Revolutionizing Room Security: Integrating ESP32-CAM for CCTV Connection With Telegram Bot

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Abstraks

ESP32 adalah mikrokontroler yang dapat digunakan untuk mengembangkan berbagai aplikasi IoT. Dalam konteks keamanan ruangan, ESP32 dapat digunakan untuk membangun sistem pengamanan yang terhubung ke jaringan Wi-Fi dan dikontrol melalui Telegram Bot. Sistem ini dapat memanfaatkan kamera CCTV untuk memantau ruangan dan mengirimkan notifikasi ke pemilik ruangan melalui Telegram Bot ketika terdeteksi gerakan yang mencurigakan. Sistem ini dapat mendeteksi adanya pergerakan dan mengirimkan notifikasi ke pemilik ruangan melalui pesan Telegram. Selain itu, sistem ini juga memiliki keunggulan dalam konsumsi daya yang rendah dan penggunaan ESP32-CAM yang memiliki semua komponen untuk WiFi dan bluetooth yang dapat digunakan untuk membangun komunikasi nirkabel yang lebih efisien dan berbiaya rendah Sistem ini dapat diimplementasikan dengan menghubungkan ESP32 ke kamera CCTV dan sensor PIR. Kemudian, sistem dapat diprogram menggunakan Arduino IDE untuk mengirimkan notifikasi ke Telegram BOT ketika terdeteksi gerakan yang mencurigakan. Sistem ini dapat membantu meningkatkan keamanan ruangan dengan memberikan notifikasi secara real-time kepada pemilik ruangan ketika terdeteksi gerakan yang mencurigakan.

Kata kunci : *ESP32-CAM, IoT, CCTV, Telegram Bot*

Abstract

The ESP32 is a microcontroller that can be used to develop various IoT applications. In the context of room security, the ESP32 can be employed to build a security system connected to Wi-Fi and controlled through a Telegram Bot. This system can utilize CCTV cameras to monitor the room and send notifications to the room owner via a Telegram Bot when suspicious movements are detected. The system is capable of detecting motion and sending notifications to the room owner through Telegram messages. Additionally, the system has the advantage of low power consumption and utilizes the ESP32-CAM, which includes all components for WiFi and Bluetooth, enabling the construction of more efficient and cost-effective wireless communication. This system can be implemented by connecting the ESP32 to CCTV cameras and PIR sensors. Subsequently, the system can be programmed using the Arduino IDE to send notifications to the Telegram Bot when suspicious movements are detected. This system can contribute to enhancing room security by providing real-time notifications to the room owner when suspicious movements are detected.

Keywords : *ESP32-CAM, IoT, CCTV, Telegram Bot*

1. INTRODUCTION

In Indonesia itself, CCTV began to gain recognition around 1995. Currently, this surveillance camera system is only used in office buildings. However, after the May 1998 riots, the use of CCTV became more widespread. It was only in 2004 that the police started using these surveillance cameras to monitor public spaces and traffic flow. Even now, traffic police in Indonesia utilize CCTV cameras for electronic ticketing programs.[1]The presence of CCTV cameras has become crucial in addressing crimes occurring in public places, offices, malls, and even stores. The development of CCTV is expected to become more sophisticated in the future, with improved resolution, usage size, and system capabilities compared to the current state.[2]

Just as in rooms without CCTV, several issues or discomforts in terms of security and surveillance may arise. Here are some possible problems:

1. Suboptimal Security: Without CCTV, a room becomes more vulnerable to theft, vandalism, or other criminal activities.
2. Inability to Monitor Events in Real-Time: CCTV allows room owners or security personnel to

monitor events directly.
3. Inability to Investigate Suspicious Incidents: CCTV often aids in investigating suspicious incidents.
4. Difficulty in Ensuring the Security of Employees or Visitors: CCTV not only contributes to the security of goods but can also be used to monitor the safety of employees or visitors.

