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A Review of Internet of Things (IoT) in Health Care Systems

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ABSTRACT- IOT is one of the essential part of the evolution of the world. "It talks about how our world can transform and become a smart world. It can be defined as an intelligent system of wireless, interconnected, and connecting digital devices that can send, collect, store and analyze data without any human intervention. IoT is emerging as an important aspect in understanding how IoT can help health systems in providing safe and efficient care to people. This paper will deal with the potential difficulties that IoT-based healthcare can face, the barriers to accepting IoT-based healthcare, and cybersecurity-focused guidelines within healthcare organizations. IoT-based health care has great potential to improve the efficiency of health systems.

KEYWORDS- Internet of Things, Digital Health, Smartphone, Delivery of Health Care.

I. INTRODUCTION

There are many challenges that our generations and future generation is and will be facing. To solve these challenges, we have to take the help of the technology like Internet of Things. IoT is a blend of hardware and software tools that produce trillions of data by involving numerous devices and sensors with the cloud and building logic of data with intelligent tools [2]. IoT in health care means taking the help of health innovations in collecting, diagnosing, monitoring, and tracking the crucial data of the patient like vital stats. "

II. OBJECTIVE

The objective of this paper is to understand how IoT can help the Health care sector and what barriers it faces will trying to implement it."What all security guidelines are there for using IoT devices in health care and what changes it brings in this sector.

Fig. 1 IoT [6]

III. BACKGROUND OF IOT DEVICES IN HEALTH CARE

From the perspective of the healthcare sector, IoT means the use of smart gadgets like smart bands, implantable surgical devices, and body monitoring devices that help to measure the state of the human body.

IoT has been integrated into healthcare systems mainly in the areas of remote patient monitoring, information collection and transfer in actual time, and end-to-end connectivity. These events allow the automation of patient flows on an organizational level, data and machine communication, interoperability, and essential information analysis [16,17]. In the case of medical diagnostics, IoT has been instrumental in transforming routine medical diagnosis into more patient- and home-centered approaches, compared to the hospital-centered approach [18]. IoT has therefore helped to redefine customary monitoring, diagnostics, treatments and decreasing expenses and detrimental errors [16,18]. However, cost-reduction is one of the significant benefits of IoT-healthcare innovation since the integration of devices and technology reduces operational costs and enhances service quality [19–21]. For instance, medical costs were significantly reduced while tenable solutions to minimize communication costs were provided by adopting cloud computing and the application of resource management [20,21].

The enactment of IoT in healthcare started with its adoption in remote patient monitoring to the retraction of data from bedside devices which can help physicians and nurses make better medical decisions and reduce human interactions thereby eliminating error rates [3]. These devices make the healthcare system better and low-costing. IoT has just started making its path in the healthcare sector. IoT's future is very bright in the upcoming decade."

Fig. 2 IoT Devices in Health Care [7]

IV. CHANGES IN HEALTH CARE DUE TO IOT

Many changes occurred in the health care system like during the pandemic,"when the whole world was in a state of emergency and no one could leave their houses, IoT devices were the one thing that connected patients with doctors and solved cases from where they were.

In 2020, the market of IoT devices exhibited a growth of 24.1% amid COVID-19. The surging number of patients for diagnosis and detection of the novel coronavirus overwhelmed healthcare settings globally. Owing to the sudden influx, the healthcare sector focused on adopting modern means to ensure reduced downtime for screening and testing of patients. Several hospitals and diagnostic centers started adopting IoT-based systems. For instance, according to the World Health Organization (WHO), in 2020, medical staff and patients in Wuhan, China, started adopting Cloud-Mind's AI-synched smart medical devices consisting of rings and bracelets. This led to the market exhibiting a growth rate of 24.1% in 2020"[4].

