offer contracts to Roscoe's former company, and since this situation involves a high-level torpedo firing system not functioning properly due to negligence the company could also incur substantial fines or even worse a lawsuit of some sort.

Environmental Impact: If the torpedo firing assembly is not up to par with its recommended safety standards, misfires could occur which could negatively impact the surrounding environment and its citizens within close proximity.

Safety Impact: If the safety testing is not implemented by Roscoe's company, the resulting effects could be most prominently felt by the customer when trying to operate the firing assembly which could result in severe bodily harm to its operators and the surrounding area.

What did we learn?

Knowing that we are about to become engineers in the industry it is very important that we understand ethics and how important it is. This assignment allowed us to showcase our ability to dissect a possible unethical situation

Being ethical is important even if you must risk your job because as an engineer your credibility matters.

Once you become an engineer you are now serving the public in some type of capacity, so the decisions you make can affect the lives of many people.

The Correct Choice

In order to comply with all ethical standards and codes the correct decision would be for Roscoe to report his company's ethical violations

Global Impact: If Roscoe reports his former company as he should, it will prevent companies across the world who purchased the torpedo firing assembly from potentially falling off an inadequate missile.

Economic Impact: There would be a delay on the production of the firing assembly, but U-sub will be able to withdraw their initial contract with Roscoe's former company and work with rival companies and have the potential to gain more profit with a safer product.

Environmental Impact: By making sure the additional safety testing is completed whether it be by Roscoe's company choosing to right their wrongs or another company, there will be a much lower chance of a misfire which could harm wildlife within the ocean.

Safety Impact: The production and release of a product that meets all proper safety protocol will provide more safety than harm to its consumers.

Conclusion and Recommendation

In conclusion, engineers are faced with many decisions based on ethical standards throughout their daily scope of work by way of the technical projects they are tasked with. It is pertinent that they always keep in mind the safety not only of those within their company but also the general welfare of the communities and environments associated with said projects.

We recommend that every engineering professional complete their due diligence when it comes to ethical reasoning and decision making as it is the only way to keep trust within your company circle as well as other companies you work alongside with and the consumer who has put their faith in you delivering a safe and functioning product.

Questions?

ASSIGNMENTS FOR OUTCOME “5”

An ability to (1) function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, (2) establish goals, plan tasks, and meet objectives.

**ELECTRICAL AND COMPUTER ENGINEERING
DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II
SPRING 2022
Instructor: VJ Turner & Sarhan Musa**

Title of Assignment

Team Contract and Weekly Team Progress Report
**This is used to establish roles, team meeting, working
relationship etc.**

Outcome Measured Using this Assignment

Outcome 5

An ability to (1) function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, (2) establish goals, plan tasks, and meet objectives.

Check the teaming problem characteristics related to this assignment

Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment. Requires students working in groups to:	
X	Organize and assign team roles; plan and keep good record of team meetings including documentation of individual contributions
X	Share ideas, complete assigned task on time, help others, and be professional to each other (through peer evaluation of team members on these characteristics).
X	Resolve conflicts professionally within the group with the view of creating an inclusive and collaborative environment
Establish goals, plan tasks, and meet objectives. Requires students working in groups to:	
X	Set goals and objectives
X	Identify and break down work into tasks and subtasks and identify the personnel and deliverables for each.
X	Develop a Gantt chart and critical path analysis for managing the project.
X	Establish major milestones for tracking progress and define performance metrics to measure success.
X	Track progress of team members to ensure project is on schedule and meets objectives (through submission of progress reports).

Brief justification of the suitability of assignment for the outcome

We use these tools to ensure successful teamwork practices are in place, how to resolve issues and how to track weekly progress of the various projects.

ELEG 4248 SENIOR DESIGN & PROFESSIONALISM II SPRING 2022

Title of Presentation: Outcome 5						
Team Number and Members:						
Date of Presentation:						
Name of Evaluator and Affiliation (University or Company name)						
	Excellent 99	Very Good 89	Average 79	Below Avg. 69	Poor 54	Comments
Function Effectively on a Team						
Have a signed contract and agreed method of working together						
Organize and assign team roles						
Plan and keep good record of team meetings including documentation of each team member contributions						
Create an inclusive and collaborative environment						
Complete assigned task on time,						
Help others, share ideas, and be professional to each other						
Detailed Weekly Progress Reports turned in every Wednesday						
Able to show that all team members are making equal contribution to work deliverables						
Planning and Tracking Progress						
Able to establish goals and objectives (deliverable)						
Identify and break down work into tasks and subtasks						
Develop a Gantt chart and critical path analysis for managing the project						
Establish major milestones for tracking progress						
Track progress of team members to ensure project is on schedule and meeting goals/objectives						

Instructions - Team Contract (ABET Outcome 5.1)

Final DUE: On or Before Jan 26 – Each Team Email to me a signed copy

Each Team must develop and sign a Sr Design contract that will define and determine work processes, relationships, and team operating norms for Senior Design

=====

Objective of this contract – must address these areas:

Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment

- i. **Organize and assign team roles**
- ii. **Plan and keep good record of team meetings including documentation of individual contributions**
- iii. **Share ideas, complete assigned task on time, help others, and be professional to each other (through peer evaluation of team members on these characteristics).**
- iv. **Resolve conflicts professionally within the group with the view of creating an inclusive and collaborative environment**

=====

Required Sections of your team contract:

Must Have the Standard Cover Page – see attachment on eCourse

1. Team Number and Project Objective

- Team number and overview of your project
- You must have one thorough statement that anyone can understand to describe your project objective – do not use any acronyms

2. Team Membership

- List team members and major
- List course instructors
- List Faculty project sponsor

3. Team Roles and Responsibilities

- List Team members and their roles
- Be sure to designate the Team Lead position

4. Team Working Relationship

- List those characteristics your team will employ to be successful in delivering your project

- Team Contract Homework - 1

Instructions
Team Contract (ABET Outcome 5.1)

5. Team Meeting Agreement

- Please plan to have 15 to 20 hours outside of class available for team work
- Document the dates, times and location of outside team work agreement
- Team Work Deliverables
- TBD to be decided can be use now for location at this time if you don't know

6. Team Work Deliverables

- **Section A** – Joint Project Items
How will you work on joint project deliverables?
- **Section B** – Individual Project Items
How will you work on individual project items?

7. Team Documentation and Communications

- List how you will use team log books to track progress
- How will you communicate as a team?

8. Conflict Resolution

- How will you resolve issues, conflicts or disagreements?
- Who will you escape issues and to who?

9. Arbitration of Team Complaints

- See Attachment A on next page

10. Signature and Date

- Each person on the team must sign the contract

**Reminder: I will be looking for thorough and complete write up.
Please write complete sentences – using good grammar and
thoughtful consideration for each section. This should be developed
as a detailed contract that each team member has agreed to follow.**

Attachment A Must be included in all Team contracts

Arbitration of Team Member Complaints for Senior Design ELEG 4247 & ELEG 4248

ECE Senior Design courses require the highest level of teamwork and contribution by all members of a team. This includes regular and on time attendance to team meetings, doing fair share of assigned work and turning in work assignments or deliverables on time so not to hold up the other member of the team.

Should an individual team member start to exhibit poor performance that will negatively affect the others on that team the following steps will be followed:

1. Team members must first attempt to resolve the issue internally before escalation
2. If the problem/issues persist then the Team Lead should quickly send an email to Course Instructors that outlines the concern/complaint and actions done in an attempt to resolve the concern.
3. An investigation will be done by Course Instructor and a discussion will be held with all members on the Team.

If the majority of team member agree that the complaint is valid, then the Course Instructor has authority to reduce that individual's team related scores within a range of 5 to 15 points, pending the magnitude of the complaint.

(In the event of a tie then Course Instructor has final decision on how to handle the complaint)

By signing this contract all students will agree to this Team Contract by-law.

Working in Lab during COVID-19 Pandemic

Those in the lab must wear a mask

Those in the lab must socially distance

If you are not feeling well, do not come to team lab

While in lab each team must appoint a safety compliance person to ensure safe practices are followed

Outcome 5

Outcome 5

Above Average

Teamwork Evaluation Form
ECE Senior Design & Professionalism
Teamwork-Outcome 5

Title of Presentation: feQW\ Q, '-1\ T u>eet('-' P,c.,c:u \ UtDJoile,						
Team Number and Members: te \ l 44' 'Z f: lA'-111,-e\						
Date of Presentation: 5orM4 2'->tl-						
Name of Evaluator and Affiliation (University or Company name)						
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Create an inclusive and collaborative environment		V				
Complete assigned task on time,		V				
Help others, share ideas, and be professional to each other						
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Planning and Trackin2 Pro2ress						
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Track progress of team members to ensure project is on schedule and meetine oals/obiectives						

95 - Average

Outcome 5

Team Work

Assignment

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- Please plan_ to have 15 to 20 hours outside of class available for team work
- Document the dates, times and location of outside team work agreement
- Team Work Deliverables
- TBD to be decided can be use now for location at this time if you don't know

6. Team Work Deliverables

- **Section A** - Joint Project Items
How will you work on joint project deliverables?
- **Section B** - Individual Project Items
How will you work on individual project items?

