Privacy and Security of IOT Devices for Monitoring Vulnerable People

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ABSTRACT

This project presents a real-time IoT-based health monitoring system developed using the ESP32 Uno microcontroller. The system integrates multiple sensors—including a DHT11 sensor (for temperature and humidity), a pulse sensor (for heart rate), and an MQ-3 alcohol sensor—to monitor essential health parameters. Sensor data is displayed locally on an LCD screen and transmitted remotely via a GSM module. To provide seamless data visualization and access, the system uses cloud platforms such as ThingSpeak and Blynk for real-time monitoring through mobile and web interfaces.

A Java-based website has also been developed to allow users to securely view their health data, with a user-friendly dashboard for live updates. Additionally, all health reports are stored in the AWS cloud, enabling long-term data storage, report generation, and remote access for healthcare providers. This system offers a scalable and accessible solution for continuous health monitoring, suitable for both personal and clinical use.

By combining IoT, cloud services, and Java web development, it ensures real-time feedback, remote monitoring, and early detection of health anomalies. This ESP32-powered system is a low-cost, scalable, and efficient solution for personal and clinical health monitoring, ensuring early detection of anomalies and continuous patient care.

Keywords— IoT-based Health Monitoring,ESP32 Uno,DHT11 Sensor,Pulse Sensor,MQ-3 Alcohol Sensor,GSM Module,ThingSpeak,Blynk,Java Web Dashboard,AWS Cloud Storage

INTRODUCTION

Health monitoring has become a pivotal aspect of modern lifestyle management, allowing individuals to track vital parameters for a proactive approach towards well-being. In response to this growing need, the development of an advanced health monitoring system is presented in this project. Leveraging the capabilities of ESP32 Uno, various sensors, an LCD display, and a GSM module, the system aims to provide users with real-time health data through the integration with the Blynk mobile application.

The contemporary emphasis on health and wellness has fueled the demand for innovative solutions that empower individuals to monitor their physiological parameters. The utilization of ESP32 Uno, a versatile microcontroller, serves as the foundation for this health monitoring system. Coupled with sensors such as the DHT11 for temperature and humidity, a pulse sensor for heart rate measurement, and an alcohol sensor for detecting alcohol levels, the system offers a comprehensive suite of health metrics.

The integration of an LCD display provides immediate, on-site feedback, enabling users to stay informed about their health status in real time. Moreover, the inclusion of a GSM module facilitates remote communication, allowing the system to transmit health data to the Blynk mobile application. Blynk, a popular Internet of Things IoT) platform, acts as an interface for users to access and monitor their health parameters seamlessly.This project seeks to address the evolving needs of individuals who prioritize health and wellness by creating an accessible and user-friendly health monitoring system. By combining the capabilities of ESP32 Uno, various sensors, Blynk integration, and GSM communication, the system aims to provide a holistic solution for both local and remote health monitoring. The subsequent sections will delve into the components, functionalities, and implementation details of the proposed health monitoring system.

II. LITERATURE SURVEY

Swan, M. Sensor mania! The internet of things, wearable computing, objective metrics, and the quantified self 2.0. Journal of Sensor and Actuator Networks, 1(3), 217-253, 2012.

This paper, authored by Swan in the Journal of Sensor and Actuator Networks, delves into the rapidly evolving landscape of sensor technologies and their impact on the Internet of Things (IoT) ecosystem. The author explores the intersection of wearable computing, objective metrics, and the Quantified Self 2.0 movement. The paper provides a comprehensive overview of the state-of-the-art in sensor technologies, emphasizing their role in advancing the IoT paradigm. Swan discusses the implications of these technologies on personal health monitoring, data-driven decision-making, and the emerging concept of the Quantified Self 2.0. Furthermore, the paper addresses the challenges and opportunities presented by the proliferation of sensors, offering insights into the transformative potential of these advancements in the field of sensor networks.

Gómez, J., Huete, J. F., Hoyos, O., Perez, L., & Grigori, D. Interaction System based on Internet of Things as Support for Education. Procedia Computer Science, 21, 132-139, 2013

In this paper authored by Gómez et al. and published in Procedia Computer Science, the authors present an exploration into the design and implementation of an interaction system rooted in the Internet of Things (IoT) to enhance educational environments. The study focuses on leveraging IoT technologies to create a dynamic and supportive framework for education. The authors discuss the conceptualization and development of the interaction system, examining its potential applications in the educational context. Through an in-depth exploration of the system's functionalities, the paper evaluates its effectiveness in providing valuable support for educational processes. The findings shed light on the role of IoT-based interaction systems in transforming traditional educational paradigms, offering insights into the integration of emerging technologies to enhance the learning experience.

