IoT-Based Telemedicine Health Analysis System – A Literature Survey

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Abstract - Smart cities, education and healthcare, home automation, transportation, and military operations are all dependent on the Internet of Things (IoT). IoT applications are extremely helpful for the provision of healthcare since they provide secure, real-time remote patient monitoring to improve people's lives. The advancement of internet technologies and its connections to machines along with the improvement and simplification of procedures has brought about tremendous improvements in human lives. Personal health devices (PHD) are part of a developing idea of a networked e-health system. ICT integration in the healthcare sector investigated ways to maximize the flow of all available medical resources and offer dependable, effective healthcare to the elderly and patients with physical disabilities and chronic illnesses. Incorporating the Internet of Things, this review paper investigates the most recent developments in healthcare monitoring systems. Regarding their importance and the advantages of IoT healthcare, the paper examines the advantages of IoT-based healthcare systems. We aim at providing the most recent research details on IoT-based healthcare monitoring systems with the literature review focusing on the contrasts in efficacy, efficiency, security, and monitoring of various systems.

Index Terms - IoT, healthcare systems, Arduino, Cloud services, ESP8266, remote monitoring

I. INTRODUCTION

The internet of things, or IoT, is a system of interconnected computers, electronic machinery, or human beings that enables data transmission over a network without the need for direct human-computer interaction. It is a relatively new technology that makes connections between individuals and objects possible at any time and from any location.. [1]

IoT does more than merely link things together; it also makes it possible for devices to talk to one another and exchange user-related data. Experts predict that 50 billion objects will be connected to the Internet by the year 2020.[2] Furthermore, there are no signs that this growing link will come to an end. Simply put, it is accelerating with each passing second. The global internet of medical things (IoMT) market is expected to rise to $187.60 billion by 2028, up from $41.17 billion in 2020, according to Fortune Business Insights. People should have access to superior healthcare services whenever and wherever they need them, in an economical and patient-friendly way, thanks to the current healthcare system. The traditional approach in healthcare is giving way to an effective patient positioning approach. Doctors play a major position in the conventional method. They need to see their patients in order to conduct the essential analysis and directing.[3]

Bedside patient monitoring and remote monitoring are the two main categories for patient monitoring systems. The benefits of this technology are progressively being reaped by the experts in healthcare systems, which has had a huge impact on the industry both inside and outside of clinical settings.[4] The objective of IoT healthcare monitoring systems is to precisely track individuals while connecting various services and objects around the globe via the Internet to gather, exchange, monitor, store, and analyze the data produced by these objects. Medical care relies on diagnosing illnesses and keeping tabs on patients, and putting sensor networks on the human body will greatly help with these tasks. The information is always easily accessible from anywhere in the world.

With the use of sensor technology, a microcontroller, and a Wi-Fi module, the user may keep an eye on their loved ones. People who are normally unable to speak can communicate by using this method. This system keeps an eye on the situation and alerts the proper authorities by sending a message through Wi-Fi when there is no one accessible to take care of the patient.[5]

Patients can also enhance their home healthcare to lessen the necessity for doctor visits and the chance of receiving subpar medical care in hospitals or clinics of lesser standards. As a result, the overall cost of therapy may decrease, while patient safety and the standard of medical care may both rise.[3] To provide improved medical services, IoT combines information and communication technology. By leveraging the Internet of Things to transfer medical data from one site to another, identify illnesses, and arrange for the correct drugs, patients' health problems can be improved even in remote areas.[4] By managing chronic diseases with fewer hospital stays, shorter travel times, and shared doctors and professionals, this technology not only makes it possible to provide healthcare services over a large distance but also decreases the cost of healthcare services.

II. LITERATURE SURVEY

A. Healthcare and patient monitoring using IoT

This paper discusses IoT-related medical applications, how it affects healthcare, and some new developments in the field, like Bio-IoT and Nano-IoT, or the Internet of Nano Things. In order to monitor patients' vital signs, Wireless Body Area Networks are the most important component of an Internet of Things-based system. (WBAN).[1] WBANs are made up of tiny, sophisticated devices placed

within or on top of patients that are capable of wireless communication. The report describes the development and testing of a specific WBAN-based biomedical application at the Ege University Hospital, including its design and execution. The key components of the proposed system are the relative oxygen ratio, plethysmogram, and pulse rate of the patient. The gathered data is transferred from the wireless sensor network to the main database using IoT technology. The robustness, accuracy of the data acquired in various network topologies, network stability, and effective range are used to evaluate the system's performance.

