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**Wavelet-based
Image Processing**

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Outline

- Research in still image processing
 - Image enhancement and feature extraction
 - Hyperspectral image compression, target detection, and remote sensing
- Example on biomedical research
 - DWT vs. RDWT
 - Application in tracing of blood vessels
 - Conclusion and future work

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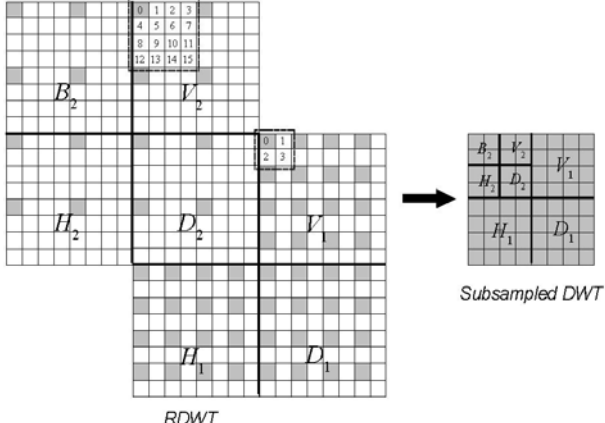
DWT vs. RDWT

- Discrete Wavelet Transform (DWT) is widely used in image processing and compression
 - DWT uses downsampling after each filtering to only retain half of the coefficients
- Redundant Wavelet Transform (RDWT) removes downsampling operation
 - RDWT upsamples the filter after each filtering to facilitate the growing coefficients

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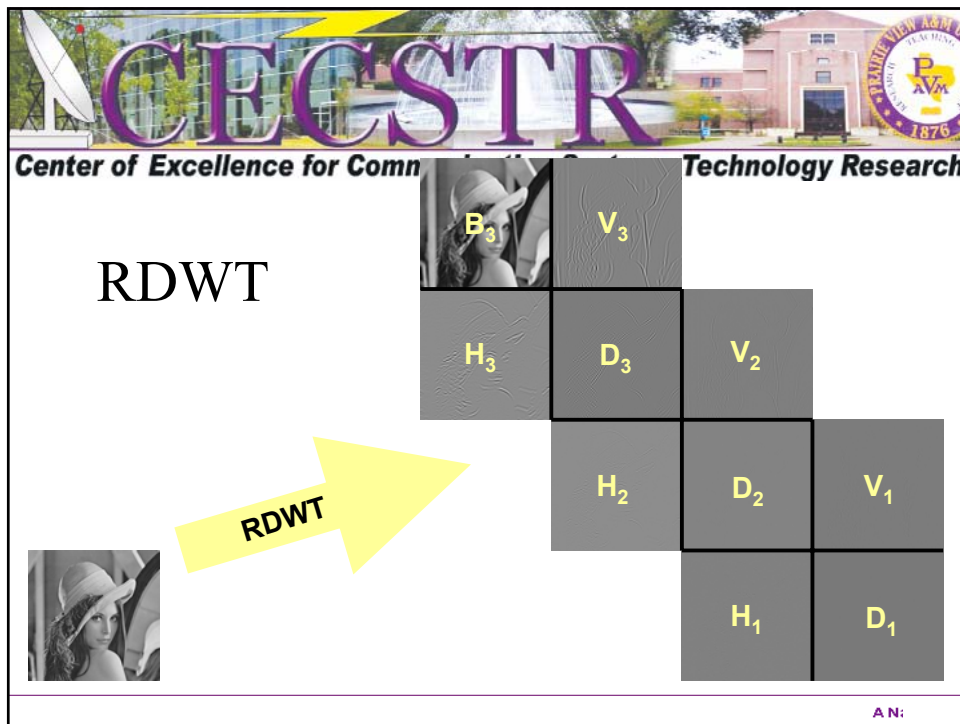
DWT vs. RDWT



