PROGRESS IN ENGINEERING APPLICATION AND TECHNOLOGY
e-ISSN: 2773-5303

PEAT

Vol. 5 No. 1 (2024) 158-169
https://publisher.uthm.edu.my/periodicals/index.php/peat

Home Security Monitoring System Based On Smartphone Application

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DOI: https://doi.org/10.30880/peat.2024.05.01.016

Article Info

Received: 28 December 2023
Accepted: 18 January 2024
Available online: 15 June 2024

Keywords

Home Security 1, Application 2, cloud 3.

Abstract

The rapid advancement of technology has transformed the traditional concept of home security systems. In the modern era, these systems now incorporate innovative solutions, utilizing applications on smartphones and connected devices. The proposed system seamlessly combines the power of smartphones with the versatility of ESP8266 to establish an efficient and cost-effective home security solution. Motion detectors serve as sensors to detect illegal intrusions, linked to the ESP8266 microcontroller, which acts as the central processing unit. This microcontroller processes data from sensors and transmits it to the smartphone application via Wi-Fi. For online connectivity, Blynk is employed before data is sent to smartphone applications, serving as a monitoring dashboard. Node red is essential for data processing, ensuring real-time connection between hardware and smartphone applications. This integration enables real-time monitoring and timely notifications through a user-friendly interface. The development environment for MIT Application offers powerful tools, including a visual layout editor, code editor, and debugging capabilities, streamlining the creation of feature-rich, user-friendly smartphone applications. The smartphone app serves as the user interface, allowing homeowners to access the security system in real time, receiving instant notifications and alerts upon detecting a security breach.

1. Introduction

The development of home security systems is essential because it adds an extra layer of security through user authentication to prevent break-ins at entry points and to monitor illegal intrusions or unsolicited activities in the home's area for both Indoors and outdoors. A lot of research has been conducted in the design of various types of automated security systems.

Currently, IoT devices are provided with various types of sensors to collect data from their surroundings. Temperature, humidity, light, motion, proximity, and other variables can be detected and measured by these sensors. Actuators, conversely, empower devices to execute physical actions in response to received data. These actions may include toggling on or off, making adjustments to settings, or activating alarms.

Smartphone app designed specifically for home security and this application will act as the command-and-control hub for your IoT devices, allowing you to manage and monitor them from anywhere. A notification

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will be dispatched to the user, ensuring that the owner remains aware of the surroundings. In this project, this system will be able to help them to protect their house from being enter without permission.

In order to change the current problems that occur, we need to gain improvements on the home security system. Burglars are aware of the times when someone is expected to be away from their house such as during the school run or holidays. They typically do not want to be seen or heard and if they feel that they would be noticed by a neighbour or passer-by then they are more likely to feel exposed and may move on to find somewhere else to burgle. On November 2022, Malaysia crime index which consists of property crimes, said that the crime recorded 41,479 cases in 2021. And these cases bring concern to Malaysia citizens.[7]

The main objective of this project is to develop a home security monitoring system based on smartphone application. The specific objectives include to develop a sensor node to read and gather motion detection data in a home premise. Then to integrate the sensor node to cloud via wireless connection. Furthermore, to develop an Android application that can fetch data from the cloud for motion detection monitoring.

2. Related works

For the comparison in summary, the combination of a PIR sensor and Arduino, along with the integration of a GSM module for alerting the surrounding, offers a wide range of applications. These include security systems, energy-efficient lighting, and wildlife monitoring. With their simplicity, cost-effectiveness, and versatility, these hardware components have become a popular choice for various projects across different domains.

