

Textile-Based Sensing System for Sleep Apnea Detection

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Abstract : Sleep apnea is a condition where a person stops breathing and can lead to cardiovascular disease, hypertension, and stroke. In the United States, approximately forty percent of overnight sleep apnea detection tests are cancelled. The purpose of this study was to develop a textile-based sensing system that acquires biometric signals relevant to cardiovascular health, to transmit them wirelessly to a computer, and to quantitatively assess the signals for sleep apnea detection. Patient interviews, literature review and market analysis defined a need for a device that ubiquitously integrated into the patient's lifestyle. A multi-disciplinary research team of biomedical scientists, apparel designers, and computer engineers collaborated to design a textile-based sensing system that gathers EKG, SpO₂, and respiration, then wirelessly transmits the signals to a computer in real time. The electronic components were assembled from existing hardware, the Health Kit which came pre-set with EKG and SpO₂ sensors. The respiration belt was purchased separately and its electronics were built and integrated into the Health Kit mother board. Analog ECG signals were amplified and transmitted to the Arduino™ board where the signal was converted from analog into digital. By using textile electrodes, ECG lead-II was collected, and it reflected the electrical activity of the heart. Signals were collected when the subject was in sitting position and at sampling rate of 250 Hz. Because sleep apnea most often occurs in people with obese body types, prototypes were developed for a man's size medium, XL, and XXL. To test user acceptance and comfort, wear tests were performed on 12 subjects. Results of the wear tests indicate that the knit fabric and t-shirt-like design were acceptable from both lifestyle and comfort perspectives. The airflow signal and respiration signal sensors return good signals regardless of movement intensity. Future study includes reconfiguring the hardware to a smaller size, developing the same type of garment for the female body, and further enhancing the signal quality.

Keywords : sleep apnea, sensors, electronic textiles, wearables

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