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A Study On Iot – Based Health Care System For Home Quarantine People

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ABSTRACT
The rapid spread of diseases like COVID-19 has driven demand for remote health monitoring, particularly for home quarantine. This paper presents a low-cost, IoT-based system using an Arduino Uno, MLX90614 temperature sensor, MAX30100 pulse oximeter, and ESP8266 module to continuously monitor temperature and heart rate. Data is securely transmitted to healthcare providers, enabling real-time, remote access and early abnormality detection, reducing in-person visits. The system, tested for accuracy, latency, and power efficiency, offers a scalable telemedicine solution, with future enhancements planned for data security and predictive algorithms for proactive care.
Keywords—*IoT, remote health monitoring, quarantine, Arduino, biosensors, telemedicine, COVID-19.*

I. INTRODUCTION

The COVID-19 pandemic has underscored the need for efficient remote healthcare monitoring, particularly for home-quarantined individuals. Traditional in-person monitoring increases transmission risk, making IoT technologies an ideal solution for contactless, continuous health tracking. IoT healthcare systems use sensors and wireless communication to collect and transmit real-time vital data, such as temperature, heart rate, and blood oxygen levels, enabling prompt intervention when needed.

This paper introduces an IoT-based health monitoring system designed around the Arduino Uno, incorporating the MLX90614 temperature sensor, MAX30100 pulse oximeter, and ESP8266 WiFi module for real-time data transmission. An LCD display provides local feedback, while data is securely sent to ThingSpeak for remote monitoring by healthcare providers.

The main contributions of this paper include:

(1) a low-cost system for real-time monitoring of key health indicators,

(2) real-time alerts for immediate responses to abnormal readings, and

(3) scalable, secure data management using IoT protocols to ensure reliable patient data confidentiality.

II. RELATED WORK

In recent years, Internet of Things (IoT) healthcare monitoring systems have gained significant attention for their ability to support remote patient care, especially in situations that limit direct contact, such as home quarantine. Previous research has shown the usefulness of IoT systems for monitoring vital signs, with applications in chronic disease management and emergency response. This section reviews important studies and highlights the challenges and limitations that guide the design of the proposed system.Adib et al. [1] introduced a contactless health monitoring solution that uses Wi-Fi-based sensors to capture vital signs like heart rate and respiratory rate. Their research highlighted the benefits of contactless technology, especially in situations where there is a risk of infection. However, the system depends on Wi-Fi, which raises concerns about latency and accuracy, particularly in crowded urban areas or networks with high interference.Similarly, Srivastava [2] examined IoT-enabled healthcare solutions and identified key challenges such as network latency, data security, and energy efficiency. These issues are especially important in remote health monitoring, where continuous data transmission is necessary yet must remain secure and efficient. Srivastava's work emphasizes the need for optimized, low-power devices that ensure secure, real-time data access while minimizing power usage. This paper addresses that need by incorporating energy-efficient components and protocols.

Another relevant study by Jeberson et al. [3] looked into using edge computing for remote health monitoring. They proposed a sensor-based IoT system with local data processing capabilities. This approach lessens the reliance on network stability since some processing happens locally instead of in the cloud. However, integrating edge computing can add complexity and cost, which may limit its scalability for applications requiring affordability and easy deployment, such as monitoring during quarantine.Nguyen and Smith [4] researched low-power IoT systems for health applications, identifying methods to cut energy consumption without losing data accuracy. Their findings support using power-efficient components and low-power modes in wireless communication modules, which this paper incorporates into its design. These optimizations are vital for extended monitoring applications where battery life is an issue.Sweeney et al. [5] focused on the data security concerns in IoT health monitoring systems. Their study suggested encryption techniques to protect transmitted health data and highlighted the importance of data privacy in IoT healthcare applications. Even though their encryption methods improve data security, implementing these protocols on limited devices can affect system performance. This paper addresses these concerns by using the HTTPS protocol for secure transmission and restricting data access to authorized healthcare providers, balancing security with system efficiency.

III. SYSTEM ARCHITECTURE

The proposed IoT-based health monitoring system aims to provide continuous, real-time monitoring for individuals in home quarantine. The system combines hardware and software components to allow smooth data collection, processing, transmission, and visualization. This section outlines the key components and their interactions.

A. Hardware Components:

The hardware design centers on the Arduino Uno microcontroller, which manages data collection from biosensors and communication with the IoT platform.