Table 1 *Comparison of existing project*

No.	Tittle (Ref no,)	Features	Software/Hardware
1	Development Of Intelligent Home Security System[1]	The system uses fingerprint, password, and RFID scans for access, alerting the admin for deviations via GSM. It also features live video with facial recognition and flame detection.	Home security that used GSM and GPRS module
2	Android based Smart House Control via Wireless Communication[2]	The affordable smart home system automates alarm, outdoor light, and fan with PIR, LDR, and LM35 sensors. Controlled through an Android app, users can manage sensor status.	Arduino Ethernet and Near bus with an MIT application
3	Remote Home Security System using Open-Source Electronic Platform[3]	The home security system, powered by Arduino Mega, features a motion sensor triggering an automatic or Bluetooth manual alarm via a buzzer.	Mobile application that used GSM Sim900 and Bluetooth HC-05
4	Enhanced Intelligent Smart Home Control and Security System Based on Deep Learning Model[4]	The smart home is managed through an Android app, offering a user-friendly interface for real-time sensor data display and control of home conditions.	Smartphone app using android studio and ESP32 Cam
5	Home Security System using IOT and AWS Cloud Services[5]	Authorized personnel images in AWS are compared with doorbell-captured images sent to our cloud service for identification.	Using Face recognition algorithm running on AWS cloud
6	re Home Entry Using berry Pi with Notification elegram[6]	The user can toggle the security system ON/OFF based on availability. Typing 'start' on Telegram activates the monitoring system.	Raspberry pi board and camera are used to detect sensor

3. Methodology

3.1 Software

This project used NodeMCU ESP8266, and Arduino IDE are needed to write the program code. Besides, other software that are needed in this project is MIT Application, which used to develop an application that can give notifications on regarding the intruder also Blynk for monitoring and Node-Red for data transferring. A Blynk Dashboard serves as the graphical interface within the Blynk mobile app or web platform, enabling real-time monitoring and control of IoT projects. Node-RED allows for quick assembly of service flows through a visual drag-and-drop interface, replacing common low-level coding tasks. MIT App Inventor is a user-friendly and visual programming application with a blocks-based tool, it enables the creation of both simple and complex applications in less time than traditional programming environments

3.2 System Block Diagram

Figure 1 illustrates a straightforward block diagram depicting the process of home system monitoring through a smartphone application. The primary objective of this project is to identify movement in the vicinity of the home premises. Additionally, an application has been developed using open-source software, specifically Android Studio. In terms of input, a smartphone running the Android operating system is imperative for installing the app, and a PIR sensor functions as input for the system. The NodeMCU ESP8266 plays a crucial role as it is utilized for programming, reading, and transmitting signals. Accurate coding is essential to prevent errors during the upload into the board. Finally, the output of the process involves a buzzer and a smart home system controllable through an Android-based operating system smartphone via a Wi-Fi platform.

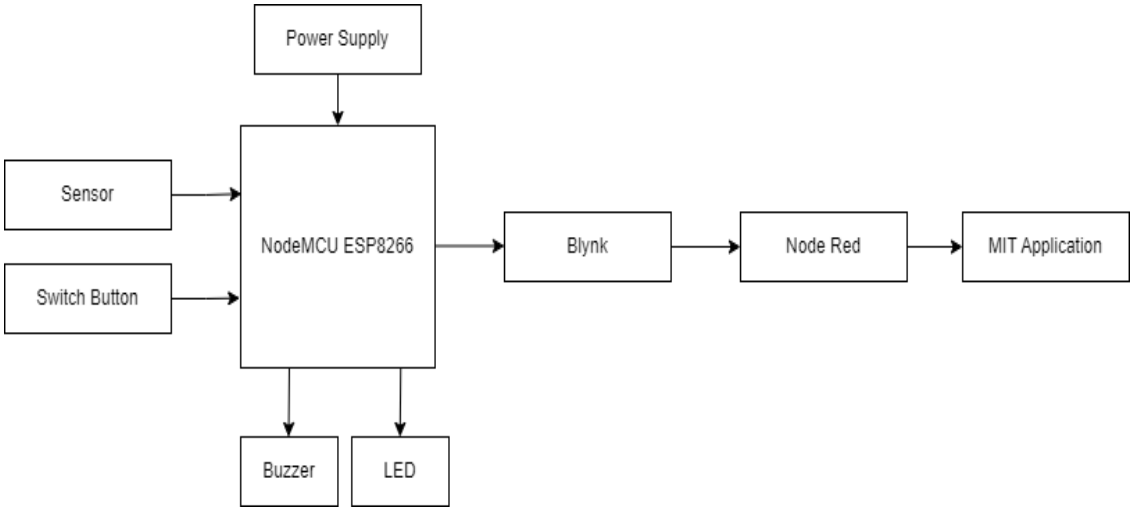

Fig. 1 *Block diagram of home security monitoring system based on smartphone application*