III. METHODOLOGY

The methodology for developing the health monitoring system involves a systematic approach to integrating various components and functionalities. The first step involves identifying the essential health parameters to monitor, including temperature, humidity, pulse rate, and alcohol levels. Subsequently, the appropriate sensors (DHT11, pulse sensor, alcohol sensor) are selected and interfaced with the ESP32 Uno microcontroller. The connections are carefully configured to ensure accurate data acquisition.

The next phase focuses on the implementation of an LCD display to provide on-site feedback, allowing users to observe their health metrics in real-time. This involves coding to display information such as temperature, humidity, pulse rate, and alcohol levels on the LCD screen. Simultaneously, a GSM module is integrated to facilitate remote communication. The ESP32 Uno is programmed to transmit the collected health data to the Blynk mobile application using the GSM module.

The Thingspeak acts as a user-friendly interface, offering a platform for individuals to remotely monitor their health parameters. Virtual pins are assigned to each health metric, enabling seamless data transfer from the ESP32 Uno to the Thingspeak. The app's interface is designed to present the data in an easily understandable format, enhancing user accessibility.

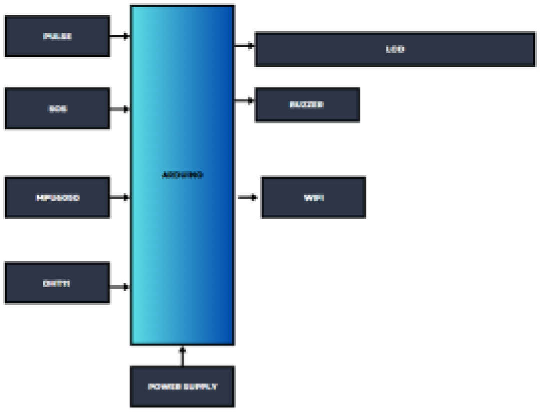
Throughout the development process, testing and calibration are crucial steps to ensure the accuracy and reliability of the sensor readings. Iterative testing allows for adjustments and refinements in the code and hardware connections. The final phase involves user testing to assess the overall usability and effectiveness of the health monitoring system.

IV. EXISTING SYSTEM

The existing health monitoring systems often fall short in providing a holistic and integrated approach to individual well-being. Many current solutions are limited in terms of sensor integration, immediate feedback, and remote monitoring capabilities. Some health monitoring devices focus on specific parameters, such as heart rate or temperature, without offering a comprehensive suite of vital metrics. Additionally, the lack of seamless communication between on-site monitoring devices and remote platforms makes it challenging for users to track their health parameters in real-time, especially when immediate intervention or medical assistance may be required. User interfaces are sometimes complex, hindering accessibility and usability for a broader audience. As a result, there is a clear need for an improved health monitoring system that addresses these limitations, offering a more inclusive, user-friendly, and integrated solution for individuals seeking to actively manage their health.

DRAWBACKS :

- Existing health monitoring systems often focus on specific parameters, neglecting the integration of a comprehensive set of vital metrics, limiting the depth of health insights.
- Many current solutions lack real-time feedback mechanisms, hindering users from receiving immediate insights into their health status during on-site monitoring.
- The absence of seamless communication between on-site devices and remote platforms restricts users from monitoring their health parameters remotely, limiting the system's versatility.
- Some health monitoring devices feature complex user interfaces, creating accessibility challenges and reducing usability, particularly for a broader audience.
- Current systems often provide fragmented health information, making it difficult for users to get a holistic view of their well-being and potentially missing critical health indicators.



V. PROPOSED SYSTEM

The proposed system is a real-time IoT-based health monitoring solution that enables users to continuously track and analyze vital health parameters such as temperature, humidity, pulse rate, and alcohol level. The system is built around the ESP32 Uno microcontroller, interfaced with various biomedical and environmental sensors. It aims to provide instant feedback, remote access, and cloud storage for health data.

The key components and functionalities of the proposed system include:

1. **Sensor Integration**:

   ○ DHT11 sensor to measure body/environment temperature and humidity.

