International Journal of Research in Engineering
www.engineeringpaper.net
Online ISSN: 2664-8784; Print ISSN: 2664-8776
Received: 04-02-2019; Accepted: 07-03-2019; Published: 14-03-2019
Volume 1; Issue 2; 2019; Page No. 15-17

Internet of things in medicine

Matthew NO Sadiku[1], Sarhan M Musa[2], Shuza Binzaid[3]

[1-3] Roy G. Perry College of Engineering, Prairie View A&M University, Texas

DOI: https://doi.org/10.33545/26648776.2019.v1.i2a.10

Abstract
The Internet of things (IoT) has greatly impacted many industries including the medical. The application of IoT is increasing daily in every aspect of the medical industry. In fact, IoT has been identified as a technological solution to some medical challenges and a game changer for the healthcare services. This paper provides a brief introduction to the use of IoT in medicine.

Keywords: Internet, Internet of things, Internet of medical things, medicine

Introduction

The Internet has evolved to be an ever more pervasive and critical infrastructure connecting society and enabling global commerce. It has become one of the most integral part of modern society. The next phase of the Internet is the Internet of things (IoT), which connects smart things or devices equipped with sensors. These devices communicate with each other without any human interaction. The central concept of the Internet of Things is to connect anything, anytime, and anywhere through Internet. The emergence of Internet of things has attracted the attention of governments, research scholars, and business community all over the world.

Medicines are the common solution for the preventing and curing diseases. The majority of our efforts are focused on treating rather than preventing disease.

The healthcare industry happens to one of the fastest industry to adopt IoT. This is due to the fact that integrating IoT technologies into medical devices substantially improves the quality and effectiveness of service. The IoT enables practices in the area of healthcare for children, elderly, chronic care, real time monitoring of patients, operation theaters, and medicine dispenser. The application of IoT in the field of medicine can provide immediate treatment to the patient as well as monitor and keep track of health record for healthy person. A typical application of IoT in medicine is shown in Figure 1 [1].

Overview of internet of things

The term "Internet of things" was introduced by Kevin Ashton from the United Kingdom in 1999. Internet of Things (IoT) is a network of connecting devices embedded with sensors. It is a collection of identifiable things with the ability to communicate over wired or wireless communication. The devices or things can be connected to the Internet through three main technology components: physical devices and sensors (connected things), connection and infrastructure, and analytics and applications.

There are four main technologies that enable IoT [2]:

1. Radio-frequency identification (RFID) and near-field communication (NFC). RFID technology can also help in the tracking and monitoring drugs and equipment. The most valuable use of NFC is contactless installment.
2. Optical tags and quick response codes: This is used for low cost tagging.
3. Communication systems (such as WiFi and ZigBee), which may include wide area networks (WANs) and personal area networks (PANs). For healthcare applications, the global positioning system (GPS) can help in precisely locating ambulances, patients, doctors, and nurses.
4. Wireless sensor network (WSN): This is used to monitor physical properties in specific environments. Sensors can monitor temperatures, pressures, chemical, and biological levels of patients. In the medical industry, sensors have numerous applications such as heart rate monitors and blood pressure monitors.

These technologies are illustrated in Figure 2 [3]. They enable devices to be smart. Other related technologies are cloud computing, machine learning, and big data.

IoT helps people and communities by making their systems smarter and their lives easier, more secure, and safer. IoT transforms ordinary products such as cars, buildings, and machines into smart, connected objects that can communicate with people and each other. These applications have given birth to smart everything, smart cars, smart homes, smart refrigerators, smart cities, smart parking, smart health, smart environment, smart transportation, smart shopping, smart agriculture, smart lighting, smart grid, and smart energy.

Internet of medical things

The Internet of things in healthcare is variably referred to as IoT-MD, IoMT, Medical IoT, mIoT, and IoHT. Internet of medical things (IoMT), a healthcare application of the IoT technology, has emerged as a combination of advanced medical sensing system, computer communication technologies. The sensing systems include RFID, GPS, and wireless sensor networks. IoMT enables machine to machine interaction and real time intervention solutions which are helping the healthcare industry increase its delivery, affordability, reliability, and productivity. When connected to the Internet, ordinary medical devices become smart and can collect more data, give insight into trends, enable remote

care, and give patients more control. For example, IoT devices can be used for reminding patients about appointments, changes in blood pressure, calories burnt, and much more [4]. An illustration of IoMT is shown in Figure 3 [5].

IoMT devices can sense real-time data for patient monitoring. Such devices are used to monitor parameters such as blood pressure, random blood sugar levels, and weight. IoMT will promote personalized care and high standard of living. Technologies used in IoMT can be divided into the three technical classes: local patient systems and controls; device connectivity and data management; and analytics solutions [6]. IoMT technology includes remote patient monitoring and medical system management. Smartphones are increasingly used as integral parts of IoMT. Various medical Internet of things platforms have been built for patient information management, telemedicine monitoring, and mobile medical [7].