7.- Team Documentation and Communications

- List how you will use team log books to track progress
- How will you communicate as a team?

8. Conflict Resolution

- How will you resolve issues, conflicts or disagreements?
- Who will you escape issues and to who?

9. Arbitration of Team Complaints

- See Attachment A on next page

10. Signature and Date

- Each person on the team must sign the contract

Reminder: I will be looking for thorough and complete write up.
Please write complete sentences - using good grammar and thoughtful consideration for each section. This should be developed as a detailed contract that each team member has agreed to follow.

Attachment A Must be included in all Team contracts

Arbitration of Team Member Complaints for Senior Design ELEG 4247 & ELEG 4248

- ECE Senior Design courses require the highest level of teamwork and contribution by all members of a team. This includes regular and on time attendance to team meetings, doing fair share of assigned work and turning in work assignments or deliverables on time so not to hold up the other member of the team.

Should an individual team member start to exhibit poor performance that will negatively affect the others on that team the following steps will be followed:

1. Team members must first attempt to resolve the issue internally before escalation
2. If the problem/issues persist then the Team Lead should quickly send an email to Course Instructors that outlines the concern/complaint and actions done in an attempt to resolve the concern.
- 3 An investigation will be done by Course Instructor and a discussion will be held with all members on the Team.

If the majority of team member agree that the complaint is valid, then the Course Instructor has authority to reduce that individual's team related scores within a range of 5 to 15 points, pending the magnitude of the complaint.

(In the event of a tie then Course Instructor has final decision on how to handle the complaint)

By signing this contract all students will agree to this Team Contract by-law.

Working in Lab during COVID-19 Pandemic

Those in the lab must wear a mask

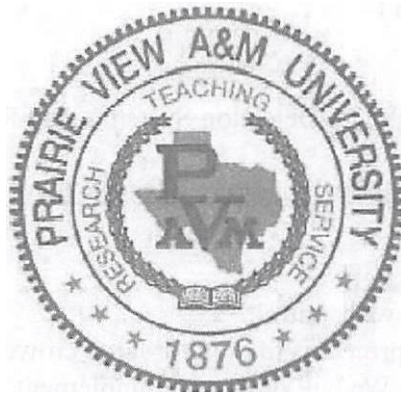
Those in the lab must socially distance

If you are not feeling well, do not come to team lab

While in lab each team must appoint a safety compliance person to ensure safe practices are followed

Outcome 5 Teamwork Contract

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



ELEG 42 ⁸ Senior Design & Professionalis⁻VJ[-

Topic: Team Member & Project Selection

Submitted by

Deonna London
Jalyn Beaty (Team Lead)
Gabrieal Maxwell
Alexis Hunter
Alyssa Reed

Instructor: Professor Turner

Date of Submission: 01/23/2022

Senior Design & Professionalism I
Senior Design Contract

Prairie View A&M University
2021-2022

Project Name: Real Time Crowd Size Detection System using Raspberry Pi and Deep Learning

By signing this contract, all students will agree to these Team Contract by-laws:

Section 1: Team Name and Mission

- a) Our team name is Crowd Control.
- b) The objective of this project is to monitor large crowd gathering size to slow the spread of COVID-19. We will design and implement a real time crowd size detection and alarm system for violation reduction.

Section 2: Membership

- a) The members of this team are Jalyn Beaty, Deonna London, Gabriel Maxwell, Alexis Hunter, and Alyssa Reed. Electrical and Computer Engineering (ECE) students assigned to this project choose group members at the discretion of the ECE Department and cannot leave the set team in accordance with the policies set forth by the ECE Department.
- b) Members of this team shall be under the direction of Dr. Lijun Qian as he is the advisor for the senior design course.
- c) Members of this team shall also work under the US Department of Defense (DOD) and the CREDIT Center as they are the sponsors.

Section 3: Roles and Responsibilities

Roles were delegated based on individual abilities. Each member is expected to take upon tasks based on their roles and will be scheduled to complete those tasks within a certain, reasonable time frame. In the event of a role vacancy, the team will have alternates that will perform the task that will be defined with the role. Although each member has a specified role everyone has an understanding that they will be providing assistance to other group members when needed.

- a) Team Leader: Jalyn Beaty
Alternate: Software Developer

The team lead must organize and maintain group meetings and oversee progress. A team leader must hold each member accountable and provide direction and work delegation. This person also acts as a direct communication with the sponsor Lijun Qian. They must have a general understanding of the project's requirements and deliverables. The team lead must also provide assistance to other members to help with all aspects of the project.

The software developer will do the required coding. They will research, design, implement and manage software programs. They will test all codes and make modifications accordingly. They will ensure the code is efficient and unique.

b) Software Developer: Alyssa Reed

Alternate: Scribe

The software developer will do the required coding. They will research, design, implement and manage software programs. They will test all codes and make modifications accordingly. They will ensure the code is efficient and unique.

The scribe is the attendee at a meeting who documents and keeps the records of meetings, decisions, and updates for the project. They take on the responsibility of the weekly updates and will make final decisions on the written report.

c) Data Analyst: Alexis Hunter

Alternate: Scribe

The data analyst researches information that relates to the project. They will collect the information and go through and interpret it. After researching multiple sources, the data analyst must clean and compile the information found.

The scribe is the attendee at a meeting who documents and keeps the records of meetings, decisions, and updates for the project. They take on the responsibility of the weekly updates and will make final decisions on the written report.

d) Procurement Lead: Gabriel Maxwell

Alternate: Data Analyst

The procurement lead oversees the project materials. They will purchase and manage the budget for the project costs. If a financial decision cannot be agreed upon by the team or sponsor, the procurement lead makes that final decision. They must have a complete understanding of the list of parts and prices of the project. The procurement lead is also responsible for reaching out to the sponsor to gather any materials needed for the project.

The data analyst researches information that relates to the project. They will collect the information and go through and interpret it. After researching multiple sources, the data analyst must clean and compile the information found.

e) Scribe: Deonna London

Alternate: Test Lead

The scribe is the attendee at a meeting who documents and keeps the records of meetings, decisions, and updates for the project. They take on the responsibility of the weekly updates and will make final decisions on the written report.

The test lead will be responsible for handling the equipment. This is the person who assembles the test for the project. This person leads decisions on how equipment will be handled and serves as the final say for decisions made about the assembly of the project.

Section 4: Team Relationships

- a) The team has a responsibility to respect other members of team 1. Conflict and criticism must be handled respectfully, and they must foster a relationship of accountability.
- b) Team members must communicate openly (discussed further in section 7) with each other about the project. A team lead has been picked, but team 1 must treat each member equally.
- c) Each member must also be responsible with outside social gatherings due to the COVID-19 pandemic. It is expected that all members uphold social distance when possible so as not to contribute to the spread or become ill.
- d) The team must be honest and reliable with regards to their completion schedule

Section 5: Joint Work

- a) Purposes of Joint Work
 - I. This team will work together primarily to achieve its goals. Teamwork is essential to completing the deliverables and ensuring that the best possible work is submitted. No individual can work as well as a cohesive team.
 - II. Team 1 must foster a healthy relationship with their teammates (further explained in Section 4) to properly work together.
- b) Team Meetings
 - I. Team Meetings are mandatory. If a team member cannot attend, they must notify the team via GroupMe or text message the day before. Depending on the other members' schedule, this can result in an excused absence. The first unexcused absence will result in a warning. The second will be reported to Dr. Turner or Dr. Musa. No team member is excused from team meetings outside of emergencies and excused absences.
 - II. Team Meetings will be held twice a week once in person and the other via Zoom or Group Facetime . As the COVID-19 situation progresses the team will consider meeting virtually full time if need be. The group and Dr. Qian made the decision to only meet if problems arise to discuss progress and hindrances. If none then the group will meet with him biweekly.
 - III. Meetings will be organized by the Team Lead, and plans for the project will be discussed. Agendas and project hindrances will be discussed and each meeting will be documented on the weekly updates.
 - IV. Meeting Times:
 - a. Tuesdays from 11AM-2PM
 - b. Fridays from 12PM-5PM

- c. Thursdays from 2PM-4PM (If necessary)
- c) Joint Work Submission
 - I. The team lead will declare joint work to be submitted before the due date. They will establish a time that the joint work will be submitted, and each team member will have until then to submit the work to Google Drive or the team lead. If a team member has not submitted work by the established time, the joint work will be submitted but incomplete. The team member responsible for the missing work will receive a warning. It will be reported to Dr. Turner and Dr. Musa, and dealt with appropriately.

