IoT based health monitoring system – Recent trends and directions

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Purpose Coronavirus in 2019 (COVID-19) has affected millions of people socially and economically and has changed people's lifestyles (Yoon & Shin, 2020). In Korea, these radical changes brought about an alternative lifestyle, known as the "untact" era (UE) (KIM, 2021). Even in the absence of direct enforcement by the government, Koreans avoid direct face-to-face contact (Yoon & Shin, 2020). The fourth industrial revolution has become an essential tool in the medical field for transitioning to a digitally fully automated environment and cyber-physical systems (Ćwiklicki et al., 2020). Internet of things (IoT), big data analytics, blockchain, cloud computing, and artificial intelligence have found successive applications in the medical and healthcare sector (Yu et al., 2022). For example, IoT enables the exchange of different health and medical information between various medical devices and medical institution systems (Yu et al., 2022). The recent improvements in computing infrastructure and the emergence of various AI frameworks in ICT have made AI-based digital healthcare analysis more intelligent and relatable for this smart healthcare era. According to the WHO, the world's population is rapidly aging, leading to increases in chronic diseases and healthcare costs. In anticipation, countries are shifting the focus of their healthcare systems from sickness and disease to prevention and wellness. In recent times, wearable sensors and IoT enabled remote patient health monitoring, especially for elderly citizens (Athavale & Krishnan, 2017; Malwade et al., 2018). Wearable sensors provide real-time monitoring of the elderly bio-signals, allowing them to be independent while encouraging the elderly to manage stable chronic conditions, dementia, and frailty by themselves (Al-Shaqi et al., 2016). IoT applications and wearable sensors are well suited to monitoring the elderly because they meet the needs of information exchange and communication with care staff on a regular and continuing basis, allowing the identification of elderly in need of healthcare assistance (Al-Shaqi et al., 2016; Athavale & Krishnan, 2017; Malwade et al., 2018). To help the elderly monitor their health, we designed and developed a remote health monitoring platform for daily activities such as walking, driving, and sleeping. For the proof of concept, we decided to use stroke as a case study since it is the number cause of death in the elderly. **Method** We collected measurements and various biosignals from 2015 to 2017 at the emergency medical center and the department of rehabilitation medicine at Chungnam National University Hospital. A total of 287 patients from the rehabilitation department were used. Each patient was put through various scenarios such as standing, walking, sitting, raising arms, and sleeping to simulate everyday activities. The collected biosignals data such as EMG, ECG (electrocardiogram), EEG (electroencephalogram), foot pressure, and voice recordings were to develop early stroke detection models with machine learning (ML) and deep learning (DL). **Results and Discussion** Overall, our system had an accuracy of 91.7% for the detection of stroke. Depending on the features extracted and the M/DL algorithms used, we managed to get an accuracy of 98.25% for body motion, 92.51% for EEG, 90.38% for EMG, and 94.85% for ECG. This study proposes a stroke detection health monitoring system using different biosignals. Details of sensors, data flow, system architecture, and ML model stroke prediction results are presented. By collecting various biosignals during daily activities such as driving, sleeping, and walking, we can detect early stroke and possibly other health diseases in the future.

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