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APPLICATION NOTE

EVALUATION OF QRS DETECTION ALGORITHM IMPLEMENTED FOR MOBILE APPLICATIONS BASED ON ECG DATA ACQUIRED FROM SENSORIZED GARMENTS

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PROBLEM

Continuous acquisition of vital parameters with mobile systems requires robust and reliable algorithms which take the limited resources into account and overcome the drawback of motion artefacts.

GOAL

The acquisition of ECG data from a sensorized garment and the modification of a state-of-the-art QRS-detection algorithm was the first step [1]. The main goal was to evaluate the modified algorithm during the performance of five defined activities respectively postures.

METHODS

The FitnessSHIRT is a garment with integrated textile electrodes and respiration bands which realizes the measurement of a single-channel ECG and thoracic respiration, acquired with a sampling rate of 256 Hz.

Figure 1: Applied FitnessSHIRT with integrated sensors (ECG – yellow, Respiration band – green)

A technique for detection of QRS complexes in ECG signals based on a feature obtained by counting the number of zero crossings per segment was used [1]. The algorithm was modified in order to obtain the best results for this use case (e.g. adaption of filters and peak extraction). This method provides high detection accuracy, as it is largely independent of sudden changes in the amplitude level of the ECG signal and is robust against noise and signal morphologies. Due to its simplicity, this approach provides a computationally efficient solution.

TESTING

Each daily activity was performed by 10 male test persons over a period of 2 minutes, containing:

- Sitting on an office chair
- Walking (at a speed of 2 km/h on a treadmill)
- Jogging (at a speed of 8 km/h on a treadmill)
- Cycling (at a resistance of 150 Watt on a bicycle ergometer)
- Rowing (rowing machine ergometer)

RESULTS

On the basis of the measured values the sensitivity (true positive rate, TPR) and the precision (positive prediction value, PPV) were computed, whereby TP denotes true positives, FN false negatives and FP false positives.

Activity	TP	FP	FN	TPR (%)	PPV (%)
Resting	1,464	0	0	100.00	100.00
Walking	1,871	33	1	99.95	98.27
Running	2,702	46	5	99.82	98.33
Cycling	2,645	3	1	99.96	99.89
Rowing	2,607	59	0	100.00	97.79
Total:	**11,289**	**141**	**7**	**99.94**	**98.77**

Table 1: Results of QRS detection grouped by activities

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CONCLUSION

The evaluation results achieved with the specific test setting showed that the system provides high detection rates for all activities, even with artefacts and noise. Especially, the results from activities with high movement levels, e.g. running and rowing, showed that the system is also suitable for mobile applications.

REFERENCES

[1] QRS Detection Using Zero Crossing Counts; B Kohler, R Orglmeister, Progress in Biomedical Research, 8, 138-145, 2003
[2] Evaluation of QRS detection algorithm implemented for mobile applications based on ECG data acquired from sensorized garments; D Tantinger, S Feilner, D Schmitz, C Weigand, C Hofmann, M Struck; Proceedings BMT 2012, 46. DGBMT Jahrestagung, Jena; 635-638

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