   ○ Pulse sensor to detect the user's heart rate.

   ○ MQ-3 alcohol sensor to monitor alcohol levels in the breath.

2. **Microcontroller and Data Handling**:

- The ESP32 Uno collects real-time data from all sensors.
- Data is displayed on a 16x2 LCD display for immediate local feedback.

3. **Remote Communication and Cloud Integration**:

- A GSM module is used to transmit the collected data to the internet where direct Wi-Fi access may not be available.
- ThingSpeak is used as a cloud platform for real-time data visualization.
- Blynk mobile app allows users to monitor health parameters remotely on their smartphones.

4. **Java-Based Web Dashboard**:

- A Java web application is developed using Servlets and JSP to serve as a centralized dashboard for users.
- Users can view live health statistics, trends, and summaries through an intuitive web interface.

5. **AWS Cloud Storage**:

- Health records are stored on AWS (e.g., RDS or DynamoDB) for secure, long-term data archiving and report generation.
- This enables historical data analysis and supports medical professionals in reviewing patient history.

6. **Alerts and Accessibility**:

- If abnormal health parameters are detected, the system can send SMS alerts via GSM.
- The solution is portable and can be used in rural or remote areas due to its GSM-based data transmission.

ADVANTAGE:

1.The system continuously collects and displays real-time data for temperature, humidity, pulse rate, and alcohol levels, enabling immediate health status awareness.

2.With GSM, Thing Speak, and Blynk integration, users and caregivers can remotely monitor vital health parameters from anywhere, even in areas without Wi-Fi access.

3.Abnormal health readings can trigger alerts, helping to detect health issues early and enabling faster medical intervention.

4.Built using affordable components like ESP32, DHT11, and pulse/alcohol sensors, the system is cost-effective and suitable for deployment in rural or low-resource environments.

5.Integration with AWS provides secure, long-term storage of health data, useful for trend analysis, doctor consultation, and medical records.

6.Both the Blynk mobile app and Java web dashboard offer easy-to-use interfaces for real-time visualization and monitoring of personal health data.

7.The GSM module ensures that health data can still be transmitted in remote areas where Wi-Fi is unavailable.

8.Additional sensors (e.g., SpO2, ECG) or functionalities (e.g., AI-based diagnosis) can be added easily, making the system scalable for future enhancements.

VI. WORKING OF PROPOSED SYSTEM

The working of the proposed health monitoring system involves a synchronized process that integrates various components to provide users with a comprehensive and accessible tool for monitoring their vital health parameters. The system begins by collecting data from multiple sensors, including the DHT11 for temperature and humidity, the pulse sensor for heart rate, and the alcohol sensor for alcohol levels. The ESP32 Uno microcontroller processes this data, ensuring accurate readings.

Simultaneously, an LCD display is employed to present the real-time health metrics on-site, enabling users to monitor their conditions instantly. The inclusion of a GSM module facilitates remote communication, allowing the ESP32 Uno to transmit the collected health data to the Blynk mobile application. The Thingspeak acts as a user-friendly interface, providing a platform for users to remotely monitor their health metrics. Virtual pins assigned to each health parameter ensure seamless data transfer between the ESP32 Uno and the Thingspeak.

Throughout this process, the system ensures the accuracy and reliability of sensor readings through calibration and testing. The user-centric design of the Thingspeak enhances accessibility, allowing individuals to track and analyze their health metrics easily. This synchronized working of sensors, microcontroller, LCD display, and GSM module creates a cohesive health monitoring system that empowers users to actively manage their well-being in both local and remote settings.

VII. SIMULATED OUTPUTS

1. Sensor Readings (Typical Output Values)

DHT11 (Temperature and Humidity Sensor):

Temperature: 36°C

Humidity: 45%

Pulse Sensor:

Heart Rate: 78 beats per minute (BPM)

MQ-3 Alcohol Sensor:

- Alcohol Level: 0.00 mg/L (No alcohol detected)

LCD Display (16x2 or 20x4) Output

```
Line 1: Temp: 36°C  Hum: 45%
Line 2: HR: 78 BPM  Alcohol: No
```

Cloud Platform Output (ThingSpeak & Blynk)

- **ThingSpeak:**
  - Live charts displaying:
  - Field 1: Temperature over time
  - Field 2: Humidity over time
  - Field 3: Heart Rate over time
  - Field 4: Alcohol Levels over time

  Each field updates every 15–20 seconds with new data sent via ESP32.
- **Blynk App (Mobile Interface):**
  - Dashboard shows:
  - Gauge widget for Temperature and Heart Rate
  - Bar display for Humidity
  - LED status for Alcohol Detection
  - Notification widget triggers if heart rate > 100 BPM or alcohol is detected.

