UNOBTRUSIVE RESPIRATORY RATE MONITORING USING ACCELEROMETRY

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SUMMARY

Respiratory rate (RR) is a key physiological parameter used in a range of clinical settings to identify deteriorations in health. It has been found to change in the hours prior to cardiac arrest, and in the progression of sepsis, making it valuable for diagnosis and prognosis. Despite this, it is still widely measured by counting breaths manually. An alternative approach is to develop techniques to automatically estimate RR from physiological signals acquired by wearable sensors. This would facilitate continuous RR monitoring in both home and hospital settings. The aim of this project is to develop signal processing techniques for automatically estimating RR from accelerometry signals measured at the chest. If such techniques could be made sufficiently reliable for use in wearable sensors, then they could allow clinicians to identify deteriorations in health earlier, and respond to them more quickly, potentially improving patient outcomes and reducing healthcare costs.

1. INTRODUCTION

Respiratory rate (RR) is an important parameter which is widely used by clinicians when assessing a patient’s physiological state. Changes in RR can be used to predict clinical deteriorations, such as cardiac arrests and exacerbations in chronic obstructive pulmonary disease (COPD). However, RR is usually measured by manually counting how many times a patient breathes in a minute. This is not suitable for continuous, automated RR monitoring. An alternative approach is to estimate RR from physiological signals which can be easily acquired using wearable sensors.

One such signal is the accelerometry signal, which can be used to track chest wall movements. The widespread inclusion of accelerometers in smart phones and fitness devices provides opportunity to acquire this signal in a range of settings. Initial studies have shown the feasibility of estimating RR from accelerometry. In this project novel techniques will be developed to estimate RR from accelerometry by measuring the subtle variations which occur with breathing, and their performance will be assessed.

2. METHODS

The CEBS database will be used for this project. It contains accelerometry signals alongside reference respiratory signals recorded from 20 subjects, as well as simultaneous electrocardiogram (ECG) signals. Algorithms to estimate RR from accelerometry signals will be developed based upon those in the publicly available RRest Toolbox. The algorithms will be implemented in Matlab®, and the RRs estimated from accelerometry signals will be compared with reference RR extracted from the reference respiratory signals. The performance will be assessed using statistical techniques. The student may wish to compare the performance of the accelerometry-based techniques with techniques for use with the ECG, in order to contextualise the results.

3. OUTCOMES

In addition to the core outcomes of the Summer Research Module, this project provides opportunity to contribute to a publicly available repository of RR estimation algorithms, providing the student with experience in making research resources publicly available. It is hoped that the student will submit a paper on their work to the 6th International Conference on Sensors and Applications, providing valuable experience in disseminating research to the wider scientific community.

4. RECOMMENDED READING

The following publications are recommended reading, and should form the basis of the literature review:

- The clinical importance of RR: [1, 2]
- RR estimation techniques for use with accelerometry signals: [3, 4]
- RR estimation techniques used with other signals: [5, 6]
- The role of wearable sensors in healthcare: [7, 8]

5. REFERENCES


