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Application of IoT in Healthcare

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ABSTRACT- There has been a lot of research into medical facilities and technological developments during the last ten years. To be more specific, the Internet (IoT) has shown promise in connecting a range of healthcare gear, monitors, and hospital professionals in order to provide high medical treatment at a remote location. Patient safety has increased, medical costs have fallen, medical solutions have becoming increasingly available, and efficiency in the healthcare business has increased. The current study presents an up-to-date review of the potential healthcare uses of IoT-based technology. This article describes the advancement of the utilization of the Hospital IoT in solving various healthcare challenges from the perspectives of enabling technology, medical providers, and applications. Furthermore, potential Healthcare IoT system problems and issues are addressed. To summarize, the current research provides a comprehensive resource of knowledge on the different applications of Healthcare IoT, with the purpose of aiding future academics engaged in studying in the area to have a better understanding of the issue.

KEYWORDS- Application, Healthcare, IoT, Technology.

I. INTRODUCTION

In previous decades, the healthcare industry has grown dramatically, generating enormous income and jobs [1]. Just a many decades ago, diseases and irregularities in the natural body could only be identified by a medical medical exam. The vast proportion of individuals was required to stay in the clinic during their treatment. As a consequence, medical expenses have risen, and medical institutions in rural and remote locations have been overburdened. With the advancement of technology, small gadgets such as smartwatches may now be used to diagnose and track a variety of conditions. In addition, technology has shifted the healthcare system's focus from hospitals to patients[2]. Several clinical tests, for instance, may be carried out at house despite the need for a healthcare professional's involvement. Modern communications technology may also be used to provide clinical data to healthcare centers from far away. The usage of this kind of communications solutions in connection with the fast expansion of technologiesg has improved access to medical facilities [4].

The Internet has given people more independence while simultaneously increasing their ability to interact with the rest of the world. The Network of Things has becoming a substantial contributor to global communications with the help of upcoming protocols and algorithms. It connects a wide range of items to the Internet, includes wirelessly detectors, home appliances, and electronic devices. IoT uses include agriculture, the home, and healthcare [3]. The Internet of Things is growing traction owing to its benefits of increased accuracy, lower costs, and the ability to effectively predict future events. Furthermore, increased knowledge of software and applications, as well as developments in mobile and laptop capabilities, ubiquitous accessibility of cellular technologies, and the expansion of the digital economy, have all supported the rapid IoT revolution. Sensors, actuators, and other Internet of Things devices have been coupled with Wifi, Wired, IEEE 802.11 (Wi-Fi), and many communications are used to monitor and share data between real equipment, whether implanted or wearable on the human skin, are utilized in a variety of applications. healthcare applications to collect physiologic information from physician 's system, like temperatures, blood rate, ECG, EEG, and so on [4].

Temperatures, moisture, time, and time are examples of environmental data that may be gathered. These data assist in the establishment of pertinent and correct judgments regarding the health state of the patients. Because a large amount of data is collected/recorded from many sources, data storage and accessibility are especially essential in the IoT system. Doctors, caretakers, and other authorized persons have access to the data collected by the aforementioned sensing devices. The ability to share this data with healthcare professionals through cloud/server enables for rapid diagnosis of patients and, if required, medical action. For efficient and secure transmission, users, patients, and the communication module must work together. The majority A user experience that acts as a showcase for healthcare practitioners is used by several IoT devices , allowing them to manage, visualize, and assess data[3]. The literature has a substantial quantity of research into the establishment of the Internet of Things (IoT) systems in medical surveillance, management, safety, and confidentiality.

These achievements demonstrate the value of IoT in the healthcare industry and its bright future. However, preserving the quality of service matrices, which include

privacy of information sharing, security, cost, dependability, and availability, is the primary issue while developing an IoT device. In order to maximize the usage of IoT in medical systems, several countries have established new technologies and laws. As a consequence, modern medical study has becoming a more intriguing field to study. The purpose of this article is to provide a complete review of the enabling technology, applications, and applications for IoT-based medical platforms, as well as to explain the state-of-the-art studies in the subject. The IoT framework for healthcare applications assists in integrating the benefits of Incorporating Internet of Things (IoT) and internet technologies into the medical field. It also provides the protocols for delivering patient data to a healthcare network from a range of devices and medical equipment. The configuration of different elements of an IoT medical system/network in a healthcare setting that are connected in a logical manner. setting is known as the topology of an Healthcare IoT[4]. Publisher, broker, and subscriber are the three major components of a simple Healthcare IoT system.

