IMHMS: IoT Based Modern Health Care Monitoring System

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Abstract

Internet of Things (IoT) technology has attracted much attention in recent years for its potential to alleviate the strain on healthcare systems caused by an aging population and a rise in chronic illness. Standardization is a key issue limiting progress in this area, and thus this paper proposes a standard model for application in future IoT healthcare systems. This survey paper then presents the state-of-the-art research relating to each area of the model, evaluating their strengths, weaknesses, and overall suitability for a wearable IoT healthcare system. Challenges that healthcare IoT faces including security, privacy, wearability, and low-power operation are presented, and recommendations are made for future research directions [1]. we survey state-of-the-art methods, protocols, and applications in this new emerging area. This survey paper proposes a novel taxonomy for IoT technologies, highlights some of the most important technologies, and profiles some applications that have the potential to make a striking difference in human life, especially for the differently abled and the elderly. As compared to similar survey papers in the area, this paper is far more comprehensive in its coverage and

exhaustively covers most major technologies spanning from sensors to applications [5]. Internet of Things (IoT) especially in the Healthcare area, we want to take care of our elders with some monitoring equipment, and the Internet of Things can play a monitoring equipment, and the Internet of Things can play a significant role [15]. ZigBee, Long-range Wide Area Network (LoRaWAN), Radio Frequency Identification (RFID). Apart from this, it was also observed that remote monitoring system in healthcare is incomplete without data processing and early prediction in such diseases [15].

Key words: Healthcare, LoRaWAN, ZigBee, Radio Frequency Identification (RFID).

1. Introduction

Internet of Things (IoT) is regarding the development of the internet ahead of computers and smart phones to an entire series of environments, procedures, and other things. It has been many years since IoT came into existence, but still, we have not entirely understood it, and this is the reason why we have not been able to use it efficiently in the healthcare area. It means to say that it is yet to be known well so that we can use it properly in our daily life [15]. Wireless transmission data technology in the medical field is the most important application that any organisation in the health sector needs it. As well as this technology is often characterised by the speed, safety and easy installation of hardware at lower costs Patient monitor systems which are used in hospitals are used for continuous monitoring of patient's physiological values. The limitation of these systems is that the sensors are ‘hardwired’ to the monitors or PCs nearby the patient. In spite of wired connectivity with the monitoring devices, nursing staff should keep track of all vital values by making note the records either manually or entering into the computers which would sometime tend to make human errors that may lead to serious consequences on the patient [15]. In this work, we have demonstrated the body temperature measurement data transmission wirelessly using two transceivers based on ZigBee. One of them is connected to a small but low-cost Raspberry Pi and the other is connected to a simple microcontroller board Arduino which works as a simulator for a medical equipment that in turn senses the temperature [15]. During the recent decade, rapid advancements in healthcare services and low-cost wireless communication have greatly assisted in coping with the problem of fewer medical facilities. The integration of mobile communications with wearable sensors has facilitated the shift of healthcare services from clinic-centric to patient-centric and is termed as "Telemedicine" in the literature [9].In the larger perspective, telemedicine can be of two types: (1) live communication type, where the presence of the doctor and patient is necessary with additional requirements of high bandwidth and good data speed, store and forward type, which requires acquisition of medical parameters such as vital signs, images, videos, and transmission of patients data to concerned specialist in hospital [9]. As adults age over 65 years, they need continuous health monitoring. Their population is increasing since the past two decades. By 2025 it is expected to reach 1200 million among which 80% will be from developing countries [10].

2. Review of Literature

Billion in 2017 to 50.1 billion by 2020, and the importance of incorporating Wi-Fi, NFC, GPS, and mobile technologies for uninterrupted connectivity. The IoT's aim is to merge organizational operations with automation, using sensors like MCUs and MPUs, to enhance smart services in areas like healthcare, transportation, energy, and homes. The development of IoT parallels software development, involving design, specification, and implementation stages. Eskelinen emphasized thoughtful planning that balances practical goals with theoretical foundations, supported by systematic testing to ensure reliability. In healthcare, IoT applications utilize Wireless Sensor Networks (WSNs) for monitoring vital signs like pulse, oxygen levels, and blood pressure, as seen in studies by Rotariu, Manta, and others. Technologies like Wi-Fi and Bluetooth are employed for remote monitoring, showcasing IoT's effectiveness in improving healthcare delivery.