- **Java-Based Web Dashboard Output**

Home Page:

- Live values:
  - Temperature: 36°C
  - Humidity: 45%
  - Heart Rate: 78 BPM
  - Alcohol Detected: No

CODE

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
#define BLYNK_TEMPLATE_ID "TMPL3GT6W_slF"

#define BLYNK_TEMPLATE_NAME "HEALTH MONITORING"
#define BLYNK_AUTH_TOKEN "8kaRvsWasAkCU4vR5W_3dKPPwLMheX5T"
#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "iot12345";  // Replace with your WiFi SSID
char pass[] = "iot12345";  // Replace with your WiFi password
#include <SPI.h>
#include <Wire.h>
#include <MPU6050.h>
MPU6050 mpu;
//#include <Wire.h>
#include "DHT.h"
#define DHTPIN 32 // CHANGE PIN NUM
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
//Heart rate sensor realted declarations
```

```
int UpperThreshold = 518;
int LowerThreshold = 490;
int reading = 0;
float BPM = 0.0;
bool IgnoreReading = false;
bool FirstPulseDetected = false;
unsigned long FirstPulseTime = 0;
unsigned long SecondPulseTime = 0;
unsigned long PulseInterval = 0;
#define BUZ 26
#define SOS 25
    int val=0;
    int ECG=0;

void setup()
{
 Serial.begin(9600);
 dht.begin()
 pinMode(BUZ,OUTPUT);
 digitalWrite(BUZ,LOW);
 Wire.begin();
 mpu.initialize();
 lcd.begin();
 lcd.begin();
 lcd.backlight();
 lcd.setCursor(0,0);
 lcd.print("IOT BASED");
 lcd.setCursor(0,1);
 lcd.print(" HEALTH");
 delay(2000);
 lcd.clear();
 lcd.setCursor(0,0);
 lcd.print("MONITORING ");
 lcd.setCursor(4,1);
 lcd.print("SYSTEM" );
 delay(2000);
 lcd.clear();
 Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
}

void loop()
{
  Blynk.run();
  Blynk.virtualWrite(V4,0);
  Blynk.virtualWrite(V5," PEOPLE HEALTH CARE")
  ECG=analogRead(33);
  ECG=map(ECG,0,4095,0,100);
  Blynk.virtualWrite(V3,ECG);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("ECG: ");
  lcd.setCursor(0,1);
  lcd.print(ECG);
  delay(2000);
  lcd.clear();
  val=digitalRead(SOS);
  Serial.println("SOS: ");
  Serial.println(val);
  if(val==HIGH)
  {
   lcd.clear();
   digitalWrite(BUZ,HIGH);
   lcd.setCursor(0,0);
   lcd.print("AM IN EMERGENCY");
```

```
  delay(3000);
  digitalWrite(BUZ,LOW);
  lcd.clear();
 }
 dht11_sensor();
 delay(2000);
 lcd.clear();
 PULSE();
 delay(5000);
 lcd.clear();
 acc();
 delay(1500);
 lcd.clear();
 }
 void dht11_sensor()
{
Serial.print("DHT IN");
//lcd.clear();
float h = dht.readHumidity();
float t = dht.readTemperature();
if (isnan(t) || isnan(h)) {       // checking sensor #2
Serial.print("DHT11 SENSOR 1 ERROR");
//  print error message
}
Serial.print(F("Humidity: "));
Serial.print(h);
Serial.print(F("%  Temperature: "));
Serial.print(t);
Blynk.virtualWrite(V0,t);
Blynk.virtualWrite(V1,h);
if(t>=35)
{
  lcd.clear();
  digitalWrite(BUZ,HIGH);
  lcd.setCursor(0,0);
  lcd.print("TEMP HIGH");
  Blynk.virtualWrite(V4,1);
  Blynk.virtualWrite(V5,"TEMP HIGH");
  delay(2000);
  digitalWrite(BUZ,LOW);
  Blynk.virtualWrite(V4,0);
 }
 lcd.setCursor(0,0);
 lcd.print("TEMP: ");
 lcd.print(t);
 lcd.setCursor(0,1);
 lcd.print("HUM: ");
  lcd.print(h);
}
void PULSE()
{
 BPM = float('inf') ;
 //Computing BPM
 Serial.println("\n          Computing BPM...");
 reading = analogRead(34);
 if(reading > UpperThreshold && IgnoreReading == false)
 {
  if(FirstPulseDetected == false)
  {
   FirstPulseTime = millis();
   FirstPulseDetected = true;
  }
  else
  {
```