3.3 System Flowchart

The flowchart in figure 2 explains the flow of the programs in. The proposed system. First, the system will be on either manually or automatically by the user. Next, the LED will light up to indicate that the system is on. The application will showcase a notification stating "MOTION DETECTED." Simultaneously, an alarm will be triggered. Furthermore, the system possesses the capability to generate a status report for both the PIR sensor. Figure 3.5 explain the system begins by initializing the hardware components, setting pin configurations for the LED and buzzer. After establishing connections to both the local Wi-Fi network and the Blynk server, the sensor node continuously monitors the PIR sensor for motion detection. When the PIR sensor reads a high value, indicating motion, the system activates the LED for visual indication and triggers the buzzer for an audible alert. Simultaneously, the system updates the Blynk dashboard, providing real-time status information on the PIR sensor, LED, and buzzer. This integrated approach allows for effective monitoring of the sensor node's activity through the Blynk dashboard, ensuring users are promptly informed of any detected motion.

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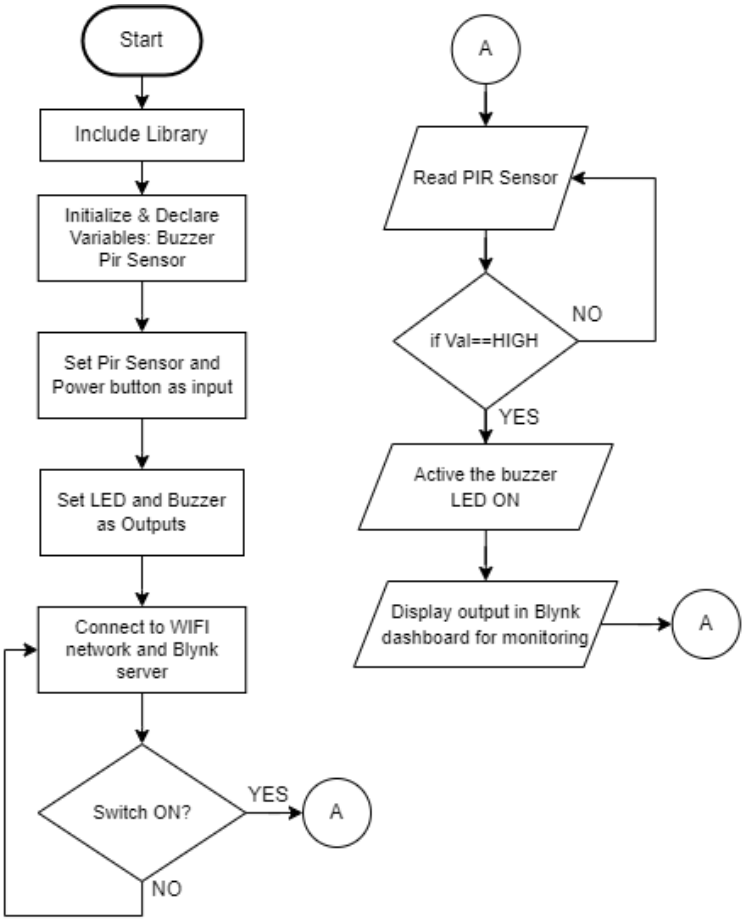

Fig. 2 *Flowchart of sensor node data collection and Blynk Dashboard*

In the figure 3 the flowchart shows the integration between Blynk Cloud and Node-RED involves transferring data from Blynk to Node-RED. As data is read on Blynk, it is published to an HTTP page through Node-RED. This connection allows Node-RED to receive and process the data for further actions or analysis.

