EXPLORING PASSIVE HEARTBEAT DETECTION USING A HYDRAULIC BED SENSOR SYSTEM

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ABSTRACT

Sleep monitoring of heartbeat, respiration and restlessness can help to detect sleep disturbances which may be indicative of poor health and functional deficits, especially in older adults. This work investigates a new hydraulic bed transducer configuration, in order to improve its ability to capture heartbeat signals from different body types and proposes a new approach for detecting heartbeats from a ballistocardiogram (BCG) signal using the k-means clustering algorithm. The system's ability to capture heartbeat signals was improved by increasing the sensitivity of the transducer, varying its length, volume of water, and positioning. The transducer placement experiments were conducted on two participants based on two criteria: 1) Visual observation of the transducer signal to verify the occurrence of heartbeats in the BCG signal, and 2) A reliability index based on the percentage of heartbeats effectively detected by the system. Additional testing on a diverse group of six participants (ranging in age and body type) was performed to validate the transducer arrangement proposed. Results showed that the system was able to capture the occurrence of heartbeats for seven out of eight participants. The BCG signals captured by the new transducer arrangement were tested to explore a new approach for detecting individual heartbeats using the k-means clustering algorithm and features extracted from the BCG signal. The performance criteria used in the evaluation was the percentage of correct detection of heartbeats derived from the confusion matrix. The percentage of correct detection for five ballistocardiogram signals acquired from different body types, tested in the laboratory setting with a coil spring mattress were in the range of 91.X% to 99.7%. When tested in residential living with an air mattress, the results were 83.3% which indicate the need

for further investigation in feature selection and machine learning. Finally, the Windowed Peak to Peak Deviation (WPPD) algorithm and the new approach for detecting heartbeats using the k-means algorithm were compared to the Ground Truth signal by computing the beat-to-beat distance and the heart rate.