BME 261A **ECG Research Articles Summaries**

Atrial Fibrillation Detection Using Stationary Wavelet Transform Analysis (2008)

Atrial Fibrillation (AF) is a cardiac failure indicative of change in blood flow dynamics and may result in chest pain, palpitations, fatigue, increased risk of stroke and heart failure. AF characterized by distinguishing features of irregular R-R interval, absence of P waves and fluctuating waveforms in baseline ECG. Difficulty of comparing AF power to ventricular waveform is poor SNR and need for QRST cancellation. For this reason use stationary wavelet transforms (SWT) because it is time-invariant, so that AF fibrillatory waveform features in AF frequency range carry same temporal resolution. Able to use SWT to generate wavelet coefficients (level 5-7) and spectral analysis on coefficients to extract features to discriminate AF segments, characterizing in frequency range 4-9Hz. Key feature is that inspection of power spectrum has same resolution in time domain such that use to calculate peak and average power in frequency range. Result was AF detection method for clinical purpose with better sensitivity than fourier transform method (0.929 AUC).

Atrial activity Estimation in Atrial Fibrillation by combining ESC and ICA methods (2011)

AF Identification in ECG characterized by chaotic-like oscillation, f-waves replacing p-waves, in narrow band of 3.5-9Hz. Present method uses Event Synchronous Canceller (ESC) and independent component analysis (ICA) for extraction of AF signal, due to overlap with ventricular activity overlap. Ventricular activity detection, QRS-T template average to find optimal position of QRS-T template to then subtract. Use ICA algorithm for AF extraction of independent components and separate it from ventricular activity residuals by a mixing matrix, such that ventricular and atrial activities are statistically independent sources along with artifact and noise elements. Squared difference between extracted AF signal and original AF was 0.0646 showing very good results.

A Technique for Automated Arryhtmia Detection of Holter ECG (1995).

Holter ECG common diagnostic tool, can be used for fast feature extraction for detecting and discriminating general ambulatory and abnormal beats in a few minutes. Method of bandpass digital filters to remove disturbance waveform and unnecessary signal. QRS detection by dynamic threshold, by a threshold updates from previous (compare if larger of update threshold if smaller) and decides heart beat pulse onset and endpoints. Allow calculation of pulse duration area and slope to characterize the QRS to provide good and simple criterion for ECG template matching. 99.8% accuracy of QRS detection and sensitivity of 93.2% of PVC arrhythmia.

Application of a BP Neural Network Based on Principal Component Analysis in ECG Diagnosis of RVH (2009)

Proposal for a BP neural network based on principal component analysis (PCA) to predicate right ventricular hypertrophy (RVH) shown superior to RVH. RVH common heart disease due to thickening of right ventricularis or dilation. Experiment used data source of 85 cases with RVH ECG recordings from reference and control groups, with data collection of: age, heart rates, sums of amplitude of R wave, depth of S wave, amplitudes of inverted T wave, and deviation degress in right axis. PCA used for dimensional reduction to compress from 5 to 3 PRINs and use DPS data processing system. Results provide a structure of 3-1-2 due to PCA (instead of 5-1-2) that allows for increased sensitivity and accuracy.

Early detection of Essential Hypertension by Time-Frequency Analysis (2002)

Hypertension affects 25% of adults and major contribution to cardiovascular disease, with a significant genetic component (60%). Study of offspring of 2 normotensive parents (control) and offspring of 1 hypertensive and 1 normotensive group (test group). Experiment of monitoring change in posture, where hypertensive patients showed enhanced sympathetic involvement in HR response to CP. Monitoring of heart rate, blood pressure, and focus on two regions of power in ECG signal: a high frequency (HF) peak located at respiratory frequency of 0.18-5Hz (reflecting vagal and beta-sympathetic activity) and low frequency peak (LF) centered around 0.1 Hz (alpha-sympathetic activity). Investigate malfunctions in branches of autonomic nervous system in hypersensitive patients. Use continuous wavelet transform to be time-dependent in frequency domain for spectral analysis to reveal changing amplitude of each frequency component present in signal. Determined LF and HF peaks, integrated the CWT over the frequencies of each band to obtain time-dependent LF peaks and HF peaks. Hypertensive test group showed greater beta-sympathetic activation (expressed as larger increase in LF of heart rate) to achieve heart rate, and group also showed HR fell more quickly despite higher LF activity.

Multivariate Analysis of Body Surface Potential Maps in Left ventricual hypertrophy (1989)

Analysis of 120 recorded ECG data from 250 normal and 213 with LVH, focus on voltage on time-normalized P, PR, QRS, and ST-T waveforms. P wave duration was most potent discriminator, voltages were mid- and late P wave, in mid QRS, and slightly before T wave. ECG evidence of LVH by repolarization abnormalities and increased QRS voltages. Discriminant analysis on waveforms for classification of 4 P measurements, 1 mid-QRS voltage, and one near T-peak voltage, from slightly outside lead locations from normal. P wave changes from LVH reflect leftward progression of atrial depolarization front in early-to-mid P wave moving dorsally and P duration average normal of 96 +/- 12 ms in normal and 120 +/- 17 ms in LVH as most potent classifier. Results showed better multivariate analysis with LVH patients of 86% classified corrects and 94% specificity.