Study of Smart Healthcare Solutions

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***Abstract*—** An IoT-based healthcare system can significantly enhance the well-being of patients and improve their quality of life, particularly in remote areas where access to healthcare facilities is limited. By leveraging IoT technology, real-time monitoring of a patient's vital health parameters can be achieved, ensuring timely medical intervention when needed.

In this project, key health indicators such as body temperature, pulse rate, and oxygen saturation levels are continuously monitored using sensors like LM35 for temperature measurement and MAX30100 for pulse rate and oxygen saturation. These sensors collect real-time data, which is then transmitted to an IoT cloud platform for storage and analysis. The recorded data helps in tracking a patient's health history, allowing healthcare professionals to access and evaluate trends over time.

To make the system user-friendly and accessible, an Android application is developed to display the current health parameters.

Keyword — **Iot technology, LM35(Microcontroller), MAX30100, ARDUINO IDE**

I. INTRODUCTION

Internet of Things (IoT) can be defined as when "Things start to think". Here things in IoT can be any physical object or entity which has unique identifiers (UIDs). It is a system of interconnected devices (with UIDs) can sense, accumulate and transfer data over a network with less or without human intervention and can be utilize remotely. In healthcare sector IoT plays an important role as it is reliable, flexible and affordable system, it offers an optimizing technology to acquire the leading healthcare services and can meliorate the current medical services [4]. There are many vital signs for measurement of health parameter, out of which measurement of body temperature is used to determine that person is having fever or not. As the body temperature varies with the variation in the temperature of environment i.e., in dawn the temperature happened to be lowest while highest in the afternoon. 37 ℃ or 98.7 ℉ is considered as the normal body temperature of a person. As we know the about the temperature variation, both the variation of environment and body need to measure. Similarly, the pulse rate of a person plays an important role in the cardiovascular process. Pulse rate expressed in beats per minute (BPM) measured by beats of heart in per minute. About 72bpm – 100bpm is taken as normal, if it either exceed or decrease then prevention is needed. BPM depends on how a person is working .Pulse rate expressed in beats per minute (BPM) measured by beats of heart in per minute. About 72bpm – 100bpm is taken as normal, if it either exceed or decrease then prevention is needed. BPM depends on how a person is working i.e., if a person is exercising then the heart rate increases. The fitness of a person is decided by the rate at which pulse rate comes to normal point. With India being the second most populous country in the world, medically challenged people increasing steadily rural population are affected most because of the lack of medical practitioners.

II. LITERATURE REVIEW

1. Ayan Banerjee and Sandeep Gupta, in their paper "Analysis of Smart Mobile Applications for Healthcare under Dynamic Context Changes" have discussed a novel technique to analyze Sport Medicine Diagnostic Coding System (SMDCS) considering the dynamic changes in the context and the constant interaction of the computing systems with the physical environment. To show the usage of the technique, Ayushman pervasive health monitoring system is considered as an example of SMDCS. To show the usage of the technique, Ayushman pervasive health monitoring system is considered as an example SMDCS. Analytical results show that practices considered healthy for a person such as mobility may not be beneficial when an SMDCS is controlling health.

2. Mayank Pandey and Sandeep Shukla, in their paper "Security of Healthcare Data Using Blockchains" have discussed the advancement in the healthcare sector is entering into a new era in the form of Health 4.0. The integration of innovative technologies like Cyber-Physical Systems (CPS), Big Data, Cloud Computing, Machine Learning, and Blockchain with Healthcare services has led to improved performance and efficiency through data-based learning and interconnection of systems. On the other hand, it has also increased complexities and has brought its own share of vulnerabilities due to the heavy influx, sharing, and storage of healthcare data.

3. Rashi Rastogi and Mumta Bansal, in their paper "Analysis

of various smart healthcare technologies" have reviewed about the ongoing advancements in healthcare technologies and the practical application and synthesis of various knowledge for enhancing, preserving, and supporting human health. The improvement of engineering applications to healthcare technologies, which has significant economic, scientific, and societal implications, determines the quality of people's lives. The creation of an efficient and cost-effective system that is completely adequate for the financial, clinical, and ancillary needs in healthcare is a challenge that all health economies face globally.