The use of CCTV is not only for security but also to improve operational efficiency and monitor daily activities. Therefore, the inability to have CCTV in a room can lead to various problems and uncertainties.[3]

Based on the issues mentioned above, coupled with the advancements in IT technology, the researcher intends to use and integrate IT technology as part of the CCTV security system. By employing tools such as Passive Infrared Receiver (PIR) sensors capable of detecting unusual movements and the ESP32 CAM Microcontroller[4] capable of sending notifications and warning messages label as 'DANGER' in both text and photo formats to the user's Telegram application when connected to the local wireless network. This is expected to assist schools in enhancing their CCTV security systems even with a minimum budget, thereby minimizing potential similar criminal activities in the future. The researcher hopes that the implementation of this security system will help address the issues in the school and prove beneficial for both the researcher and readers.

2. RESEARCH METHOD

2.1. Research Flow Scheme

This research employs the Research and Development (R&D) method, which can be defined as a deliberately systematic research method aimed at seeking, formulating, improving, developing, producing, testing the effectiveness of products, models, methods/strategies/approaches, services, specific procedures that are superior, new, effective, efficient, productive, and meaningful. R&D[5] explains that for research analyzing needs to produce a hypothetical product, the basic research method is often used. Subsequently, to test the still hypothetical product, experiments or action research are employed. Once the product is tested, it can then be applied. The process of testing the product through experiments is referred to as applied research. Research and development aim to discover, develop, and validate a product.

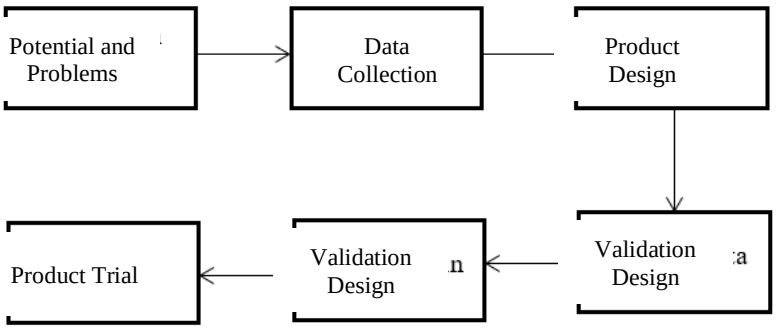


Figure 1. Research Model

2.2. Data Collection

The data collection process is conducted to obtain information about this research, including:

a. Direct Observation: This involves observing the CCTV management in the field firsthand. Directly observing the field operations, the researcher gains insights relevant to the study.
b. Interview: To obtain accurate information, the researcher engages in question-and-answer sessions with the managers or administrators in the field.

2.3. Data Analysis

This section describes the analysis carried out by applying one of the analysis methods by describing the object being analyzed clearly and measurably by applying 5W+1H (Why, Who, What, Where, When and How).

2.4. Equipment Assembly Step

The stages of assembling the tool can be informed as follows:

2.4.1. Assembly Design

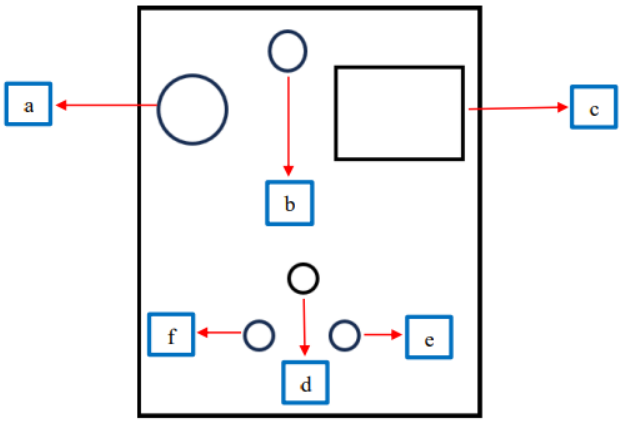


Figure 2 CCTV Box Design

Example:

