An IoT Based Home Security System With ESP32, Video Monitoring, and Blynk Integration

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Abstract

IoT-based home security systems have grown in popularity as an innovative and comprehensive option for protecting residential properties. These systems make use of networked devices including motion sensors, surveillance cameras, and a centralized control hub, which are all linked via the Internet of Things (IoT).[1] This paper describes an Internet of Things (IoT)-based home security system with ESP32, video monitoring and Blynk integration. This project stands out from others in the realm of home security systems by leveraging components, such as the ESP32-CAM module, which are not commonly employed in conventional designs. The utilization of these distinctive components sets this project apart, offering a unique and innovative approach to home security that diverges from mainstream solutions.[4]

1. Introduction

Nowadays, every home lacks the necessary security to prevent intrusion. The percentage of intrusion is increasing day by day. Through networked devices like as sensors, cameras, and alarm, this system enables full surveillance and alarm capabilities. An IoT based system provide remote access and control are the most useful function for user to monitor or control their system from anywhere by use their smartphones. This home security system can detect every motion that happen around the sensor area and give a direct notification to the user. The system will notify automatically when the sensor detects the movement. Additionally, the system allow user to live streaming on the application to monitor what is happening during they are away from home. At night, the system can be set for lights turn on at certain times to prevent intrusions and an early sign to tell that the house has an owner while they sleep.

This home security system uses ESP32 as a microcontroller with built-in Wi-Fi and dual-mode Bluetooth. Timer for alarm work automatically will be set on ESP32 which is as microcontroller-based timer. The system also uses esp32cam as wireless video monitoring and automatically pop up the notification if sensor trigger. This system uses PIR sensor to detect heat energy in the surrounding environment and Infrared sensor as motion detector. The requirement for notification pops up, need two sensors triggered. If one of them triggered, the notification will not pop up to the owner because of want to minimize wrong notification. The Blynk App will be used for applications that receive notifications and application that allow the user to monitor their home environment. User also can turn on the alarm from the Blynk App when intrusion happen.

1.1   Problem Statement

Home security needs to be in every home to prevent intrusion. Homeowner can prevent this happening to their home or their family with home security system. Nowadays, peoples are extremely busy in quest of better life that always not at home. Closed-circuit Television (CCTV) is an important device that should be present in our homes. Home invasion or break-ins always happen in our country and cause the percentage of such incidents is increasing. Advanced monitoring capabilities including real-time alerts, remote access, and smartphone and other device integration are missing from current home security systems. Homeowners are unable to keep track of their property while away, which causes response times to be delayed and decreases the efficiency of deterring criminal conduct.

This project is intended to build a strong home security system to the user which is they can monitor the area through live streaming in the application. User also receive warning notification when strange motion was detected by the system. User do not need to monitor all the time. Notification of any strange motion detect by PIR sensor and Infrared sensor will be given to the user as an alert.[2] The alarm can be turn on by homeowner if they detect something suspicious to give a danger alarm to their neighbors.

1.2   Objectives

The purpose of this project is as listed below:

a) To design a user-friendly Blynk app interface for seamless interaction with the home security system
b) To analyse the collected data from the PIR sensor and Infrared sensor
c) To validate the functionality of the ESP32-CAM for video surveillance through practical testing, ensuring clear and timely transmission of videos in response to detected activities.

1.3   Project Scopes

To fulfil the state objectives, the scope of this project is as following below:
a) Designing a user-friendly Blynk app interface to facilitate seamless interaction with the home security system.
b) Conducting thorough analysis on the data collected from the PIR sensor and Infrared sensor.
c) Validating the functionality of the ESP32-CAM for video surveillance through practical testing

2   Materials and Methods

This section provides a comprehensive overview of an IoT based Home Security System's hardware details, illustrating the system's architecture through a block diagram, and clarifying the sequential processes with a system flowchart.

Table 1 *Hardware Details*

No	Part Name	Qty	Function	Cost (RM)
1	NodeMCU ESP32	1	Used as microcontroller board to read and send data to Blynk	5.00
2	ESP32 cam	1	Used as video monitoring	38.00
3	PIR sensor	1	used to detect changes in infrared radiation	16.00
4	Infrared sensor	1	used to detect infrared radiation	9.90
5	ESP32 shield	1	used to extend the capabilities of the ESP32 microcontroller	19.90
6	LED bulb	1	Used to light automation	8.80
7	12v alarm	2	used to produce a loud audible alert in response to specific events or triggers	18.80