4. Sepideh Poorejbari and Wathiq Mansoo, in their paper "Smart healthcare systems on improving the efficiency of healthcare services" have discussed the rapid rise in e-health technologies such as Electronic Health Records (EHRs) and some emergency detection and response methods. One of the advances that can manage some of the challenges of smart healthcare in terms of security, sharing, integration and management, is cloud computing. The purpose of this article is to highlight the value of pervasive computing, especially cloud-based systems in healthcare sector. The significance and opportunities of using cloud computing in pervasive healthcare and then look at the current as well as the future challenges it faces.

5. Yasmeen Shaikh and V. K. Parvati, in their paper "Survey of Smart Healthcare Systems using Internet of Things (IoT)" have reviewed that monitoring the health of a person(s) has become a major IoT application where we need to have a system at home that helps inhabitants to have their health check done without affecting their daily routines. It is very much essential to have a IoT-driven remote health monitoring system for ailing individuals which can inform caretakers in case of an emergency. These applications are constrained by the amount of data collected, managed and exchanged. The factors that constraint IoT applications are robustness, privacy, security and reliability.

6. Houriyeh Khodkari, Saeed Ghazi Maghrebi, and Abbas Asosheh, in their paper "Smart Healthcare and Quality of Service Challenges" have discussed that by increasing intelligence in health services, people's quality of life will improve and access to emergency medical services and care for patients and elderly will be faster and easier. Internet of Things (IoT) services can provide health care to a new generation of skilled services that are highly acclaimed. However, there are challenges in this area. One of these challenges includes assurance quality of service (QoS) due to the high volume of information. The existence of programs that produce a large amount of real-time data in terms of velocity and variety has turned this into a big data problem. To overcome these challenges, the researchers recommend the integration of the cloud and the Internet of Things.

7. Durga Amarnath M. Budida and Ram S. Mangrulkar in their paper "Design and implementation of smart healthcare system using IoT" have discussed a diagnosis, and monitoring of health is a very important task in the healthcare industry. Due to time constraints, people are not visiting hospitals, which might and possibly lead to a lot of health issues in one instant of time. Predominantly, most of the healthcare systems have been developed to predict and diagnose the health of the patients, by which people who are busy with their schedules can also monitor their health at regular intervals. Many studies show that early prediction is the best way to cure health because early diagnosis will help and alert the patients to their health status.

8. Ajay Rana, Ajay Reddy, and Anurag Shrivastava in their paper "Secure and Smart Healthcare System using IoT and Deep Learning Models" have discussed how patients of smart healthcare systems have access to their medical records through an online portal. Since patients do not want their names made public, maintaining data privacy and security is essential to the success of the organization. Users are required to submit personal information to an authentication server before they can proceed with the login process. The information includes a login ID as well as a password. It is possible that the patient's adversaries will be able to violate their right to privacy if they are able to keep an eye on the patient or get in touch with them. In the course of this research, they utilized a method known as camel-based rotating panel signature.

9. Repu Daman Chand and Ranjana Rajnish in their paper "IoT-enabled Smart Healthcare System for Accessing Healthcare Services Anywhere and Anytime" have discussed this paper aims to deploy an Internet of Things (IoT) enabled Smart Healthcare System for accessing healthcare anywhere and anytime in India. Health Systems deployed in the Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS) telemedicine network. These systems are in use at primary hospitals and large public events/mela for providing health service to understand the effectiveness of pre-screening at remote places where there is always a shortage of trained health professionals and explore challenges & issues with potential solutions for its effective implementation. In future smart healthcare systems have the potential to transform health care delivery, making it more accessible, affordable and effective.

Sarfraz Hussain and Sujay Deb in their paper "A Study on Securing Data in Smart Healthcare Applications" have discussed that as the human population is growing drastically fast, the need for medical attention is also increasing proportionally. With the evolving technology and advancement in science, smart healthcare applications are being implemented. Big data and IoT brought the smartness in the healthcare system. The data can be accessed by anyone, anytime and from anywhere, which gives flexibility to use the online platform for multiple users at the same time. It is faster, cheaper, and easily accessible. Fraudsters make use of the patient or doctor details to claim insurance and buy drugs. This paper presents a study on the development of smart healthcare applications and discusses the security measures to protect user's ID and their details.