Section 6: Individual Work

- a) Each team member will have individual responsibilities to oversee. The team lead will delegate those responsibilities, but it is up to the individual to complete their tasks as they see fit.
- b) The team will address any schedule or objective conflicts in the work of each member in a responsible way (as mentioned in section 4) and take upon responsibilities if another member is found lacking.
- c) Should an individual member be unable to complete tasks or attend meetings with regularity, responsibilities can be shifted, but no team member is to shirk responsibilities, lest they be found in violation of this contract.
- d) Quality of work must be checked by multiple team members, but everyone must contribute. Quantity of work will be documented and kept by the team scribe.

Section 7: Documentation and Communication

- a) Team members are expected to log their progress in Google Drive and communicate their availability and progress with the rest of the team.
- b) The scribe will keep a weekly progress update, and a report will be formed over the course of the project. Everyone must contribute their findings to that report.
- c) Each teammate has each other's contact info, and will remain in regular contact over Zoom, GroupMe, Text, and E-mail. They will be active and attentive to meetings, changes, and updates through GroupMe.
- d) Communication is to be kept professional.

Section 8: Conflict Resolution

- a) Conflict must be resolved effectively and professionally. Each teammate has individual responsibilities and will have the final say on their part of the project.
- b) This team must be kept together, and so no splits or schisms should be formed within the group. Teammates may raise legitimate concerns against each other but must do so in a way that is not divisive or disrespectful.
- c) If a conflict cannot be resolved within the team, Dr. Musa or Dr. Turner will be contacted as a last resort.

Section 9: Working in a Lab During the COVID-19 Pandemic

- a) Those in the lab must wear a mask.
- b) Those in the lab must socially distance
- c) If you are not feeling well, do not come to the lab.
- d) While in the lab, each team must appoint a safety compliance person to ensure safe practices are followed.
- e) Team 1 currently does not require a lab space, but this by-law is in case lab space is taken.

Section 10: Arbitration of Team Member Complaints

All team members in the ECE Senior Design courses require the highest level of teamwork and contribution. All team members participation is a must which includes attending the team meetings regularly and on time, doing a fair share of assigned work and turning in the work assignments or deliverables on time so as not to hold up the other member of the team.

Should an individual team member start to exhibit poor performance that will negatively impact the others on the team, the following steps should be taken:

- a) Team members must first attempt to resolve the issue internally before escalation.
- b) If the problem/issues persist then the Team Lead should quickly send an email to Course Instructors that outlines the concern/complaint and actions done in an attempt to resolve the issues.
- c) An investigation will be done by the Course Instructor and a discussion will be held with all members of the Team.

If the majority of the team members agree that the complaint is valid, then the Course Instructor has the authority to reduce that individual's team related scores within a range of 5 to 15 points, pending the magnitude of the complaint.

(In the event of a tie then the Course Instructor has the final decision on how to handle the complaint.)

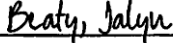
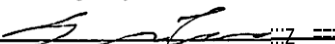
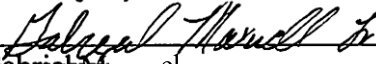
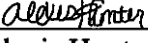
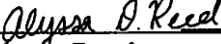
Section 11: Amendments

- a) Amendments can be agreed upon to this contract or to the project goals by Team . Each member will sign a copy and decide if a change must be made later.
- b) Amendments to the project will be constant, but the goals will change with less frequency. This is still a possibility.
- c) Should the contract need to be edited, the new contract will be signed by each teammate and distributed to them. It will remain on Google Drive for further reference.

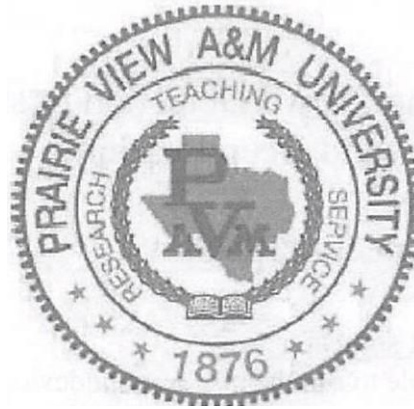
Section 12: Affirmation and Compliance

We, the members of this team affirm that we have established this contract with the input and consensus of all members. By our signatures, we commit to the compliance with the contract for the benefit of all members and the team.

Signatures:

DocuSigned by:  Jaiyn Beaty	1/23/2022 Date
DocuSigned by:  Deonna London	1/23/2022 Date
DocuSigned by:  Gabriel Marshall Jr	1/23/2022 Date
DocuSigned by:  Alexis Hunter	1/23/2022 Date
DocuSigned by:  Alyssa Reed	1/23/2022 Date

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4241: Senior Design & Professionalism I!

Topic: Spring Weekly Report 1

Meeting Times

Tuesday - 9:30am

Wednesday - 11am

Friday - 4pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: January 26, 2022
ELEG 4247/4248

Weekly Sr Design Project Status Report

Team Number: 1

Date: 1/26/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

Project Status: Some Aspect at Risk

Accomplishments from the last semester:

Last semester, we were able to run the raspberry pi device and identify only humans. We had improved the frame rate and we were focused on defining our prediction border. The bounding boxes we had were on the identified objects. We wanted to have one box that identified anything that crossed the boundary and served as the people counter.

Team Meeting Attendance:

We have met on the following days:

Wednesday January 19, 2022 11:00am- 1:00pm

Sunday January 23, 2022 (virtual) 8:00-9:00pm

Everyone was present for both team meetings. On Wednesday, after class, we looked at the ethics assignment, which Jayln had already reviewed and started over the break. On Sunday we amended the team contract.

Team member Contribution to Project

- Alyssa Reed
 - Working on getting code back working from the break
- Jalyn Beaty
 - Erased raspberry pi since it was not working
- Deonna London
 - Downloaded software and set up for the Intel Compute Stick
- Gabriel Maxwell
 - Worked on the ethics assignment
- Alexis Hunter
 - Worked on the ethics assignment

Upcoming Action Items Assigned per Team Member

Deonna - finish setting up Intel Compute Stick, begin executive summary
Gabriel- complete ethics slides
Jalyn- redo the coding and set up for Raspberry Pi
Alyssa Reed- redo coding and set up for Raspberry Pi
Alexis Hunter- complete ethics slides

Tentative Plans for Upcoming Week

This week, our main priority is getting the code working for our Raspberry Pi. For some reason the code would not run once we got back to school. Instead of trying to make it worked we opted to start over. We can do over what we already accomplished. This will be the second time we have done it.

Issues or Concerns

We need to make sure we don't have to reset the Raspberry Pi again. There is no reason a code that was once working isn't when we come from a break. This uncertainty of the problem could lead the system to fail in crucial moments.

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator
ELEG 4247: Senior Design & Professionalism I

Topic: Weekly Progress Report

Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 1/26/2022

ELEG 4247

Weekly Senior Design Project Status Report

Team Number: 2

Date: 1/26/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Created a testing environment on Ubuntu
- Found some parts with through pins
- Completed a majority of the development board

Team Meeting Attendance

- We all met on January 25th from 1:00pm CST to 2:00pm CST with David from Chart Industries to give him an update on our progress.

Team Member Contribution to Project

- Breon
 - o Assisted Bryce with gathering a list of various parts that were deemed necessary for physical makeup of testing circuit board.
- Matthew
 - o Created testing environment on Ubuntu Virtual Machine.
 - o Installed OpenHMI on Ubuntu and Windows.
 - o Further researched the pros and cons of using CODESYS to program pins.
- Hyram
 - o Completed most of the routing for the development board.
- Bryce
 - o Gathered a list of various parts that were deemed necessary for physical makeup of testing circuit board.
 - o Conducted research on KiCad software to better understand integration and creation of board.
 - o Contacted sponsor to gain info about results from testing done on site regarding the dosing actuator process.
- George
 - o Researched OpenHMI and CODESYS.
 - o Got familiarized with KiCad software.

Upcoming Action Items assigned per Team Member

- Breon
 - o Assist Bryce with designing interface board for ethernet, USB, and micro USB connections.
- Matthew
 - o Continue working with OpenHMI and CODESYS.
 - o Decide how to connect to Exor Development kit by either SSH or Serial Port.
 - o Configure uboot on Ubuntu machine.
 - o Collaborate with Hiram, Breon, and Bryce on which daughter boards are necessary for debugging purposes.
- Hiram
 - o Fix the footprint for the Nano some in KiCad.
 - o Redo some of the routing for the development board.
- Bryce
 - o Begin designing interface board for ethernet, USB, and micro USB connections.
- George
 - o Work alongside Matthew on OpenHMI and CODESYS.
 - o Familiarize myself with Exor user manual.