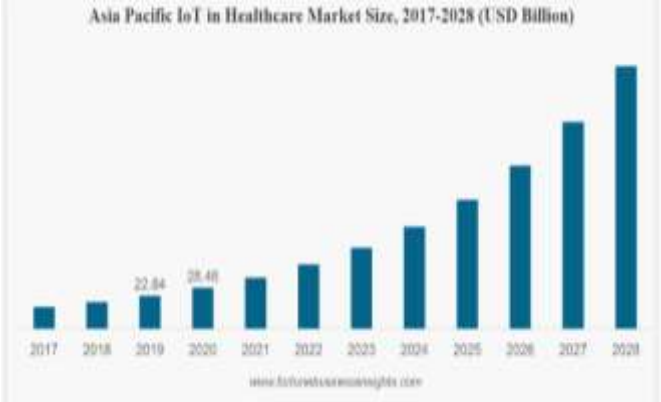

Fig 3. Growth of IoT in health care during 2017-2028 [5]

V. THE ARCHITECTURE OF IOT- BASED HEALTH CARE

The application of IoT in healthcare transforms it into a smart, accurate, and fast service. The architecture of an "IoT-based healthcare system consists of 3 layers majorly the Perception layer, Network Layer, and Application Layer [1]:

A. Perception Layer

This layer is the foundation layer of IoT. It tells about the status of the condition of the patient via sensors such as a pulse-oximeter, electrocardiogram, thermometer, fluid level sensor, and sphygmomanometer (blood pressure) that read the current patient situation (data) [8].

These sensors allow for comprehensive perception through object recognition, location recognition, and geographic recognition and can convert this information to digital signals, which is more convenient for network transmission [1]. This layer allows us to monitor treatments in real-time, and facilitate the healthcare workers in making diagnoses easier and faster.

B. Network Layer

This layer is the layer that stores and transports data throughout the world. The layer includes wireless and wired networks of IoT. These networks stores and process the data that is present locally or at a location for easy access from wherever in the world.

The use of cloud computing for storing the data helps in easy access and scalable in terms of transmission, data acquisition, and storage between devices connected to the cloud [1]. The use of the cloud can be foreseen to support data-intensive electronic medical records (EMRs), patient portals, medical IoT devices (which can include smartphone apps), and big data analytics driving decision support systems and therapeutic strategies[9].

With more usage of the cloud, the healthcare systems must make sure about the security issues it can lead to and must take care of its proper maintenance and management. There must be evidence for the security of the data, transparency of the system, and reliability.

The device depends on its effect of it on the human body, security, and latency. The types of ranged devices they are using are short-range and long-range.

If the device is short ranged then they must provide a strong security mechanism so that the sensitive data couldn't be accessed by anyone else except the doctors and the patient themselves and low latency is essential. If the device is long ranged then the data would be transferred into the databases. When selecting these types of devices the consumer must make sure that it includes security, error-correcting capabilities, robustness against interference, low latency, and high availability" [10].

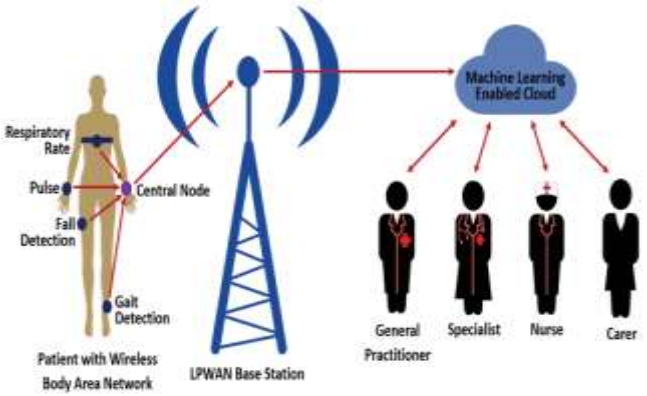

Fig 4. How IoT bases architecture works [10]

C. Application Layer

This layer defines how the user would get the information. Mostly the data is delivered to the users by using artificial intelligence (AI) that includes image analysis,text"recognition with natural language processing, drug activity design, and prediction of gene mutation expression. AI can read available EMR data, including medical history, physical, laboratory, imaging, and medications, and contextualize these data to generate treatment and/or diagnosis decisions and/or possibilities [1].

The use of IoT-based healthcare along with machine learning can help in assisting health professionals in analyzing the reports and predicting the unseen future.

For example, compared with the diagnostic evaluation by 54 ophthalmologists and senior residents, applying AI to retinal images improved the detection and grading of diabetic retinopathy and macular edema, achieving high specificities (98%) and sensitivities (90%) [11]. AI and deep learning can also optimize disease management, can

provide big data and analysis generated from mHealth apps and IoT devices, and are starting to see adoption in healthcare [12].

