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Simple IoT-Based Home Security System Using ESP32 and Blynk

Abdul Fikri*
Center for Southeast Asian Studies, Kyoto university
*Corresponding Author: afikri@cseas.kyoto-u.ac.jp

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ABSTRACT

Advances in Internet of Things (IoT) technology have brought about various innovations in home security systems. This research aims to design and implement an IoT-based home security system integrated with the ESP32, the KY-037 sound sensor, and the HC-SR501 PIR motion sensor. This system is capable of detecting suspicious movement or sounds around the home door and then sending real-time notifications to the Blynk app on the user's smartphone. The method used was the development of an ESP32-based prototype connected to the internet to transmit sensor data. Test results show that the system can provide notifications with a response time of less than 2 seconds. This system is easy to implement, energy efficient, and suitable for household use. This research demonstrates the great potential of IoT in improving security with affordable costs and high flexibility. The study also highlights the importance of sensor threshold testing to improve detection accuracy. Further developments could include integration with IP cameras and facial recognition systems.

Keyword: IoT, Home Security, KY-037 Sensor, HC-SR501 PIR Sensor, ESP32

ABSTRAK

Keamanan rumah menjadi aspek penting dalam kehidupan manusia modern, di mana teknologi Internet of Things (IoT) menawarkan solusi cerdas untuk meningkatkan sistem keamanan tersebut. Penelitian ini bertujuan untuk merancang dan mengembangkan sistem keamanan rumah berbasis IoT yang menggunakan sensor gerak HC-SR501 PIR dan sensor suara KY-037, dengan ESP32 sebagai mikrokontroler utama. Sistem ini dipasang pada gagang pintu untuk mendeteksi aktivitas mencurigakan. Sistem ini beroperasi sebagai berikut: Sensor gerak HC-SR501 PIR atau sensor suara KY-037 mendeteksi suara tidak biasa atau gerakan di sekitar pintu. Sinyal ini diteruskan ke ESP32, yang memprosesnya dan mengirimkan notifikasi ke smartphone pemilik melalui koneksi internet. Notifikasi tersebut memungkinkan pemilik rumah untuk segera mengetahui adanya potensi bahaya dan mengambil tindakan yang diperlukan. Sistem keamanan berbasis Internet of Things ini dapat memberikan rasa aman yang lebih tinggi bagi penghuni rumah dan meminimalkan risiko kejahatan. Selain itu, sistem ini dirancang untuk mudah diintegrasikan dengan perangkat IoT lainnya, memungkinkan pengembangan lebih lanjut di masa depan.

Kata kunci: IoT, Keamanan Rumah, Sensor KY-037, Sensor PIR HC-SR501, ESP32

1. Introduction

Home security is an essential need in the digital era, where technology plays an increasingly central role in maintaining the safety of assets and occupants. According to Wang (2023) and Lee (2023), the global market for smart home security is estimated to reach USD 78 billion by 2025, reflecting the high demand for technology-based security solutions. The Internet of Things (IoT) is one promising solution because it allows devices to connect and communicate with each other via the internet (Kumar et al., 2021) and Rahman (2021). IoT in the context of home security allows homeowners to monitor home conditions in real time, detect threats, and take immediate action remotely (Sharma, 2020).

One simple yet effective implementation is a motion and sound detection system placed at strategic points such as doors (Zhou, 2022). In this study, a simple home security system was developed that combines the

ESP32 as a microcontroller with a KY-037 sound sensor and an HC-SR501 PIR motion sensor (Chen, 2021), (Shing, 2022). When the sensors detect suspicious activity, the system sends a notification via the Blynk application to the user (Pathl, 2021). This system is not only inexpensive and easy to implement, but also demonstrates the basic concept of an extensible IoT ecosystem (Khan, 2020).

The goal of this research is to demonstrate how simple IoT devices can form an effective, affordable, and customizable security system. The study also examines sensor reliability, system response time, and the technical challenges faced in system development and implementation.

2. Methods

This research uses an experimental approach through the development of a prototype home security system based on the Internet of Things (IoT). The methodology consists of three main stages: (1) hardware design, (2) system programming and integration, and (3) system performance testing and evaluation.