Applications

IoT has opened up a world of possibilities in medicine. From adherence to diagnosis, the applications are manifold. These various applications provide solutions for the patient and health care professionals. Some of the common applications are discussed below [6, 8]:

1. *Digital Hospital*: Internet of Things has broad application prospects in the field of medical information management. Currently, the demand for medical information management in hospitals is in form of identification, sample recognition, and medical record identification. Healthcare in hospitals is one way the medical is segment involved in IoT. With IoMT, hospital medical work is becoming increasingly intelligent, meticulous, and efficient.
2. *Cancer treatment*: Smart technology helps simplify care for both cancer patients and their care providers. By using smart monitoring system, patients experience less severe symptoms related to both the cancer and its treatment [6].
3. *Glucose monitoring*: Diabetes has been a fertile ground for developing smart devices. Such devices can help diabetics to continuously monitor their blood glucose levels for several days. Another smart device for diabetes patients is the smart insulin pen, which can automatically record the time, amount, and type of insulin [6].
4. *Drug Anti-Counterfeiting*: The amount of counterfeit medicines in the world has increased greatly and many people die each year because of wrong medication. The label attached to a product will have a unique identity that is very difficult to forge and this will serve as an effective counter-measure against medical fraud [9].
5. *Elderly Independent Living*: RFID sensor systems are being developed to support older people so that they can safely stay independent. This application is important in view of an aging population. IoT applications can provide support for the elderly by detecting the activities of daily living using wearable devices.
6. *Remote Monitoring*: Many patients continuously wear medical sensor-based devices to monitor their health statistics. Fitness, health electronics, and even smart watches have a role to play in monitoring, providing feedback, and in some cases a link to medical professionals. Remote monitoring translates into a greater number of patients worldwide having access to adequate healthcare. Continuous patient monitoring provides the real-time tracking, collects patient data, and wirelessly transmits for ongoing display. This increases operational efficiency.
7. *Wearables Devices*: Innovative devices, such as wearable devices, implantable chips, and embedded systems in biomedical devices continuously track continuous data on patient activity. Smart wearable devices can be used for patients who need to collect data about their health status through sensors on the wearable technologies. They support fitness, health education, symptom tracking, and disease management. They can be used to store health records especially for patients with diabetes, cancer, coronary heart disease, stroke, seizure disorders, and Alzheimer's disease [10].

Benefits and challenges

IoMT is the technology that embeds wireless sensors in medical equipment, combines with the Internet and integrates with hospitals and patients. It enables a radical improvement of health care and quality of life. It creates new job and employment opportunities and bridges traditional engineering, computer sciences, and health care. IoT enables real-time monitoring. It is transforming healthcare industry by increasing efficiency, lowering costs, and improving patient quality of care and safety. The doctors can break the limit of the geographical scope and provide medical education for medical personnel in remote areas. Medical devices present unique IoT challenges. These include the broad range of medical technologies, the diversity of network protocols, critical security and vulnerability .considerations, regulatory compliance imperatives resulting from the handling of patient data and stakeholders with varied interests. Security is crucial in healthcare applications, especially in the case of patient privacy. Wearable sensors, for example, are prone to expose patient information and patient privacy. Medical security and privacy issues directly influence patient life and the healthcare system all over the world. Privacy issues may include misuse of medical information, leakage of prescriptions, and eavesdropping on medical data. An enemy may obtain your health status while you are busy exercising in a fitness center since medical sensors may be placed on your body [11, 12]. Integrating complex medical devices is problematic due to lack of standards. In addition, the big data accumulated by IoT devices is a challenge for the IoT data processing.

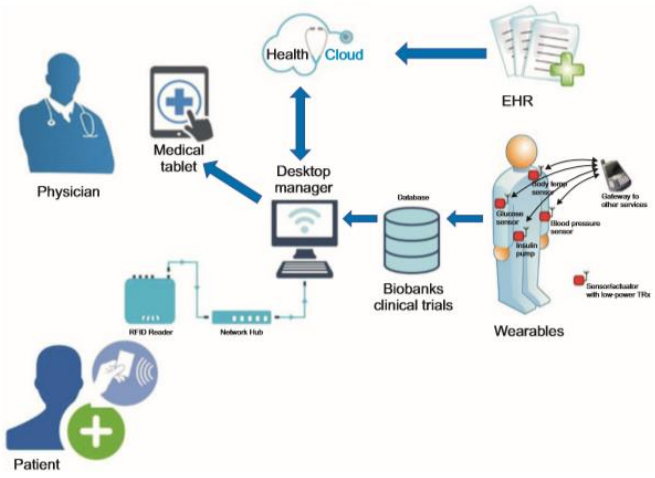

Fig 1: A typical IoT approach in medicine [1].