Fig 5. IoT Architecture [8]

VI. What Improvement IoT Brings to Health Care Delivery

A. More accessibility to primary healthcare

Due to IoT availability to people, primary health care become more accessible.

Like during the pandemic, the whole nation was told to download AI-based applications like Aarogya Setu on our mobile phones. In this, the people had to tell details about their latest interactions with people and also recorded their health status. It also provided the facilities like booking an appointment, talking to a chatbot and getting alerts of being at risk of infection, so on.

On an individual level, being tracked by healthcare apps that record and monitor daily activities like walking, calories count, etc. of a person which helps in analyzing the potential risk of being unhealthy.

It is the best technique to track patients and staff, thereby reducing the waiting time. It introduces several devices to make the patient comfortable. With smart devices like blood-gas analyzers, thermometers, smart beds, glucose meters, ultrasound, and X-rays, there is an improvement in inpatient care."IoT is applicable to replace the biological part or enhance the biological structure [13].

B. Secondary and tertiary healthcare became proactive, coordinated, and continuous

IoT-based healthcare made the overall healthcare system proactive, and coordinated and continued from reactive, intermittent, and uncoordinated. It offers in giving high-quality care that is appealing to patients and professionals as it increases the efficiency of the system."It also becomes flexible for the delivery of healthcare on an individual or population basis.

VII. Barriers and Security Guidelines for IoT-Based Health Care

A. Barriers of IoT based healthcare

1) Privacy and Security

IoT allows many opportunities for cyberattacks as it is in a vulnerable state since it is completely a wireless mode and all the components are on low energy, therefore they can hardly secure themselves. The National Institute of Standards and Technology has recently released a draft security guide and recommendations for IoT devices, which will see an emphasis on data security in IoT devices [14], but their application in healthcare is still a bit unclear.

2) Acceptance

There lies a gap in the understanding and awareness of the public regarding the IoT and its application in healthcare. If there is acceptance then there is also rejection. Everyone has different perspectives regarding if IoT is beneficial or not. Many factors affect the acceptance like creditability, ease of use, compatibility with the lifestyle, and financial and also its accuracy.

B. Data Storage, Control, and Ownership

For the acceptance and future usage of IoT in healthcare, there has to be a transparent and enforced way of conduct. The people should be aware and told about where the data is being stored, whom all have access to it and how it is controlled and maintained. For example, does the data host have viewing rights to someone's data, and are these data completely controlled by individuals, or are they never deleted from the cloud, despite a user's request? [1].

C. Security Guidelines for IoT based healthcare

According to the Core Baseline, there are 6 recommended security features that manufacturers can build into IoT devices, and that consumers can look for on a device's box or online description while shopping [15]. They are as followings:

1) Device Identifiaction

The device must have a way to identify itself like a MAC number or unique serial number.

2) Device Configuration

An authorized user should be able to change the configuration of the device.

3) Logical Access to Interfaces

The device must have a limit to the people it can access through the local and network interfaces.

4) Software and Firmware Update

There must be frequent updates in the software and the firmware of the device and must be updated in a secure and configurable mechanism.

5) Cybersecurity Event Logging

The devices should be logged in cyber security events and these logs should be accessed by the manufacturer, these help in identifying vulnerabilities in the device.

6) Data Protection

It must be clear how the data is protected while it is being stored and transferred over the network. For example, some

devices use encryption to obscure the data held on the internal storage of the device [15].

VIII. CONCLUSION

This paper would like to conclude that IoT is a great way for managing chronic disease, medical emergencies, better patient care, fitness, blood pressure monitoring, health check system, measurement & control system, heart rate checking systems, and hearing aids [13].

From this viewpoint, IoT has great potential in the healthcare field as it can assist in managing many issues and challenges that healthcare systems face." With the adaption of these technologies, healthcare systems become much easier to understand and proceed with.

However, the implementation of IoT in health care will rely on a clear and robust code of practice for the management of data, privacy, confidentiality, and cybersecurity concerning the supply and use of IoT devices in health care. From a health system perspective, there is a need for clinical guidelines on digital health prescriptions and robust policies regarding remuneration for primary and secondary care services provided through IoT [1].

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