a. ESP32 CAM: Functions as the main microcontroller in this security system, responsible for capturing images and sending them to the Telegram application.
b. Flash ESP32 CAM (White): The flash LED on the ESP32 CAM used for providing flash light during image capture.
c. PIR Sensor (Passive Infrared Receiver): A sensor utilized to detect the movement of an object that is not supposed to be present.
d. PIR LED (Red): Serves as an indicator that the PIR Sensor is active. If any unwarranted movement is detected by the PIR Sensor, the PIR LED will illuminate and stop once the movement is no longer detected.
e. ON/OFF Switch for Breadboard Power Supply Module MB102: Functions to turn on and off the indicator LED on the Breadboard Power Supply Module MB102.
f. Indicator LED for Power Supply Module MB 102 (Green): Used as an indicator that the Power Supply Module MB 102 is operational and not damaged.

2.4.2. Hardware Design

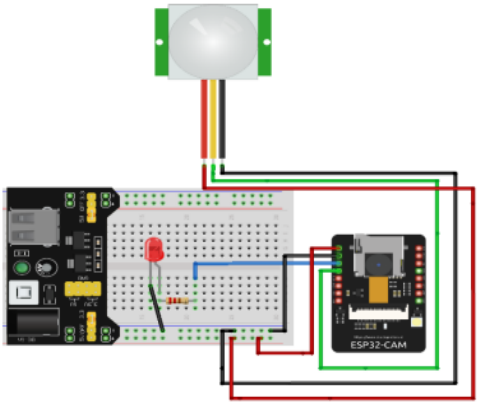


Figure 3 Sensor Wiring Diagram

The description of the image above is as follows:

Table 1. Port Configuration PIR Sensor

NO	PIR Sensor	Breadboard	ESP32-CAM
1.	VCC	Positive (+)	-
2.	OUT	-	GPI013
3.	Ground	Negative (-)	-

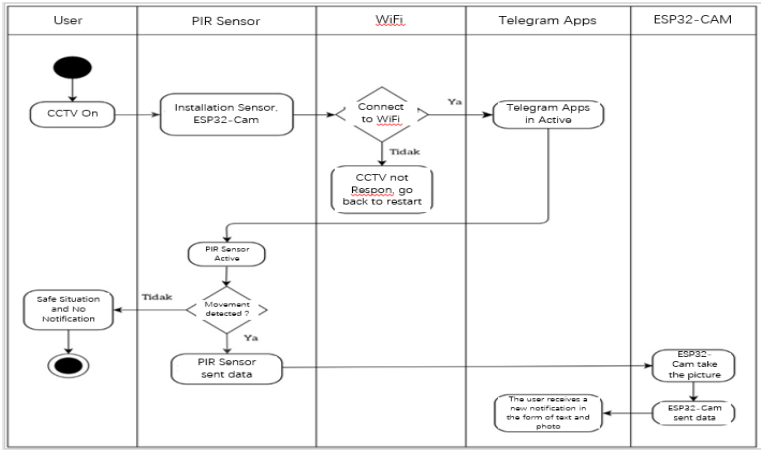
Table 2. Port Configuration ESP32-CAM

NO	ESP32 CAM	Breadboard	PIR Sensor
1.	5V	Positive (+)	-
2.	GND	Negative (-)	-
3.	GPI012	-	-
4.	GPIO13	-	OUT

3. RESULTS AND DISCUSSION

The steps in using this system include:

- The user (teacher) turns on the CCTV by plugging the 12Volt Adapter into the power outlet and pressing the ON/OFF switch on the MB102 Power Supply Module.
- The PIR LED in active calibration for 30 seconds, then connects to the local wireless network.
- After connecting to the local wireless network, there are two possibilities: good or bad connection. If it is good, both the Telegram application and the PIR sensor are active. If bad, it cannot be used to process data, and some damaged components need to be replaced or the wireless network needs to be changed.



Firgure 4 How the system works.