2.1 System Block Diagram

Figure 1 illustrates a block diagram, providing a visual depiction of the interconnections among system components.
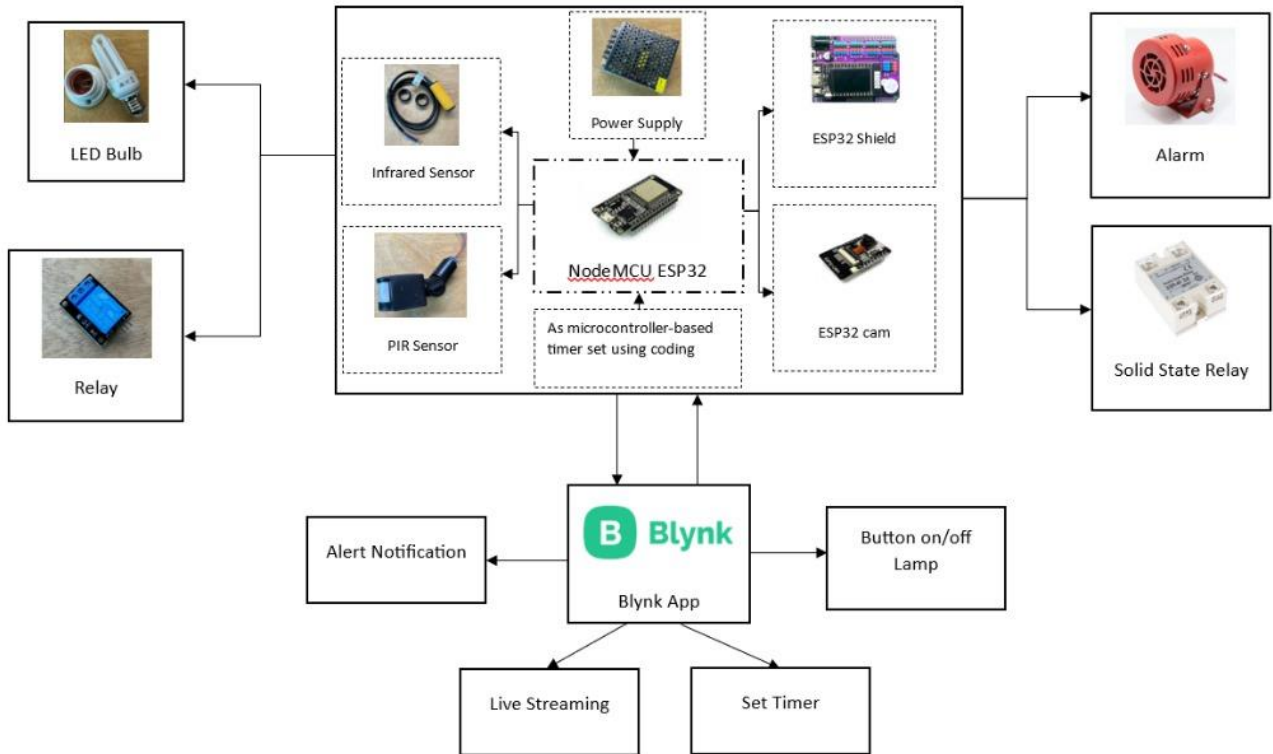

Fig. 1 *System Block Diagram*

Figure 1 shows into the explanation of block diagrams, providing insight into the visual representation of system components and their interconnections. By delving into the exploration of block diagrams, this subtopic aims to improve comprehension by clearly and concisely illustrating both the structural and functional aspects of the system.