B. IoT based Health Care Monitoring Kit

An Internet of Things (IoT)-based smart doctor kit for a dangerous medical condition is designed and developed in this study. It can provide a flexible link to IOT data that can help urgent care facilities like intensive care units. (ICU). The healthcare control system must now routinely monitor the patient's physiological characteristics. The in-depth health monitoring system discussed in this article can instantly give clinicians the pertinent patient health history.[2] Active health monitoring and controlling have been developed in order to precisely track the patient's state when the doctor is not there. The device notifies the doctor after collecting the patient's ECG, temperature, blood pressure, and pulse rate.

C. Recent Advances on IoT-Assisted Wearable Sensor Systems for Healthcare Monitoring

The article provides a comprehensive compendium of the rapidly evolving IoT in healthcare technology. It is based on how the Internet of Things (IoT) has changed, connected, and facilitated the healthcare industry over the previous few decades. The architecture must have layers for sensors, communication, cloud services, data processing, and analysis in order to integrate IoT with healthcare. The paradigms for data collection, data transfer, data processing, and computing are then thoroughly examined. A virtual system is often utilised for storage, calculation, and processing while a wearable system is used to collect data. This considerably improves accessibility.[3] It elaborates on many forms of computing, such as parallel, cluster, grid, edge, fog, and cloud computing, as well as how they work. d the various tools available to implement said technology. Every technique used to send the data acquired to the server and medical personnel is covered in the document. These include Wi-Fi, LoRaWAN, Bluetooth, and ZigBee. These are the short- and long-range communication techniques that are most frequently used in Internet of Things-based healthcare systems. Data transfer speeds, communication ranges, power needs, networking kinds, and the spectrum of devices that can utilise these technologies have all been thoroughly explored.

Fig 1. IoT-assisted hospitals for healthcare monitoring

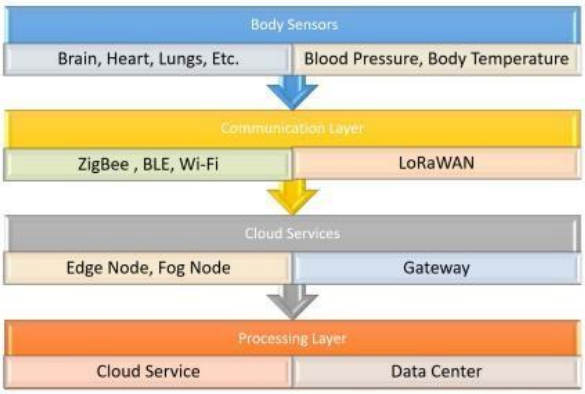

Fig 2. An overview of IoT-assisted wearable sensor systems for healthcare monitoring

D. Development of Smart Healthcare Monitoring System in IoT Environment

The use of healthcare monitoring systems in hospitals and other healthcare institutions has significantly increased, and many countries around the world are now highly concerned about portable healthcare monitoring systems with emerging technology. Internet of Things (IoT) technology development has made it possible for healthcare to move from in-person consulting to telehealth. This article proposes

a smart healthcare IoT system that can continually monitor a patient's vital signs and the condition of the room they are currently in[4] The implementation incorporated "smart healthcare" to monitor a patient's vital signs, such as heart rate and body temperature, as well as some indicators of the health of a hospital room, such as humidity levels and CO2 and CO concentrations in the air. The success percentage between observed data and real data for all instances of the developed healthcare system is roughly better than 95%.

E. IoT-Based Health Monitoring System Development and Analysis

This paper presents the design and implementation of a health monitoring system using IoT-enabled technologies in order to deliver cutting-edge and non-invasive clinical assistance services. Particularly for patients in a rural context in a poor country who have COVID-19, high blood pressure, diabetes, etc. The device measures a patient's body temperature, heart rate, and blood oxygen saturation (SpO2) levels and transmits data to a mobile application through Bluetooth. The mobile application, which was created using the MIT Inventor and receives data from the device over the Bluetooth connection. The physical, logical, and application layers are the three tiers that make up the system. The logical layer processes the data that the physical layer's sensors have collected. Intersensory communication and media access control are managed by the logical layer. In response to the data processed by the logical layer, the application layer makes decisions.[5]

