Abstract

Multisensor ECG Simulation

Name der/des Studierenden

Thomas Unterer

Name der/des Betreuer/in

Prof. Dr. Guido Schuster

Name des externen Partners

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Sensor, Actuator and Communication Systems

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Abstract der Projektarbeit

Multi-Sensor ECG Simulation

The purpose of this project thesis is the comparison of various digital signal processing methods for multi-sensor electrocardiogram (ECG) denoising. A nonlinear dynamic ECG model as well as two approaches to incorporate this model in an Extended Kalman Filtering (EKF) framework for single-channel ECG denoising has been studied. The well-known cardiac dipole vector model for the electrical activity of the heart allows an extension of the EKF framework for multi-channel ECG denoising. Also two variations of this multi-channel extension of the nonlinear ECG model have been analyzed in detail. In order to avoid the disadvantages accompanying the usage of the complicated EKF structure, a linear model based on the spatiotemporal correlation of multi-sensor ECG recordings has been developed. An ordinary Kalman Filter (KF) based on this linear model has then been implemented and compared with the multi-channel EKFs regarding their performances in multi-channel ECG denoising.

The filtering performances of the two multi-channel EKFs and the multi-channel KF are excellent. All three methods are able to remove high noises in the ECG recordings significantly and with a considerable improvement compared to the single-channel approaches. Since the multi-channel KF is simpler, more robust and even provides the optimal mean squared error solution in terms of its linear model, it may serve as a good method for a future hardware implementation.