RDWT

Subsampled DWT

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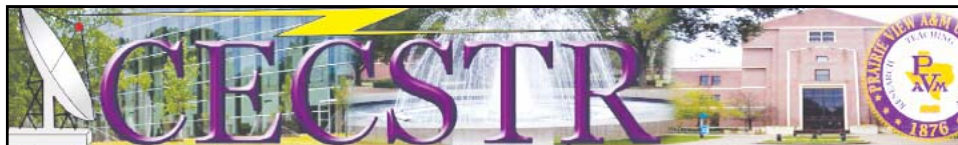
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- RDWT**
- Redundant Wavelet Transform
 - Overcomplete expansion system
 - Approximation to continuous wavelet transform
 - No decimation as in critically sampled DWT
 - Each subband has same size as image
 - Used in signal detection, enhancement, denoising
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Biomedical Application

- Use image processing technique in cancer treatment
 - Tumour detection and starving
 - Detect the change of blood vessels
- Applications focus on trace of the blood vessels
- We explore usage of redundant wavelet transform (RDWT) in this area

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RDWT Correlation Mask

- RDWT facilitates feature detection
- Salient features exist across all scales
- RDWT coefficients for features are correlated across scales
- Correlation exists in DWT too -but, changing spatial sampling rate hinders calculation of an explicit correlation mask

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RDWT Correlation Mask

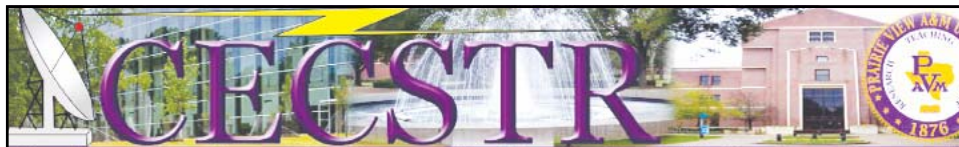
- Find feature points by calculating an RDWT correlation mask:

$$mask(x, y) = \left| \prod_{j=J_0}^{J_1} H_j(x, y) \right| + \left| \prod_{j=J_0}^{J_1} V_j(x, y) \right| + \left| \prod_{j=J_0}^{J_1} D_j(x, y) \right|$$

J_0 : starting scale

J_1 : ending scale

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RDWT Correlation Mask

$$H_1(x, y) \times H_2(x, y) = W_H(x, y)$$

$$W_H(x, y) + W_V(x, y) + W_D(x, y) = mask(x, y)$$

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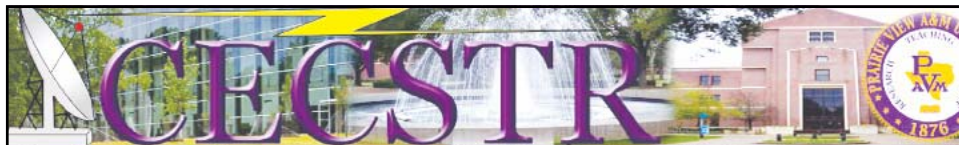
Extract Feature

$$\tau = \alpha \bullet \max_{x,y} \text{mask}(x, y)$$

Where $0 \leq \alpha \leq 1$ is the threshold parameter

If a mask value is greater than the α value, this location is marked as edge

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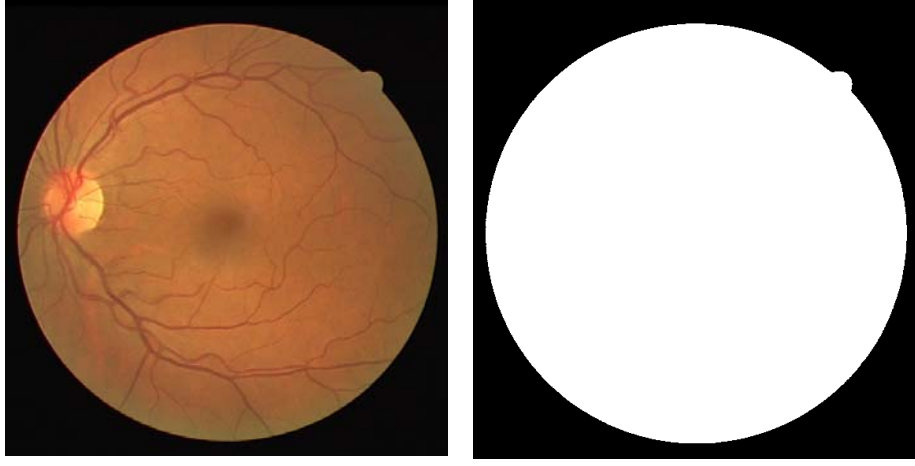
Adaptive RDWT

