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IoT in Healthcare Domain

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Abstract: ***The Internet of Things (IoT) is a system of wireless, interrelated, and connected digital devices that can collect, send, and store data over a network without requiring human-to-human or human-to-computer interaction. Recent advancement in IoT systems has positively impacted the daily activities of humans, from accessing information to the delivery of service in real-time. This has improved healthcare management and services, especially in medical hospitals, for effective and timely access to diagnostic information and treatment of patients. The IoT promises many benefits to streamlining and enhancing health care delivery to proactively predict health issues and diagnose, treat, and monitor patients both in and out of the hospital. Worldwide, government leaders and decision makers are implementing policies to deliver health care services using technology and more so in response to the novel COVID-19 pandemic. It is now becoming increasingly important to understand how established and emerging IoT technologies can support health systems to deliver safe and effective care. The aim of this viewpoint paper is to provide an overview of the current IoT technology in health care, outline how IoT devices are improving health service delivery, and outline how IoT technology can affect and disrupt global health care in the next decade. IoT-based health care has great potential to improve the efficiency of the health system and improve population health.***
Keywords: Internet of Things, digital health, smartphone, delivery of health care,

I. INTRODUCTION

The challenges presented by an aging population with multiple chronic conditions are ubiquitous worldwide [1]. Considering a recent aging and health study conducted by the World Health Organization (WHO), the number of people aged 60 years and above (900 million in the year 2015) is estimated to increase to over 2 billion before the year 2050, increasing approximately from 12 to 22% on aggregate based on global population [2]. Therefore, the rapid increase in demographic shift becomes a burden and challenge to healthcare practitioners. This is due to limited healthcare resources available in hospital to meet the influx of patients.

Entering the 2020 decade, more devices are connected to the internet than ever before, and this will continue to grow at a rapid trajectory. Worldwide, more than 21 billion devices have been estimated to be connected to the internet in 2020, which is 5 times the number of devices 4 years prior [3]. The Internet of Things (IoT) can be defined in its simplest scenario as a network that connects uniquely identifiable devices (or *things*) to the internet, enabling them to collect, send, store, and receive data [4]. From a health care perspective, IoT can be considered as any device that can collect health-related data from individuals, including computing devices, mobile phones, smart bands and wearables, digital medications, implantable surgical devices, or other portable devices, which can measure health data and connect to the internet [5]. Moreover, IoT-based healthcare systems has improved health service delivery exclusively from a conventional healthcare point of view, providing a modern real-time healthcare system. Consequently, traditional medicine has been modernized with the support of biotechnology that act as key enablers in the emergence of smart healthcare enabled hospital management systems. Hence, the smart healthcare-based hospital management system emerges as the better option for the delivery of healthcare services due to its integration with IoT technologies [6]. The technology that supports the realization of a smart healthcare enabled hospital management system is sometimes described as the Internet of Medical Things (IoMT) [5]. It consists of utilizing internet-enabled smart devices and wearable medical sensors to monitor patient health, check adherence to prescriptions, predict an impending heart attack and retrieve timely diagnostic information [7].

II. OVERVIEW OF IOT AND HEALTHCARE SYSTEM

The IoT paradigm enables smart devices (mobile phones, sensor device and Raspberry Pi) to sense, monitor and react to the environment. It aims to achieve a wider connection range by connecting numerous devices to the internet at a particular time [8]. Therefore, both human-to-machine and machine-to-machine interactions are feasible. This means that humans can interact with a machine for the purpose of performing healthcare related tasks such as surgery on patients, monitoring of prospective patients in their place of residence, and monitoring of hospital legacy facilities and environments in real-time [9]. In addition, machines interact with their counterparts for information storing and retrieval, such as sensors transmitting its information to a cloudlet system for temporary storage [10]. A typical example of an IoT-enabled healthcare platform is depicted Fig. 1.

