Design and Implementation Of IoT Based Security System

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Abstract. The paper presents the design and practical implementation of an IoT Based Security System that leverages Arduino UNO, ESP32s, Fast2SMS API, and a buzzer. This system provides smart alarm/buzzer system with a buzzer and PIR sensor, SMS alerting technology with Fast2SMS API and a keypad authentication using a 4x4-keypad. Integrating all these technologies with IoT devices like Arduino UNO and ESP32s will makeup this system. The paper covers the system architecture, hardware setup, software components, testing, and real-world applications.
Keywords: IoT, Security System, Arduino UNO, ESP32s, Fast2SMS API, Buzzer.

1. Introduction

1. Internet of Things
The Internet of Things, refers to the network of physical devices, vehicles, appliances, and other objects embedded with sensors, software, and connectivity, enabling them to connect and exchange data. These connected devices can communicate with each other and with humans, creating a vast network of interconnected systems. IoT has numerous applications across various domains, including smart homes, healthcare, transportation, agriculture, and industrial automation. It enables automation, data collection, analysis, and remote control, leading to improved efficiency, convenience, and insights. In simpler terms, IoT connects everyday objects to the internet, making them "smart" and capable of interacting with us and each other. It's like having a world where everything is interconnected and can work together to make our lives easier and more efficient.
2. Scope And Objectives
The paper's scope serves as a foundation, with the potential for future enhancements and customization to meet specific security needs and applications. In this paper as it is expected that a fully functional IoT-based security system will be realized, offering practicality, reliability, and peace of mind to users in various settings.
The paper revolves around the concept of the Internet of Things (IoT), where everyday objects are transformed into 'Smart version' of itself. The security system to be designed and implemented aims to detect security events, such as unauthorized access or motion detection, and promptly alert the user through SMS notifications while activating an audible alarm via the buzzer.

2. System Description

The paper achieves a comprehensive security solution that integrates hardware and software components to safeguard homes, offices, or other relevant spaces. The system employs a multi-faceted approach to ensure security, combining user authentication through a keypad lock and proactive security event detection using Passive Infrared (PIR) sensors.

The system is mainly consisting of two parts, where the first part is concerned about the authentication of the user and the second part is associated with detecting unusual events and sending SMS alerts to the authorized phone numbers. This can be done using IoT devices like Arduino UNO R3 and ESP 32s.

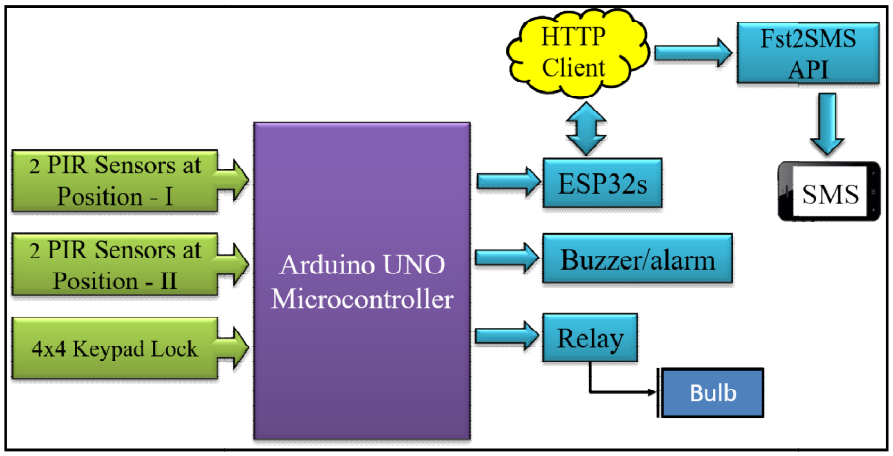

Fig. 1. Block Diagram of proposed system

Arduino UNO board is connected to a 4x4 keypad, 16x2 LCD, Buzzer, and a series of PIR Sensors which altogether form an efficient Security System. PIR sensors detect the unusual events and triggers the Arduino to make a buzzer sound and ESP32s to connect to the Fast2SMS API and trigger a message(SMS) regarding security breach. This happens only when the system is locked. Locking and unlocking the system can be achieved by the keypad connected to the Arduino board. The user is authenticated by a 4-digit numerical PIN, whenever the user enters the PIN in the keypad, event detection(PIR Sensors) section is kept inactive for 5 minutes. After 5 minutes of unlock the system automatically gets locked. For this operation an Arduino Code is made using respective libraries and uploaded into Arduino UNO and ESP32s to work cumulatively.

3. Software Implementation

To accomplish the exact nature of working of the proposed system, we need to write two programs separately (one for Arduino, one for ESP32s) which plays a major in working of this system. The system requires use of two software platforms. They are ArduinoIDE(To write and upload program code), Fast2SMS API(To send SMS alerts).