1. Microcontroller (Arduino Uno):

The Arduino Uno acts as the central processing unit for the system. It gathers data from the sensors, processes it, and sends it to the IoT server. Its ability to work with various sensors and modules makes it a suitable choice for this application.

2. Sensors:

- **MLX90614 Infrared Temperature Sensor:** This sensor records body temperature using non-contact infrared sensing. It is ideal for quarantine monitoring as it avoids physical contact. The MLX90614 delivers precise measurements within an error margin of ±0.5°C.
- **MAX30100 Pulse Oximeter:** The MAX30100 features a heart rate sensor and SpO_2 sensor in one module. It monitors both heart rate and blood oxygen levels, which are essential for assessing patient health.

3. Communication Module (ESP8266 WiFi Module):

The ESP8266 module enables wireless data transfer from the Arduino to an IoT platform, allowing medical personnel to access health data from a distance. This module is set to work in low-power mode when not in use, which helps to save energy for longer operation.

4. LCD Display:

A 16x2 LCD provides real-time feedback for the patient by displaying current values of monitored health parameters. This feature ensures that patients can quickly check their health status without needing external devices.

5. Power Supply:

The system gets its power from an external DC supply or a rechargeable battery, allowing flexible installation. This setup enables continuous monitoring, even in places with limited power. The power supply design ensures reliability and portability, which are important for remote healthcare.

B. Software Components

The software manages data collection, processing, and communication with the IoT platform for remote monitoring and visualization.

1. **Arduino IDE and Embedded Code:**
The system is programmed using the Arduino Integrated Development Environment (IDE). This setup allows for efficient sensor data collection and processing. The Arduino reads and processes data from the temperature and pulse sensors, preparing it for transmission.
2. **Data Transmission and Communication Protocols:**
The ESP8266 WiFi module uses secure HTTP (HTTPS) protocols to send data to the ThingSpeak IoT platform. This secure method protects patient data during transmission and addresses privacy concerns. ThingSpeak provides an API that simplifies data upload and retrieval for real-time visualization and alerts.
3. Data Visualization and IoT Platform:
Data sent to ThingSpeak appears on a real-time dashboard that healthcare providers can access. The IoT platform displays temperature, heart rate, and SpO_2 levels, allowing for continuous monitoring of the patient's health. It also keeps historical data for trend analysis, enabling healthcare staff to track patient health over time.
4. Alert Mechanism:
An essential feature of the system is its real-time alert mechanism. If sensor readings go beyond set thresholds, such as high body temperature or low oxygen saturation, an alert activates. A buzzer sounds locally to alert the patient, and the IoT platform sends a notification to healthcare providers for immediate action.

C. System Workflow

The system follows a structured workflow that starts with data acquisition, followed by processing, transmission, and real-time visualization:

1. **Data Acquisition:** The MLX90614 and MAX30100 sensors gather body temperature and heart rate/SpO_2 data, then send these readings to the Arduino.
2. **Data Processing:** The Arduino processes the sensor data, filtering out noise to ensure clarity before transmission.
3. **Data Transmission:** The processed data is sent to the ThingSpeak IoT platform through the ESP8266 module using HTTPS.
4. **Real-Time Monitoring and Alerts:** The data is visualized in real-time on the IoT dashboard. Alerts are triggered for readings outside the normal range, notifying healthcare providers of potential health risks.