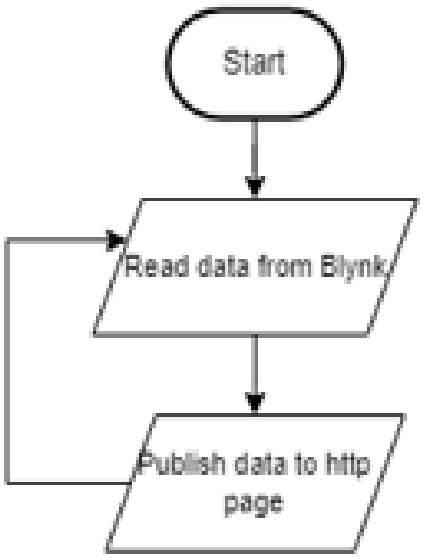

Fig. 3 *Integration of data from Blynk cloud to Node Red*

While figure 4 shows the smartphone application flowchart begins with the login page, where users enter their credentials. Correct login details lead to the home monitoring screen, displaying real-time data. Incorrect details prompt an error message. The flow then fetches data from Node-RED, showing "Motion Detected" when activity is sensed and "No Motion Detected" otherwise.

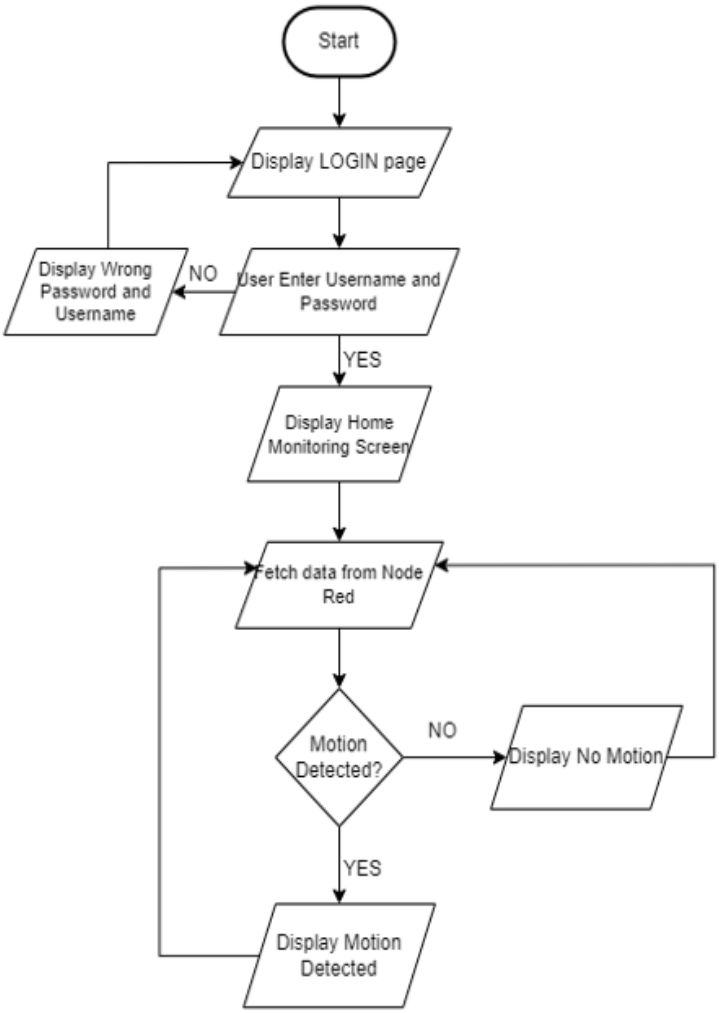

Fig. 4 *Flowchart of smartphone Application*

4. Result and Discussion

The following chapter presents the implementation and operation of Home Security Monitoring System Based on Smartphone Application will be illustrated in this chapter. In this section, the actual results of the system are presented in more detail, together with supporting data to confirm the results acquired during the tests.

4.1 Motion Detection System

The figure presented in Figure 5 (a) show the front view of the hardware, the sensor are being place on top of the door to make sure it will be able to get the motion that being detected. While figure 5 (b) shows the side view of the hardware. The switch is being put on top of the controller box to make it easy access to on off the hardware. And the board can be put beside the house.

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Fig. 5 *(a) Front View of the Prototype (b) Overview of the prototype*

Figure 6 shows the hardware prototype is placed inside a box to get a better image of the systems and how it's functioning. This diagram illustrates the physical connections and orientations among the different hardware components.