Tentative Plans for the Upcoming Week

- Finish the development board.
- Configure uboot on Ubuntu machine.
- Designing interface boards for ethernet, USB, and micro USB connectors.

Issues or Concerns

- N/A

Outcome 5
Weekly Update
Assignment

)))

email to VJTURNER@PVAMU.EDU And SMMUSA@PVAMU.EDU And Faculty Sponsor

Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment

1. Organize and assign team work
2. Plan and keep good record of team meetings including documentation of individual contributions
3. Share ideas, complete assigned task on time, help others, and be professional to each
4. Resolve conflicts professionally within the group with the view of creating an inclusive and collaborative environment
5. Keep your project on track and to identify concerns/issues early
6. Raise Issue and Concerns Early

This report must be detailed with explanation, good grammar/spelling and thorough.

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Project Name=> Tethered Drone Blimp Design Challenge
(your project name)

ELEG 4472: Senior Design & Professionalism I

Topic e.g Weekly
Progress Report =>

Topic: Meeting Time & Location Agreement
(topic should be subject of submission)

Team number 10

Submitted by

Team Member A
Team Member B (Team Lead)
Team Member C
Team Member D
Team Member E

Team Number and All
Team Members plus
Identify Team Lead

Instructor: Turner

Date of Submission: 09/20/2017
(Date of submission)

Weekly Sr Design Project Status Report

Team Number:

Project Name:

Date:

Project Status : On Track OR Some Aspect at Risk OR Serious Concern
(Please Provide a weekly status)

Provide an email copy every Wednesday before
start of class

Email to VJTURNER@PVAMU.EDU

And SMMUSA@PVAMU.EDU

And YOUR FACULTY ADVISOR

Accomplishments From Previous Week

This section list all your accomplishments for the previous week

example : Met with Faculty Sponsor for 2 hours to finalize test protocol

Team Meeting Attendance

List outside of classroom time when/were you met and who attended each meeting and who did not attend (I want to know why a person missed team meeting)

example : Team 3 met on Friday November 14 in ECE 137 for 2 hours

example : All team members present except Mike who was on a job interview trip

Team Member Contribution to Project

List individual contributions of team member - show names

example : Completed final parts list (Joe)

Upcoming Action Items Assigned per Team Member

List upcoming work items assigned to each team member - show names

example : Need to complete design for project power source (Amy)

Tentative Plans for Upcoming Week

What are some plans/expected deliverable for the team next week

example : complete literature review for software options to develop operating code

Issues or Concerns

List any concerns you have that should be raised to instructor or faculty sponsor

example: Sponsor requirements keep changing

example: Camera parts on back order

Outcome 5

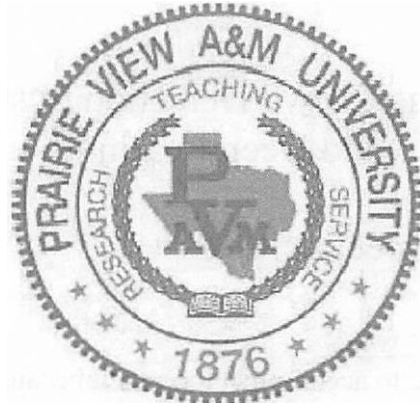
Weekly Update

Outcome 5

Team Work

Above Average

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4248: Senior Design & Professionalism II

Topic: Spring Weekly Report 1

Meeting Times

Tuesday - 9:30am

Wednesday - 11am

Friday - 4pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: February 2, 2022

ELEG 4247/4248

Weekly Sr Design Project Status Report

Team Number: I

Date: 2/2/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

Project Status: Some Aspect at Risk

Accomplishments from the last week:

Last week we weren't able to accomplish too much because the wifi in the engineering building was down. We were able to successfully erase our raspberry pi device to start installing the software on it again. We have also started to install the software back on the device but we are running into some roadblocks with the installation of Tensorflow.

Team Meeting Attendance:

We have met on the following days:

Wednesday January 19, 2022 11:00am- 1:00pm

Sunday January 23, 2022 (virtual) 8:00-9:00pm

Everyone was present for both team meetings. On Thursday, after class, we worked on completing the ethics assignment. We also submitted our team contract.

Team member Contribution to Project

- Alyssa Reed
 - Working on getting code back working from the break
- Jalyn Beaty
 - Working on getting code back working from the break
- Deonna London
 - Downloaded software and setup for the Intel Compute Stick
- Gabriel Maxwell
 - Worked on the ethics assignment
- Alexis Hunter
 - Worked on the ethics assignment

Upcoming Action Items Assigned per Team Member

Deonna - finish setting up Intel Compute Stick, begin executive summary

Gabriel- complete ethics slides

Jalyn- redo the coding and set up for Raspberry Pi

Alyssa Reed- redo coding and set up for Raspberry Pi

Alexis Hunter- complete ethics slides

Tentative Plans for Upcoming Week

This week we hope to get the issues that we're having resolved so we can move on to the next step of the installation process. Just for clarification we are "some aspect at risk" but not completely. We know exactly what software we need and how to get it. We also know how to code our raspberry pi to satisfy the requirements of our project. Once we get everything installed again we will be back in good standing for the completion of our project.

Issues or Concerns

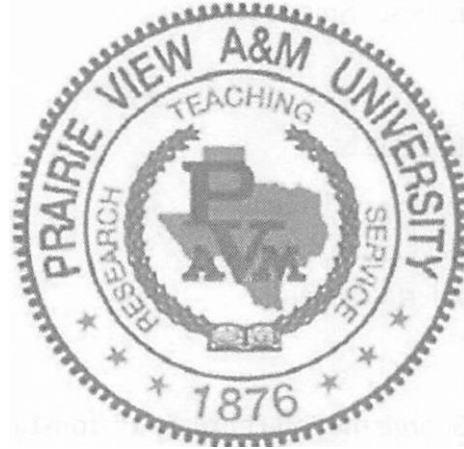
Since we reset the raspberry pi we now have to complete the installation process again and because we are running into some installation issues it's becoming a setback. We plan on working on getting that resolved this week and moving forward with our project.

PRAIRIE VIEW A&M UNIVERSITY

ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator

ELEG 4248: Senior Design & Professionalism II



Topic: Weekly Progress Report

Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 2/2/2022

ELEG4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 2/2/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Created a testing environment on Ubuntu.
- Completed most of the development board.
- Started working on the interface boards.

Team Meeting Attendance

- Hiram, Matthew, and George met on February 1st from 1:00pm CST to 2:00pm CST with David and Paul from Chart Industries to give him an update on our progress.

Team Member Contribution to Project

- Breon
 - o Assisted Bryce with gathering a list of various parts that were deemed necessary for physical makeup of testing circuit board.
- Matthew
 - o Created testing environment on Ubuntu Virtual Machine.
 - o Installed OpenHMI on Ubuntu and Windows.
 - o Further researched the pros and cons of using CODESYS to program pins.
 - o Looked at the .dts files
- Hiram
 - o Completed most of the routing for the development board.
 - o Looked into the footprint specifications that Exor had for the Nano SoM
- Bryce
 - o Gathered a list of various parts that were deemed necessary for physical makeup of testing circuit board.
 - o Conducted research on KiCad software to better understand integration and creation of board.

- o Contacted sponsor to gain info about results from testing done on site regarding the dosing actuator process.
- George
 - o Researched OpenHMI and CODESYS.
 - o Got familiarized with KiCad software.

Upcoming Action Items assigned per Team Member

- Breon
 - o Assist Bryce with designing interface board for ethernet, USB, and micro USB connections.
- Matthew
 - o Continue working with OpenHMI and CODESYS.
 - o Decide how to connect to Exor Development kit by either SSH or Serial Port.
 - o Configure uboot on Ubuntu machine.
 - o Collaborate with Hiram, Breon, and Bryce on which daughter boards are necessary for debugging purposes.
 - o Going to research the device tree files for the STM Cubed software
- Hiram
 - o Redo some of the routing for the development board.
 - o Finish routing of the development board and have Paul review it.
- Bryce
 - o Start the final stages of the design process for the interface boards of the ethernet, USB, and micro USB connections.
- George
 - o Work alongside Matthew on the STM Cubed software
 - o Familiarize myself with Exor user manual.

Tentative Plans for the Upcoming Week

- Finish the development board.
- Configure uboot on Ubuntu machine.