IV. BLOCK DIAGRAM

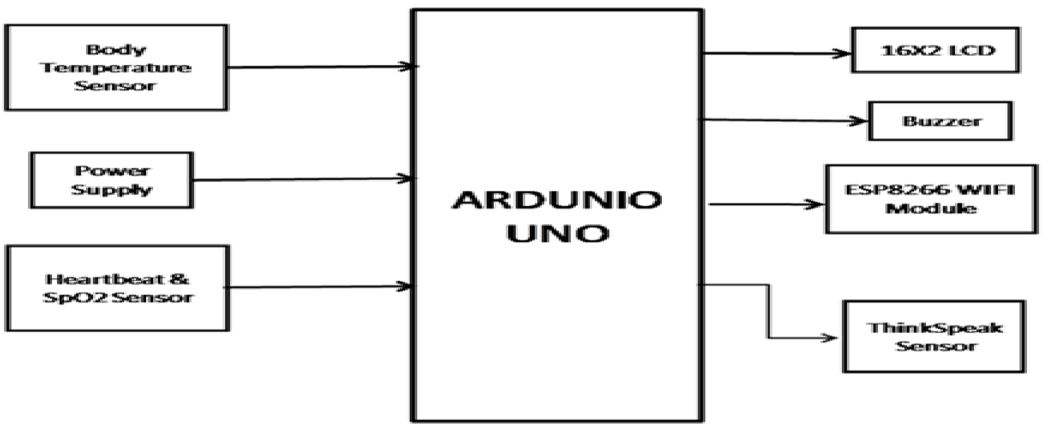

Fig: Block Diagram

A. Power Supply

The system's power supply unit delivers regulated power to ensure stable operation for all components. The selected power rating and voltage levels meet the needs of the Arduino, sensors, display, and Wi-Fi module, which helps reduce fluctuations that could affect measurements.

B. Arduino Uno
The Arduino Uno is the main controller of the system. It connects with the sensors, processes incoming signals, and runs logic to decide when to trigger alerts. Its reliable and flexible design makes it perfect for low-power applications and real-time processing in IoT-based health systems.
C. Body Temperature Sensor
This sensor, usually a thermistor or digital temperature sensor, accurately measures body temperature by detecting the infrared radiation emitted from the body. The Arduino Uno processes these signals and calibrates them to show meaningful temperature data.
D. Heartbeat & SpO_2 Sensor
The heartbeat and SpO_2 sensor works by detecting photoplethysmographic (PPG) signals, which measure changes in blood volume in the skin. The sensor has an integrated light and photodetector that allows it to check pulse rate and blood oxygen levels without needing to break the skin. It sends these readings to the Arduino for further analysis and display.
E. ESP8266 WiFi Module
The ESP8266 module gives the system internet access. It connects to local Wi-Fi and sends data from the Arduino Uno to the ThinkSpeak cloud platform. This wireless link allows for easy data transmission and supports real-time remote monitoring.
F. 16x2 LCD Display
This display offers a quick and clear interface, showing real-time data like temperature, heart rate, and SpO_2 levels. Its low power use and simple interface make it suitable for continuous monitoring in low-power settings.
G. Buzzer
An audio alert device, the buzzer activates based on specific health conditions. This includes high or low temperature, low SpO_2, or irregular heart rates, giving immediate notifications for abnormal readings.
H. ThinkSpeak Cloud Platform
ThinkSpeak is a cloud-based IoT analytics platform for data visualization, analysis, and remote access. The collected data is sent to the cloud, where healthcare professionals or caregivers can monitor and analyze it. This allows for efficient tracking of patient health metrics and timely interventions.

V. IMPLEMENTATION
The IoT-based health monitoring system is developed using a clear method that includes hardware and software integration, data handling, and real-time alert systems.
Data collection starts with setting up the MLX90614 infrared temperature sensor and the MAX30100 pulse oximeter, both connected to the Arduino Uno. The temperature sensor follows the I^2C protocol, while the pulse oximeter uses digital communication. Data is gathered every second. To improve accuracy, a moving average filter reduces noise in the heart rate data, and the sensors are calibrated to match medical standards. The collected data, including timestamps and vital signs, is stored in local variables for processing.Communication happens through the ESP8266 WiFi module, which connects to a local network using preset credentials. The health data is organized in a JSON format for sending, including fields for temperature, heart rate, and SpO_2 levels. The Arduino transmits this data to the ThingSpeak server using HTTPS and HTTP POST requests, receiving confirmation when logging is successful.A real-time alert system is set up with specific limits: temperature above 37.5°C and heart rate below 60 bpm or above 100 bpm. The Arduino keeps track of sensor readings against these limits. If any readings exceed the thresholds, the system sounds a local buzzer to notify the patient and sends an alert to the IoT platform. The LCD display shows real-time updates of health parameters and alert messages, increasing patient awareness.To ensure the system works well, thorough testing and validation take place. Functional testing checks the performance of components, such as sensor accuracy and communication reliability. Performance evaluation looks at metrics like data transmission delay and power use to confirm efficient operation. Finally, user acceptance testing involves healthcare professionals to collect feedback, find ways to improve, and ensure the system suits the needs of both patients and medical staff.

VI. System Evaluation And Performance

The IoT-based health monitoring system was assessed for accuracy, latency, and power efficiency to ensure it operates effectively for home quarantine applications.

A. Accuracy and reliability:

The MLX90614 temperature sensor and MAX30100 pulse oximeter showed accuracy within ±0.5°C and gave reliable heart rate readings, respectively. The readings closely matched those from standard medical devices, giving confidence in the system's reliability for health monitoring.