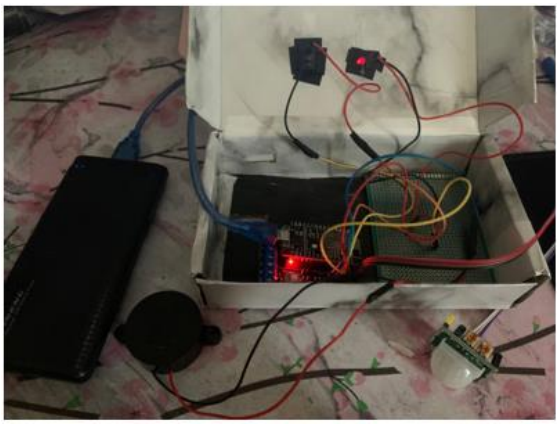

Fig. 6 *Hardware connection of the prototype*

4.2 Integration of Motion Detection System to Blynk Application

In the Blynk app, three components are being placed on the dashboard which is the buzzer, led and the pir sensor. The figure 7 show the web dashboard of the system. For the Blynk applications, the data from ESP8266 are needed to be send to the Blynk dashboard for monitoring the real-time data of the hardware. In the dashboard, it shows that when pir sensor detect motion, the led for pir sensor, buzzer and led will light up in different colour. If there is no connection with the hardware, there will be nothing that light up in the dashboard.

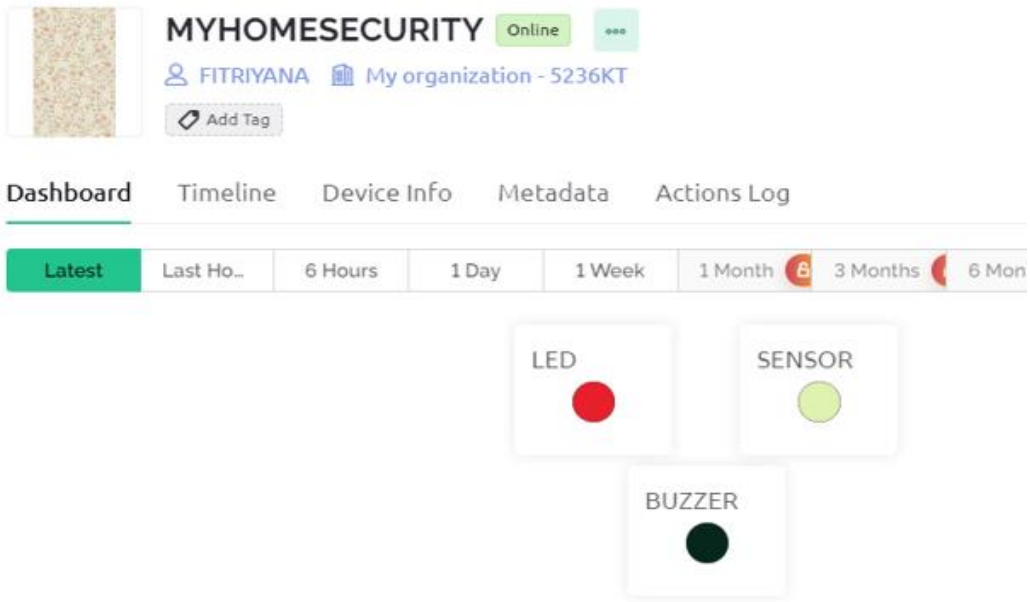

Fig. 7 *Display of the System Status in Blynk Web Dashboard*

4.2 Integration of Data from Blynk to Node Red

The controller is successfully connected with Node-RED, where all the Blynk-in nodes display the "CONNECTED" sign below them. The data that being fetched from the Blynk is the data of Pin EsP8266 that being used on the hardware. Each Pin represent one connection pin V3 represent Pir sensor and pin V1 represent buzzer. Then, the data fetched from Blynk is the data to be published to an http page to be linked to MIT App.

