A Feasibility Study on the Automatic Detection of Atrial Fibrillation using an Unobtrusive Bed-Mounted Sensor

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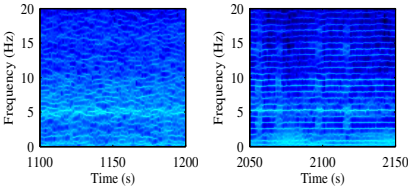
We present a feasibility study on the automatic detection of atrial fibrillation (AF) from a cardiac vibration signal (ballistocardiogram). Considering the prevalence of AF among the elderly and the risk of silent and undetected AF, there is a need for screening this population.

One way to unobtrusively measure cardiopulmonary activity is the integration of sensors into bed frames or mattresses which then record the vibrations of the body caused by the mechanical activity of the heart. For this study, such ballistocardiograms (BCGs) were recorded by means of an electromechanical foil attached to a bed's mattress.

A clinical study with 10 AF patients was conducted to assess whether BCG signals alone allow an automatic distinction between atrial fibrillations and normal sinus rhythms. The AF patients underwent a routine procedure called synchronized electrical cardioversion to return their heart rhythm to a regular sinus rhythm. From each patient, BCG and reference ECG signals were acquired before (AF) and after (sinus rhythm) the procedure.

For the automatic detection of AF, the entire BCG recordings were split into 856 non-overlapping, 30 s long, segments. Epochs containing motion artefacts were manually labelled and excluded from further analysis. Each of the remaining 245 epochs was assigned a label (i.e. AF or sinus rhythm) based on manual analysis of the reference ECG by an expert. From each epoch, 2 time-domain features and 7 features based on an auto-regressive time-frequency representation of the signal were extracted. After dimensionality reduction by means of principal component analysis, a radial basis function support vector machine classifier was trained to detect AF epochs. The classifier was evaluated by means of leave-one-out cross-validation. We could achieve a sensitivity of 96.17 % and a specificity of 91.94 %, which suggests that it is indeed feasible to use bed-mounted BCG sensors to screen for atrial fibrillations.



(a) AF (b) Sinus rhythm

BCG spectrogram (a) before and (b) after cardioversion