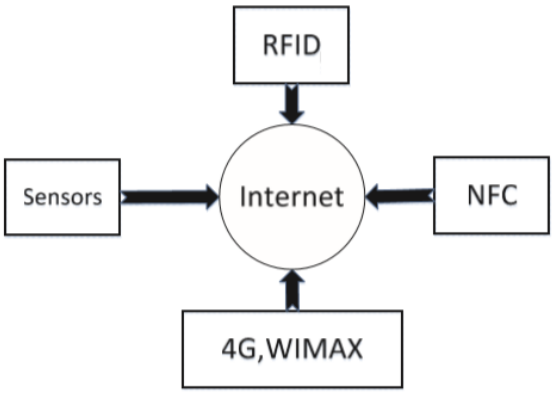

Fig 2: Typical block diagram for IoT [3].

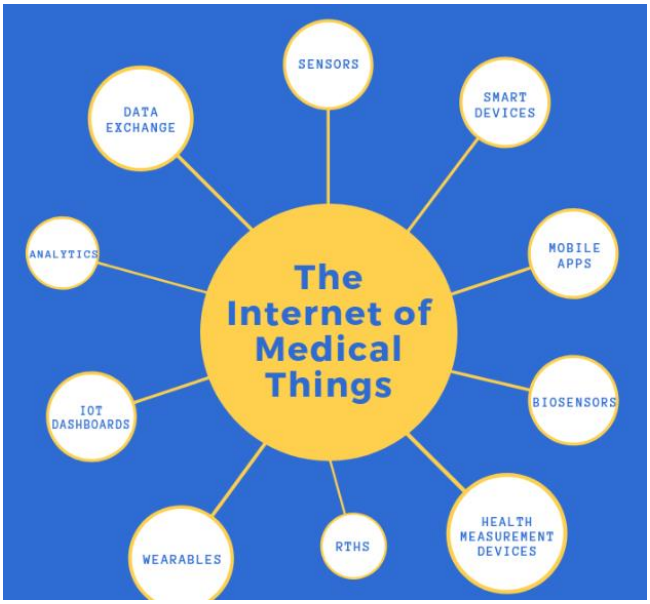

Fig 3: The Internet of medical things [5].

Conclusion

The era of the Internet of things has already started and it will drastically transform our way of life. Healthcare is one of the major sectors where IoT can have the most relevant economic and social impact. IoT technologies have created a world of opportunities in medicine and organizations serving these markets are increasingly looking to take advantage of them. They will revolutionize 21st century medicine. However, the rapid growth of IoT has presented some significant challenges. IoT's development has been restricted by the challenges. Security happens to be the most prominent challenge for physicians interested in IoT applications in medicine

References

1. Dimitrov DV. Medical Internet of things and big data in healthcare, Healthcare Informatics Research. 2016; 2(3):156-16.
2. Sadiku MNO, Musa SM, Nelatury SR. Internet of things: An introduction," International Journal of Engineering Research and Advanced Technology. 2016; 2(3):39-43.
3. AboBakr A, Azer MA. IoT ethics challenges and legal issues," Proceedings of 12th International Conference on Computer Engineering and Systems. 2017, 233-237.
4. Joyia GJ, *et al*. Internet of medical things (IOMT): Applications, benefits and future challenges in healthcare domain, Journal of Communications. 2017; 12(4):240-247.
5. Maltseva D. .IoT applications in healthcare. The Internet of medical things," October 2018, https://blak-it.com/blog/iot-applications-in-healthcare-internet-of-medical-things/.
6. Examples of the Internet of things in healthcare," February 2019, https://econsultancy.com/internet-of-things-healthcare/.
7. Yaoa C, *et al*. A deep learning model for predicting chemical composition of gallstones with big data in medical Internet of things," Future Generation Computer Systems, vol. 94, 2019, pp. 140-147.
8. Sadiku MNO, Alam S, Musa SM. IoT for healthcare," International Journal of Electronics and Communication Engineering. 2018; 5(11):5-7.
9. Zhang L. Applications of the Internet of things in the medical industry (Part 1): Digital hospitals," https://dzone. com/articles/applications-of-the-internet-of-things-in-the-medi-1.
10. Bandyopadhyay D, Sen J. Internet of things: Applications and challenges in technology and standardization," Wireless Personal Communications. 2011; 58(1):49–69.
11. Kumar P, Lee HJ. Security issues in healthcare applications using wireless medical sensor networks: A survey, Sensors. 2012; 12:55-91.
12. US Government, A Study of the Internet of Things (IOT) and Radio Frequency Identification (RFID) Technology: Big Data in Navy Medicine - Healthcare Industry Transformation to Manage Costs and Increase Efficiency, 2017.