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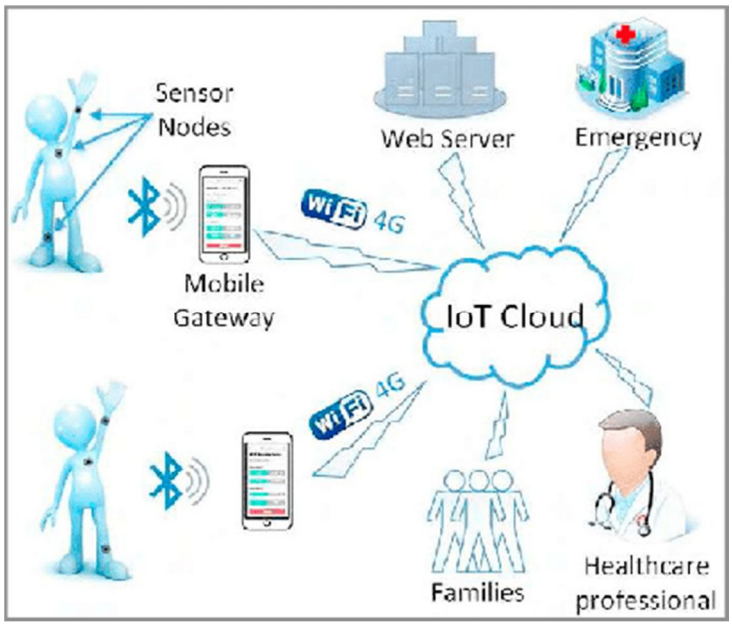


Fig1:- IoT and its associated healthcare platform

Fig. 1 describes how IoT can be implemented on the healthcare platform by using Wireless Sensor Network. The diagram illustrates how IoT Cloud is functioning as a platform in integrating all parties, which are the patient itself equipped with all sensor nodes, healthcare professional, the patient families, and the emergency department. The dependence of healthcare on IoT is generally to improve access to care, increase the quality of the care and reduce the cost of care [12]. Despite the rise of many healthcare applications based on IoT, the excitement around these applications far outdoes the reality. Furthermore, there is a risk that excessive leveraging on IoT technologies will disassociate caregivers from patients, potentially causing in a loss of caring [13]. In more specific, resource constraints that have to reduce IoT capabilities are often comprised of limited computation performances, energy supply and memory capacity. These limitations made applicability onto the conventional security solutions are less feasible.
Following subsections will discuss IoT components and their potential risk Fig. 1 describes how IoT can be implemented on the healthcare platform by using Wireless Sensor Network. The diagram illustrates how IoT Cloud is functioning as a platform in integrating all parties, which are the patient itself equipped with all sensor nodes, healthcare professional, the patient families, and the emergency department. The dependence of healthcare on IoT is generally to improve access to care, increase the quality of the care and reduce the cost of care [11]. Despite the rise of many healthcare applications based on IoT, the excitement around these applications far outdoes the reality. Furthermore, there is a risk that excessive leveraging on IoT technologies will disassociate caregivers from patients, potentially causing in a loss of caring [12]. In more specific, resource constraints that have to reduce IoT capabilities are often comprised of limited computation performances, energy supply and memory capacity. These limitations made applicability onto the conventional security solutions are less feasible.