The printer represents a network of connected sensors and other healthcare devices that might independently or simultaneously capture the patient's essential information. ECG, EEG, EMG, pulse temperature, pulse rhythm, temp, oxygen content and other parameters may be included. The publisher may transmit this data to a broker in a continuous stream via a network. The broker is in charge of processing and storing the data that has been collected in the cloud. Finally, the subscriber is involved in the continuing monitoring of the doctor 's information, which might be accessible and presented through a cellphone, laptop, ipad, or similar equipment. The publication may examine these information and offer feedback after viewing any biological irregularity or decline in the patient 's medical status. The Healthcare IoT combines separate components into a hybrid grid, with each component on the IoT network and cloud in the healthcare network serving a particular function. It's difficult to propose a common framework for Healthcare IoT since the topology is dependent on the healthcare need and application. For an Healthcare IoT system, many structural modifications have been implemented in the past[5]. When developing a new IoT-based healthcare system for real-time patient monitoring, it's critical to make a list of all linked actions related to the intended health application.

The success of the IoT system is determined by how well it meets the needs of healthcare professionals. The topologies must follow the medical norms and procedures in the diagnostic method since each illness necessitates a complicated sequence of healthcare actions [6].

A. Application Of IoT In Healthcare

- *ECG Monitoring*: The electrical activity of the heart is represented by an electrocardiogram (ECG), which shows the depolarization and repolarization of the atria and ventricles. An ECG is a kind of electrocardiogram that shows the fundamental rhythms of the heart muscles and may be used to detect different cardiac problems. Arrhythmia, a prolonged QT interval, myocardial ischemia, and other anomalies are among them. The use of IoT technology in the early identification of cardiac problems via ECG monitoring has shown promise[6]. In the past, IoT has been used in ECG monitoring in a number of research. A wireless data collection system and a receiving processor are suggested in the research, which is an IoT-based ECG monitoring system. It made use of a real-time search automation technique to identify cardiac abnormalities. A tiny wearable low-power ECG monitoring device combined with a t-shirt was suggested in.
- It collected high-quality ECG data using a bio potential chip. The captured information was then sent to the end users through Bluetooth. A smartphone app may be used to view the captured ECG data. The suggested technology may run on only 5.2 mill watts of electricity. After combining an IoT system with big data analytics to handle increased data storage, real-time monitoring in an IoT system may be feasible. By combining the concepts of nan electronics, big data, and IoT, Bansal’s and Gandhi have suggested an ECG monitoring system that can manage long-term and continuous monitoring [6]. It's worth noting that the authors of attempted to address the problem of power consumption in a wearable ECG monitoring device. They have suggested compressive sensing, a novel technique for reducing power usage and improving ECG monitoring performance describes an IoT-based A cloud-based computer and a smartphone app are used to detect falls and supervise ECGs. This machine were created to provide real-time monitoring for elderly patients by continuously evaluating their ECG and gyroscope data [7].
- *Glucose Level Monitoring*: Diabetes is a disease in which the body's blood glucose levels stay high for an extended length of time. It is one of the most prevalent human illnesses. Type-I diabetes, type-2 diabetes, and gestational diabetes are the three most common forms of diabetes. A randomized blood sugar testing, a fast liquid sugar exam, and an oral sugar intolerance exam are among the three assays, may be used to determine the illness and its kinds. However, "fingerpicking," followed by blood glucose level testing, is the most commonly used diagnostic technique for diabetes diagnosis. Various wearable devices for blood glucose monitoring that are noninvasive, pleasant, convenient, and safe have been designed using recent advancements in IoT technology [3]. A noninvasive m-IoT-based glucometer was suggested in order to keep track of plasma sugar readings in real time.
- IPv6 connection was used to connect the wearable sensors to the healthcare professionals. Alarcón-Paredes et al. created a blood glucose measuring glove that includes a detectable laser, a Rasp Pi webcam [8]. The diabetes status of the patients was detected using a series of photographs obtained from the fingertip. In a separate research, For glucose level monitoring, a method centered on a twofold rolling averaged were implemented in the Architecture. It's also important mentioning that glucose levels have

been detected using optical sensors such as ultraviolet LEDs and near-infrared photodiodes. The laser output returned form the individual body is used to calculate the sugar levels in the individual system [9].