```
  SecondPulseTime = millis();
  PulseInterval = SecondPulseTime - FirstPulseTime;
   FirstPulseTime = SecondPulseTime;
   }
  IgnoreReading = true;
 }
 if(reading < LowerThreshold)
 {
  IgnoreReading = false;
 }
  BPM = 58+(1.0/PulseInterval) * 60.0 * 1000;
  Serial.print(reading);
  Serial.print("\t");
  Serial.print(PulseInterval);
  Serial.print("\t");
  Serial.print(BPM);
  Serial.println(" BPM");
  Blynk.virtualWrite(V2,BPM);
  if(BPM<=50)
 {
  lcd.clear();
  digitalWrite(BUZ,HIGH);
  lcd.setCursor(0,0);
  lcd.print("PULSE LOW");
  Blynk.virtualWrite(V4,1);
  Blynk.virtualWrite(V5,"PULSE LOW");
  delay(2000);
  digitalWrite(BUZ,LOW);
  Blynk.virtualWrite(V4,0);
  }
  lcd.setCursor(0,0);
  lcd.print("PULSE: ");
  lcd.print(BPM);
  lcd.print(" BPM");
  }
  void acc()
  {
  // Read raw accelerometer and gyroscope values
  int16_t ax, ay, az, gx, gy, gz;
  mpu.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);
 // Convert raw values to meaningful units (in this case, degrees per second and m/s^2)
  float accelX = ax / 16384.0; // MPU6050_ACCEL_FS_2 -> 16384 LSB/g
  float accelY = ay / 16384.0;
  float accelZ = az / 16384.0;
  float gyroX = gx / 131.0;

  // MPU6050_GYRO_FS_250 -> 131 LSB/°/s
  float gyroY = gy / 131.0;
  float gyroZ = gz / 131.0;
  // Print the sensor values
  Serial.print("X: ");
  Serial.print(accelX);
  Serial.print("  Y:");
  Serial.print(accelY);
  Serial.print("  Z:");
  Serial.print(accelZ);
  Serial.println();
  lcd.setCursor(0,0);
  lcd.print("X: ");
  lcd.print(accelX);
  lcd.print(" Y: ");
  lcd.print(accelY);
```

```
lcd.setCursor(0,1);
lcd.print("Z: ");
lcd.print(accelZ);
}
```

VIII . CONCLUSION AND FUTURE SCOPE:

The proposed IoT-based health monitoring system successfully demonstrates the integration of hardware sensors, cloud connectivity, and mobile/web platforms to monitor vital health parameters in real time. Using the ESP32 microcontroller, along with DHT11, pulse, and alcohol sensors, the system effectively measures body temperature, humidity, heart rate, and alcohol level. Real-time data visualization through the LCD, ThingSpeak, Blynk mobile app, and a custom Java-based website ensures that both users and caregivers can access vital health information from any location. The incorporation of a GSM module makes the system suitable for use in remote or rural areas lacking Wi-Fi access, enhancing its versatility. With data securely stored on AWS, the system supports long-term health tracking, analysis, and medical consultations. It provides a foundation for future expansion, such as the addition of more sensors, predictive analytics, and integration with hospital management systems. Overall, the project offers a cost-effective, portable, and scalable solution for personal and remote healthcare, especially valuable in today’s context of telemedicine and smart health monitoring. Additionally, collaboration with healthcare professionals to validate the accuracy and reliability of the system's readings could enhance its credibility for clinical and preventive healthcare applications. The future scope also includes optimizing power consumption for prolonged device operation and exploring opportunities for scalability in terms of supporting more diverse health sensors and parameters.

In essence, the presented health monitoring system lays the foundation for a proactive and user-centric approach to individual health management. As technology continues to evolve, there is immense potential for further advancements, making health monitoring systems more sophisticated, user-friendly, and integral to promoting well-being.

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