Novel ECG Classifier for Automatic Atrial and Ventricular Wave Separation

Background
Heart rhythm disorders (arrhythmias) can be associated with severe outcomes such as cerebral apoplexy. The surface electrocardiogram (ECG) is routinely used to diagnose the arrhythmia. Intermittent episodes of arrhythmias, e.g. paroxysmal atrial fibrillation, require long-term ECG recordings to detect the episodes of irregular activity whereupon a prolonged recording period increases the detection probability. However, the ECG signal quality and recording capability is particularly limited because the electromechanical contact properties give rise to motion artefacts and alter over time. The signals emanating from the atria usually suffer from low amplitudes that turn the automatic detection cumbersome.

As a promising alternative, ECG signals derived via the esophageal mucosa might be used. These signals offer more detailed information on atrial activity [1] and the esophagus allows long-term instrumentation with excellent electromechanical contact. However, to take advantage of the increased signal quality, the electrical activity of the atria and of the ventricles need to be detected and separated automatically. The pattern recognition problem becomes challenging because these two waves are often very similar in morphology (see figure), change with insertion level and lead configuration and are perturbed by electrode motion artifacts.

Aim
The focus of this master’s thesis is to investigate an automatic classifier for atrial and ventricular waves within the esophageal ECG signal using clinical data.

Tasks
- Familiarize with (esophageal) ECG signals
- Build up a database consisting of annotated long-term surface and esophageal ECGs
- Define adequate training / test / validation sets
- Investigate dedicated feature vectors, required scaling and check for statistical relevance
- Design of a robust classification system based on e.g. Hidden-Markov-models or artificial neuronal network to separate atrial -, ventricular waves and motion artifacts
- Statistical quantification (sensitivity, specificity etc.) & optimization

Nature of the Thesis
Pattern recognition: 80%
ECG signal analysis: 10%
Statistical assessment: 10%

Requirements
Basic understanding of ECG
Interest in signal processing / pattern recognition
Programming knowledge (MATLAB)

Supervisors
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References

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http://www.microlab.ti.bfh.ch/research/projects/cti10717/