- *Temperature Monitoring*: Human body temperature is an essential component because it is a sign of metabolism; it is used in many diagnostic procedures. A change in body heat might also be a warning indication in some conditions, like injury and infection. Keeping record of temperature changes over moment allows doctors to draw findings regarding a patient's health status in many illnesses. The usual technique of measuring temperature is using a temperature thermometer attached to the lips, ear, or scrotum. However, the patient's discomfort and the significant danger of infections are always a worry with these treatments. Multiple solutions to this problem have been proposed as a result of the latest progress of IoT-based technology. The use of an infrared sensor to monitor the core body temperatures from the eardrum was proposed in a motion wearable gadget that might be placed on the ear.
- A wireless sensor module and a data processing unit were included into the gadget. The observed temperature is unaffected by the surroundings or other physical activity in this experiment. Gunawan used Arduino and Raspberry Pi to create an IoT-based temperature monitoring system. The temperature readings were saved in a database and presented on a web page that could be viewed through a PC or a mobile phone. Wearable and lightweight sensors were employed in another research to monitor babies' body temperature in real time. It may also notify the parents if the temperature rises over a certain threshold[8].
- Blood Pressure Monitoring: The measurement of blood pressure is one of the mandatory steps in any diagnostic procedure (BP). The most common technique of blood pressure measurement requires the participation of at least one person. The integration of IoT and other sensor technologies, on the other hand, has changed the way blood pressure was previously measured[10]. For example, a wearable cuffless device that can monitor both systolic and diastolic pressure was suggested. The data collected may be saved in the cloud. The device's effectiveness was also tested on 60 people, and its accuracy was confirmed. In his IoT-based BP measuring system, Guntha used cloud computing and fog computing. The system was now ready for long-term real-time monitoring. The gadget may also save the captured information for future use. A deep learning-based CNN model with time-domain features was utilized to evaluate systolic and diastolic blood pressure in a comparable research suggested measuring blood pressure using an ECG signal and a photoplethysmogram (PPG) collected from the fingertip. The BP was calculated using the connected microcontroller module, and the data was subsequently transmitted to cloud storage.
- *Monitoring Oxygen Saturation:* Pulse oximetry is a noninvasive method of measuring oxygen saturation that may be utilized as a critical parameter in medical research. The noninvasive technique removes the drawbacks of the traditional method and allows for real-time monitoring. Pulse oximetry has improved as a result of the integration of IoT-based technologies, with potential applications in the healthcare sector. A noninvasive tissue oximeter that could detect blood oxygen saturation, heart rate, and pulse characteristics was suggested. Furthermore, the recorded data may be sent to the server through a variety of communication protocols, such as Zigbee or Wi-Fi. A medical intervention choice was taken based on the collected data. An alarm system that may warn patients when their oxygen saturation reaches a critical level was described in another research. The system included a pulse oximeter and a WLAN router, both of which were linked through the Blynk server. Von Chong et al. have also suggested a multispectral sensor that mitigates the negative effects of a single LED proposes a low-power and cost-effective remote patient monitoring system. The gadget is capable of providing real-time monitoring.
- *Asthma Monitoring:* Asthma is a chronic disease that affects the airways and may make breathing difficult. Asthma causes the airways to narrow as the air channel swells. This comes after a slew of health problems, including wheezing, coughing, chest discomfort, and shortness of breath. An asthma attack may strike at any time, and an inhaler or nebulizer is the only thing that can rescue you at that point. As a result, real-time monitoring of this situation may be required. In recent years, a slew of IoT-based asthma monitoring systems have been suggested a smart HIoT solution for asthma sufferers was suggested in, which utilized a smart sensor to monitor breathing rate. The health data was saved on a cloud server to which caregivers have access for diagnostic and monitoring reasons. Raji developed a respiratory monitoring and warning system in which the breathing rate was measured using an LM35 temperature sensor. This was accomplished by measuring the temperature of the air that was breathed and exhaled. The data on respiration was transmitted to a health center and displayed on a web server. When a threshold value was achieved, the suggested system sounded an alert and automatically delivered a message to the patient. In another research the proposed system not only monitored and alerted patients about their asthma symptoms, but it also advised them on the proper dosage of medicine to take. Furthermore, the system was able to assess the patient's surroundings and advise him to leave a location that was harmful to his health.
- *Medication Administration:* In the healthcare sector, medication adherence is a frequent problem. Patients' unfavorable health problems may be exacerbated if they do not take their medications on time. Medication no adherence is particularly common in the elderly, as they age and acquire clinical problems such as cognitive decline, dementia, and so forth. As