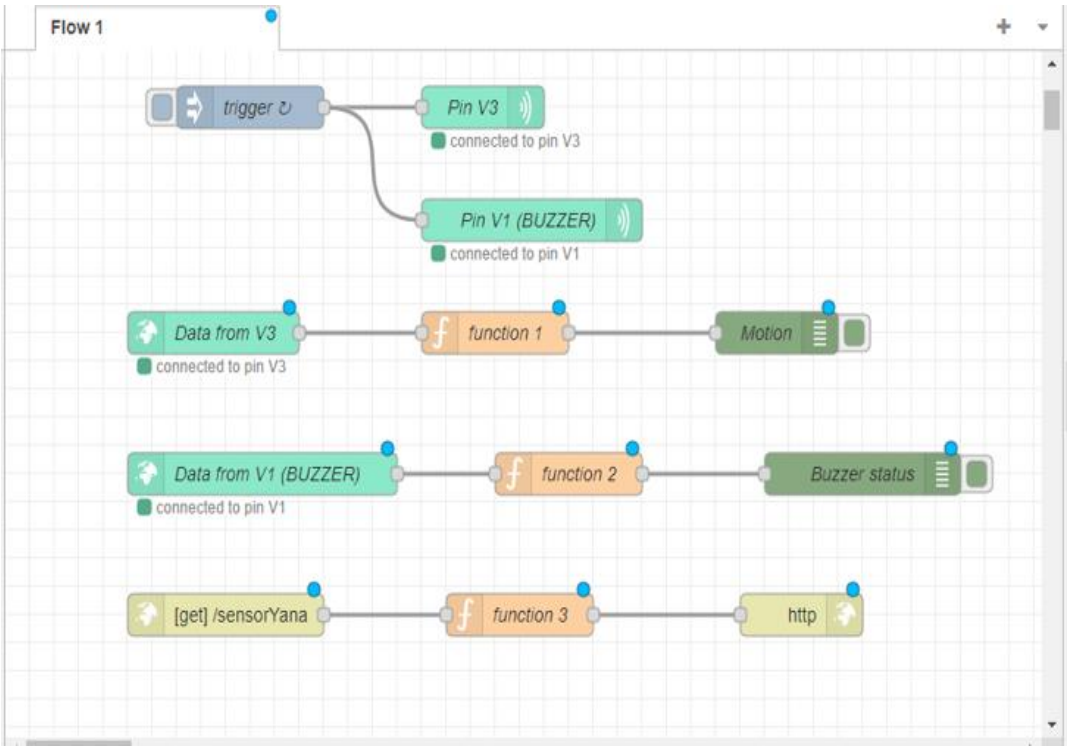

Fig. 8 *Node Red Flows*

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In Node Red, the debug nodes on each node are employed to detect any errors during the data transmission process. The debug node passes the message to the Debug sidebar, displaying messages within the flow and certain log messages from the runtime. In figure 9, its show that's When the data '0' its mean no Motion detected and no Buzzer status, and if it the data is '1' that's mean there are motion detected and the Buzzer Status are On

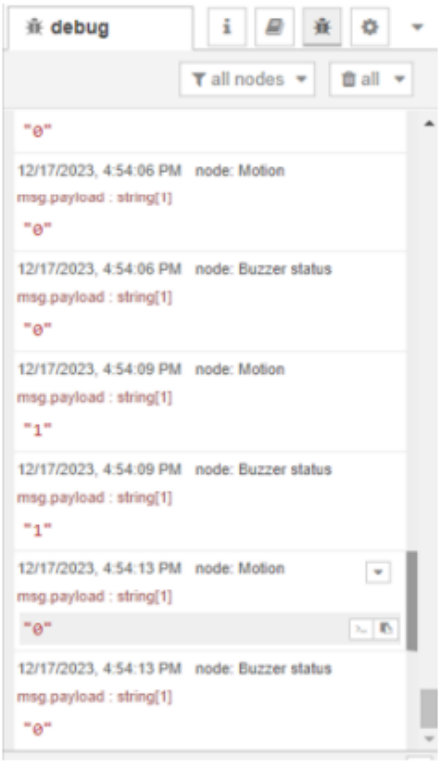

Fig. 9 *The debug output of the Node Red*

4.3 Smartphone Application

Figure 10 and 11 shows the primary interface is the main page of the Home Security Monitoring Application system. Once the user installs the application on their Android smartphone and clicks on it, they will be directed to the main page. The main page features a login button. Users can enter their username and password in the provided boxes. If the entered username or password is incorrect, a pop-up notification will appear indicating the error.

