Karlsruher Institut für Technologie

Institut für Biomedizinische Technik

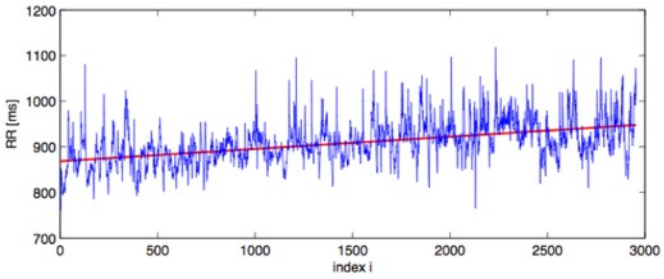
Research Project

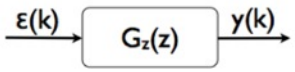
Analysing physiologic time series with ARMA models

Motivation

The normal rhythm of the heart is the sinus rhythm. It is controlled by a very complex interaction of the autonomic nervous system. The sympathetic system accelerates the heart rate and the parasympathetic system is responsible for slowing it down. The perfect balance between the two counterparts of the nervous system is what makes the physiology of the human heart work so stable. However, when taking a closer look to the time series obtained when measuring the instantaneous heart rate in the electrocardiogram (ECG) it seems to be chaotic. Modelling such a behaviour is not trivial and demands a deep understanding of the theory of systems and the identification of those. System parameters could have a relationship to the healthy state of the subject.

In order to investigate and quantify the system behaviour that describes physiological time series, state of the art methods for system analysis have to be considered. ARMA models can be used to represent the characteristics of the underlying the behaviour. Furthermore, from the ARMA model a spectrum or a state space model can be obtain also. The poles an zeros of the ARMA model and properties such as controllability and observability of the state space model can contain hidden information about the healthy state of the patient.





$$G_z(z) = \frac{Y(z)}{\mathcal{E}(z)} = \frac{(1 + c_1 z^{-1} + \ldots + c_q z^{-q})}{(1 - a_1 z^{-1} - \ldots - a_p z^{-p})}$$

Tasks

In this project, a robust algorithm for the identification and characterisation of physiological time series with ARMA models. A literature research in this field should be carried out first. In the end, a representation of the transfer function describing the heart rate variability (HRV) system in the Z domain together with a spectrum and a state space representation should be easily created for every patient.

Requirements

- Literature research
- Programming skills in MATLAB
- Strong fundamentals of signal processing
- Statistics and data mining
- Ideally some fundamentals of cardiac physiology

Field of Research
Signal processing of the ECG

Project
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Areas
Signal processing
Software programming
Algorithmic

Field of Studies
Engineering
Computer science

Starting Date
November 2012

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