3. Proposed System

The proposed system is a remote health monitoring solution using IoT. It includes wearable sensors to measure a patient's heart rate and body temperature, and environmental sensors to monitor room temperature and humidity. All sensor data is processed by a microcontroller (e.g., Arduino or ESP32) and transmitted via Wi-Fi to a secure cloud platform. Doctors can access real-time data through a dashboard or mobile app to monitor patient health and receive alerts if any parameters exceed safe limits. The system is cost-effective, portable, and easy to install, making it ideal for homes and rural clinics. It also stores historical data for long-term analysis and may be enhanced in the future with AI, stronger security, and additional sensors. Zigbee plays vital role in a healthcare monitoring system is to enable reliable, low-power, and wireless communication between various medical sensors and central monitoring units to support continuous, real-time patient monitoring. And Lora may use in this proposed system because of The main purpose of LoRa (Long Range) in a healthcare monitoring system is to enable long-distance, low-power, wireless communication for transmitting patient health data especially in remote, rural, or large-scale environments where traditional connectivity (like Wi-Fi or Zigbee) is unavailable or impractical. And RFID merged with this system to facilitates RFID plays a crucial role in healthcare monitoring systems, primarily for identification, tracking, and automation, rather than for physiological data transmission like Zigbee or LoRa. It enhances patient safety, inventory management, and workflow efficiency.

4. IoT Architecture

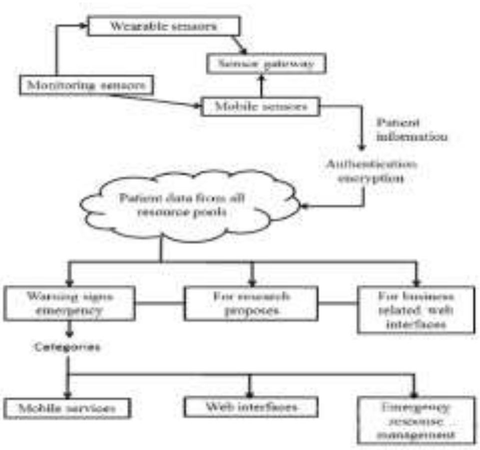

Fig-1: Health Care Architecture in IoT

The Figure 1 is explaining about the Architecture of IoT used in (IMHMS)

4.1. Connectivity

Physical object connects into embedded systems, Sensors, Applications, Networks connectivity based on Iot device, Network, Gateway, Cloud platforms and applications.

4.2. Sensors

Sense based detects changes in the environment (e.g., heat, motion, pressure). convert physical signals into digital data. Send the data to IoT gateways, cloud platforms, or other devices.

4.3. Application Platforms

Software frameworks that help manage, process, and analyse data from IoT devices Management, Data Collection & Storage, Data Processing & Analytics, Visualization & Dashboards, Integration, and Security & Authentication.

4.4. Data analysis

Process of collecting, processing, and interpreting data from connected devices and sensors collect the information is Data Processing, Data collection, storage and Data Analysis and Data visualization& Actins.

4.5. Product Infrastructure

Refer to the complete architecture support to the system development and deploying the systems with multiple layers such as Application, Control, Data Layers.

5. Types of Sensors Used in IoT Health Care System

5.1. IoT Wearable Sensor

IoT Wearable Sensor is the sensor used to sense all the metrices in wearable part like Human body.

Fig-2: Wearable Sensors in IoT

The above Figure 2 is explaining about Measuring body metrics (e.g., heart rate, temperature). Monitor movements or posture. Track environmental exposure (e.g., UV, air quality). Transmit real-time data via Bluetooth, WIFI, or cellular networks to phones or cloud platforms.