F. A Rigid-Flex Wearable Health Monitoring Sensor Patch for IoT-Connected Healthcare Applications

Wu et al.'s wearable system monitors a variety of physiological parameters, including body temperature (BT), electrocardiogram (ECG), and heart rate. (HR). By monitoring the ECG and PPG with pulse arrival time (PAT), blood pressure can be estimated. (BP). Communication between humans and remote monitoring technologies is straightforward because every component is developed according to a rigid design. Additionally, the devices have wireless communication capabilities and utilize minimal power while measuring a specific physiological signal.[6] The physiological measurements can be wirelessly transmitted to a gateway using a BLE module. The data are encrypted at the sensor patch and gateways to protect transmission security and privacy.

G. Smart Healthcare Monitoring using IoT

The system being discussed here is composed of various medical devices, such as sensors and web- or mobile-based applications, which connect with one another across a network and facilitate the monitoring and archiving of patient health data and medical data. an automated system that guarantees ongoing surveillance of many health indicators and the early identification of any illness or problem to spare the patient the burden of making many hospital visits.[7] The suggested system can be put in hospitals, allowing for the collection and online storage of vast amounts of data. The parameters and outcomes of many people's medical histories can be examined using data mining to search for recurrent patterns and logical linkages in the condition.

H. Secure IoT communications for smart healthcare monitoring system

Wireless healthcare monitoring devices with a range of technologies have drawn substantial interest in many nations throughout the world over the past 10 years, and healthcare monitoring systems in hospitals and other healthcare institutions have seen great expansion. The suggested paradigm has a trust framework that regulates the collection of authenticated physiological data from the patient's body. Then, using a logic-based algorithm that has been taught in a fuzzy-based inference system (FBIS), this data is transmitted by GSM module to Azure IoT Hub, where it is converted into linguistic representation in order to ascertain the patient's status [8]. The suggested system provides dependable, accurate, secure, and real-time patient monitoring as a result. The medical sensor inputs have also been interpreted using fuzzy inference utilizing an upgraded intelligent patient monitoring model that automatically assesses the patient's vital body characteristics. Medical personnel can keep an eye on patients' bio signals in real-time thanks to the recommended platform.

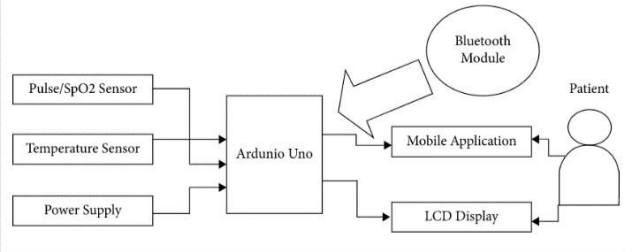

Fig 3. Block diagram of fuzzy-based inference system (FBIS)

I. Design of Health Care Monitoring System Based on Internet of Thing (IOT)

The Internet has changed this place into a global metropolis and the Internet of Things (IoT) by enabling a range of devices and perceptive things to collect and analyze data for various functions. By weakening the Internet of Things (IoT)'s (smart things) physical roots, a clear structure is created. The authors of this paper use a remote healthcare system that uses cutting-edge communications, information technology, and remote physiological monitoring technologies.[9] The "remote benefit services framework" offers "free welfare authorities" and "remote long-term human services administrations" through a comprehensive "remote social insurance data stage" work instrument that makes use of coordinated terminal programming and improved social insurance modules.

J. Smart healthcare in smart cities: wireless patient monitoring system using IoT

A necessity for ambulances to have an intelligent navigation system is proposed in this study. When vital patients are referred by an ambulance, the hospital is completely unaware of the patient's parameters and much time is lost in information facilitation. For this reason, a patient monitor and ambulance tracking system is a useful tool for performing a quick 30-second diagnosis using heartbeat, temperature, and breathing rate sensors to record crucial patient parameters needed at the beginning of any treatment by the doctors and to remotely transmit these parameters over wireless medium to the hospital even before the ambulance is deployed.[10] A simple way for the patient to summon an ambulance at the touch of a button eliminates the need to call the hospital. It also immediately SMS the relevant emergency information to an emergency contact, providing the hospital and contact with the information much earlier.