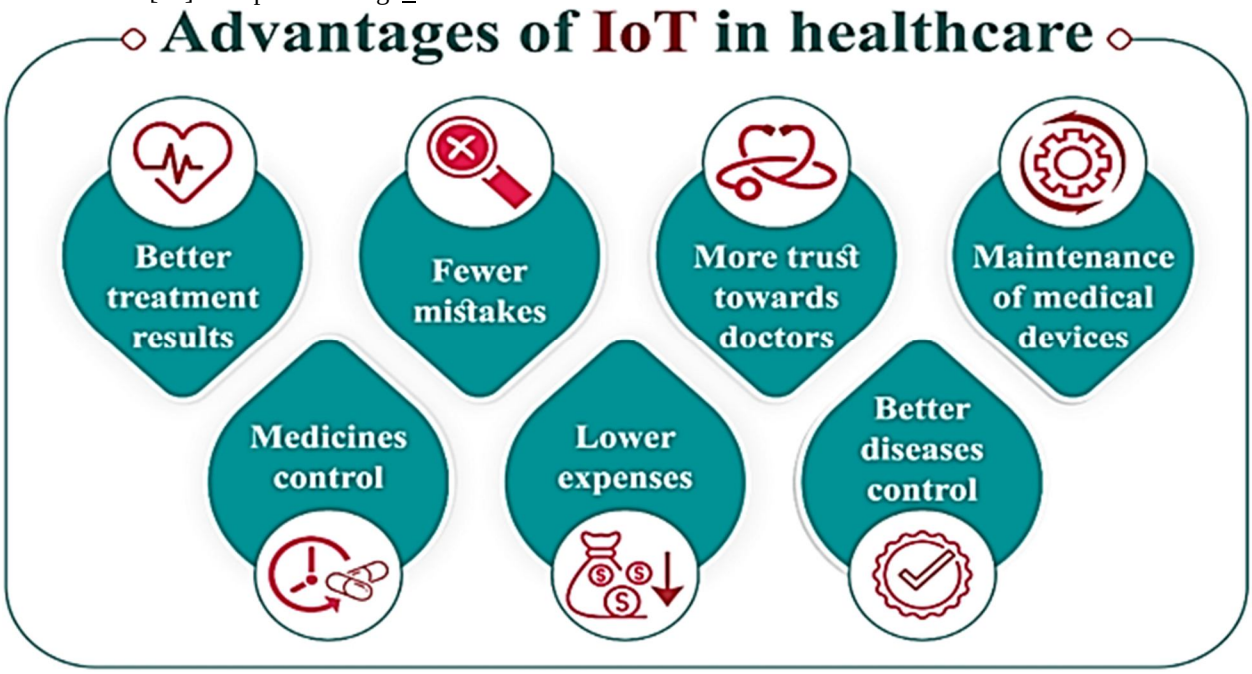
III. SMART HEALTHCARE

Smart healthcare originates from the concept of “Smart Planet” introduced in 2009 by IBM [13]. The Smart Planet is described as an intelligent infrastructure that utilizes sensors to retrieve information. The retrieved information is transmitted via IoT related devices to the Cloud Data-Centre where it a processed into useful information and accessed by healthcare providers and authorized patients. In addition, the emergence of smart healthcare was motivated by the concept that patients expect healthcare providers to render quality and timely services to them anytime–anywhere. Many authors classified smart healthcare as patient-centric facilities connected to an ecosystem where healthcare programs are delivered at different locations, including patient’s homes and hospital wards. Smart healthcare is capable of facilitating affective communication between patients and management of a healthcare facility [14]. It assists healthcare stakeholders in making intelligent choices, enables logical sharing of healthcare facilities, and ensures quality healthcare services. Furthermore, smart healthcare refers to an advanced form of data interpretation for medical purposes [15].

Conversely, an IoT-enabled healthcare management service is a form of heterogeneous computing. This is because of the type of wireless communication system of applications and devices that serve as connection buses between patients and healthcare officials. The services include diagnosing, monitoring, tracking, and storing vital statistical and medical information [16]. Some of the smart healthcare application opportunities includes handsets that measure brainwaves, clothes embedded with sensing devices, blood pressure (BP) monitors, glucose monitoring [13], Electrocardiogram (ECG) monitoring, and pulse oximeters. Other application areas are sensors embedded in medical equipment, dispensing systems, surgical robots, device implants, and any wearable devices. A good example of smart healthcare is the provisioning of a smart bed provided by Ably Medical Centre in Norway. The smart bed is embedded with sensors to measure vital signs, weight, heart beat rate and blood pressure. It has the ability to inform medical health care providers of the current status of a patient's condition. In addition, it prevents patients from falling or turns them to alleviate pressure points on their bodies without human assistance.