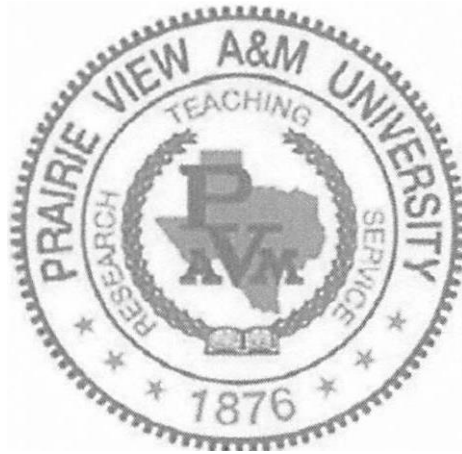
- Desing interface boards for ethernet, USB, and micro USB connectors.
- Start looking more into the STM Cubed software some *more*

Issues or Concerns

- *N/A*

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator
ELEG 4248: Senior Design & Professionalism II



Topic: Weekly Progress Report

Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 2/9/2022

ELEG 4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 2/9/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Created a testing environment on Ubuntu.
- Completed the development board.
- Started working on the interface boards.

Team Meeting Attendance

- Everyone met on February 8th from 1:00pm CST to 2:00pm CST with Paul from Chart Industries to give him an update on our progress.

Team Member Contribution to Project

- Breon
 - o Assisted Bryce with gathering a list of various parts that were deemed necessary for physical makeup of testing circuit board.
- Matthew
 - o Helped install STM32CubeIDE software onto devices.
 - This will allow us to reprogram pins on the STM32 Chip.
 - o Looked at the .dts files.
 - o Worked with Hiram on interface boards as well as deciding what components were necessary for transfer.
- Hiram
 - o Completed the routing for the development board.
- Bryce
 - o Finalized list of various parts that were deemed necessary for physical makeup of testing circuit board.
 - o Gathered update on testing being completed by sponsors at Chart
 - o Conducted further research for possible ethernet and Microchip USB additions for software and hardware compatibility.

- George
 - o Got familiarized with KiCad software.
 - o Got familiarity with STM Cubed software

Upcoming Action Items assigned per Team Member

- Breon
 - o Assist Bryce with designing interface board for ethernet, USB, and micro USB connections.
- Matthew
 - o Continue working with OpenHMI and CODESYS.
 - o Decide how to connect to Exor Development kit by either SSH or Serial Port.
 - o Continue research for the device tree files.
 - o Work with George on reprogramming STM32 pins.
- Hiram
 - o Finish annotating the pdf of the development board layout and have Paul review it.
- Bryce
 - o Continue the final stages of the design process for the interface boards of the ethernet, USB, and micro USB connections.
- George
 - o Work alongside Matthew on the STM Cubed software
 - o Familiarize myself with Exor user manual.

Tentative Plans for the Upcoming Week

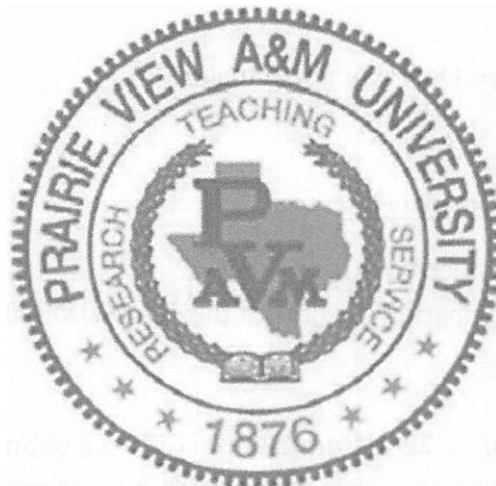
- Finish designing interface boards for ethernet, USB, and micro USB connectors.
- Get head start on IDE reprogramming
-

Issues or Concerns

- *N/A*

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator
ELEG 4248: Senior Design & Professionalism II



Topic: Weeldy Progress Report
Team Numher 2

Submitted by:

Hyrarn Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 2/23/2022

ELEG 4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 2/23/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Placed parts on the interface board.
- Made an excel sheet comparing the pins of the nanoSOM to the pins of the STM32 chip.

Team Meeting Attendance

- Everyone met on February 22nd from 1:00pm CST to 2:00pm CST with Paul and David from Chart Industries to give them an update on our progress.

Team Member Contribution to Project

- Breon
 - o Assisted Bryce with gathering a list of various parts that were deemed necessary. Waiting for the board to start doing testing.
- Matthew
 - o Installed STM32Cube1DE software onto Linux machine.
 - Linux machine needs to be repartitioned with more hardware space.
 - o Properly document all the steps taken to install all software onto devices as well as the following steps involving reprogramming.
- Hiram
 - o Created the Gerber files for the development board
 - o Placed components on the interface board
- Bryce
 - o Finalized list of various parts that were deemed necessary for physical makeup of testing circuit board.
 - o List sent out to sponsors and parts have now been ordered by them
- George
 - o Got familiarity with STM Cubed software

Upcoming Action Items assigned per Team Member

- Breon
 - Coming up with a step by step process to lay out how the working microchip is supposed to work and find a way to simulate it.
- Matthew
 - o Finish reprogramming pins in the next few weeks
 - o Properly document entire process so far
 - o Reinstall Ubuntu and allocate for more hard drive space.
- Hiram
 - o Give paul the dimensions of both the development board and the interface board.
 - o Route the interface board
- Bryce
 - o Continue the final stages of the design process for the interface boards of the ethernet, USB, and micro USB connections.
- George
 - o Continued working alongside Matthew on the STM Cubed software

Tentative Plans for the Upcoming Week

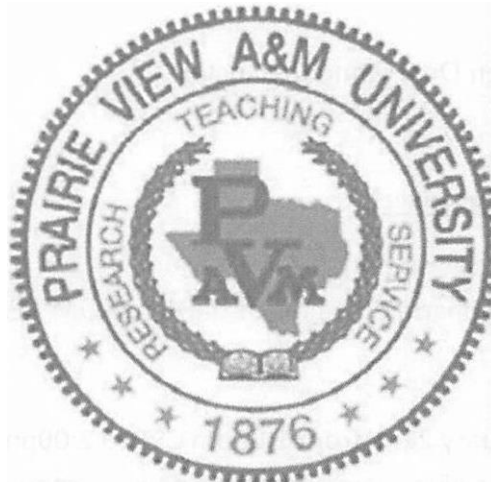
- Finish routing the interface board
- Get head start on IDE reprogramming
- Plan out which pins to reprogram on the nanoSOM

Issues or Concerns

- N/A

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator
ELEG 4248: Senior Design & Professionalism II



Topic: Weekly Progress Report

Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 2/23/2022

ELEG4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 2/23/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Placed parts on the interface board.
- Made an excel sheet comparing the pins of the nanoSOM to the pins of the STM32 chip.

Team Meeting Attendance

- Everyone met on February 22nd from 1:00pm CST to 2:00pm CST with Paul and David from Chart Industries to give them an update on our progress.

Team Member Contribution to Project

- Breon
 - o Assisted Bryce with gathering a list of various parts that were deemed necessary. Waiting for the board to start doing testing.
- Matthew
 - o Installed STM32CubeIDE software onto Linux machine.
 - Linux machine needs to be repartitioned with more hardware space.
 - o Properly document all the steps taken to install all software onto devices as well as the following steps involving reprogramming.
- Hiram
 - o Created the Gerber files for the development board
 - o Placed components on the interface board
- Bryce
 - o Finalized list of various parts that were deemed necessary for physical makeup of testing circuit board.
 - o List sent out to sponsors and parts have now been ordered by them
- George
 - o Got familiarity with STM Cubed software

Upcoming Action Items-assigned per Team Member

- Breon
 - Coming up with a step by step process to lay out how the working microchip is supposed to work and find a way to simulate it.
- Matthew
 - o Finish reprogramming pins in the next few weeks
 - o Properly document entire process so far
 - o Reinstall Ubuntu and allocate for more hard drive space.
- Hiram
 - o Give paul the dimensions of both the development board and the interface board.
 - o Route the interface board
- Bryce
 - o Continue the final stages of the design process for the interface boards of the ethernet, USB, and micro USB connections.
- George
 - o Continued working alongside Matthew on the STM Cubed software

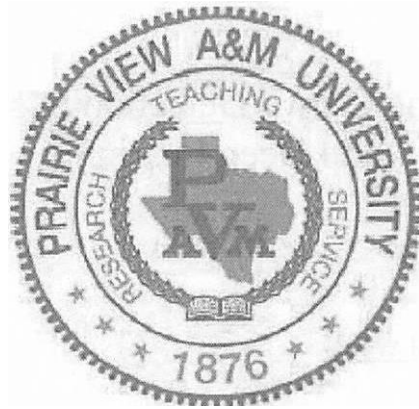
Tentative Plans for the Upcoming Week

- Finish routing the interface board
- Get head start on IDE reprogramming
- Plan out which pins to reprogram on the nanoSOM

Issues or Concerns

- *N/A*

PRAIRIE VIEW A&M UNIVERSITY
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Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4248: Senior Design & Professionalism II

Topic: Spring Weekly Report #3

Meeting Times

Tuesday - 9:30am

Wednesday - 11am

Friday - 4pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: 2/16/2022

ELEG 4248

Weekly Sr Design Project Status Report

Team Number: 1

Date: 2/16/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

Project Status: On Track

Accomplishments from the last week:

We have successfully downloaded all of the software back on the raspberry pi. We also have been working on the installation of the intel stick to help with increasing the frame rate of the raspberry pi.

