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IoT in Healthcare

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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. 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.**

Keywords: IoT, Healthcare, Patients, Device, Monitoring, Sensors, COVID-19.

I. INTRODUCTION

Healthcare is an essential part of life. The Internet of Things (IoT) has been widely identified as a potential solution to alleviate the pressures on healthcare systems, and has thus, been the focus of much recent research. IoT remains a relatively new field of research, and its potential used for healthcare is an area in its infancy. In this section the internet of things is explored and its suitability for healthcare is highlighted.

II. IOT HEALTHCARE APPLICATIONS

Healthcare monitoring devices

IoT devices offer a number of new opportunities for healthcare professionals to monitor patients, as well as for patients to monitor themselves. By extension, the variety of wearable IoT devices provides an array of benefits and challenges, for healthcare providers and their patients alike.

A) Remote patient monitoring

Remote patient monitoring is the most common application of IoT devices for healthcare. IoT devices can automatically collect health metrics like heart rate, blood pressure, temperature, and more from patients who are not physically present in a healthcare facility, eliminating the need for patients to travel to the providers, or for patients to collect it themselves. When an IoT device collects patient data, it forwards the data to a software application where healthcare professionals and/or patients can view it. Algorithms may be used to analyze the data in order to recommend treatments or generate alerts. For example, an IoT sensor that detects a patient's unusually low heart rate may generate an alert so that healthcare professionals can intervene. A major challenge with remote patient monitoring devices is ensuring that the highly personal data that theseIoT devices collect is secure and private.

B) Glucose monitoring

For the more than 30 million Americans with diabetes, glucose monitoring has traditionally been difficult. Not only is it inconvenient to have to check glucose levels and manually record results, but doing so reports a patient's glucose levels only at the exact time the test is provided. If levels fluctuate widely, periodic testing may not be sufficient to detect a problem. IoT devices can help address these challenges by providing continuous, automatic monitoring of glucose levels in patients. Glucose monitoring devices eliminate the need to keep records manually, and they can alert patients when glucose levels are problematic.

Challenges include designing an IoT device for glucose monitoring that:

a) Is small enough to monitor continuously without causing a disruption to patients. Does not consume so much electricity that it needs to be recharged frequently.
b) These are not insurmountable challenges, however, and devices that address them promise to revolutionize the way patients handle glucose monitoring.

C) Heart-rate monitoring

Like glucose, monitoring heart rates can be challenging, even for patients who are present in healthcare facilities. Periodic heart rate checks don't guard against rapid fluctuations in heart rates, and conventional devices for continuous cardiac monitoring used in hospitals require patients to be attached to wired machines constantly, impairing their mobility. Today, a variety of small IoT devices are available for heart rate monitoring, freeing patients to move around as they like while ensuring that their hearts are monitored continuously.

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D) Hand hygiene monitoring

Traditionally, there hasn't been a good way to ensure that providers and patients inside a healthcare facility washed their hands properly in order to minimize the risk of spreading contagion. Today, many hospitals and other health care operations use IoT devices to remind people to sanitize their hands when they enter hospital rooms. The devices can even give instructions on how best to sanitize to mitigate a particular risk for a particular patient. A major shortcoming is that these devices can only remind people to clean their hands; they can't do it for them.

E) Depression and mood monitoring

Information about depression symptoms and patients' general mood is another type of data that has traditionally been difficult to collect continuously. Healthcare providers might periodically ask patients how they are feeling, but were unable to anticipate sudden mood swings. And, often, patients don't accurately report their feelings. "Mood-aware" IoT devices can address these challenges. By collecting and analyzing data such as heart rate and blood pressure, devices can infer information about a patient's mental state. Advanced IoT devices for mood monitoring can even track data such as the movement of a patient's eyes. The key challenge here is that metrics like these can't predict depression symptoms or other causes for concern with complete accuracy. But neither can a traditional in-person mental assessment.

III. WHY SECURITY MATTERS FOR IOT IN HEALTHCARE

In order to make the most of IoT for healthcare, critical security challenges must be addressed. Above all, IoT device developers, managers and healthcare providers must ensure that they adequately secure data collected by IoT devices. Much of the data collected by medical devices qualifies as protected health information under HIPAA and similar regulations. As a result, IoT devices could be used as gateways for stealing sensitive data if not properly secured. Indeed, 82 percent of healthcare organizations report having experienced attacks against their IoT devices.

Developing secure IoT hardware and software is one step in addressing this challenge. Equally important, however, is ensuring that IoT devices in healthcare are managed properly in order to protect against data from unmonitored devices falling into the wrong hands. A patient monitoring device that has an older version of software or firmware, or a device that is not properly decommissioned after it is no longer needed, for example, could.

Proper discovery and classification of all IoT devices on a healthcare provider's network helps guard against this risk. Once IoT device networks are properly identified, classified, regulated, and secured, managers can track device behavior to identify anomalies, perform risk assessments and segment vulnerable from mission-critical devices.

IV. SIMPLE HEALTHCARE SYSTEM ARCHITECTURE

The application of the Internet of Things (IoT) in healthcare transforms it into more smart, fast and more accurate. There is different IoT architecture in healthcare that brings start health care system.

Product Infrastructure: IoT product infrastructure such as hardware/software component read the sensors signals and display them to a dedicated device.