B. Latency:

Data transmission latency averaged 1.8 seconds from the Arduino to the ThingSpeak platform. This setup allows near real-time data access for healthcare providers. Low latency ensures timely monitoring and quick responses to abnormal health readings.

C. Power Consumption:

Designed for low power use, the system consumed about 80 mA. This makes it suitable for prolonged use with a rechargeable battery. Efficient power consumption supports continuous operation in home quarantine situations.

D. Fault Tolerance:

The system included error-handling features for network disruptions. It stored data locally on the Arduino when connectivity was lost. This resilience improves reliability by maintaining monitoring under various conditions.

VII. DATA SECURITY AND PRIVACY

Implementing IoT-based healthcare monitoring systems requires strict measures to safeguard data security and privacy because health-related information is sensitive. To reduce risks of data breaches, our system uses HTTPS encryption for all data transmissions. This creates a secure channel that protects patient information from unauthorized access during communication with the IoT platform.

Additionally, the system has strict access controls. Only authorized healthcare providers can view patient data. By using role-based access management, we make sure sensitive information is available only to those who need to know, improving overall data integrity. Future work will look at adding more security features such as end-to-end encryption and two-factor authentication to further protect patient privacy.Ultimately, focusing on data security and privacy not only safeguards patient information but also fosters trust in the IoT health monitoring system. Continuous monitoring and updating of security protocols will be essential to address new vulnerabilities and meet relevant healthcare regulations.

VIII. DISCUSSION AND LIMITATIONS

The IoT-based health monitoring system described in this study offers a practical solution for ongoing health monitoring of individuals in home quarantine. By using readily available components, the system captures vital signs and allows remote healthcare access. This can greatly improve patient outcomes through timely intervention with real-time alerts.However, several limitations exist. Scalability is a concern, as more users may lead to network congestion and challenges in data management. Additionally, dependence on stable internet connectivity can limit performance in remote areas. Although the system uses power-efficient components, battery life is still an issue for extended monitoring, requiring better energy management solutions.Addressing these limitations is important for improving the system's effectiveness in telemedicine applications. Future work will concentrate on enhancing scalability, optimizing data handling, and exploring alternative energy solutions to improve performance across various healthcare settings.

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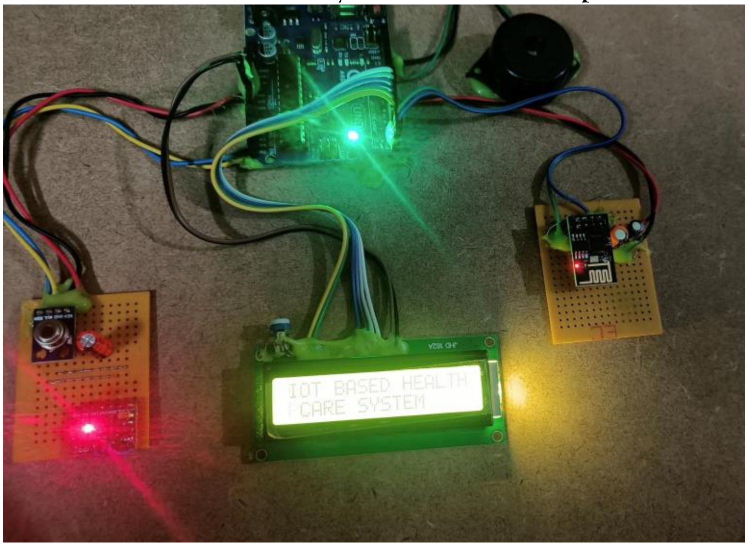
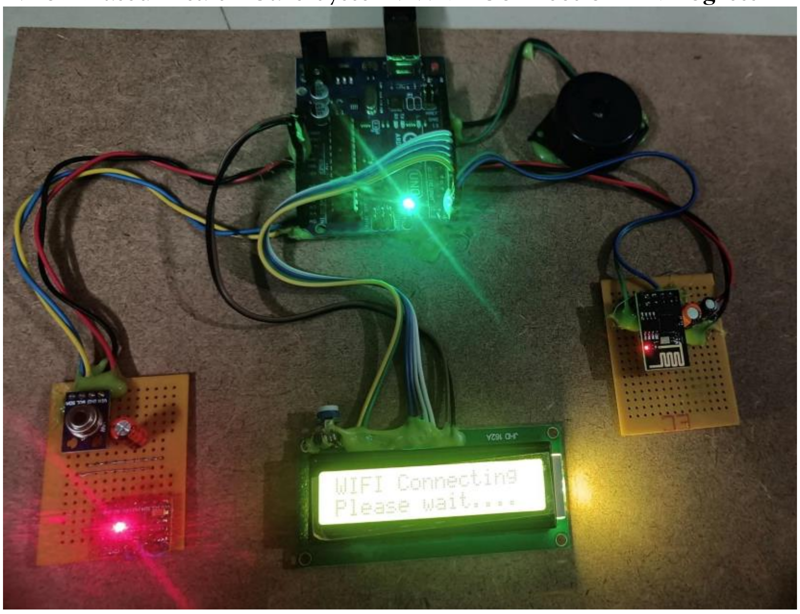
IX. RESULTS