Team Meeting Attendance:

We have met on the following days:

Wednesday February 9, 2022 11:00am- 2:00pm

Friday February 11, 2022 (virtual) 6:00-8:30pm

Everyone was present for both team meetings. On Wednesday, after class, we looked at our presentation and worked on completing our codes and standards, executive summary, and our target audience. On Friday, we briefly practiced the presentation and worked on finishing up the installation process on the raspberry pi.

Team member Contribution to Project

- Alyssa Reed
 - Outlined Executive Summary Presentation. Worked on resetting Raspberry Pi
- Jalyn Beaty
 - Worked on resetting Raspberry Pi and the Tensorflow issue
 - Finished the installation process
- Deonna London
 - Worked on the Executive Summary Presentation and Codes and Standards
- Gabriel Maxwell
 - Worked on the Executive Summary Presentation and Codes and Standards
- Alexis Hunter
 - Worked on Executive Summary Presentation and Codes and Standards

Upcoming Action Items Assigned per Team Member

Deonna - finish up powerpoint for the executive summary and codes and standards
Gabriel- finish up powerpoint for the executive summary and codes and standards

Jalyn- continue to work with our code to be tailored more to our project
Alyssa Reed- continue to work with our code to be tailored more to our project
Alexis Hunter- finish up powerpoint for the executive summary and codes and standards

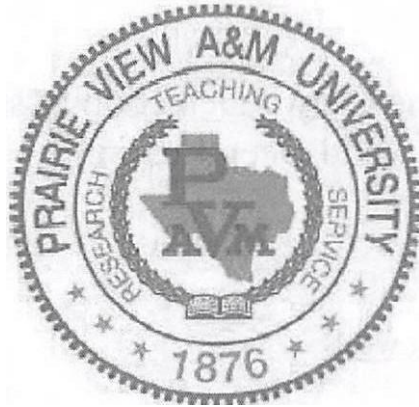
Tentative Plans for Upcoming Week

This week we plan on making more progress on the raspberry pi to get it working for our project demo on March 5th. We plan on having a completely functioning product by this date so we are working around the clock to get that done. This week all hands will be on deck in terms of getting our project done and making sure that our presentations are up to par.

Issues or Concerns

At this point there are no issues and concerns.

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Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4248: Senior Design & Professionalism II

Topic: Spring Weekly Report #3^{'''}1

Meeting Times

Tuesday - 9:30am

Wednesday - 11am

Friday- 4pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: 2/23/2022

ELEG 4248

Weekly Sr Design Project Status Report

Team Number: I

Date: 2/23/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

Project Status: On Track

Accomplishments from the last week:

Last week, we presented the Executive Summary. We also began trying to connect the light and sound alarm to our device so that we could program them for our requirements.

Team Meeting Attendance:

We have met on the following days:

Wednesday February 16, 2022 11:00am- 2:00pm

Friday February 25, 2022 (virtual) 6:00-8:30pm

Everyone was present for both team meetings. On Wednesday, after class, we tried finding out how to hook up the alarms to our device. We noticed that the case around our Raspberry Pi may get in the way of several connections. On Friday, we tried to see if the compute stick would help frame rate. However, we are unsure if we programmed it correctly and will be checking over the steps again.

Team member Contribution to Project

- Alyssa Reed
 - Worked on resetting Raspberry Pi, working on the code for the sound alarm
- Jalyn Beaty
 - Worked on resetting Raspberry Pi, working on the code for the light alarm
- Deonna London
 - Presented Executive Summary
- Gabriel Maxwell
 - Researched other projects that use the alarm systems for set-up help
- Alexis Hunter
 - Presented Executive Summary

Upcoming Action Items Assigned per Team Member

Deonna - redo installation process for the USB compute stick
Gabriel- find a working model with the light and sound alarms
Jalyn- work on light alarm connection and code

Alyssa Reed- work on sound alarm connection and code

Alexis Hunter- figure out how to add components around case on Raspberry Pi

Tentative Plans for Upcoming Week

This week we want to have at least one alarm system connected to the Raspberry device. We aim to have it programmed as well.

Issues or Concerns

At this point there are no issues and concerns. We are just working to meet our goals by the midterm deadline next week.

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator
ELEG 4248: Senior Design & Professionalism II



Topic: Weekly Progress Report

Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 3/2/2022

ELEG4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 3/2/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Finished routing the interface board.
- Reallocated hard drive space on linux machine.

Team Meeting Attendance

- Hiram and Bryce met on March 1st from 1:00pm CST to 2:00pm CST with Paul and David from Chart Industries to give them an update on our progress.

Team Member Contribution to Project

- Breon
 - o Assisted Bryce with gathering a list of various parts that were deemed necessary. Waiting for the board to start doing testing.
- Matthew
 - o Installed STM32CubeIDE software onto Linux machine.
 - Reallocated for more hard drive space on the machine.
 - o Pin reprogramming is developing as planned.
- Hiram
 - o Created the Gerber files for the interface board.
 - o Drew dimensions on interface board.
- Bryce
 - o Finalized list of various parts that were deemed necessary for physical makeup of testing circuit board.
 - o List sent out to sponsors and parts have now been ordered by them
- George
 - o Got familiar with STM Cubed software and worked on Final Executive Summary with Bryce.

- o Worked on installing OpenHMI and Codesys utilizing the User Instruction manual provided from Exor.

Upcoming Action Items assigned per Team Member

- Breon
 - o Working on the final power point presentation with Bryce
- Matthew
 - o Finish reprogramming pins in the next few weeks
 - o Properly document entire process so far
- Hiram
 - o Give Paul the dimensions to the interface board
- Bryce
 - o Working on the final power point presentation
- George
 - o Continued working alongside Matthew on the STM Cubed software
 - o Installation of OpenHMI and Codesys
 - o Formulating testing plan for test board

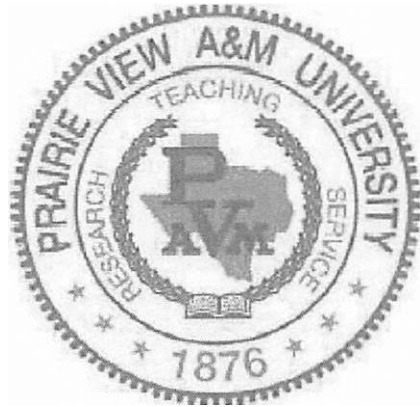
Tentative Plans for the Upcoming Week

- Get head start on IDE reprogramming
- Plan out which pins to reprogram on the nanoSOM
- Receive Paul's development board

Issues or Concerns

- *N/A*

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ROY G. PERRY COLLEGE OF ENGINEERING



Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4248: Senior Design & Professionalism II

Topic: Spring Weekly Report #3

Meeting Times

Tuesday - 9:30am

Wednesday - 11am

Friday- 4pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: 2/9/2022

ELEG 4248

Weekly Sr Design Project Status Report

Team Number: 1

Date: 2/9/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi
and Deep Learning

Project Status: Some aspect at risk

Accomplishments from the last week:

More than half of the software is back on the Raspberry Pi. We are slowly heading back on track to begin the process of coding to meet our other device requirements.

Team Meeting Attendance:

We have met on the following days:

Wednesday January 19, 2022 11:00am- 1:00pm

Sunday January 23, 2022 (virtual) 8:00-9:00pm

Everyone was present for both team meetings. On Wednesday, after class, we looked at the ethics assignment. On Thursday, we finished it up. On Sunday, we decided who would present and briefly practiced the presentation. The other made significant development on the Raspberry Pi.

