¢   414

A review of internet of medical things (IoMT) ó based remote health monitoring through wearable sensors: a case study for diabetic patients

Omar AlShorman[1], Buthaynah AlShorman[2], Mahmood Al-khassaweneh[3], Fahad Alkahtani[4]
[1,4]Electrical Engineering Department, Faculty of Engineering, Najran University, Saudi Arabia
[1]AlShrouk Trading Company, Najran University, Saudi Arabia
[2]South Alternative Center for Physiotherapy and Rehabilitation, Saudi Arabia
[3]Computer and Mathematical Sciences Department, Lewis University, USA
[3]Computer Engineering Department, Yarmouk University, Jordan

Article Info	ABSTRACT
	The latest advances and trends in information technology and communication have a vital role in healthcare industries. Theses advancements led to the Internet of Medical Things (IoMT) which provides a continuous, remote and real-time monitoring of patients. The IoMT architectures still face many challenges related to the bandwidth, communication protocols, big data and data volume, flexibility, reliability, data management, data acquisition, data processing and analytics availability, cost effectiveness, data security and privacy, and energy efficiency. The goal of this paper is to find feasible solutions to enhance the healthcare living facilities using remote health monitoring (RHM) and IoMT. In addition, the enhancement of the prevention, prognosis, diagnosis and treatment abilities using IoMT and RHM is also discussed. A case study of monitoring the vital signs of diabetic patients using real-time data processing and IoMT is also presented.

Corresponding Author:

Omar AlShorman,
Electrical Engineering Department, Faculty of Engineering,
AlShrouk Trading Company,
Najran University, Najran, Saudi Arabia.
Email: omar2007_ahu@yahoo.com

1. INTRODUCTION

Nowadays, healthcare and modern technology industries [1, 2] have gained crucial intentions in gxgt{fc{øu"nkhg"kpenwfkpi"jgcnvjectg"u{uvgou"[3]. The main goal in integrating technology with the healthcare systems is to provide a better interfacing capability between patients and caregivers to improve the efficiency and accessibility of medical devices and services [4-8].

Recently, Internet of Medical Things (IoMT) [9-11] played a vital role in remote healthcare monitoring (RHM) [12, 13]. The IoMT is mainly used to collect the remote data for patient through wearable sensors/devices [14] and store them in the cloud databases. These data are made avaialble for real-time analysis and application by caregivers [15]. The IoMT has three main stages: device layer (body sensor network (BSN)) Fog layer and cloud service [16-23] as shown in Figure 1.
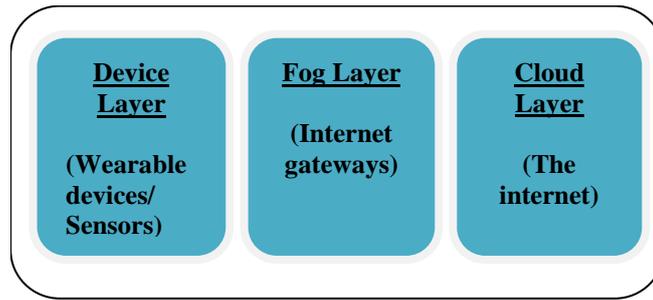
Figure 1. The architecture of IoMT

The main purpose of the device layer (sensing layer) is to establish an effective and accurate sensing technology to collect various types of health-based data. Table 1 shows wearable sensing technologies [24-29]. Communication technologies support network solutions and infrastructures of IoMT system [30, 31]. However, communication techniques include Bluetooth, RFID (NFC), WI-FI, IrDA, UWB, and ZIGBEE [32]. In the cloud layer (data layer) [33], the data is processed and stored [34]. Moreover, enqwf"igv"rcvkgpvøu"fcvc"vq"rgthqto"cpcn{uku."rtqeguukpi"cpf"uvqtkpi"[35]. Thus, data become available for caregivers [36].

Table 1. Wearable sensing technologies

Sensor type	Example
Inertial sensor	Magnetic field sensors, Accelerometer, and Gyroscopes
Location sensor	GIS and GPS
Physiological sensor	Electrocardiogram (ECG),
	Electrooculography (EOG), Galvanic skin, and Spirometer
Brain activity sensor	Electroencephalogram (EEG)
Image sensor	Camera

RHM [37-42] is a continuous monitoring process of the health data. This includes: physiological monitoring such as heart rate, temperature and blood pressure, physical activity monitoring, diet monitoring, medication tracking and behavior monitoring). The health-related data are wirelessly communicated to both the patient and caregivers through the cloud [43, 44]. Thus, IoMT supports real-time, fast, remote and reliable diagnosis of several types of disease and enhances the decision-making process. Through this process, large amount of data are received, analyzed and monitored [45].

With nowadays busy life, majority of people fqpøv"jcxg"vjkgr routine medical checkup. In addition, the cost of the healthcare is rising and governments spend a large amount of money yealry for healthcare services. It is also nkted that people in Europe and United States prefer home healthcare over going to hospitals. Therefore, there is a critical need for remote real-time healthcare monitoring to address all these challenges. Continuous monitoring for patients and elderly people through wearable devices and sensors have gained a a great attention [46-48]. The goal is to provide vital signs monitoring such as blood pressure, temperature and heart rate which has significant importaneg"qh"vqfc{øu"jgcnvjectg"yqtnf0 According to the World health organization (WHO), the number of type 2 diabetes (T2D) patients is 422 million in 2014. That means 8.5 % of adults suffer from diabetes. However, WHO expects that the number will reach to 500 million in 2030 [49]. Therefore, using RHM may reduce the risk for those who are more vulnerable by capturing the medical data and send them to the caregivers [50], as shown in Figure 2. RHM uses inlcude the following [51-53]:
1) Diagnosing diseases
2) Diseases management
3) Diseases prediction
4) Diseases prognosis
5) Diseases prevention
6) Giving the suitable medications and treatments
7) Rehabilitation