K. Remote Patient Monitoring: Health Status Detection and Prediction in IoT-Based Health Care

In this paper, sensors for electrocardiography (ECG), electroencephalography (EEG), temperature, and blood pressure are used. Additionally, they track patient behavior using ambient sensors, which improves the accuracy of predicting health conditions. Through edge and cloud computing, several healthcare subsystems communicate with one another. Edge computing is a distributed computing paradigm that brings computation and data storage closer to the point of demand in order to shorten reaction times and save bandwidth.[11] Additionally, edge computing-based healthcare solutions are more efficient because computation is done in areas that are closer to patients. This leads to the creation of real-time health status prediction, which is crucial in healthcare systems.

L. Development of IoT Based Healthcare Monitoring System

This article introduces a smart security system and a multi-sensor Internet of Things-based healthcare monitoring system. A DHT11 sensor for humidity and room temperature, a pulse sensor for heartbeat, and an infrared thermometer sensor for body temperature were all used in the system's construction. The sensors that used the Arduino to track the patient's condition received the data from the Wi-Fi module and stored it to ThingSpeak.[12] On the LCD (cloud platform), the gathered data were shown. The patient's family or doctor would be immediately notified via a short message service (SMS) sent over the Global System for Mobile (GSM) to the patient's mobile phone if the sensor discovered an abnormal reading from the patient. Several experiments were used to evaluate the effectiveness of the temperature and pulse sensors. The percentage inaccuracy for the infrared thermometer sensor was 1.2% when compared to the previous equipment and sensors

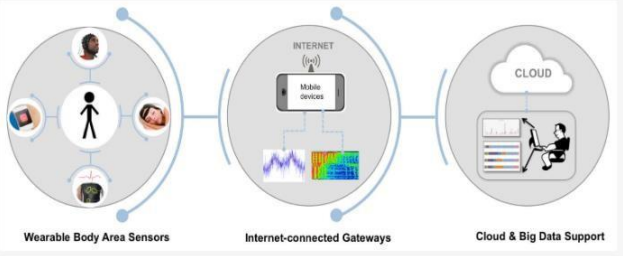

Fig 4. Architectural elements of IoWT

M. IoT Based Health Monitoring System with LoRa Communication Technology

Supporting sensors that are a component of IoT healthcare can efficiently collect and analyze patient physical health data, which has aided IoT healthcare in gaining popularity. This article shows how to use the Arduino Uno MySignals development shield with a health monitoring system that is Internet of Things-based. The study also intends to evaluate the wireless platform devices' and sensors' capabilities and effectiveness. Temperature, ECG, oxygen saturation, and pulse rate are just a few of the physical data that can be gathered by various sensors with the help of MySignals. The data gathered by MySignals is to be transferred to a computer or cloud using a wireless LoRa technology.[13] The results show that MySignals has been successfully interfaced with the ECG, temperature, oxygen saturation, and pulse rate sensors.

N. IOT Based Health Care Monitoring and Facilitation

This effort is focused on creating an IOT-based remote healthcare monitoring system with the Arduino IDE and NodeMCU. The IOT platform indicated in the previously presented work is called Ubidots. Internet of Things (IOT) open-source software is required for the Ubidots application. It is also an API for storing and retrieving data across a local area network or the Internet using the HTTP and MQTT protocols.[14] This IOT device makes it possible to take temperature and blood pressure readings as well as read the pulse rate. The proposed system continuously monitors the patient's vital signs and searches for irregularities. The findings of the ECG test per minute, the percentages of oxygen and the individuals' temperatures are recorded. The suggested design is user-friendly and affordable due to its cost effectiveness.

O. Internet of Things (IOT) based Patient health care Monitoring System using electronic gadget

An electronic wearable device and a Wi-Fi-connected smart phone are displayed in this study. Sensors are used in an IOT-based healthcare system to measure patient physical characteristics like heart rate, temperature, blood pressure, and oxygen saturation level. In the suggested system, health parameters are continuously tracked while patient data is received and saved in a cloud server via Wi-Fi at a remote location.[15] To track patient health, sensors (inputs) are connected to an ARDUINO Uno microcontroller, and the information is stored on a cloud server. An automatic alarm message with the patient's location will be delivered to medical experts via a smart phone if the patient experiences any anomalies.

P. Design and Implementation of an IoT-Based Healthcare Monitoring System

An Internet of Things-based project that offers a system for sanitising hands without touching them as well as ongoing monitoring of the patient's body temperature, heart rate, and degree of oxygen saturation. Additionally, it maintains the data readings on the doctor's mobile device and in front of the patient.[16] The suggested design uses a small box that contains a NodeMCU, DS18B20 Temperature Sensor, Max30100 Pulse-Oximeter, and other essential parts. The process only takes a minute or so, and the readings are just as precise as those from conventional medical equipment. The new initiative outperformed the conventional method by providing a service that was safer, easier, quicker, and more reasonably priced.