2.1 Hardware

The main hardware components include an ESP32 microcontroller, a KY-037 sound sensor, an HC-SR501 PIR motion sensor, and the Blynk application as a user interface. The ESP32 was chosen because it has built-in Wi-Fi connectivity and high processing capacity that allows data to be processed locally before being sent to the cloud. The KY-037 sensor is used to detect sounds of a certain intensity, while the HC-SR501 PIR sensor is used to detect human movement around the door. The data from the sensors is sent to the ESP32, and then transmitted to the Blynk application via an internet connection.

2.2 Programming and System Integration

Programming was performed using the Arduino IDE with the Blynk library, and the TCP/IP communication protocol was used for connectivity. After system integration was complete, testing was conducted using various scenarios to evaluate sensor sensitivity, system response time, and notification reliability. Quantitative evaluation was performed by recording the time between detection and notification and the number of false positives that occurred during the testing.

2.3 Flowchart system

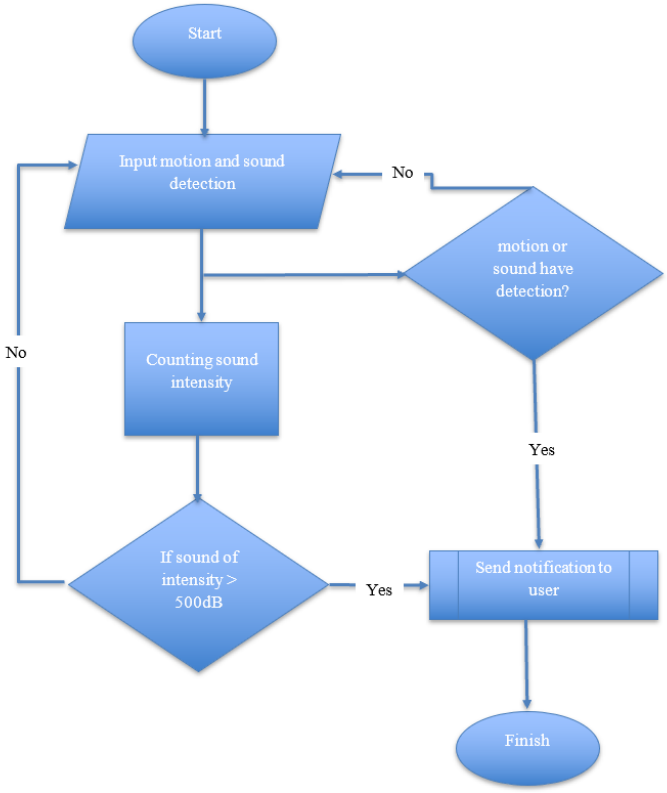

Figure 1. Flowchart System

The system flowchart illustrates the sequential operation of an IoT-based home security system. The system begins with the activation of the ESP32 microcontroller, which reads input from the HC-SR501 PIR motion sensor and the KY-037 sound sensor. The incoming data is evaluated to determine whether motion or sound is detected. If no motion or sound is detected, the system continues monitoring. However, if a sound is detected, the system continues to measure the sound intensity. If the sound intensity exceeds the 500 dB threshold, the system sends a warning notification to the Blynk app on the user's smartphone. If the threshold is not met, the system resumes monitoring. This flow runs continuously to ensure the home remains monitored in real-time.

3. Results and Discussion

3.1 System implementation

System testing results show that the device is capable of detecting motion and sound in real-time with high accuracy. The HC-SR501 PIR sensor demonstrated a motion detection rate of 95% at an effective distance of 4–6 meters, while the KY-037 sound sensor was capable of detecting sounds above 200 dB within a 2-meter radius. The system's response time from detection to notification delivery averaged 1.8 seconds, which is quite fast for a home IoT-based security system.