III. WORKING:

In the data acquisition stage, vital health parameters such as body temperature, pulse rate, and oxygen saturation levels are continuously monitored using LM35 and MAX30100 sensors. The LM35 sensor measures body temperature, while the MAX30100 sensor detects pulse rate and SpO_2 levels through photoplethysmography (PPG). These sensors are connected to an ESP32 microcontroller, which serves as the central

processing unit. The microcontroller reads sensor data at regular intervals and converts the analog signals into digital values. The data transmission stage involves sending the acquired sensor data wirelessly to a cloud-based platform via the ESP32's built-in Wi-Fi module. The data is formatted and transmitted using MQTT or HTTP protocols, ensuring reliable and efficient communication. Secure data transmission techniques, such as encryption, are implemented to protect patient confidentiality. The system is designed to be non-invasive, cost-effective, and portable, making it ideal for deployment in hospitals, homes, schools, offices, and commercial spaces. By leveraging IoT and cloud technology, this system ensures continuous health monitoring, facilitates early disease detection, and enhances healthcare accessibility, particularly in remote areas where medical facilities are scarce.

IV. BLOCK DIAGRAM:

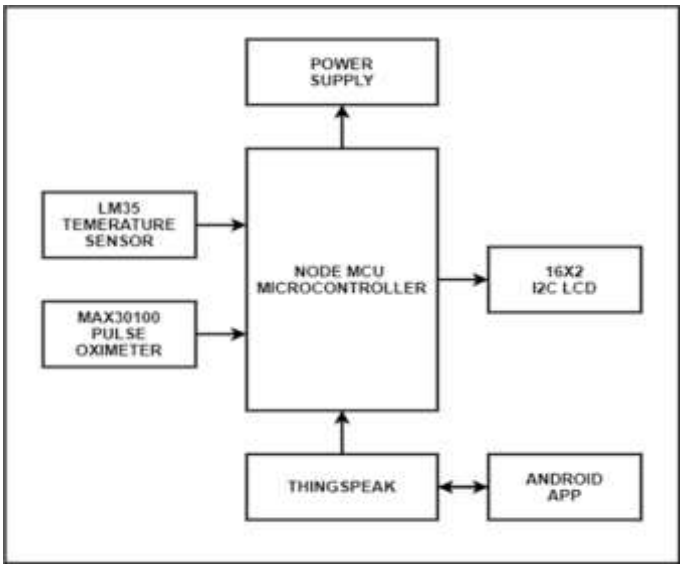

Figure 1: Block Diagram of Smart healthcare solutions

1. Power Supply
- Provides the necessary electrical power to all components in the system.
- Ensures stable voltage for the Node MCU, sensors, and display.

2. LM35 Temperature Sensor
- Analog sensor that measures body temperature.
- Sends temperature data to the Node MCU for processing.

3. MAX30100 Pulse Oximeter
- Measures blood oxygen saturation (SpO2) and pulse rate.
- Sends data to the Node MCU via I2C or other communication protocols.

4. Node MCU Microcontroller
- Core processing unit of the system.
- Collects data from LM35 and MAX30100 sensors.
- Processes sensor data and sends it to both:
  - 16x2 I2C LCD for real-time display.
  - ThingSpeak cloud platform for remote monitoring.

5. 16x2 I2C LCD
- Displays sensor readings (temperature, SpO2, pulse rate) in real-time.
- Uses I2C communication to reduce wiring complexity.

6. ThingSpeak
- An IoT analytics platform.
- Receives processed sensor data from the Node MCU.
- Allows real-time monitoring through the internet.

7. Android App
- Interfaces with ThingSpeak to display the health data on a smartphone.
- Enables users or healthcare providers to monitor patient health remotely.

V. CONCLUSION:

The IoT-based healthcare system provides an efficient and real-time solution for monitoring vital health parameters such as body temperature, pulse rate, and oxygen saturation. By integrating sensors with an ESP32 microcontroller and cloud-based data storage, the system ensures continuous health tracking, particularly in remote and underserved areas. The inclusion of a mobile application enhances accessibility, allowing patients, caregivers, and healthcare professionals to monitor health conditions from anywhere. The system's ability to generate automatic alerts in case of abnormal readings ensures timely medical intervention, reducing the risk of severe health complications. This model is designed to be non-invasive, cost-effective, and scalable, making it suitable for various applications such as hospitals, home healthcare, workplaces, and public spaces. By reducing the need for frequent hospital visits, it alleviates the burden on healthcare facilities while improving patient outcomes. However, challenges such as data security and internet dependency must be addressed to enhance its reliability.

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