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Online heart rate estimation in unstable ballistocardiographic records

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Abstract:
When recording the pressure oscillations of a seated subject two distinct effects are assessed, ample vibrations due to the person's movement, and periodic oscillations of small amplitude due to cardiopulmonary activity, expressed by the ballistocardiogram (BCG). Embedding a pressure sensor in a chair's back or seat allows unobtrusive monitoring of the BCG. However, inconspicuously acquired signals are affected by numerous artifacts, often generated by the subject's forgetfulness, and posture changes due to lack of constrains. Moreover, the signal changes considerably its shape from person to person, and when the seating posture, or conversely, sensor position, is different. For real-time continuous monitoring, it is still to be found a method which, without introducing significant delays, can deal with such volatility. Thus, tailored calibration of peak detectors and other algorithms is recurrent, and even so, the neighboring samples of artifacts are possibly untreatable. This work evaluates the advantages of Empirical Mode Decomposition, as well as a coarser demodulation approach of the BCG signal, as dependable methods to allow real-time heart rate estimation on unstable BCG records. An analysis of the Fourier transform of the demodulated signals is the method used to provide and compare robustness of heart rate estimates.

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Contents

I. Introduction

CARDIOVASCULAR and respiratory activity unobtrusive assessment is a striking purpose that has been subject to much attention lately. With the latest technological developments, non-invasive systems based on ballistocardiography, contactless electrocardiography, and plethysmography are being considered as solutions for accurately, continuously, and non-invasively assessing the cardiovascular system status, by monitoring the heart and respiration rates, and estimating blood pressure [1]–[3].