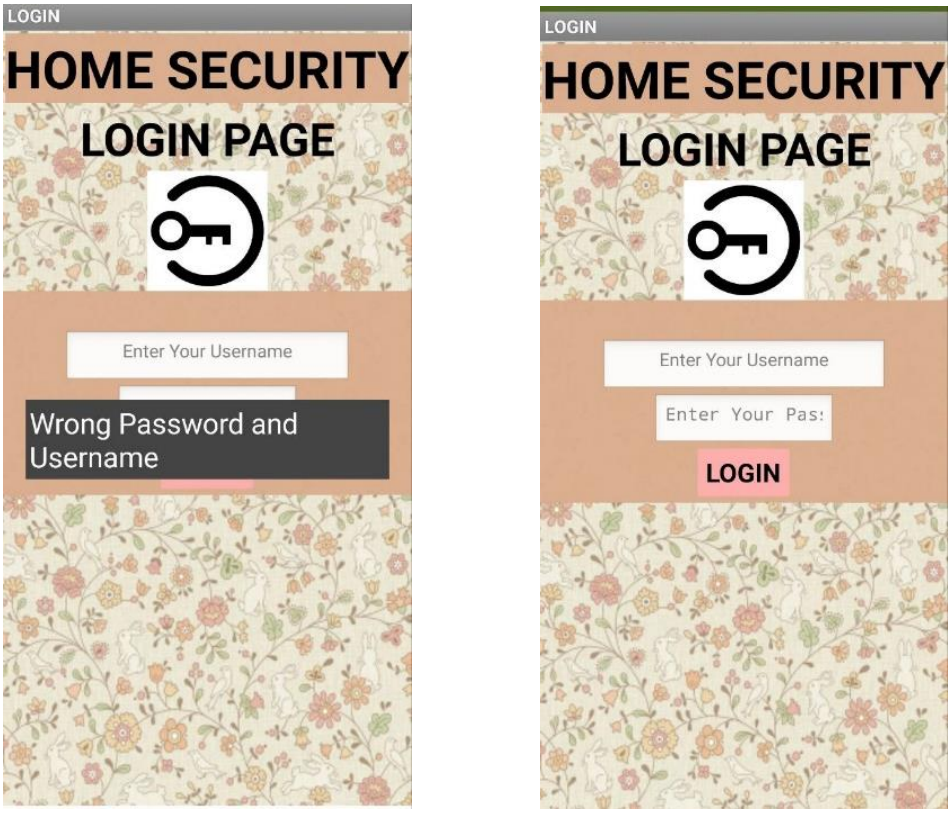

Fig. 10 *(a) Main Interface (b) shows the error*

A warning pop-up will dynamically appear, prominently displayed in a vivid red colour. This distinctive visual cue serves as an immediate indicator that motion has been detected, ensuring users are promptly alerted to any activity within the monitored area

Fig. 11 *(a) Motion detected in the application (b) Home status monitoring page*

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5. Data Analysis

In this project, the are some parameters that has been taken down to test the effectiveness of the system. The home security system has been tested with different distance and the result is as below. The time of the tested was set from 10 AM until 10:30 AM. This system has been tested for five times. Each of the system are being tested on different distance to see the accuracy of the sensor. The recorded distances in the tests, which ranged from 5 cm to 25 cm, demonstrated the sensor's ability to detect motion consistently within its specified sensitivity range of up to 20 feet (6 metres). These results show the sensor's reliability across a range of proximity, as well as its effectiveness in capturing movements at varying distances

Table 1 *Shows the testing of time vs distance*

No.	Time	Distance (cm)
1	10:03 AM	5
2	10.11 AM	10
3	10:18 AM	15
4	10:22AM	20
5	10:27AM	25