A. Advantages of IoT-enabled Healthcare System

The advantages of IoT-enabled smart healthcare systems includes "better treatment, optimal disease control, maintenance and safety of medical facilities" [17] as depicted in Fig. 2.



B. Advantages of IOT In Healthcare

Better treatment is achieved with the support of error free diagnostic information captured and processed by IoT devices. When patients experience better or quality treatment, it enhances their confidence and trust in the healthcare personnel and facilities of that hospital. In addition, the general public can have access to medical advice at an affordable rate, anytime–anywhere in real-time via the internet. Smart healthcare also enables the maintenance and safety of healthcare facilities by constant monitoring with the assistance of embedded camera sensor devices. Furthermore, it assists the elderly in managing critical health challenges without frequent visits to the hospital for checkups by doctor/nurses.

IV. SCOPE OF UTILIZATION OF IOT IN HOSPITAL MANAGEMENT SYSTEM

The Internet of Things technology have gained a developmental stride in the digital world, deployed in various units and departments in the healthcare domain, resulting in better treatment and efficient healthcare service delivery in real time. The health sector is known for its constant exploration of ways to enhance its services, mitigate costs, and improve the integrity of health services rendered. Therefore, there is the possibility of an exponential increase in the rate at which the healthcare system relies on this technology [18]. This is due to the fact that it becomes easy to obtain tips for healthy living with the support of an IoT-enabled healthcare system. This minimizes cost, improves patients experience and satisfaction. Furthermore, IoT-based systems can be applied for remote monitoring of physiological status in patients that require continuous monitoring [19].

Advancements in the smart healthcare system can be achieved through collaboration among different IoT architectures [20]. To examine the health condition of a patient, IoT-driven applications can be useful to generate a comprehensive entity with the convergence of different devices. Hence, the current technology in the hospital management system and overall medical activities are improved with the IoT system. The capability to easily reach out to healthcare professionals and medical consultants is rapidly advancing. Data gathered from large areas of real-world scenarios increase both the size and accuracy of medical data [21]. Moreover, the precision of healthcare delivery is equally enhanced by incorporating a higher number of modern technologies in the hospital management system.

V. APPLICATION OF INTERNET OF THINGS IN HEALTHCARE DOMAIN

1) Improved treatment, assessment, and diagnosis of psoriasis.Reduction in expenses that accompany the transfer of patients from one clinic to another owing to improper diagnosis and/or treatment of psoriasis.
2) A technology to effectively differentiate six forms of erythemato-squamous diseases using his to pathological and clinical parameters of patients. Improved quality of healthcare by accurately proffering diagnostic results to guide dermatologists in taking
3) Seamless environment for interoperability of heterogeneous vocabularies and data formats
4) Sensorial observations are shared, data is contextualized, knowledge is reused, and information is processed to address integration and heterogeneity challenges of smart hospital system
5) Monitoring activities, health, and behavior of incapacitated or elderly individuals in their homes using a convenient and safe approach