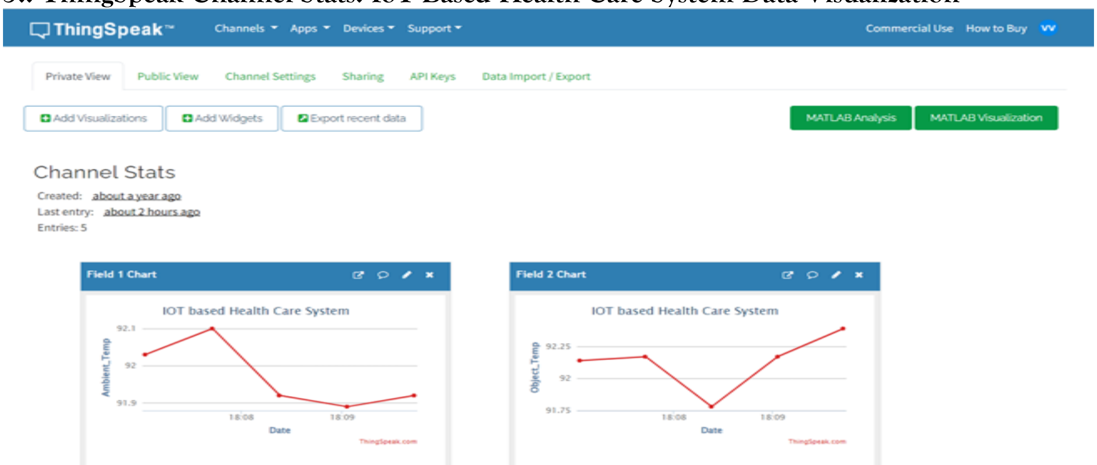
1. IoT-Based Health Care System: Arduino Setup with LCD Display and Sensors



