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A deep learning approach for wireless Photoplethysmography(PPG) sensor.

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Introduction

Photoplethysmography(PPG) sensor uses the basic idea of measuring instantaneous changes in volume within an organ and provides continuous hemodynamic information of the body. Compared with ECG sensor, it is easier to apply and is less disturbed by movements. However, it has not been suitable as a mobile equipment since it becomes unstable with the position change of the sensor itself and can pick up interrupting signals from the movement of the subjects. We propose that if the equipment can become mobile by applying deep learning classification of wireless PPG equipment, more efficient monitoring of the patients will be possible.

Methods

Noise outside PPG active frequency band, high-frequency noise, direct current noise, and baseline generated by subject's breath were removed using an oscilloscopic biosignal-filtering technology. Input PPG data was obtained by using the principle of artificial neural network, and a meaningful signal period was detected. Devised system consisted of a PPG sensor applied to index finger, a signal transmitter connected to the sensor, a laptop computer with the mentioned program and a signal receiver. Assessments of static and mobile status were carried out in healthy 32-year-old male subjects. For the static status assessment, the subjects wore the device and performed the following four tasks within 10m from the receiver: sitting in a stable position; speaking while resting; repeating sitting and standing on a chair 5 times; and compressing on the radial and ulnar arteries. The mobile status assessment was performed in wards with patients and staffs yet, plenty of space was available for walking in normal speed. The receiver was placed in the nursing station and the subject walked in the halls of 10 different wards while wearing the device and performed the following tasks: continuous 200m walking; and compression of the radial and ulnar arteries at a distance of 100m.

Results

The static status assessment showed 96.1% agreement with the existing wired equipment and the mobile status assessment showed 97.2% agreement. Noise from the movement of the sensor was observed, but noise caused by movement of the subjects was not significant. Although there is only a minor difference in the raw data between the new device and the conventional wired equipment, in the presence of communication obstacles (walls, partitions), the delay of the signal display was as long as 2.4 to 6.5 seconds.

Conclusion.

Despite the importance of cardiovascular monitoring in rehabilitation equipments like ECG is largely affected by movements hence it is difficult to use the device in the actual setting of rehabilitation. Extraction of significant biomedical signals through simple equipment and effective feedback can help to increase compliance and allow patients to actively get involved in rehabilitation.

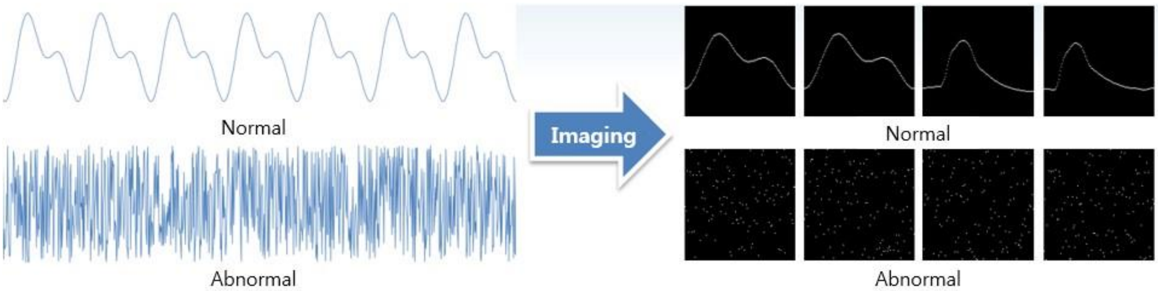

Figure 1. Significant signal segment detection based on deep learning.

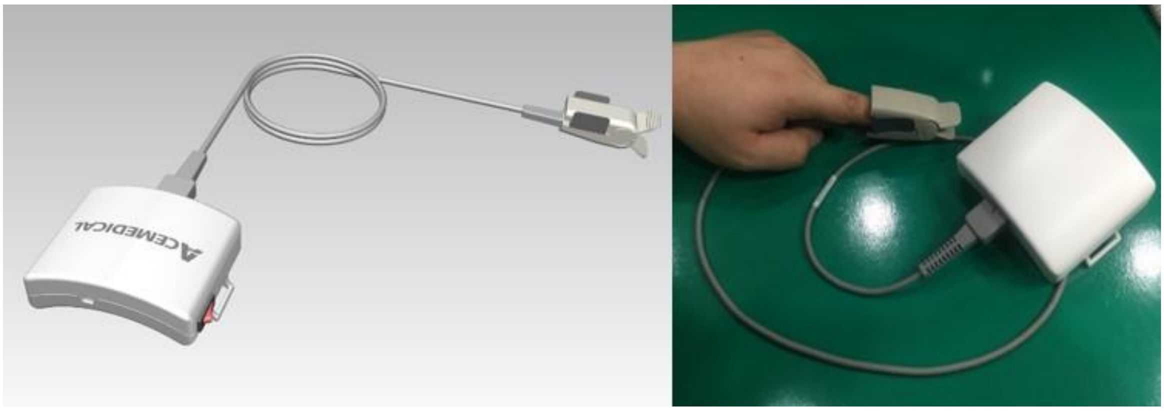

Figure 2. PPG sensor and mobile signal transmitter.