On the Performance of Bed-Integrated Ballistocardiography in Long-Term Heart Rate Monitoring of Vascular Patients

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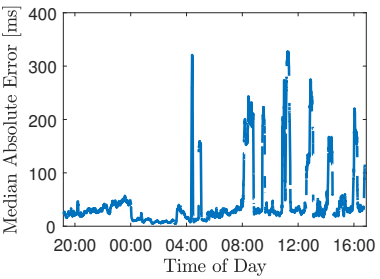
The application of ballistocardiography (BCG) for unobtrusive monitor of (beat-to-beat) heart rate in sleeping subjects has seen increased attention in recent years. While most research is performed on healthy volunteers, some studies have included subjects with sleep-related problems. Even so, little attention has been payed to patients suffering from cardiovascular diseases. In addition, most studies are either limited to short laboratory measurements or overnight recordings of sleeping subjects.



In this work, we present preliminary results on beat-to-beat interval estimation of long-term ($>$ 21 h) BCG recordings including day- and nighttime measurements. BCG signals were obtained from five subjects in a hospital environment and compared to ECG Holter recordings. The subjects had undergone different vascular and endovascular procedures: one lower limb endografting, one abdominal aortic endografting, two carotid endarterectomies, and one femoropopliteal bypass surgery. The commercially available sensor Emfit QS was placed between the hospital bed mattress and the bed base. An augmented version of the CLIE interval estimation algorithm was used: In addition to straightforward outlier rejection, an iterative estimation approach using a Laplacian prior is introduced and analyzed. Using the proposed approach, an average beat-to-beat interval estimation error of 3.8 % at a coverage of 61.5 % was achieved. Both error and coverage were found to vary from subject to subject, ranging from 2.4 % to 4.4 % in terms of error and 72.3 % to 48.9 % in terms of coverage. Moreover, dependency on the time of day was observed. On average, findings are comparable though inferior to results reported in the literature on insomniac subjects in sleep laboratory studies (e.g. 1.8 % relative error, 80 % coverage). As subtle motion artifacts are a likely cause of the decreased performance during daytime, novel algorithms need to be developed for their detection.