If unwarranted movement is detected by the PIR sensor, there are two possible scenarios:
If the situation is deemed 'DANGER,' the PIR LED will light up, the Flash on the ESP32 CAM will activate, followed by the activation of the ESP32 CAM itself. The user will receive a notification and a warning message in the form of text and a photo on the Telegram application.

In the second scenario, if the situation is safe, the user (teacher) will not receive any notifications or 'DANGER' warning messages.

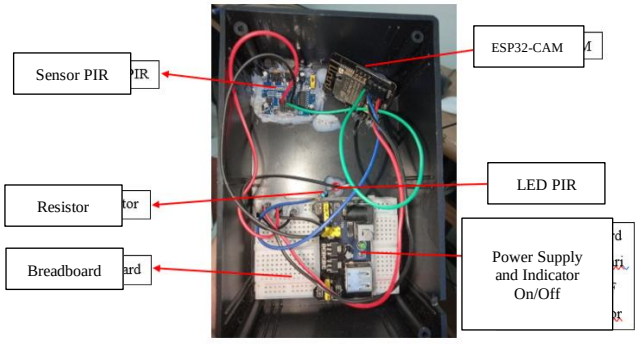


Figure 5 Prototype circuit

Telegram BOT Appearance:

Steps for creating a Security System Bot This bot is created so that it can interact with the CCTV Security System that has been created, the steps for creating it are as follows:

The first step is to first search for BotFather in the search column in the Telegram application.

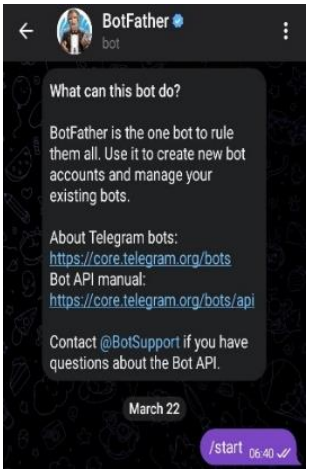


Figure 6 Telegram BOT display

This message is the third display after clicking '/start' and several commands appear, namely: photo_with_flash and photo_without_flash. These two commands can be selected or executed and the results will be like the image above.

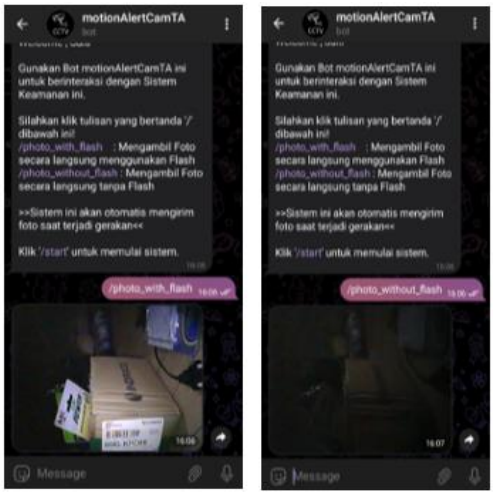


Figure 7 Telegram BOT Photo Results

PIR sensor test results :

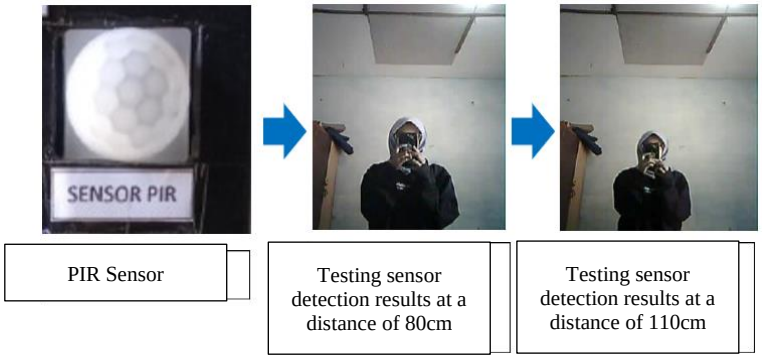


Figure 8 PIR Sensor Test Results

This PIR Sensor test aims to determine the distance that can be detected between objects and the PIR Sensor.