The ArduinoIDE(Integrated Development Environment) is an open-source software platform used for programming Arduino microcontrollers. It provides an easy-to-use interface for writing, compiling, and uploading code to Arduino boards. The IDE supports the C/C++ programming languages and simplifies hardware interaction for makers and developers. We have used some of its libraries like LiquidCrystal_I2C.h, Keypad.h, SoftwareSerial.h in Arduino UNO and WiFi.h, HTTPClient.h in ESP32s. And there are some special keywords like tone(), untone() related to triggering buzzer. Keyword tone() is used to make alarm sound at a specified frequency and time using buzzer.

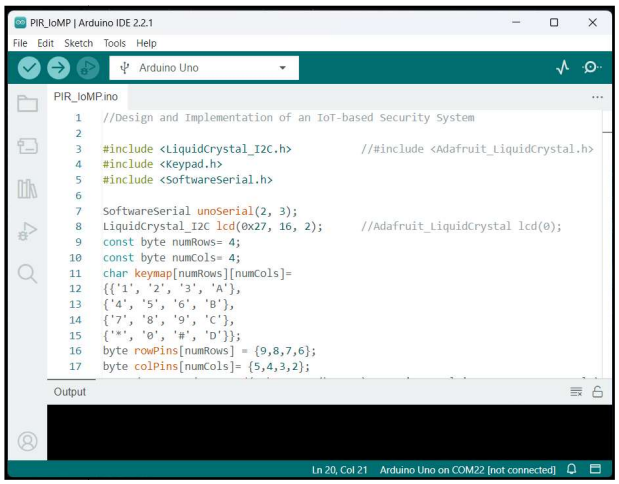

Fig. 2. Overview of Arduino IDE platform**3.3. Feature Extraction**

In ESP32s program code, HTTPClient.h provides an ability to make a connection to the API website (Fast2SMS) and after the connection is made successfully, whenever Arduino send a signal to ESP32s regarding unusual event detection, a request URL is created containing the message content, mobile number of authorized users. This URL is used to make a post request using the keyword HTTPClient.Post(URL), hence the request made and ESP32s will receive a response code for every request. If the response returns true then SMS is sent successfully. If the response code is numeric and returns false then SMS is not sent and the response code contains the reason for the bad request.

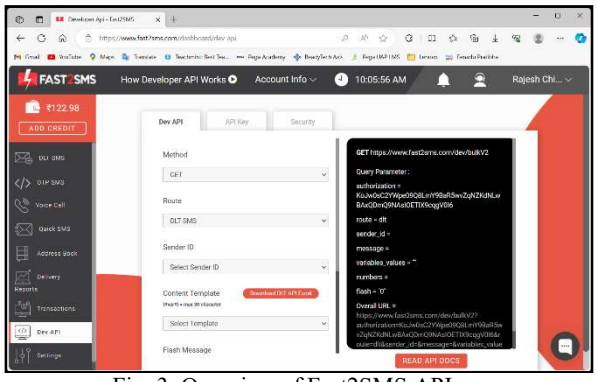

Fig. 3. Overview of Fast2SMS API

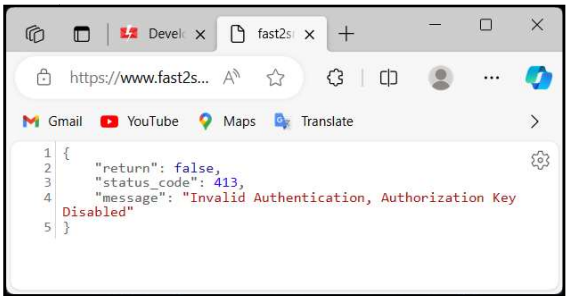

Fig. 4. Response Code of HTTPClient.Post Request

The above figure is the response code of a URL Post request made through HTTPClient of ESP32s. As the request returns false, SMS is not sent and the status code states that the request is made using a disabled authorization key. So, by this we can say that to send SMS alerts an Active authorization key is required and it must maintain a minimum balance of Rs.100 to start sending messages.

4. Event Detection

Generally, PIR Sensors are designed to detect the motion of an object. Even there is an object in range of the sensor, if the object is at rest, sensor won't trigger any output. The output of the sensor is HIGH only when the object is moving. But the problem is PIR sensor detects the motion of a human, cat, flying balloon as same object. So, using a series of PIR sensors can overcome that problem.

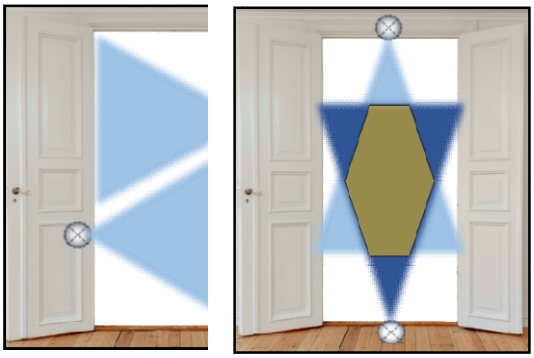

Fig.5.Positioning of PIR Sensors (a, b)

From the above figure(left - Fig. 5.a, right - Fig.5.b), we can see two different approaches of arranging PIR Sensors in a way to detect only human made activity/ motion. In the Figure 5, the summer shape indicates the PIR Sensor and the blue color indicates the range of the sensor, the yellow color/ highlighted segment indicates the collision between two sensors which helps in detecting only human activity accurately. Sensors can be arranged in any of the two approaches mentioned to improve the accuracy of event detection.