2. IoT-Based Health Care System: WiFi Connection in Progress



3.. ThingSpeak Channel Stats: IoT-Based Health Care System Data Visualization



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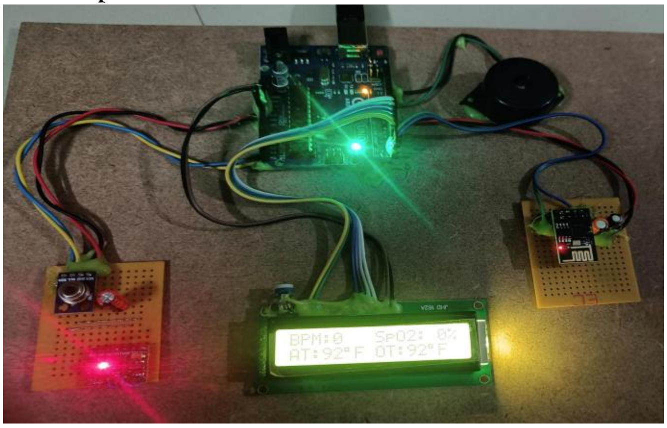
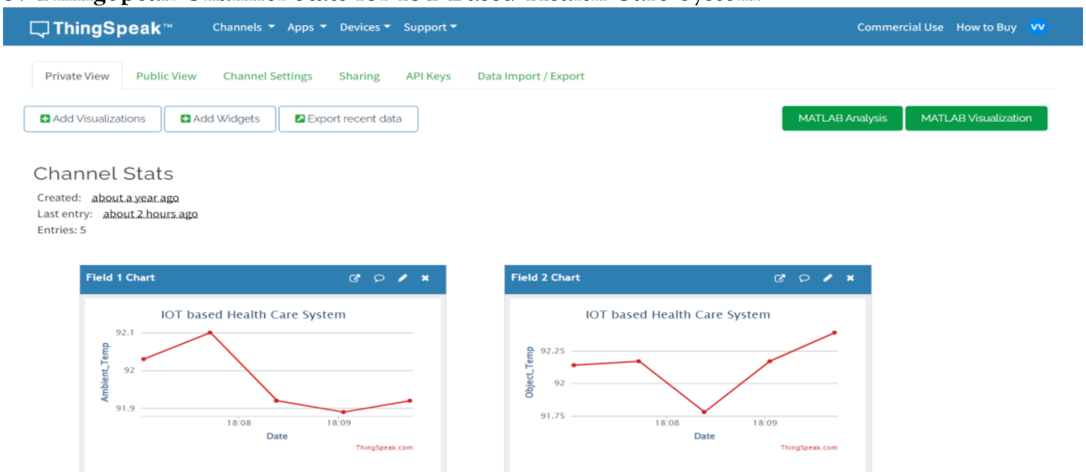
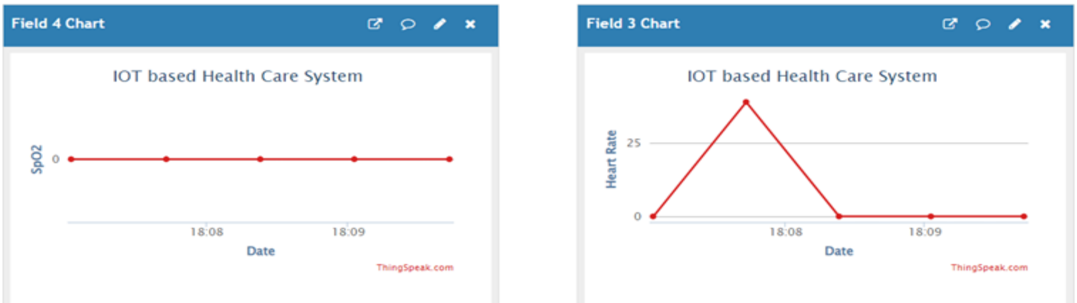
4. Arduino-Based IoT Health Monitoring System with LCD Display monitoring BPM, SpO2 and Temperature



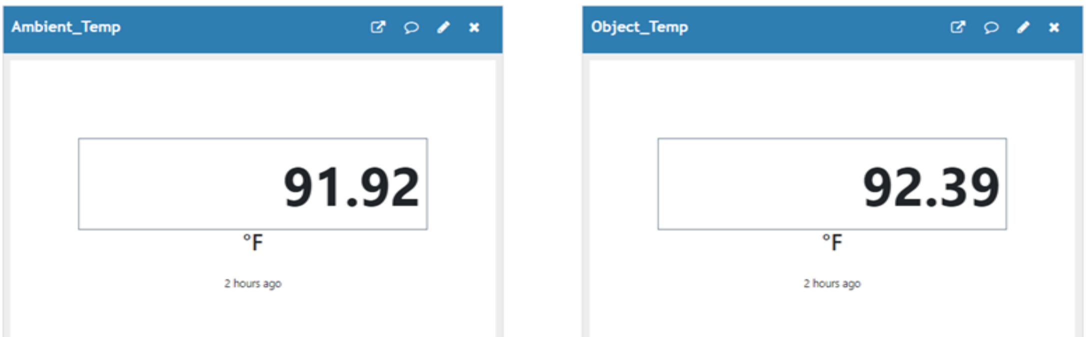
5. ThingSpeak Channel Stats for IoT-Based Health Care System



6. IoT-Based Health Care System: SpO2 and Heart Rate Data Visualization



7. Temperature Readings: Ambient and Object Temperature Display



X. CONCLUSION AND FUTURE WORK

This paper discusses an IoT-based health monitoring system made for people in home quarantine. It uses affordable components like the Arduino Uno and different biosensors to monitor vital health data and provide remote healthcare access. Real-time alerts and secure data transmission improve its effectiveness, making it a useful tool for telemedicine.For future work, we plan to strengthen the system's security features by adding end-to-end encryption and multi-factor authentication. Adding machine learning could help predict patient health trends, allowing for quicker interventions. We will also look into edge computing to address issues related to network dependency and scalability, ensuring the system remains reliable even in remote areas.By focusing on these improvements, we aim to enhance the system's functionality and expand its use in various healthcare settings, ultimately leading to better patient care.

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