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Editorial

Special issue on wearable medical devices for healthcare measurements

At present, the wearable devices are small sized and are worn to monitor and check the activity details and keep a check on their regular health levels. They can provide abundant data pertaining to the regular activities and fitness levels to physicians thereby enabling better treatment of ailment to patients. Meanwhile, wearable devices can take any form such as wearable medical gadgets, wearable clothes, wearable electronic devices like bands, watches and wearable goods like shoes. The role of wearable devices and wearable technology has spanned across several domains. It can be observed that wearable medical devices promote consistent and efficient means for exchanging data between software solutions and medical technology enabled systems thereby promoting interoperability across healthcare domain. These data collected about a person using wearable devices are instrumental in providing continuous patient care and monitoring services. Therefore, it is very important to study wearable medical devices for healthcare measurements.

The special issue provides a platform to present various advancements in wearable medical devices for healthcare measurements. Finally, the special issue has selected 20 papers for publication after a strict peer review. Details of these selected papers are as follows:

The paper titled *"Link quality and energy utilization based preferable next hop selection routing for wireless body area networks"* provided by Kashif Naseer Qureshi et al. presents an Energy Aware Routing (EAR) protocol to minimize energy utilization and select preferable next hop by evaluating the link quality of sensor nodes. Experimental results indicate that the proposed protocol has a better mechanism for date routing and better solution to minimize the energy of sensor nodes in Wireless Body Area Networks (WBANs).

The paper titled *"Combination of wearable sensors and internet of things and its application in sports rehabilitation"* provided by Yanping Jiang et al. develops a sports rehabilitation monitoring system based on wearable sensors and Internet of Things technology. The experimental results show that the system constructed in this paper can closely monitor the changes of vital signs of target users while providing real-time monitoring, and provide feedback.

The paper titled *"Wearable health monitoring system based on human motion state recognition"* provided by Xiaoxiang Zhou et al. proposes a wearable health monitoring system architecture based on human motion state recognition. The experimental results show that the proposed system achieves a high accuracy in state recognition, and the recognition accuracy of running and walking is better than other methods.

The paper titled *"A dynamic and interoperable communication framework for controlling the operations of wearable sensors in smart healthcare applications"* provided by S. Baskar et al. introduces a dynamic and interoperable communication framework (DICF) for regulating the operations of wearable healthcare devices. The framework can improve the interoperability of the devices acclimatized to adapt dynamic nature of different tracking healthcare applications to leverage its performance.

The paper titled *"Tooth implant prosthesis using ultralow power and low cost crystalline carbon bio-tooth sensor with hybridized data acquisition algorithm"* provided by Sajith Vellappally et al. proposes a tiny ultralow-power and low-cost tooth sensor with hybridized data processing algorithm for monitoring implant tooth implant prosthesis performance.

The paper titled *"Design and development of wireless wearable bio-tooth sensor for monitoring of tooth fracture and its bio metabolic components"* provided by Mohamed Hashem et al. designs and develops an improved wireless wearable Graphite bio-tooth sensor (GBTS) to diagnose Coughing, drinking, chewing, Fracture, Infection and bio fluid. The experimental analysis has been evaluated on lab scale and the results demonstrate promising diagnostic and screening tools to improve the quality of life of patients.

The paper titled *"MDS: Multi-level decision system for patient behavior analysis based on wearable device information"* provided by Amr Tolba et al. introduces a multi-level decision system (MDS) for monitoring and detecting patient behavior based on sensed information. Experimental analysis of MDS proves its reliability by improving accuracy, true positive rate, F-measure score, and by reducing fusion delay.

The paper titled *"An optimal sensor placement algorithm (O-SPA) for improving tracking precision of human activity in real-world healthcare systems"* provided by Abdulaziz Alarifi et al. designs an Optimal Sensor Placement Algorithm (O-SPA) for improving the precision of human activity. The efficiency results of O-SPA are the best compared to Hybrid sensing aided human activity recognition (HHAR), Multi-sensor fusion with ensemble pruning system (MSF-EP) and Activities of daily living Compressive sensing (ADL).

