Suggested Project Topics

1. **Adaptive Wavelets.** Explore, develop, and design adaptive wavelets that automatically tuned themselves from the past samples or from a large set of training data.

2. **Wavelets with Sub-Optimal Smoothness.** Popular wavelets are obtained from the spectral factorization of a maxflat halfband filter. All of the degrees of freedom are imposed on the zeros at $\pi$. What happens if we reduce the number of zeros and use the resulting free parameters to optimize for other properties, say stopband attenuation, coding gain, or integer coefficients.

3. **Complex Wavelets and Filter Banks.** Explore wavelet designs and applications without the real-coefficient constraint.

4. **Nonlinear Wavelets and Filter Banks.** Can we have a perfect reconstruction filter bank with a nonlinear median filter? How can we choose the nonlinear operator appropriately to obtain good energy compaction?

5. **Near-Perfect-Reconstruction Wavelets and Filter Banks.** In most practical applications, the majority of the wavelet coefficients will be discarded and perfect reconstruction is lost. Study the possible advantages of relaxing the perfect reconstruction constraint. From another viewpoint, what is the optimal solution in the mean square sense given a simple quantization model?

6. **Multidimensional Nonseparable Wavelets.** How about 2D wavelet transforms with nonseparable 2D filters? Wavelets that are directionally steerable?

7. **Principal Component Wavelets and Filter Banks.** Given a particular input signal or a particular input statistics, how can we compact as much of the signal energy as possible into one subband? Of high interest are of course the FIR linear phase and FIR orthogonal solutions.

8. **M-band Wavelets.** Spectral factorization of a maxflat halfband filter is a simple, yet elegant, method to design wavelets with high degrees of regularity. Unfortunately, no analogous factorization method exists in the more general $M$-band case. The challenge: how to enforce regularities and vanishing moments on an $M$-band filter bank to obtain $M$-band wavelets.
9. **Java Wavelet Applets.** Design java applets to demonstrate various interesting properties, design procedures, applications associated with the wavelet transform: signal decomposition, spectral factorization, lattice structure, lifting scheme, denoising, signal coding, signal approximation, etc.

10. **Fast Implementations.** Can we take advantage of current technologies to obtain the fastest transform time? How about an MMX wavelet implementation? Can we minimize memory accessing time too? Also, in practical wavelet coders, more than 80% of the subband samples are discarded; can we exploit the sparseness of the quantized subband matrix to perform fast reconstruction?

11. **Wavelet and the Stock Market.** Can we use wavelets to study financial time series and predict the stock market? More realistically, can we develop novel wavelet-based technical analysis indicators?

12. **Efficient Content-Based Archival and Retrieval.** Can archiving and fast retrieving a certain image or a certain class of images from a large image database be achieved by simply comparing a few wavelet coefficients?

13. **Pre- and Post-Processing Algorithms for Wavelet Systems.** Exploring pre- and post-processing techniques to enhance certain performance aspect of wavelet systems. For example, pre-filtering can improve coding performance; post-filtering can reduce ringing artifacts.

14. **Signal Processing in the Wavelet Domain.** Exploring signal processing applications that can be performed directly in the wavelet domain, preferably at reduced complexity. How about wavelet transcoding?

15. **Wavelets in Telemedicine.** A universal framework for delivering medical signals at different resolutions, different quality levels, and arbitrary regions of interest with the capability of recovering signals lossily as well as losslessly.

16. **Multiresolution Medical Imaging.** Can the multiresolution characteristics of the wavelet transform improve the processing speed of various medical imaging techniques? This is applicable to other types of signals as well.

17. **Motion Estimation in the Wavelet Domain.** Can we estimate the motion of video sequences in the wavelet domain? What are the advantages and disadvantages? Can the multiresolution characteristics help in speeding up the estimation?

18. **Wavelet-Based Signal Coding.** This topic has been beaten to death! However, any breakthrough or any original idea is definitely welcome, especially in video coding.

19. **Signal Detection. Target Recognition.** Can we recognize a particular shape or object from the wavelet coefficients of the data?

20. **Signal Denoising.** Soft and hard thresholding of the wavelet coefficients have been shown to be very useful in signal denoising. Study alternative denoising strategies.
21. **Wavelet-Based Digital Watermarking.** Can we hide robust invisible data for verification and authentication purposes in the wavelet domain?

22. **Wavelets in Communications.** Possible directions include transmultiplexing, precoding, modulation... using wavelet bases.