VI. CHALLENGES IN IOT-ENABLED HEALTHCARE APPLICATION

A. *Infrastructural Challenges*

Security challenges



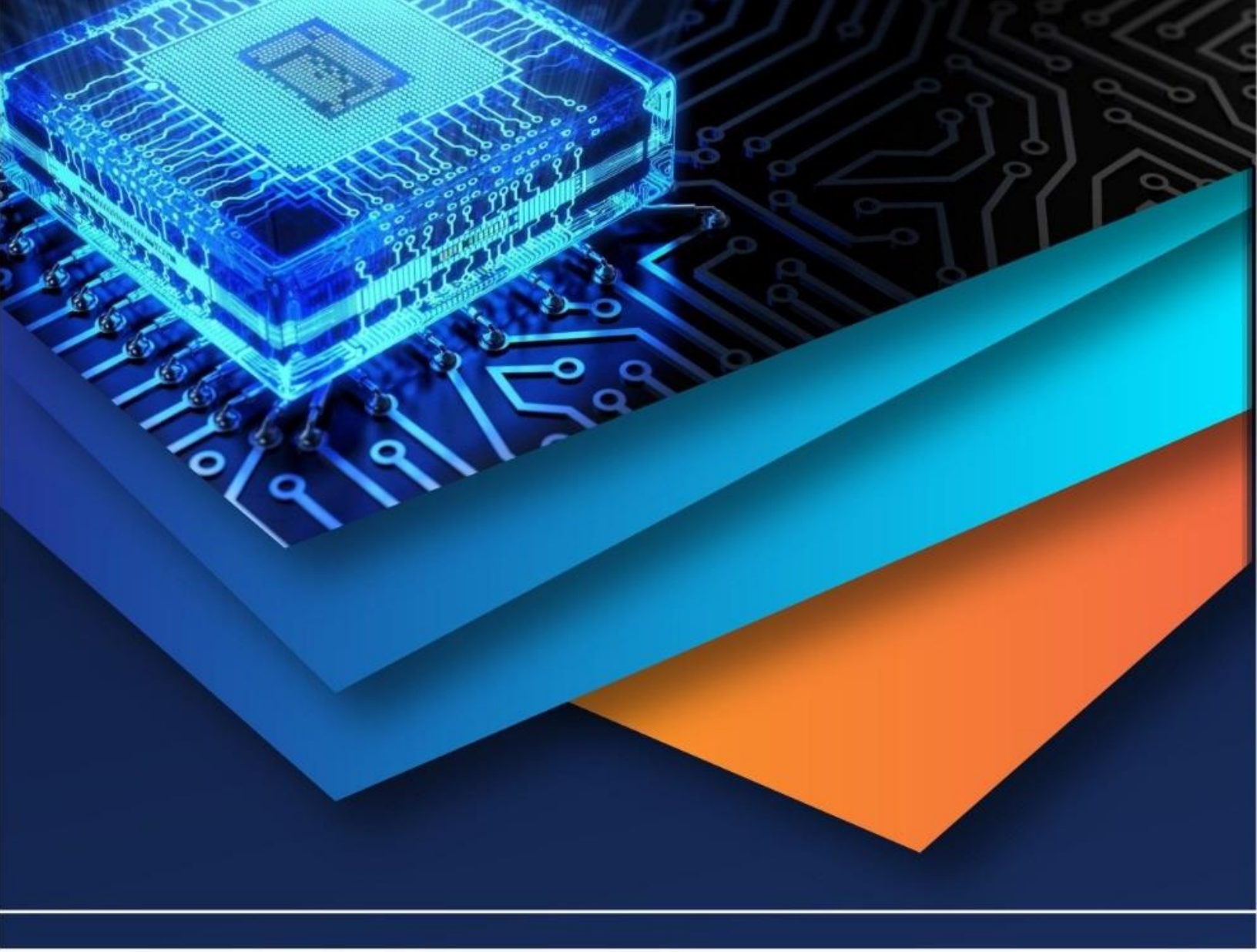
Security Problems in IoT

VII. CONCLUSION

Health maintenance is one of the global challenges for humanity. In the last decade, the healthcare industry has attracted scholarly attention. This study investigates the current trends in the application of IoT technology in the healthcare sector and its potential benefits. Additionally, it investigates future trends which discuss emerging technologies that could improve the effectiveness and efficiency of IoT-enabled healthcare application for better treatment. Numerous challenges that tend to impede the development of reliable, effective, efficient, and scalable IoT-enabled healthcare applications as well as its adoption are highlighted and discussed extensively. Thus, opportunities that provide new insight and solutions for the improvement of quality health treatment that will enhance human life span. In the future, a re-enforcement algorithm will be developed and integrated in IoT-enabled healthcare infrastructure to resolve the challenges of redundant sensory data retrieved from wearable sensor devices.

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