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# Internet of Things (IoT)-Based Wireless Health: Enabling Technologies and Applications

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Wireless health is transforming health care by integrating wireless technologies into conventional medicine, including the diagnosis, monitoring, and treatment of illness. The list of tools for wirelessly monitoring and diagnosing disease is expanding. The ability to remotely manage drugs and health devices is increasing. With the aid of smart and intelligent systems, the knowledge of how genetics affects susceptibilities to disease is growing. These trends suggest that the society is approaching a revolution in health care. The role that wireless health plays is being further enhanced by the Internet of things (IoT) [1]. The IoT revolution is reshaping modern healthcare with promising technological, economic, and social prospects. IoT-based healthcare services are expected to further reduce costs, increase the quality of life, and enrich the user's experience. Despite the enormous potentials and a decent amount of existing research, IoT-based healthcare comes with several difficulties in its path, including regulatory hurdles, privacy, and interoperability standards. The IoT still remains in its infancy in the healthcare field, and researchers across the world are therefore working hard to address the potential of the IoT in the healthcare field, with consideration of the various practical challenges.

This Special Issue features fourteen papers highlighting both theoretical and practical aspects of algorithms, system design, performance analysis, and experimental studies related to IoT-based wireless health. The contents of these papers are summarized here.

Two papers [2,3] discuss the issues related to the monitoring and tracking of Coronavirus disease 2019 (COVID-19) using wireless technologies. In [2], the authors proposed an end-to-end deep-learning-assisted communication framework for COVID-19 disease management. The work introduces a monitoring system that has potential to limit the spread of infection through the continuous monitoring of the suspected and infected patients. The framework attempts to integrate both fog and cloud computing paradigms optimizing power consumption, transmission issues, data analysis, etc. The underlying classification model detects and classifies COVID-19 patients using chest X-ray images. The article [3] proposes a public platform based on a Software-Defined Networking concept to monitor and track information for the COVID-19 relevant people. It supplies real-time information disclosure services to various service providers worldwide for disease control and prevention (CDC) and regular users of interest. It enables the CDCs to manage a list of people to be monitored related to COVID-19 and compulsorily install the required application on their smartphones creating COVID-19 virtual IoT nodes. The platform also provides required confidentiality and authentication services through the distribution of different secret keys among individuals while maintaining scalability and reduced latency.

Three articles work on the identification of biomedical literature [4–6]. The deep learning-based model proposed in [4] considers both high-quality studies and general studies data into the learning process, which is then able to classify biomedical literature in an automatic-manner. The multi-layer perceptron model was basically trained based on textual features such as title and abstract. In the study, the authors used data from Cochrane and PubMed. A closely related work of [4] is [5], which automatically identifies potentially useful research articles to assist physicians and health professionals in their clinical decision making. The work introduces an attention-based deep learning approach for finding and ranking relevant studies. The model was built based on the data obtained from a large number of clinical articles. The article [6] presents an interesting machine learning based work that helps to recognize topics of interest based on online health communities. The proposed model basically attempts to develop chronic disease prediction, detection, and treatment exploiting text mining on accumulated online experiences shared by patients and physicians.

Three papers present disease-specific systems suitable for IoT-based wireless health applications [7–9]. The research [7] introduces a framework to diagnose diabetes mellitus. In the work, the authors applied bagging and random subspace-based multiple classifiers. The ensample framework integrates various data mining techniques exploiting the relevance and relationship among datasets, feature sets, and classifiers. The article [8] proposes a glucose monitoring system architecture for the diabetic disease surveillance. Using the system, the physicians can remotely monitor the health of their patients. The architecture executes an intelligent algorithm in the form of applications in smartphones and portable devices equipped with suitable sensors. In [9], the authors design an air quality sensing system for open-skin wound monitoring. Appropriate sensors are used for the acquisition of real-time environment data. Then, environments are classified based on a support vector machine algorithm.

Two articles analyze the security issues encountered in electronic health services [10,11]. The paper [10] deals with the secure exchange of medical data using biometric-based access techniques. In the research, the authors basically introduce a new form watermarking that tries to eliminate the limitations of existing approaches. It validates the imperceptibility of the respective images and/or documents via the newly introduced watermarking. The proposed technique is useful for IoT-based wireless health because of its real-time operations on embedding, extraction, and recognition of biometrics. The article [11] introduces a blockchain-based architecture for patient-centric eHealth services in multiple cloud environments. Using the architecture, care providers can securely complete eHealth transactions. It helps them to access patient data following the compliance with data-protection laws.

Two papers introduce a couple of emerging concepts expected to be useful in advancing IoT-based wireless health [12,13]. The article [12] introduces an IoT-based smart environment that helps to implement decentralization in disease diagnosis. On the one hand, the work is able to perform fall detection in crowded indoor environments. On the other hand, using the given solutions, third party researchers can perform analysis based on gait datasets collected. In [13], the authors propose an IoT architecture for emergency patient monitoring in hospital settings. The architecture uses WiFi-enabled wearable sensors. The system runs on the oneM2M, a set of open communication protocols.

Finally, two comprehensive review articles highlight ongoing trends in IoT-based applications [14,15]. The paper [14] surveys the contemporary state of the art on IoT architectures for healthcare systems. The review pays focus to a set of aspects of IoT-based healthcare, such as the enabling technologies, applications and challenges. It also summarizes the relevant opportunities and open-source platforms. In [15], the authors present a systematic review of IoT technologies and their utilization in agriculture. The paper discusses the agricultural applications, sensors and devices, and communication protocols.

The articles presented in this special issue provide ample coverage of IoT-based wireless health. The collection therefore implies the broadness of the field of wireless health in general and IoT-based healthcare technologies in particular. To transform the IoT-based wireless health, emerging computing and communication paradigms need to be integrated. Many research challenges are yet to be addressed by the community. For example, substantial research needs to be carried out to investigate big data analytics platforms to analyze different sources of healthcare data including multimodal data such as videos, emoticons and images [16]. Deep-learning-assisted data fusion techniques can be investigated with the aim of smart disease prediction [17]. To do so, novel methods are required for feature reduction to obtain scalable solutions to handle a large volume of healthcare records. Interested researchers can also investigate how artificial intelligence (AI) algorithms can be utilized for IoT-based medical diagnosis [18]. The researchers can also examine how IoT-enabled precision medicine can offer various benefits, such as real-time monitoring of adverse drug reactions and secure healthcare supply chains [19].

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