Dhaval G. Shah / Prof. P. C. Pandey (Supervisor), “Investigations on wavelet-based ECG denoising”, M.Tech. Dissertation, Biomedical Engineering, Indian Institute of Technology Bombay, July 2014.

ABSTRACT

Ambulatory ECG recording are often corrupted by baseline wander (BW), EMG noise, and motion artifact (MA). These artifacts make it difficult to measure the duration and amplitude of P wave, time interval between characteristic points, dip or elevation of ST segments from isoelectric point. For suppression of these artifacts, an investigations on a wavelet-based denoising technique is carried out.

Objective evaluation of denoising technique is carried out by applying it on ECG with simulated noise, obtained by adding noise-free ECG and ECG-free noise, and calculating SNR improvement and correlation coefficient. Use of correlation coefficient is extended to decompose the error in the output with respect to the noise-free reference to get the estimates of signal attenuation, noise attenuation, and magnitude of distortion for devising further improvements. An automated method for calculating insertion and detection errors in R-peak detection as a function of temporal tolerance is developed for assessing the usefulness of the denoising technique for arrhythmia detection.

A wavelet-based denoising technique developed using discrete Meyer wavelet, smooth thresholding and smooth limiting of wavelet coefficients, and thresholds determined from the signal statistics and two externally supplied control parameters is investigated for suppression of BW, EMG noise, and MA in ECG and to study the effect of the control parameters. Results of subjective and objective evaluation showed the effectiveness of the denoising technique. The control parameters selected for usefulness over a range of input SNR values resulted in SNR improvement of 18.5, 6, 8.3 dB for BW, EMG noise, and MA, respectively for input SNR of – 12 dB. Results showed that the denoising can be made more effective by selecting the denoising control parameters on the basis of an assessment of the level and type of artifacts.