Team member Contribution to Project

- Alyssa Reed
 - Outlined Ethics Presentation. Worked on resetting Raspberry Pi
- Jalyn Beaty
 - Worked on resetting Raspberry Pi and the Tensorflow issue
- Deonna London
 - Practiced for Ethics Presentation
- Gabriel Maxwell
 - Finished Ethics Report, Review Executive Summary Assignment
- Alexis Hunter
 - Practiced for Ethics Presentation

Upcoming Action Items Assigned per Team Member

Deonna - presenting ethics presentation, test out Compute stick and frame rate effects
Gabriel- complete executive summary
Jalyn- complete raspberry reset to get back to developing code for object detection
Alyssa Reed- assist with raspberry pi set up, complete executive summary
Alexis Hunter- presenting ethics presentation

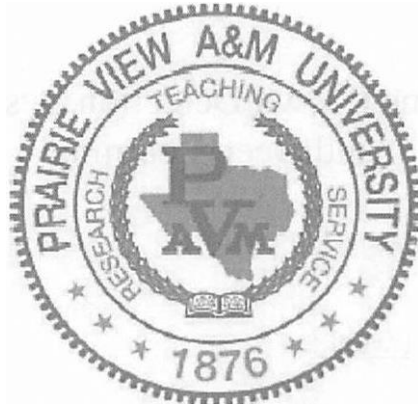
Tentative Plans for Upcoming Week

This week, it is our top priority to get the Raspberry Pi device back to how it was before the break. We will get past the TensorFlow issue in set up so that we can start working again on the code to add in our other requirements besides object detection, which we already had achieved..

Issues or Concerns

We are unsure if the set-up for the Intel Compute stick worked. We need the rebooted Raspberry Pi to test it out.

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Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4248: Senior Design & Professionalism II

Topic: Spring Weekly Report #5

Meeting Times

Monday: 10am-12pm

Tuesday: 5pm-until

Wednesday: 11am-2pm

Friday: 10am-12pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: 3/8/2022

ELEG 4248

Weekly Sr Design Project Status Report

Team Number: 1

Date: 3/9/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

Project Status: On Track

Accomplishments from the last week:

Last week, we worked on the pedestrian counter on the Raspberry Pi. We have finished the code for the program and corrected the problem with OpenCV, but the camera will not open when running. Now, the process is going back looking for minor errors that could cause this. While that is being done we have discovered the Compute stick needs to be set up and programmed to the Raspberry Pi rather than set up on windows.

Team Meeting Attendance:

We have met on the following days:

Wednesday, March 2 11:00am-2:00pm

Monday, March 7 7:00-10:00pm

Tuesday, March 8 5:00-9:30pm

Everyone was present for all meetings and we have adjusted our schedule to meet our availability better and added days to have more time dedicated to the code. On Wednesday We successfully got the OpenCV issue fixed so our light on the camera would turn on when the program ran, though it wouldn't open. Monday, we worked on fixing pedestrian code. Tuesday we updated meeting times and roles and split the important projects into two. One focus is software for getting the pedestrian code running. The other focus is the hardware of the added components.

Team member Contribution to Project

- Alyssa Reed
 - Worked on pedestrian counter code
- Jalyn Beaty
 - Worked on pedestrian counter code
- Deonna London
 - Worked on set up for USB compute stick, started research on Audio HAT
- Gabriel Maxwell
 - Worked on connecting parts to Raspberry Pi, began final report draft
- Alexis Hunter

- Working on LED lights connection for Raspberry Pi

Upcoming Action Items Assigned per Team Member

Deonna - research and construct schematic for audio HAT connection
Gabriel- attempt alarm connections
Jalyn- finish pedestrian counter code
Alyssa Reed- finish pedestrian counter code
Alexis Hunter- come up set up instructions for LED light connections

Tentative Plans for Upcoming Week

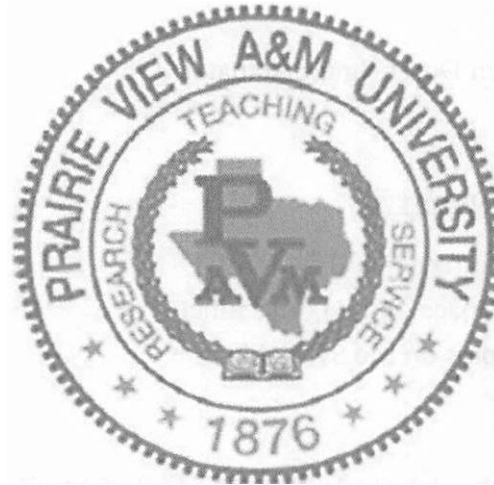
This week, we want to have the pedestrian counter code finished and one alarm hooked to the Raspberry Pi.

Issues or Concerns

At this point there are no issues and concerns. We are just working to meet our goals.

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator
ELEG 4248: Senior Design & Professionalism II



Topic: Weekly Progress Report

Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 3/9/2022

ELEG4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 3/9/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Finished routing the interface board.
- Reallocated hard drive space on linux machine.
- Reprogrammed some pins on the STM chip

Team Meeting Attendance

- Everyone met on March 8th from 1:00pm CST to 2:00pm CST with David from Chart Industries to give them an update on our progress.

Team Member Contribution to Project

- Breon
 - o Helping with finding codes and standards for pcb design.
- Matthew
 - o Installed STM32CubeIDE software onto Linux machine.
 - Reallocated for more hard drive space on the machine.
 - o Pin reprogramming is developing as planned.
- Hiram
 - o Started making an instruction manual for our project.
- Bryce
 - o Finalized list of various parts sent back from Chart sponsor because some parts are now out of stock needed for circuit board
 - o Currently using other sources like Mouser electronics to try and find some viable alternatives for the out of stock parts
- George
 - o Got familiar with STM Cubed software and worked on Final Executive Summary with Bryce.

- o Worked on installing OpenHMI and Codesys utilizing the User Instruction manual provided from Exor.

Upcoming Action Items assigned per Team Member

- Breon
 - o Testing the board to make sure all functions are working properly.
- Matthew
 - o Finish reprogramming pins in the next few weeks
 - o Start doing research for what kind of LCD screen we will use for the development board.
- Hiram
 - o Give Paul the Gerber files for the development board and the interface board
 - o Helping Matthew find the correct functions for specific pins.
 - o Help Matthew with the research of finding what kind of LCD screen we will use for the development board.
- Bryce
 - o Working on the final power point presentation
- George
 - o Continued working alongside Matthew on the STM Cubed software
 - o Installation of OpenHMI and Codesys
 - o Formulating testing plan for test board

Tentative Plans for the Upcoming Week

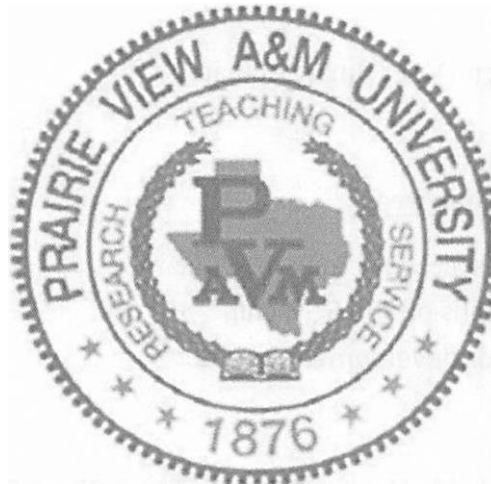
- Start research in a LCD screen
- Start making a user manual for the project
- Finish reprograming all the pins for the STM chip

Issues or Concerns

- N/A

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator
ELEG 4248: Senior Design & Professionalism II



Topic: Weekly Progress Report
Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 3/23/2022

ELEG4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 3/23/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Reallocated hard drive space on Linux machine.
- Reprogrammed some pins on the STM chip
- Found an LCD screen for development board.

Team Meeting Attendance

- Everyone met on March 23rd from 1:00pm CST to 2:00pm CST with David and Paul from Chart Industries to give them an update on our progress.

Team Member Contribution to Project

- Breon
 - o Working on final written report.
- Matthew
 - o Installed STM32CubeIDE software onto Linux machine.
 - Reallocated for more hard drive space on the machine.
 - o Pin reprogramming is developing as planned.
- Hiram
 - o Started making an instruction manual for our project.
 - o Found an LCD screen for development board.
 - o Gave Paul the Gerber files for the development board and the interface board
- Bryce
 - o Finalized list of various parts sent back from Chart sponsor because some parts are now out of stock needed for circuit board
 - o Currently using other sources like Mouser electronics to try and find some viable alternatives for the out-of-stock parts
- George

- o Got familiar with STM Cubed software and worked on Final Executive Summary with Bryce.
- o Worked on installing OpenHMI and Codesys utilizing the User Instruction manual provided from Exor.