The paper titled *"Signal extraction and monitoring of motion loads based on wearable online device"* provided by Xidan Gong et al. proposes an improved R-peak detection algorithm based on adaptive threshold. Experiments show that the proposed algorithm has higher detection accuracy.

The paper titled "Energy efficient routing algorithm in wireless body area networks for smart wearable patches" provided by A. Sundar Raj et al. introduces the opportunistic energy-efficient routing with load balancing (OE2-LB) algorithm in wireless body area networks for smart wearable patches. The efficiency has been validated in terms of network lifetime, delay, error metrics, Energy efficiency and throughput of the network.

The paper titled *"Hybridized interference bounded intuitive splitting for smart wearable system using cognitive assisted Internet of Things"* provided

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by Torki Altameem et al. introduces cognitive internet of things (CIoT) along with hybridized Interference bounded intuitive splitting (HIBJS) algorithm to meet and address some demands in data transmission of wearable sensors. The experimental and numerical results show that the proposed HIBJS approach has more effective performance in terms of energy consumption, data transmission speed of wearable devices, error rate, accuracy and average signal to noise ratio (SNR) than traditional algorithms.

The paper titled *"Location of three-dimensional movement for a human using a wearable multi-node instrument implemented by wireless body area networks"* provided by Dong Wang et al. introduces key technologies and characteristics of wireless sensor networks and the status of node localization, analyzes wireless sensor network localization algorithms and their performance evaluation indicators, and conducts in-depth research on wearable 3D node localization algorithms.

The paper titled *"Design on a wearable armband device for assessing the motion function of upper limbs"* provided by Xiupeng Gao et al. designs a human motion signal acquisition system composed of terminal nodes and gateway nodes. The terminal node is worn on the arm part of the human body to collect movement data of the corresponding part, and receive commands from the gateway node wirelessly.

The paper titled *"Wearable exercise electrocardiograph signal quality assessment based on fuzzy comprehensive evaluation algorithm"* provided by Jiajie He et al. introduces a signal quality evaluation model based on fuzzy comprehensive evaluation algorithm to analyze and describe the detection principle of ECG signals in wearable monitoring system, and the characteristics of ECG waveform.

The paper titled *"Study on real-time wearable sport health device based on body sensor networks"* provided by Jiayi Zhao et al. designs a wearable sport health monitoring system with low cost, low power consumption, high modularity, high reliability, and high precision to realize early monitoring, early prevention and early intervention of some common chronic diseases.

The paper titled *"Experimental research on real-time acquisition and monitoring of wearable EEG based on TGAM module"* provided by Liyong Yin et al. designs a wearable EEG acquisition system based on TGAM module. The results show that the technical requirements of the wearable system can be met in terms of algorithm accuracy and result performance, which can provide theoretical support for sleep monitoring.

The paper titled *"Emotion recognition from spatiotemporal EEG representations with hybrid convolutional recurrent neural networks via wearable multi-channel headset"* provided by Jingxia Chen et al. proposes an integration of EEG-based emotion recognition algorithm for new data representation of electroencephalogram (EEG), which transforms 1D chain-like EEG vector sequences into 2D mesh-like matrix sequences. The experimental results demonstrate that the classification accuracies of the proposed algorithm on the spatial–temporal EEG representation achieve over 93%, which outperform the most recent baseline methods in within-subject validation scenario.

The paper titled *"A wearable device for collecting multi-signal parameters of newborn"* provided by Xiqiu Hu et al. designs a wearable multi-physiological parameter monitoring system, which can continuously monitor multiple physiological parameters of newborns for a long time without affecting the normal human activities.

The paper titled *"A wearable blood oxygen saturation monitoring system based on bluetooth low energy technology"* provided by Qingguo Chen et al. proposes a new adaptive cancellation algorithm based on adaptive filtering for monitoring blood oxygen saturation. The effectiveness of the algorithm in eliminating motion interference is verified, and the anti-interference ability and time complexity of the algorithm under severe motion are verified.

Finally, the paper titled *"Wearable bracelets with variable sampling frequency for measuring multiple physiological parameter of human"* provided by Jian Hu et al. proposes a method for measuring the human body's multiple physiological parameters with multiple sampling frequencies. It can monitor real-time human physiological parameters and conduct a comprehensive assessment of human health recording changes in human health information.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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