5. Results and Discussions

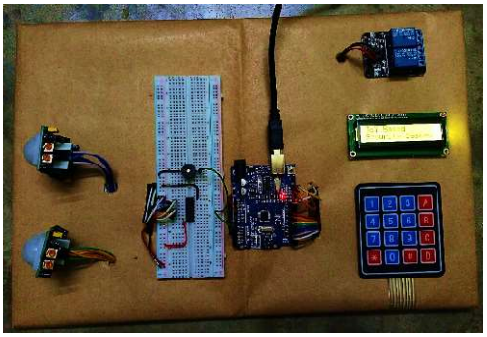

Fig. 6. Proposed model of IoT based Security System - Stage 1

The above figure shows the keypad lock module of the proposed system, where it meant to authenticate the user by 4-digit numerical security PIN. This model at this stage is not connected to ESP32s so, it is unable to send SMS.

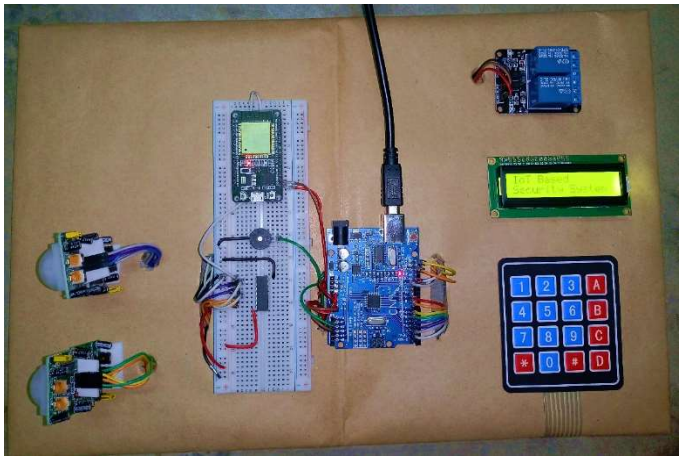

Fig. 7. Proposed model of IoT based Security System – Final Stage

The above figure shows the exact proposed system containing PIR Sensors, keypad, display, relay(to connect real-time applications like large buzzers/sirens and bulbs) contribute for the exchange of information and control actions through Arduino UNO R3 and ESP32s.

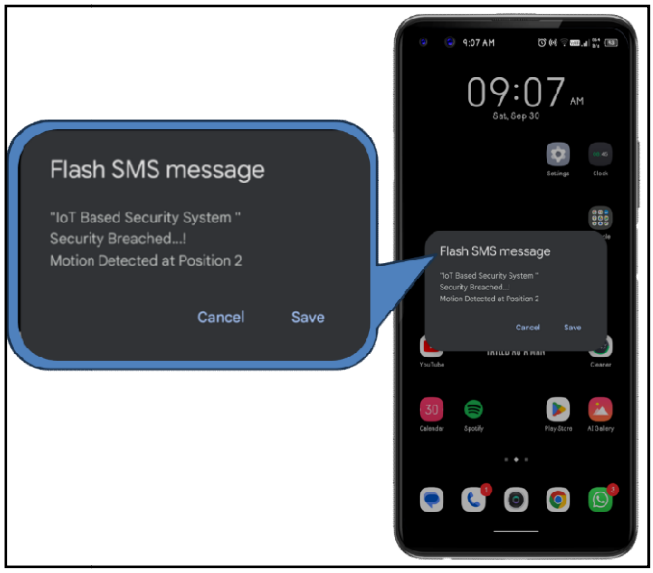

Fig. 8. SMS alert received on Mobile

When there is an unusual activity detected by PIR Sensors ESP32s will send SMS to the authorized mobile number mentioned in its program code. The above figure shows the SMS received while testing the sensors.

6. Conclusion

In conclusion, the proposed system represents a significant step towards enhancing security and access control in various environments. The system successfully combines hardware components and IoT technology to provide robust motion detection, user-friendly access control, and remote monitoring capabilities. This system can serve as a foundation for further development, with future prospects including mobile app integration, cloud-based data storage and analysis, advanced biometric authentication methods, and expanded compatibility with other IoT devices. Ultimately, the "Design and Implementation of IoT-based Security System" paper showcases the possibilities of IoT technology in improving security measures and access control, making it a valuable contribution to the realm of smart and secure environments. This security framework can used in different places like bank, hospital, offices etc.

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