Thota Tejasri / Prof. P. C. Pandey (Supervisor): “Wavelet-Based Denoising of ECG Using Quantile-based Dynamic Threshold Estimation”, *M.Tech. dissertation*, Department of Electrical Engineering, Indian Institute of Technology Bombay, June 2016.

ABSTRACT

Electrocardiogram (ECG) is a non-stationary biological signal which is useful in diagnosis of cardiac problems. It gets corrupted by several disturbances like electromyogram (EMG) noise, baseline wander, and motion artifact, particularly during ambulatory recordings. Removal of EMG noise is difficult due to significant spectral overlap between ECG and EMG noise. Wavelet-based thresholding has been reported to be effective for denoising ECG corrupted with EMG noise. It involves non-linear modification of wavelet coefficients at different levels after multilevel wavelet decomposition of the noisy ECG. For this purpose, use of quantile-based estimation of time-varying thresholds is investigated. It is evaluated by denoising the noisy signals with different SNR values, generated using ECG and EMG noise records from MIT-BIH database. SNR improvement and wavelet-weighted percentage root mean square difference (WWPRD) are used as performance indices. Errors in the clinically important features are also examined. Comparing the contributions of $D1$ removal and thresholding, with thresholds obtained by 90th percentile, it is seen that thresholding results in additional SNR improvement of 3.86 dB, 3.10 dB, and 1.54 dB for input SNR of -10 dB, -5 dB, and 0 dB, respectively. Visual inspections show that median followed by mean combination estimates the EMG noise envelope more effectively. High performance is shown by choosing 90-percentile in time-varying threshold for input SNR from -20 dB to 5 dB, while 75-percentile gives better results for input SNR from 5 dB to 15 dB. Results with 50-percentile are relatively low unless the input SNR itself is very high. The WWPRD values of 19.95, 22.07, and 22.92 for 90, 75, and 50 percentiles, respectively, for −10 dB input SNR also indicate the suitability of threshold estimation. The proposed denoising method also improves the estimation of clinically important features of P-wave amplitude, T-wave amplitude, and PR interval.