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Interferences in biomedical signals: Signal processing techniques to minimize the noises for better diagnosis

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Statement of the Problem: Biological signals are often corrupted by undesirable noises which makes clinical diagnosis a difficult task. The noises that get added are power line interference, muscle artifacts, baseline wandering etc. Among these noises 50 Hz power line interference is more severe and changes the signals morphological characteristics. Signal processing techniques play a vital role in elimination of such interference without disturbing the nature of original signal.

Methodology & Theoretical Orientation: Denoising of biological signal is very seminal to understand the signal characteristics buried in noise. The common method of estimating signals, which are corrupted by additive noise, is to pass them through a filter that tends to suppress noise while leaving signals being unchanged. Some recent relevant contributions have proposed solutions using a wide range of different techniques, like maximally decimated filter banks and nonlinear filter banks, independent component analysis, adaptive filtering and the wavelet transform. The design of filter will be based on prior knowledge of both signal and noise, but adaptive filters have the ability to adjust their own parameters automatically, and no prior knowledge of signal or noise characteristics is needed. The least mean square (LMS) algorithm introduced by Widrow and Hoff is one of the most widely used algorithms in adaptive filtering due to its simplicity and ease of computation. In practical system this algorithm can be implemented without squaring, averaging or differentiation and is elegant in its simplicity and efficiency. The wavelet transform is a time-scale representation technique with translation and dilation of a function called mother wavelet. This allows signal features to be isolated in time, while dilation operation allows features at different scales to be identified. It represents a signal as a sum of wavelets with different scales. Wavelet shrinkage concepts developed by Donoho and Johnstone is a pivotal ground-breaking work in denoising of biosignal. Shrinkage method compares empirical wavelet coefficient with a threshold and is set to zero if its magnitude is less than the threshold value. For any threshold scheme to be effective, an essential property is that the magnitude of signal should be larger than that of existing noise. Poornachandra and Kumaravel have developed a subband adaptive shrinkage function for denoising of ECG signals. The shrinkage function is incorporated at the vicinity of power line frequency by selecting the proper subband level. Another limitation of wavelet approach is that the basic functions are fixed and, thus, do not necessarily correspond to all real signals. Apart from basic filters and adaptive filters, various tools are also being used for filtering like wavelet transform and Empirical Mode Decomposition (EMD). Among these techniques, EMD based filtering is fully a signal dependent approach and is adaptive which can be used for real time applications.

Conclusion & Significance: Signal processing techniques are tools developed for non-invasive detection and diagnosis of various abnormalities in human. These methods are computationally efficient and less complex.

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