Sensors: IoT in healthcare has different sensors devices such as pulse-oximeter, electrocardiogram, thermometer, fluid level sensor, sphygmomanometer (blood pressure) that read the current patient situation (data).

Connectivity: IoT system provides better connectivity (using Bluetooth, WiFi, etc.) of devices or sensors from microcontroller to server and vice-versa to read data.

Application Platform: IoT system access information to healthcare professionals on their monitor device for all patients with all details.

IoT challenges in healthcare

- Data security & privacy
- Integration: multiple devices & protocols
- Data overload & accuracy
- Cost

Remote medical assistance

In event of an emergency, patients can contact a doctor who is many kilometers away with smart mobile apps. With mobility solutions in healthcare, the medics can instantly check the patients and identify the ailments on-the-go. Also, numerous IoT-based healthcare delivery chains that are forecasting to build machines that can distribute drugs on the basis of patient's prescription and ailment-related data available via linked devices. IoT will improve the patient's care in hospital. This in turn, will cut on people's expense on healthcare.

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V. RESEARCH

IoT healthcare applications can also be used for research purposes. It's because IoT enables us to collect a huge amount of data about the patient's illness which would have taken many years if we collected it manually. This data thus collected can be used for statistical study that would support the medical research. Thus, IoT don't only saves time but also our money which would go in the research.

Thus, IoT has a great impact in the field of medical research. It enables the introduction of bigger and better medical treatments. IoT is used in a variety of devices that enhance the quality of the healthcare services received by the patients. Even the existing devices are now being updated by IoT by simply using embedding chips of smart hospital devices. This chip enhances the assistance and care that a patient requires.

Data overload & accuracy

As discussed earlier, data aggregation is difficult due to the use of different communication protocols & standards. However, IoT devices still record a ton of data. The data collected by IoT devices are utilized to gain vital insights.

However, the amount of data is so tremendous that deriving insights from it are becoming extremely difficult for doctors which, ultimately affects the quality of decision-making. This will eventually lead to patient safety issues. Moreover, this concern is rising as more devices are connected which record more and more data.

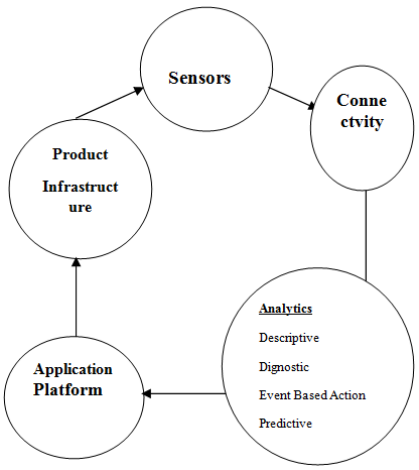
How IoT Helps In Healthcare Process

- A sensor collects data from a patient, doctor or nurse inputs data.
- AI-driven algorithms like Machine Learning (ML) are used to analyze the collected data.
- The device decides whether to act or send the information to the cloud.
- Doctors or health practitioners can make actionable and informed decisions based on the data provided by IoT healthcare solutions.

Advantages of IoT in Healthcare

- It brings continuous health monitoring.
- It makes hospital smarter.
- It helps you to keep a track on your patients.
- It helps in medical researches.

IoT Healthcare System Architecture



Research Methodology

According to the WHO, 4.9 million people died from lungs cancer, overweight 2.6 million, 4.4 million for elevated cholesterol, 7.1 million for high blood pressure. Patients who need regular monitoring by doctors to discuss the state of health condition, IoT-based patient monitoring system is useful for them. The main concept of IoT is defined as the integration with electronic devices that connect with doctors or health monitoring persons. The proposed system consists of Raspberry-pi, ECG Simulator, Node MCU.

Discussion

In medical, IoT brings significant changes to improve the facilities and information system during COVID-19 Pandemic. It improves the digitisation of medical processes and proper management in hospitals. IoT opens new applications in medicine when the device/instruments are being connected to the Internet. For patients, internet-connected devices are being introduced in different forms, to monitor patient health more effectively. It alerts about public health problems by tracking climate change. This technology gives way for the proper management of the hospital during COVID-19 Pandemic.

Future Scope

In the future, IoT will monitor vital signs of the patient in a real-time environment. This technology will digitally collect all detailed information to prevent ongoing issues regarding treatment of the COVID-19 patient. There will be a major enhancement in healthcare practice, using the latest technologies, and doctors would have to use them. IoT is a sophisticated developing technology with extensive applications in providing precise medical care that opens up an effective way to analyse valuable data, information, and testing. The future has applications in managing inventories

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used in the medical field and the medical supply chain for getting the right item at the right time and location.

VI. RESULT

Briefly studied the significant achievements of IoT with the help of a process chart. Then identifies seven major technologies of IoT that seem helpful for healthcare during COVID-19 Pandemic. Finally, the study identifies sixteen basic IoT applications for the medical field during the COVID-19 Pandemic with a brief description of them.

VII. CONCLUSION

IoT is for better managing chronic disease, medical emergencies, better patient-care, fitness, blood pressure monitoring, health check system, measurement & control system, heart rate checking system, and hearing aids IoT-enabled devices can facilitate digital storing of COVID-19 patients' personal health information and connect to different databases. This technology can help to minimise the manual record keeping. With the help of a well-informed decision, it reduces errors and provides results on time. By using this technology, healthcare devices and networks become smarter and efficient during COVID-19 Pandemic.

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