- Most of time, in biomedical imaging, an arbitrary-shaped area-of-interest (AOI) is analyzed
- In adaptive RDWT, only data within AOI will be transformed into RDWT domain, data outside will be treated as transparent

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Adaptive RDWT



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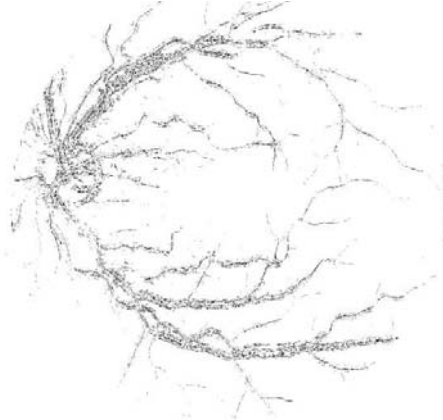
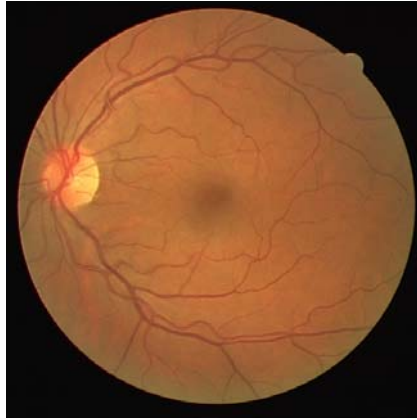
Experiment Result

- We perform experiments on retina images and bat wing images
- Wavelet transform uses the popular 9-7 biorthogonal filter with symmetric extension for 3 levels

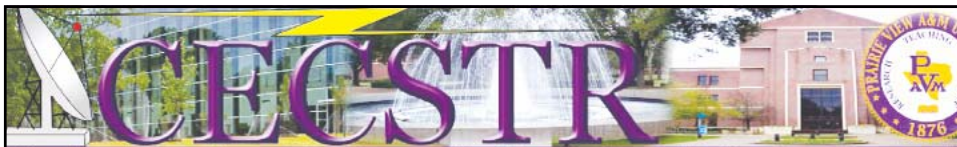
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Experiment Result



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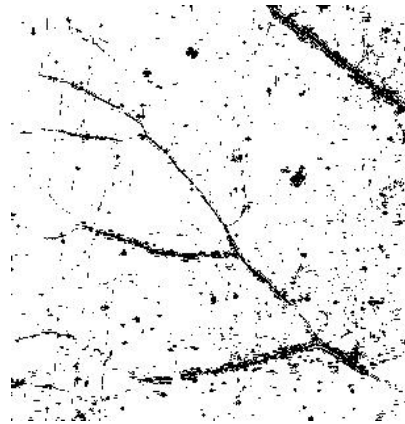
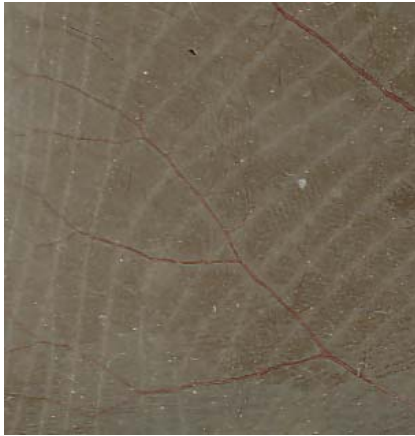
Experiment Result



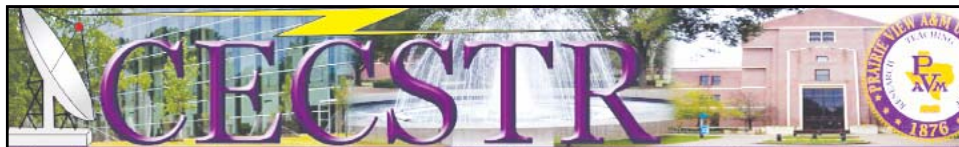
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Experiment Result



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Conclusion and Future Work

- A new method to locate blood vessels via RDWT correlation mask
- Simple and easy to perform
- Can locate blood vessels quickly and efficiently
- This algorithm can combine with other algorithms to build blood vessel segmentation system

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Thank you....

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