2.2 System Flowchart

Figure 2 visually represents the flowchart detailing the operations of the home security system. By examining the flowchart, viewers gain insight into the sequential processes and decision points that constitute the functioning of the home security system.
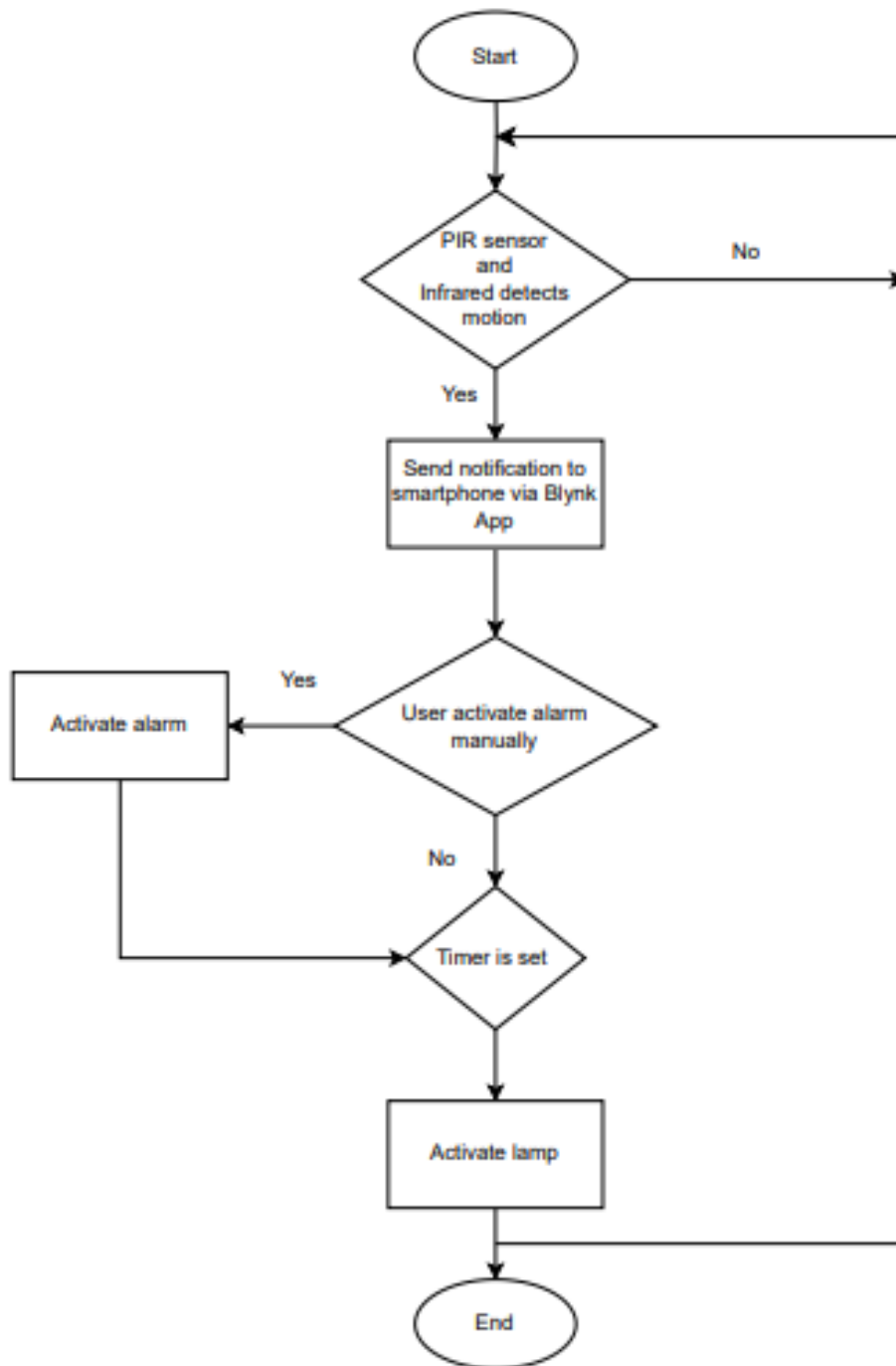
Fig. 2 *Flowchart of the system*

This home security system is built based the ESP32 microcontroller, which has built-in Wi-Fi and dual-mode Bluetooth capabilities. The system includes a timer feature built on the ESP32, which functions as a microcontroller-based timer.[3] The system works as follows: When the PIR sensor and Infrared sensor detect motion or heat energy in the surrounding environment, a notification is sent immediately to the user's smartphone via the Blynk App. Requirement for pop up notification is needed two of sensor detect, if one of them detect, the notification will not pop up to the user. If the user notices any unusual movement, they can activate the alarm. In addition, the user can live stream the surroundings on their smartphone to watch the region in real time. The Blynk App includes an interface where the user may enable or disable the alarm.[5] The user can set a timer to turn on a lamp at various times, particularly at night. Once the timer reaches its designated timeout, the lamp will turn off.

3   Result and Discussion

This section focuses on the result and discussion of the thief monitoring system, involving components such as the PIR sensor, infrared sensor, sensor notification, live monitoring system, and Time-Set Lighting Automation. The examination aims to provide insights into the functionality and effectiveness of these elements within the broader context of the security system.