5.2. Heart Rate Sensor

Function: Measures the patient's heart rate, providing data on their cardiovascular health.

Application: Used in wearable devices like smartwatches or chest bands to monitor heart rate continuously. This helps in identifying any abnormal heart rhythms or irregularities.

Examples: Photoplethysmogram (PPG) sensors, electrocardiogram (ECG) sensors.

5.3. Temperature Sensor

Function: Monitors body temperature, an essential indicator of a person’s overall health.

Application: Used to detect fever or abnormal temperature fluctuations, which can be symptoms of infections or other health conditions. Thermostats, thermocouples, infrared temperature sensors.

5.4. Blood Pressure Sensor

Function: Measures the blood pressure of the patient in real-time, which is crucial for assessing the risk of cardiovascular diseases.

Application: Typically used in wearable devices or home health monitoring kits. Regular monitoring of blood pressure can help detect hypertension or hypotension early.

Examples: Oscillometer sensors, oscillography sensors.

5.5. Oxygen Saturation Sensor (Pulse Oximeter)

Function: Measures the oxygen saturation level (SpO2) in the blood, an important indicator of respiratory health.

Application: Used in devices like pulse oximeters that help in tracking oxygen levels, especially in patients with respiratory disorders or during post-operative recovery.

Examples: LED-based sensors using red and infrared light.

5.6. ECG (Electrocardiogram) Sensor

Function: Monitors the electrical activity of the heart to identify any arrhythmias or abnormalities. **Application:** Typically used for patients with heart conditions or those undergoing cardiac rehabilitation. These sensors help detect early signs of heart disease.

Examples: Electrodes placed on the skin, integrated in wearable ECG monitors.

5.7. Repository rate sensor

Tracks the number of breaths taken per minute, which can be an important indicator of lung and respiratory health.

Application: Used to monitor patients with chronic respiratory diseases, such as asthma or COPD. It can also be used during recovery or in intensive care units.

Examples: Piezoelectric sensors, capacitive sensors.

5.8. Glucose Sensor

Function: Monitors blood glucose levels in diabetic patients.

Application: Continuous glucose monitoring systems (CGM) are used to help diabetics manage their blood sugar levels in real-time.

Examples: Enzyme-based sensors, electrochemical glucose sensors [15].

6. Network Components

6.1. Microcontroller or IoT Gateway

Raspberry Pi:

A low-cost, single-board computer often used for IoT experiments, capable of acting as both a sensor hub and server.

Arduino: An open-source platform that is commonly used to prototype IoT devices and sensors, integrating sensors and controllers. This may use Wi-Fi Connection for Data transfer.

6.2. Connectivity Modules

Wi-Fi module (e.g., ESP8266, ESP32): To connect sensors to the internet for remote monitoring and control.

6.3. Bluetooth/BLE module

If the experiment involves short-range communication. LoRa module: For long-range communication in rural or remote areas

6.4. Power Supply

Batteries or power adapters to provide energy to sensors and microcontrollers. If the system is running sensors continuously, consider a stable power source like a USB adapter or a battery pack with a power management system.

7. Types of IoT Server Technologies

7.1. Data Collection & Edge Servers

Located near the patient, they gather real-time data from IoT sensors. Devices like Raspberry Pi are commonly used.

7.2. Application Servers

Handle backend logic, run alert systems, and manage APIs, notifications, and user authentication using frameworks like Node.js or Django.

7.3. Database Servers

Store sensor data and medical records using relational (MySQL, PostgreSQL) or NoSQL databases (MongoDB, Influx DB).

7.4. Cloud Servers

Offer scalable storage and processing through platforms like AWS, Azure, or Google Cloud, enabling features like remote monitoring and AI integration.

7.5. AI/Analytics Servers

Run predictive models (e.g., fall detection) using tools like TensorFlow or Apache Spark.