Q. Development of Pervasive IoT Based Healthcare Monitoring System for Alzheimer Patients

Alzheimer's disease is a progressive brain disease that gets worse over time. People with this illness are less likely than ordinary people to leave their homes because it is currently incurable. The main objective of this research is to show a continuous process that enhances the quality of life for both Alzheimer patients and their care takers. The data from Internet of Things (IoT)-based sensors used in the

proposed study determines several patient body characteristics, including temperature, blood pressure, stride action, stride speed, and other variables. These sensory inputs will be gathered by the Atmega Microcontroller.[17] The acquired data is then sent to the cloud server for data analysis via parallel communication. The patient's desired parameter is retrieved, assisting in giving patients real-time support.

R. Integrated healthcare monitoring device for obese adults using internet of things (IoT)

This research focuses on the use of IoT in the healthcare industry for monitoring and analysing the health problems of obese people in addition to emphasising the value of medical data preservation. Additionally, a device with a new design and system is developed that permits real-time monitoring in addition to the simultaneous saving of medical data for multiple patients. An Arduino environment is used by the tool to enable measurements of these parameters, and a Wi-Fi module is used to relay the data onto an IoT dashboard for remote monitoring by medical professionals.[18] The primary goal is to create an appropriate gadget that doctors will suggest for obese patients, so that doctors may evaluate patients' health patterns over time from the saved data to watch for any changes that could be a symptom of an underlying undetected health condition.

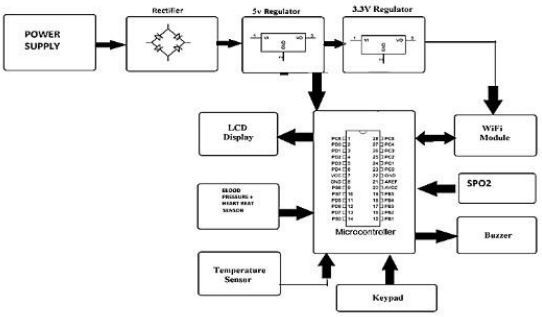

Fig 5. Block diagram of the monitoring system

S. IoT-Based Smart Health Monitoring System for COVID-19

Since the COVID-19 epidemic, it has been challenging for patients to routinely visit their doctors and for patients and medical staff to socialize due to social isolation and quarantine.[19] A smart health monitoring system that can track a person's temperature, heart rate, blood pressure, and oxygen saturation is being developed using the Internet of Things (IoT). This strategy works well in rural or village settings when neighborhood clinics can consult with city hospitals about the patients' medical issues. However, if any changes in the patient's health based on standard values occur, the IoT system will alert the doctor or physician. The cloud platform also permits data storage so that earlier measurements can be quickly accessed.

T. A health monitoring system for vital signs using IoT

This article describes the construction of a real-time health monitoring system that can store a patient's basic health parameters. The information can be sent to a medical practitioner via a variety of communication methods as an alert and for monitoring. Currently, healthcare systems only provide one type of communication, which is frequently either GSM or data access through a web application. By providing multiplexed data across three modes—GSM message services, Wi-Fi, and mobile applications—the proposed health monitoring system enhances the delivery of healthcare.[20]

III. CONCLUSION

An analysis of these research taught us about the mindset of innovators who developed these systems using conventional sensors such as a standard temperature sensor, an Arduino microcontroller board, local servers, or clouds. The security and ease of use of Amazon Web Services (AWS) make it the best cloud for this kind of application, according to a thorough study of these tests. The information may also be transmitted and routine tracking performed using other clouds. Additionally, these IoT systems can be used in line with the person's earlier data if we focus on them for diseases or age groups. Additionally, this information can be used by the patient or an individual to forecast their health, since each person's blood pressure, body temperature, and other details vary.

The survey document summarizes the current Health Monitoring systems. On the basis of their implementations, applications, and methods, the technology and applications for various IOT-based health monitoring systems are examined and evaluated. Each technology has its own limitations and applications. The executive summary of this article provides examples of the approaches and programs that should be used to improve the IOT-based health monitoring system's performance.

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