3.1 Sensor Notification

The requirement for notification pops up on user's phone is two of sensor which is PIR sensor and Infrared sensor needed to trigger at the same time. If one of them does not trigger, the notification will not pop up. Once both sensors detect an object concurrently, the system promptly initiates the notification process, sending an immediate alert to the user's phone. This ensures swift and real-time communication of potential security breaches, enhancing the system's responsiveness.
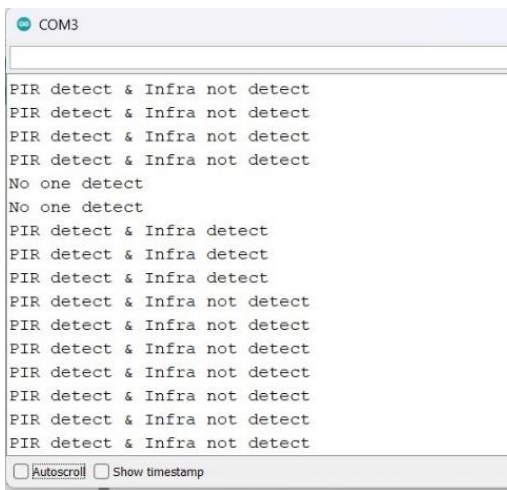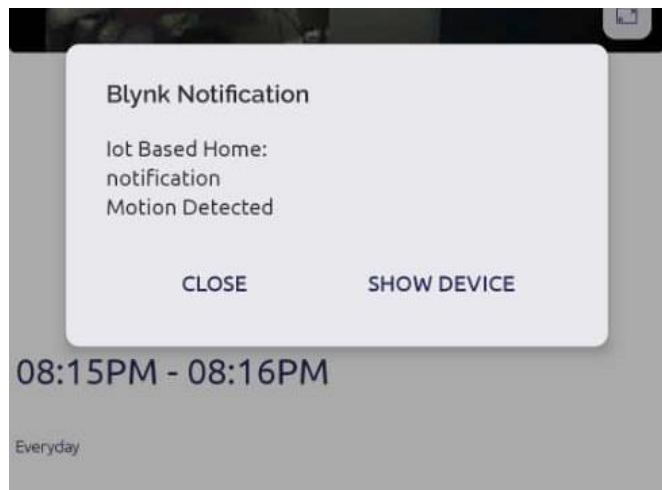
(a)   (b)

Fig. 3 *(a) Result of sensor notification testing (b) Pop up notification*

3.2 Live Monitoring System

The live monitoring system integrates the versatile ESP32-CAM module with the Blynk app, creating a powerful and user-friendly solution for real-time surveillance. The ESP32-CAM streams live video, transforming any space into a monitored environment. The ESP32-CAM module is commonly known to support a frame rate of approximately 12.5 frames per second (fps) when capturing images at a resolution of 1280x720 pixels, which is considered regular HD (High Definition) resolution. With Blynk, users can seamlessly access and control the ESP32-CAM from their smartphones, receiving instant alerts and visual updates. Blynk is created to serve the user as user interface and the live streaming will be on the front page.
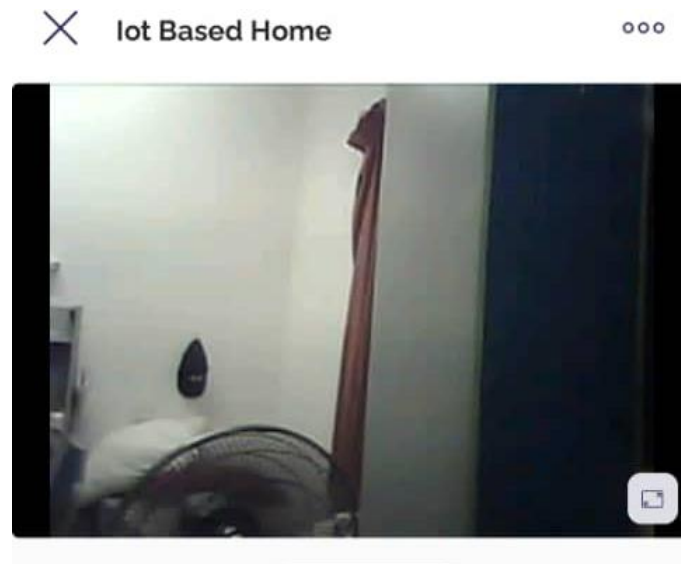
Fig. 4 *Live streaming on Blynk app*

3.3 Time-Set Lighting Automation

The time-set lighting automation system offers a seamless and user-friendly solution for hands-free control of LED bulbs. With this system, users can effortlessly set specific time intervals for their LED bulbs to turn on or off automatically. his innovative system simplifies the user experience, providing an efficient and eco-friendly approach to home lighting management.