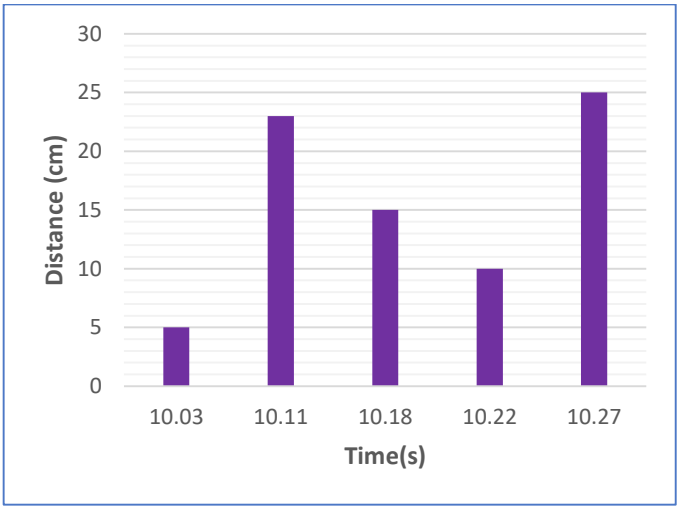

Fig. 12 *Graph for time vs distance*

Table 2 *Shows the motion that has been detected*

No.	Time	Motion Detected
1	10:03 AM	1
2	10:11 AM	0
3	10:18 AM	1
4	10:22AM	1
5	10:27AM	0

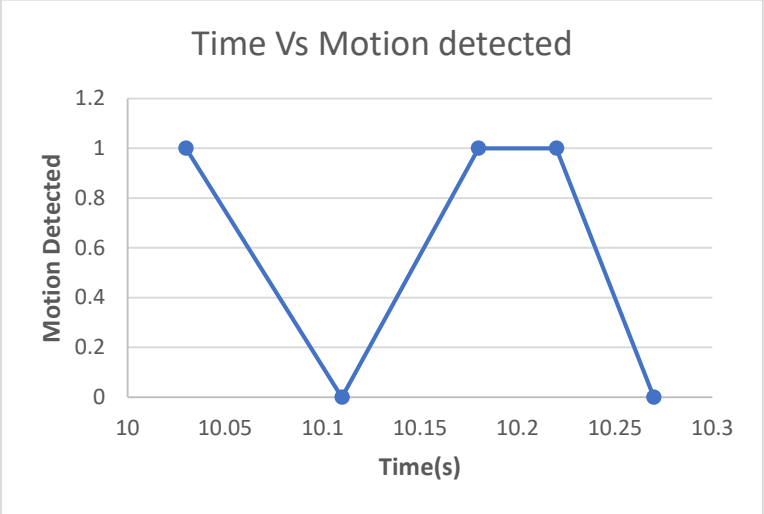

Fig. 13 *Graph for motion detection tested*

5.1 Discussion

The challenges identified in this study, based on the analyzed data, have spurred insightful recommendations to refine the functionality and user experience of the security monitoring application. One notable proposal is the integration of a camera feature within the application, allowing users to gain clearer insights into detected items or events. This enhancement seeks to elevate the overall comprehension of the security situation, providing users with more nuanced visual information. Additionally, the absence of a detailed log of security events has been recognized, prompting a suggestion to introduce a feature that meticulously logs and categorizes these events. This would empower users to have a comprehensive and easily accessible history, contributing to a more informed understanding of the security landscape and enabling efficient review of past incidents.

6. Conclusion

In general, the app has been successfully developed, meeting most of the goals we set earlier. However, it's important to note that the app isn't perfect; there's still a lot of room for improvement. Recognizing the areas where the app could do better is key to making it even better in the future. Developers need to pay attention to the things that aren't working perfectly and work on fixing them to make the app more user-friendly and effective. To further enhance the system's capabilities, future iterations of the project aim to incorporate additional features such as, data storage for detailed analysis and historical tracking of security events. These enhancements will contribute to a more robust and comprehensive home security system, offering homeowners an advanced solution to safeguard their properties. The combination of electronic components, software technologies, and the smartphone application offers a holistic approach to home security, providing homeowners with a user-friendly system that prioritizes efficiency and effectiveness.

Acknowledgement

The authors would also like to thank the Department of Electrical Engineering Technology, Faculty of Engineering Technology, University Tun Hussein Onn Malaysia. Communication of this research is made possible through monetary assistance by University Tun Hussein Onn Malaysia and the UTHM Publisher's Office via Publication Fund E15216.

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