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| **Automated Real-Time Measurement of Soil Properties with Unmanned Ground Vehicle** |
| Sponsor | *Industry Related Sponsor* |
| Investigators | Raghava Kommalapati with Hongbo Du (PI), Wang, Jiang, and Ampim |
| Project Dates | 12/22-11/25 |
| Amount Awarded | $915,742  |
| Project Description: |
| Measuring organic carbon, nutrients, and minerals is very important for agricultural scientists and farmers to evaluate soil quality, monitor soil quality change, and nutrient dynamics, and plan which crop should be cultivated. Unlike the conventional soil analysis in the lab, we will develop an intelligent unmanned ground vehicle (UGV) system that can automatically measure soil properties in real-time when UGV runs in the crop field. The system will be realized with modern technologies of an agricultural robot, remote control, real-time kinematics (RTK) GPS navigation, and machine learning, including deep learning and our genuine mechanical design and system integration. A reliable Naio Oz robot that is commercially available will be used as the system platform. A portable spectrophotometer, a soil pH meter, a soil moisture meter, and a portable digital microscope as payloads will be mounted to the robot with proper connections of signal lines and power lines to the power outlets of UGV. An industrial computer containing a communication module will be attached to the robot for communicating with sensors and a control cellphone through air data transfer. A solar panel will be installed on the top of the vehicle to protect the robot's payloads and reduce the influence of the field environment on the measurement system. A mechanical soil sampling unit, including a dark chamber, will be designed, fabricated, and attached to the robot. The probes of the spectrometer, the pH meter, the moisture meter, and the microscope will be inserted into the dark chamber to measure soil properties. A detachable bagging/labeling unit will also be designed and fabricated to collect soil samples for laboratory analysis. Codes and software for robot control, soil sampling, air data transfer, data visualization, and data processing with machine learning will be developed and tested. After the smart system is assembled, field tests will be conducted on the experimental farm of Prairie View A&M University (PVAMU). The research project consists of 7 tasks and activities: (1) field selection, (2) mounting various payloads to UGV, (3) field sampling, (4) laboratory analysis of soil samples, (5) spectra and vision data preprocessing, (6) Data analysis with machine learning, and (7) education and outreach activities. The success of our research project will train our future workforce in engineering, computer science, and agriculture and will strengthen the research capacity of the faculty at PVAMU. Our pilot research will realize automatic real-time soil analysis and evaluation in the field and will pave the way to alleviate the intensity of soil analysis in the field and laboratory. **Intellectual Merit** The automatic in-situ soil characterization system will have the ability to analyze soil organic carbon, moisture context, soil nutrients, and soil texture in real-time by integrating modern agricultural robot technologies, advanced Vis-NIR spectroscopy, microscopy, computer vision, and machine learning. The system can measure the soil parameters for various soil depths almost at the same time in one soil sampling cycle. The dark chamber included in the soil sampling unit can significantly reduce the signal noise in soil spectrum and microscopy. The field data can be transferred through the cellular network for data storage and soil spectrum analysis, and texture analysis.  **Broader Impacts** The results of the proposed work will be presented at local/regional/national/international conferences, published in peer-reviewed publications, and developed into patent applications. Education and outreach activities will demonstrate the research capabilities of PVAMU in soil science, precision agriculture, and machine learning to the scientific community. This project will strengthen our solid collaboration between PVAMU, the Shell Oil Company, and other industrial partners. This proposed project will help to increase the number of students from underrepresented groups participating in agriculture- and STEM-related research activities. It will also help PVAMU to lower the research gap in precision agriculture between PVAMU and other top-tier research universities. |