(a)

08:15PM - 08:16PM

Everyday
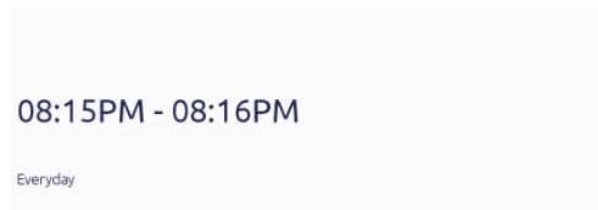
(b)

Fig. 4 *(a) Automation lighting (b) Menu for time configuration*

3.4 Discussion

The home security system employs a sensor notification system that sends immediate alerts to user's smartphone through the Blynk App whenever the Infrared and PIR sensors detect any suspicious movement. Additionally, the live monitoring system utilizes ESP32 and ESP32-CAM microcontrollers to enable real-time video streaming, providing a virtual eye for remote surveillance.[7] The Time-Set Lighting Automation feature adds a smart touch by allowing user to schedule lighting operations, enhancing security through the illusion of an occupied home, and promoting energy efficiency. Together, these components create a comprehensive and user-friendly security solution for their home.

4   Conclusion

By integrating the ESP32-CAM module, ESP32 microcontroller, PIR sensor, infrared sensor, Blynk app, 12v alarm, and LED bulb, an effective and economical home security system may be created. The ESP32-CAM module functions as a surveillance camera. The ESP32 microcontroller serves as the core control unit, integrating and enabling communication between the various components. Passive Infrared (PIR) sensor and infrared sensor, integral to home security systems, detect changes in infrared radiation emitted by warm objects within their field of view. These sensors are adept at motion detection, triggering alarms or activating lights and cameras when movement is detected, making them invaluable for indoor and outdoor security applications. Users may remotely monitor and control the security system via the Blynk app, receiving live video feeds and notifications of any suspicious activity. The 12v alarm acts as an audible alarm, notifying residents and maybe deterring attackers when triggered by unauthorized access or movement. The LED bulb can be used for automation, mimicking occupancy by turning on and off at predetermined periods or by sensor-based activation. With these components functioning together, homeowners may improve their security measures, remotely monitor their houses, and receive real-time notifications, resulting in peace of mind.

In conclusion, combining the ESP32-CAM, ESP32, PIR sensor, Infrared Sensor, Blynk app, alarm, and LED light allows for the development of a comprehensive and user-friendly home security system. Through the Blynk app, homeowners may remotely monitor their property, receive alerts, and control various security features by integrating these components. The 12v alarm and LED bulb add extra layers of security and automation, increasing the system's efficacy. Overall, this configuration provides a cheap and adaptable solution that improves home security, protecting the safety and peace of mind of homeowners and their families.[6]

Acknowledgement

References

[1]   Hoque, Mohammad Asadul; and Davidson, Chad. 2019. Design and Implementation of an IoT-Based Smart Home Security System. International Journal of Networked and Distributed Computing. Vol.7(2). 85-92. https://doi.org/10.2991/ijndc.k.190326.004 ISSN: 2211-7938

[2]   Surantha, N., & Wicaksono, W. R. (2018, January 1). Design of Smart Home Security System using Object Recognition and PIR Sensor. Procedia Computer Science. https://doi.org/10.1016/j.procs.2018.08.198

[3]   3. R. K. Kodali, V. Jain, S. Bose and L. Boppana, "IoT based smart security and home automation system," 2016 International Conference on Computing, Communication and Automation (ICCCA), Greater Noida, India, 2016, pp. 1286-1289, https://doi.org/10.1109/CCAA.2016.7813916

[4]   Andreas, Cornelio Revelivan Aldawira, Handhika Wiratama Putra, Novita Hanafiah, Surya Surjarwo, Aswin Wibisurya, Door Security System for Home Monitoring Based on ESP32, Procedia Computer Science, Volume 157, 2019, Pages 673-682, ISSN 1877-0509, https://doi.org/10.1016/j.procs.2019.08.218. (https://www.sciencedirect.com/science/article/pii/S1877050919311378)

[5]   Taiwo, O., Ezugwu, A. E., Oyelade, O. N., & Almutairi, M. (2022, January 15). Enhanced Intelligent Smart Home Control and Security System Based on Deep Learning Model. Wireless Communications and Mobile Computing. https://doi.org/10.1155/2022/9307961

[6]   Starters, I. (2021, June 17). IoT Security Camera using ESP32-Cam Blynk and PIR Sensor - IoT Starters. IoT Starters. https://iotstarters.com/iot-security-camera-using-esp32-cam-blynk-and-pir-sensor/

[7]   Santos, R., & Santos, R. (2020, June 29). ESP32-CAM Video Streaming Web Server (works with Home Assistant) | Random Nerd Tutorials. Random Nerd Tutorials. https://randomnerdtutorials.com/esp32-cam-video-streaming-web-server-camera-home-assistant/