7.6. Security Servers

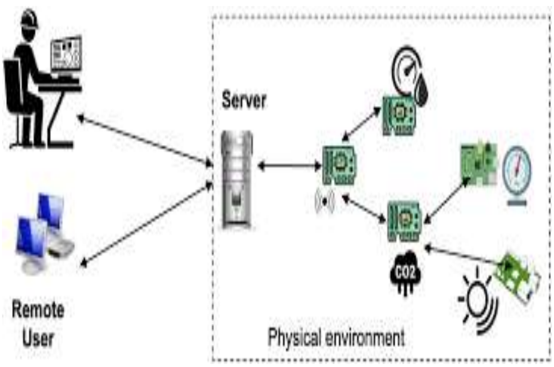

Fig-3: IoT Server

Figure 3 describes Managing encryption, access control, and compliance using technologies like OAuth2, VPNs, and firewalls.

8. IoT SERVER REQUIREMENTS

8.1. Hardware Infrastructure

IoT servers require solid hardware to handle large amounts of data in real-time. This includes computing power, storage capacity, and networking capabilities to manage and process data from numerous IoT devices simultaneously.

8.2. IoT Protocol Support

IoT servers should support a variety of communication protocols like MQTT, HTTP, CoAP, and WebSocket to ensure compatibility with different IoT devices. MQTT is particularly popular in IoT because of its lightweight nature and ability to handle low bandwidth conditions.

8.3. Data Processing Engine

The server must have an efficient engine for processing the data received from IoT devices. This could include stream processing engines, data analytics tools, and machine learning algorithms for real-time insights and decision-making.

8.4. Database

IoT data can be massive, coming from multiple of multiple devices and sensors. To store this data, IoT servers need powerful databases that can handle time-series data or event-based data efficiently. Popular database choices for IoT include Influx DB, Cassandra, and Timescale DB.

8.5. Security Framework

IoT servers must prioritize security, given that IoT devices are often vulnerable to attacks. Secure communication protocols, encryption, and authentication mechanisms are critical to prevent unauthorized access and data breaches.

9. Key Findings

9.1. Sensor Accuracy:

The temperature, humidity, and motion sensors performed within the expected accuracy ranges, providing reliable data with minimal variance. This confirms the effectiveness of the sensors in practical applications, such as environmental monitoring and smart home systems.

9.2. Communication Efficiency:

The system, using MQTT as the communication protocol, showed low latency and minimal packet loss, ensuring smooth and efficient data transfer. Even under high device loads, the communication infrastructure handled the data with acceptable delays, supporting the system's scalability.

9.3. Communication Efficiency:

The system, using MQTT as the communication protocol, showed low latency and minimal packet loss, ensuring smooth and efficient data transfer. Even under high device loads, the communication infrastructure handled the data with acceptable delays, supporting the system's scalability. without noticeable performance degradation. While performance slightly decreased with 100devices, the system was still functional, indicating that optimizations in infrastructure or cloud-based solutions could further enhance scalability.

9.4. System Reliability

The IoT network demonstrated strong fault tolerance, with quick recovery from power failures and device disconnections. This robustness makes the system well-suited for mission-critical applications that require continuous operation and minimal downtime.

Latency with High Load While the system performed well under moderate load, further scalability improvements would be needed for environments requiring support for hundreds of devices. Optimizing the communication network and cloud database for high traffic can address this limitation.

9.5. Data Retrieval Time

With increasing numbers of devices, the data retrieval time from the cloud platform slightly increased. Enhancing the database architecture or introducing data caching mechanisms could help reduce this delay.

10. Challenges and Areas for Improvement

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11. Conclusion and Future Enhancement

The IoT-Based Modern Health Care Monitoring System (IMHMS) enhances healthcare by enabling real-time monitoring of vital signs through smart devices, leading to faster, more accurate treatment, improved patient comfort, and reduced costs. It supports remote, efficient, and personalized care through features such as AI integration, cloud-based analytics, enhanced data security, and compatibility with wearable devices. Additional elements like telemedicine, energy-efficient design, and user-friendly interfaces further improve the system's overall efficiency, accessibility, and usability.

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