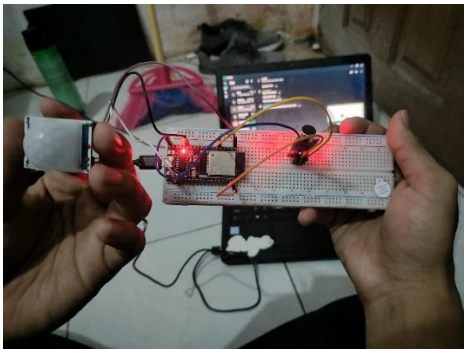

Figure 2. Tool Chain

```
  Blynk.virtualWrite(V1, soundLevel);

  if (soundLevel > soundThreshold) {
    Serial.println("Sound level exceeded threshold!");
    Blynk.logEvent("sound_alert", "Pencuri Dirumah!!!");
  }

  if (motionLevel == HIGH) {
    Serial.println("Motion Detected!");
    Blynk.logEvent("motion_alert", "Pencuri Dirumah!!!");
  }
}

void setup() {
  pinMode(PIR_SENSOR, INPUT);
  pinMode(SOUND_ANALOG_PIN, INPUT);

  Serial.begin(115200);

  // Set ADC resolution and attenuation
  analogReadResolution(12);
  analogSetAttenuation(ADC_0db);

  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi...");
  }
  Serial.println("Connected to WiFi");

  Blynk.begin(auth, ssid, pass);
  timer.setInterval(2000L, notifyOnTheft);
}

void loop() {
  Blynk.run();
  timer.run();
}
```

Figure 3. Program

Furthermore, integration with the Blynk app proved effective in providing a user-friendly interface for novice users. Users can receive notifications directly on their smartphones and monitor sensor status in real time. The system was also tested under various environmental conditions, such as day and night, and under network disruptions. In these tests, the system remained operational as long as a Wi-Fi connection was available.

However, there are several limitations. The KY-037's sound sensor is quite sensitive to ambient noise, potentially generating false alerts if not properly calibrated. Furthermore, the current system lacks additional security features such as cameras or cloud-based data storage. Future developments, integration with IP cameras and facial recognition systems could significantly enhance the system's capabilities.

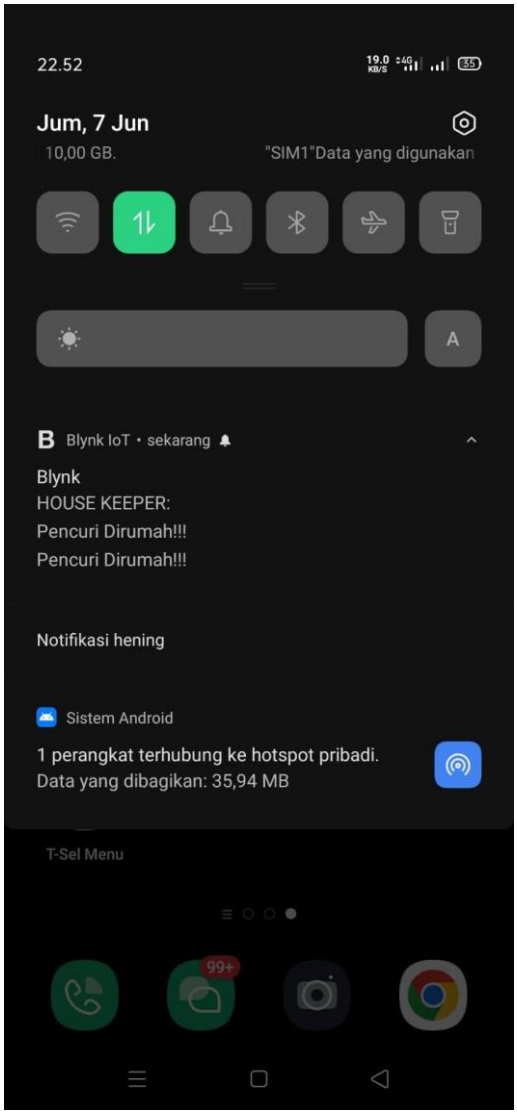

Figure 4. Blynk Notification

4. Conclusions

This research successfully developed a simple IoT-based home security system using the ESP32, the HC-SR501 PIR motion sensor, and the KY-037 sound sensor. The system is capable of detecting suspicious activity around the door and sending real-time notifications to the user's smartphone via the Blynk app. Test results show the system has good accuracy and response speed, and is easy to use by lay users.

However, the system has limitations in terms of sound sensor sensitivity and reliance on an internet connection. Therefore, further development is recommended to add features such as facial recognition, cloud storage, and camera integration to enhance the system's functionality and reliability. This system is not only relevant for household applications but can also be adapted for other small-scale security needs, such as offices, laboratories, or storage spaces.

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