Table 3. PIR Sensor Testing

No.	Sensor Distance to Object (cm)	Information
1.	20 cm	Detected
2.	30 cm	Detected
3.	40 cm	Detected
4.	50 cm	Detected
5.	60 cm	Detected
6.	70 cm	Detected
7.	80 cm	Detected
8.	90 cm	Detected
9.	100 cm	Detected
10.	110 cm	Detected

Overall testing of the device :

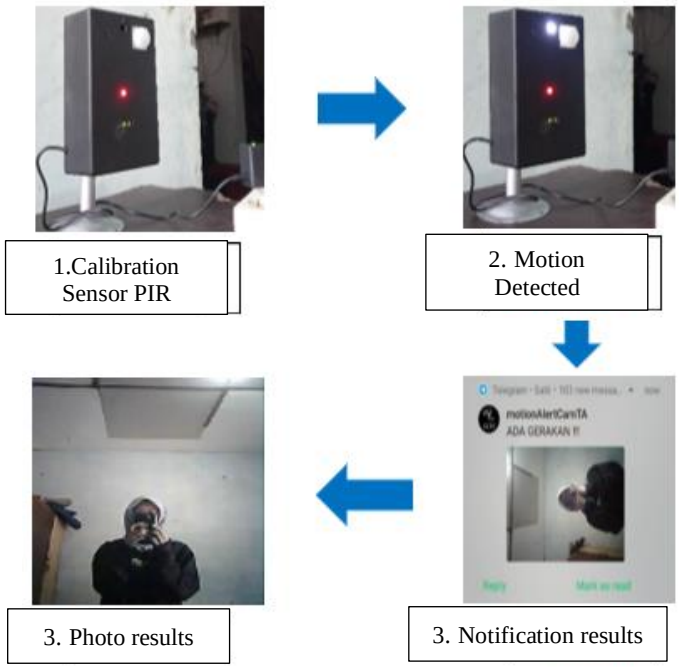


Figure 8 Overall Testing Device

Testing the entire device begins by turning on the CCTV by plugging the 12V Converter Adapter into the Contact Stop then pressing the ON/OFF Switch, MB 102 Power Supply Module, then waiting for the Sensor LED to calibrate 6 times for 30 seconds and connect to the local wireless network, if if inappropriate movement is detected by the PIR Sensor, the ESP32 CAM Flash LED and PIR LED will light up and send a Notification and Message indicating "DANGER" to the Telegram User Application. This stage is carried out after testing the ESP32-CAM Microcontroller and PIR Sensor has been completed.

Table 4 Overall Test Results of the Device

No.	Distance (cm)	PIR	ESP32-CAM	Telegram	Status
1.	20 cm	Active	Flash in Active	Active	Dangerous
2.	30 cm	Active	Flash in Active	Active	Dangerous
3.	40 cm	Active	Flash in Active	Active	Dangerous
4.	50 cm	Active	Flash in Active	Active	Dangerous
5.	100 cm	Active	Flash in Active	Active	Dangerous
6.	110 cm	Active	Flash in Active	Active	Dangerous
7.	150 cm	Active	Flash in Active	Active	Dangerous

8.	180 cm	Active	Flash in Active	Active	Dangerous
9.	200 cm	Active	Flash in Active	Active	Dangerous
10.	280 cm	Active	Flash in Active	Active	Dangerous

4. CONCLUSION

From the results of testing and analysis on the CCTV security system based on the ESP32 CAM microcontroller using a passive infrared receiver with the Telegram application, the following conclusions can be drawn:

1. Designing a CCTV Security System has 5 stages, including: preparation, making a prototype, assembling components, uploading the program, and finally finishing.\
2. This system can only use a 12 Volt Adapter as a voltage source.
3. Based on the results of research that has been carried out, it is known that the PIR sensor can detect movement up to a distance of 280 cm.

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