Upcoming Action Items assigned per Team Member

- Breon
 - o Continue working on final written report.
- Matthew
 - o Finish reprogramming pins in the next few weeks
 - o Finish doing research for what kind of LCD screen we will use for the development board.
- Hiram
 - o Helping Matthew find the correct functions for specific pins.
 - o Help Matthew with finding a connector for the LCD screen.
- Bryce
 - o Continue working on the final power point presentation
- George
 - o Continue working alongside Matthew on the STM Cubed software
 - o Continue formulating testing plan for test board

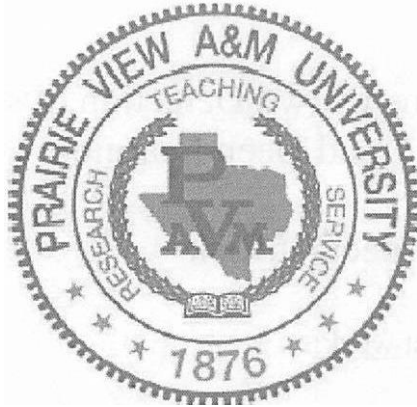
Tentative Plans for the Upcoming Week

- Finish research in a LCD screen and find a connector for LCD
- Continue making a user manual for the project
- Finish reprograming all the pins for the STM chip

Issues or Concerns

- N/A

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4248: Senior Design & Professionalism II

Topic: Spring Weekly Report #6

Meeting Times

Monday: 10am-12pm

Tuesday: 5pm-until

Wednesday: 11am-2pm

Friday: 10am-12pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: 3/30/2022

ELEG 4248

Weekly Sr Design Project Status Report

Team Number: 1

Date: 3/30/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

Project Status: Some Aspect At Risk

Accomplishments from the last week:

Last week, after meeting with our advisor, we started focusing more on people detection. We were able to code our device to detect people instead of just objects. We plan to use this to meet our requirements. After acquiring another Raspberry Pi, we were also able to make very good progress on programming the USB Compute Stick in order to use OpenVino. We want the compute stick to speed up the framerate for our people detection. The setup process is a little more complicated because all of the guides we have are from years ago and certain things do not apply anymore. However, we discovered a key mistake we were making trying to set it up via desktop instead of Raspbian. We are now very close to having it set up.

Team Meeting Attendance:

We have met on the following days:

Wednesday, March 23 11:00am-2:00pm

Monday, March 28 10:00-12:00pm

Tuesday, March 29 4:00-6:00pm

Everyone was present for the meetings. Two of us worked on presentations and written reports. The rest of us worked on the Raspberry Pis. We are keeping our first initial code under construction to see if we are able to fix our code using a new feature we discovered last week. The other Raspberry Pi is focused mainly on people detection. Using this alone, we will be able to meet a good number of our requirements. This Raspberry Pi is also where we are installing the Intel Compute Stick software, OpenVino, to improve our framerate. By the end of this week, we will see which Raspberry Pi has the most success and progress, and we will all focus in on that one to use as a working demo for finals.

Team member Contribution to Project

- Alyssa Reed
 - Worked on people counter code and got people detection code finished
- Jalyn Beaty
 - Worked on people counter code original code,
- Deonna London

- Finished people detection code, worked on USB Compute stick setup
Gabriel Maxwell
- began final report, design 3D print holder, worked on timeline and Gantt chart
- Alexis Hunter
 - Worked on slides for final presentation and USB compute stick setup

Upcoming Action Items Assigned per Team Member

Deonna - finish compute stick setup
Gabriel- finish final gantt chart and timeline, print out 3D case
Jalyn- continue to work on people counter
Alyssa Reed- continue to work on people counter
Alexis Hunter- finish slides for rehearsal, continue to help with USB compute stick

Tentative Plans for Upcoming Week

This week, we will be finding out which option of Raspberry Pi we are going with. We will take the one with the most progress and zero in on that one to create the demo.

Issues or Concerns

At this point, there are no new issues or concerns past the ones we had last week.

PRAIRIE VIEW A&M UNIVERSITY

ROY G. PERRY COLLEGE OF ENGINEERING

Liquid Nitrogen Doser Smart Actuator

ELEG 4248: Senior Design & Professionalism II



Topic: Weekly Progress Report

Team Number 2

Submitted by:

Hiram Pouncy

Matthew Barnett

George Polk

Breon Holmes

Bryce Lovejoy

Instructor: Professor Turner

Date of Submission: 3/30/2022

ELEG4248

Weekly Senior Design Project Status Report

Team Number: 2

Date: 3/30/22

Project Name: Liquid Nitrogen Doser Smart Actuator

Project Status: On Track

Accomplishments from previous week

- Reallocated hard drive space on Linux machine.
- Reprogrammed some pins on the STM chip
- Found an LCD screen for development board.

Team Meeting Attendance

- Everyone met on March 24th from 11:00am CST to 1:00pm CST to go over PowerPoint presentation.

Team Member Contribution to Project

- Breon
 - o Working on final written report.
- Matthew
 - o Installed STM32CubeIDE software onto Linux machine.
 - Reallocated for more hard drive space on the machine.
 - o Pin reprogramming is developing as planned.
- Hiram
 - o Continuing making an instruction manual for our project.
 - o Found an LCD screen for development board.
- Bryce
 - o Finalized list of various parts sent back from Chart sponsor because some parts are now out of stock needed for circuit board
 - o Currently using other sources like Mouser electronics to try and find some viable alternatives for the out-of-stock parts
- George

- o Working on installing OpenHMI and Codesys utilizing the User Instruction manual provided from Exor.
- o Working on final written report.

Upcoming Action Items assigned per Team Member

- Breon
 - o Continue working on final written report.
- Matthew
 - o Finish reprogramming pins in the next few weeks
 - o Finish doing research for what kind of LCD screen we will use for the development board.
- Hiram
 - o Continue to help Matthew find the correct functions for specific pins.
 - o Continue to help Matthew with finding a connector for the LCD screen.
 - o Continue to work on user manual for the project.
- Bryce
 - o Continue working on the final power point presentation
- George
 - o Continue working alongside Matthew on the STM Cubed software
 - o Continue formulating testing plan for test board

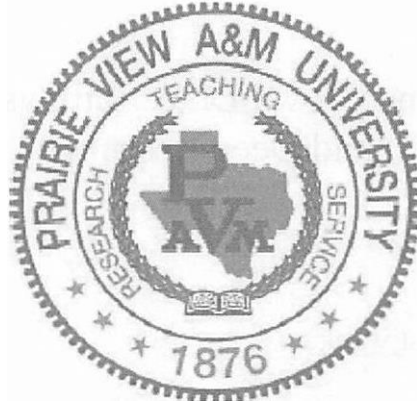
Tentative Plans for the Upcoming Week

- Finish research in a LCD screen and find a connector for LCD
- Continue making a user manual for the project
- Finish reprogramming all the pins for the STM chip
- Continue working on final written report

Issues or Concerns

- N/A

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

ELEG 4248: Senior Design & Professionalism II

Topic: Spring Weekly Report #8

Meeting Times

Monday: 10am-12pm

Tuesday: 3pm-until

Wednesday: 11am-2pm

Friday: 10am-12pm

Team Number 1

Submitted By:

Jalyn Beaty (Team Lead)

Gabriel Maxwell

Deonna London

Alexis Hunter

Alyssa Reed

Instructor: Professor Turner

Date of Submission: 4/06/2022

ELEG 4248

Weekly Sr Design Project Status Report

Team Number: 1

Date: 4/06/2022

Project Name: Real-Time Crowd Detection System using Raspberry Pi and Deep Learning

Project Status: On Track

Accomplishments from the last week:

Last week, while focusing on our people detection to meet our requirements, we got our people counter to work. Our device can now identify and count people entering the frame. We have since begun connecting the alarm system for the final touches. We have a 3D printed case to house our device that was finished last week as well. We redid our slides for the final presentation, adding in the new slides, correcting older ones, and adding the executive summary slides.

Team Meeting Attendance:

We have met on the following days:

Wednesday, March 30, 11:00am-2:00pm

Friday, March 1, 10:00am-12:00pm

Monday, March 4, 10:00am-12:00pm

Everyone was present for the meetings. We were able to get the people counter to work and then the two software leads began working on the alarm system. One of us worked to get the 3D print case finished. We also now have a more high-level project schedule. We worked to correct our old slides based on previous feedback and our meeting with Dr. Qian. We also worked on the new slides that needed to be included. Since then, we have assigned everyone their final slides and have been practicing.

Team member Contribution to Project

- Alyssa Reed
 - Worked on alarm system and final design
- Jalyn Beaty
 - Worked on alarm system and final design
- Deonna London
 - Finished people counter, revised final slides
- Gabriel Maxwell
 - began final report, got 3D printed case finished, finished improved project schedule

Alexis Hunter

- Worked on slides for final presentation, worked on schematic for Raspberry Pi

Upcoming Action Items Assigned per Team Member

Deonna - began revising and editing written report

Gabriel- finish final Gantt chart for written report

Jalyn- finish alarm system and final design

Alyssa Reed- finish alarm system

Alexis Hunter- finish schematic

Tentative Plans for Upcoming Week

This week, we will be rehearsing our final oral presentation and putting the final touches on our design

Issues or Concerns

At this point, there are no issues or concerns.