a result, it is difficult for them to properly follow doctor's orders. Several studies have previously focused on using IoT to monitor a patient's medication compliance created a smart medical box that can remind individuals to take their medicine. Each of the three trays in the package includes medication for three separate occasions (morning, afternoon, and evening). Some important health indicators are also measured by the device (blood glucose level, blood oxygen level, temperature, ECG, and so on). The cloud server receives all of the recorded data. Communication between the two end-users was established via a mobile app. Doctors and patients may use the mobile app to access the recorded information.

- *Management of Wheelchairs*: For individuals with limited mobility, a wheelchair is an unavoidable aspect of their daily lives. It offers them with both physical and psychological assistance. When a handicap is caused by brain injury, however, the use of a wheelchair is restricted. As a result, current research is focused on combining these wheelchairs with navigation and tracking systems. IoT-based solutions are now demonstrating that they can help achieve this objective proposes an IoT-based steering system that is coupled with a real-time obstacle avoidance system. Using image processing methods on captured real-time movies, the steering system can identify impediments. Wheelchair management has become more engaging and convenient for patients because to the usage of mobile computers. The combination of different sensors, mobile technology, and cloud computing resulted in the development of a smart wheelchair, as seen in. A smartphone app is included in the system, which allows patients to communicate with the wheelchair and caregivers. The software also allows caretakers to keep an eye on the wheelchair from afar. Another research suggested an IoT-based wheelchair monitoring system that controlled the wheelchair using hand gestures.

II. DISCUSSION

The Internet of Things (IoT) is a network of linked objects or things that collect and exchange data using hardware, programming, sensory, and a network connection. The Internet of Things allows devices to be remotely sensed and controlled using current network infrastructure. Recent advancements in RFID, intelligent detectors, communications technology, and Internet protocols have enabled the Internet of Things. The basic notion is that intelligent detectors would operate collectively to generate a fresh class of apps with the requirement for human interaction. The current Web, smartphone, and computer (M2M) revolutions might be thought of as the IoT's first stage. In the next years, the Internet of Things (IoT) is expected to connect a variety of technologies to enable new apps by connecting physical objects to aid intelligent decision-making. Intelligent medicine serves a significant role in medical solutions by combining sensors in individuals and their medications for diagnostic and recording purposes.

Clinical treatment makes use of the Internet of Things to track patients' physiological states via sensors, collect and analyze their data, and then send the packaged information to handling hubs for action. Not just for patients, but also for normal people, wearingable gadgets with sensors might help them monitor their health. In conclusion, one future vision for IoT is for it to grow into a service with increased complexities in sensors, actuators, communication, control, and information generation from large amounts of data. As a consequence, our lives will be radically different than they are today. Nobody knows how their life will turn out. To be honest, we can't predict how folks 's life would change. We could not have foreseen the Computer, the Web, online networks, Twitter, Instagram, millions of mobile apps, and other technologies that have drastically transformed society's lifestyle. Everybody in the medical sector benefits from it. As a consequence, with an IoT medical network, health risks might be detected sooner.

III. CONCLUSION

The current research looked at a variety of aspects of the health IoT network. The structure of a Hospital IoT network, its parts, and the communications between them has all been thoroughly examined in this article. This article also includes details on current healthcare companies that have looked at IoT-based technologies. By using these concepts, IoT technology has benefited medical professionals in tracking and treating a range of health conditions, measuring a number of health parameters, and offering diagnostic services at remote locations. As a consequence, the healthcare industry has moved away from a clinic paradigm and toward a patient-centric approach. We've also discussed a few IoT applications for healthcare and their current developments. The problems and issues associated with the HIoT system's design, production, and use have also been highlighted. These challenges would provide as a basis for future growth and research focus in the next years. Additionally, users who are interesting in not just beginning their research but also making advancements in the field of Hospital IoT gadgets will get comprehensive, up-to-date data about the equipment.

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