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Research Article

Optimisation of ESP32-Cam-based Smart Security Using Fingerprint and PIR Sensor with Telegram App Notification

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Abstract: Smart security is a combination of technologies that utilise devices connected through connectivity and data with integration between one device to another with the aim of utilising the IoT (Internet of Things) based internet network. In today's global technology, smart security systems are very widely used in various tools that can facilitate activities, including server rooms. The system can use several devices such as the NodeMCU ESP32-Cam microcontroller, fingerprint sensor, PIR (Passive Infrared Receiver) sensor, buzzer and telegram application. This system sends a telegram notification in the form of an object image that will be sent to a telegram message on a smartphone or laptop if motion is detected in the server room with an emergency door lock feature. Based on the results of testing the tool, the overall test data results of this system are obtained, the PIR sensor is able to detect motion at a distance of 0 to 7 metres marked by the active buzzer and telegram notifications appear on smartphones and laptops with an average time delay of 1 to 3 seconds and total storage data usage for 1 month required on average of 3.1 MB. This intelligent security system can also distinguish server room members and non-members of the server room, with the implementation of intelligent security tools in this server room, it can increase security and reliability in the server room.

Keywords: ESP32-Cam, Fingerprint, PIR Sensor, Smart Security, Telegram

1. Introduction

Modern technology at this time has become an important part, especially in terms of security. Technological advances are increasingly significant, bringing individuals into a modern era that demands everything to work quickly, precisely and efficiently, one form of technological progress today is the emergence of the era of global competition Industry 4.0. Facing competition in the global era like today, the nation's children are expected to be able to think quickly, creatively and responsively. In addition, students as children of the nation are expected to have enthusiasm, competitiveness and seriousness in facing global competition in the current Industry 4.0 era [1].

Along with the progress of the times and the need for fast information technology, it is needed in various aspects of life today. So that it can support the performance of these aspects, one of which is the security aspect [2]. Security aspects are currently needed in various sectors of life, privacy factors also contribute to the importance of a security system. Especially in server room security if you want to avoid criminality such as theft, vandalism, and other criminal acts. In server rooms, especially in the power generation industry, damage often occurs due to human error or interference from people other than server members. So far, the CCTV in the server room that is installed, does not have a significant effect on the security and reliability of the server room, because it cannot record human movements that enter the server room [3]-[4]. Real-time monitoring is needed through direct notification to the server room manager by utilising an application that can be accessed anywhere [5]-[6].

By considering the above problems, the computer system can also be used as a server room security regulator by utilising IoT (Internet of Things) based mobile phone and laptop facilities connected to telegram notifications [7]-[8]. Controlling this server room smart secu-

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rity system requires software that is used to manage the IoT control system, namely the Telegram message application, hardware using the ESP32-Cam microcontroller as the main control, fingerprint fingerprint sensor as an automatic door safety and motion sensor or PIR (Passive Infrared Receiver) to detect any human movement in the server room. Of course, this server room security system will be much safer because it can control the state of the server room without having to always be in the server room and can monitor the security of the server room wherever and whenever the user is via a mobile phone connected to the Telegram message application in every possible condition of the threat of dangerous actions that might occur [9]-[10]. the contributions of this research are:

1. an IoT (Internet of Things)-based Smart Security system that can help monitor and record human movement in the server room.
2. security in the server room so that it can be monitored remotely using a mobile phone.
3. designing an IoT (Internet of Things) based Smart Security system where this tool can help and facilitate human work, especially in the field of security..

The purpose of this research are:

1. Able to design, create a system and know how the ESP32-Cam-based Smart Security tool works using fingerprints and PIR (Passive Infrared Receiver) Sensors with notifications via Telegram messages..
2. Able to test the design of tools to improve security and reliability in the server room.

Tool Testing and Observation At this stage, testing of the tool design that has been made is carried out. Then, the data obtained from the test results, in the form of image recording results that have been sent and displayed on the Telegram message application that has been built. Implementation and Data Collection Actual implementation of the system and tools and observation or observation and data collection of the system and tools in actual conditions [11]-[12].

2. Proposed Method

As a fundamental framework for instructional design, the ADDIE model provides a methodical approach to developing training programs that are both successful and efficient..

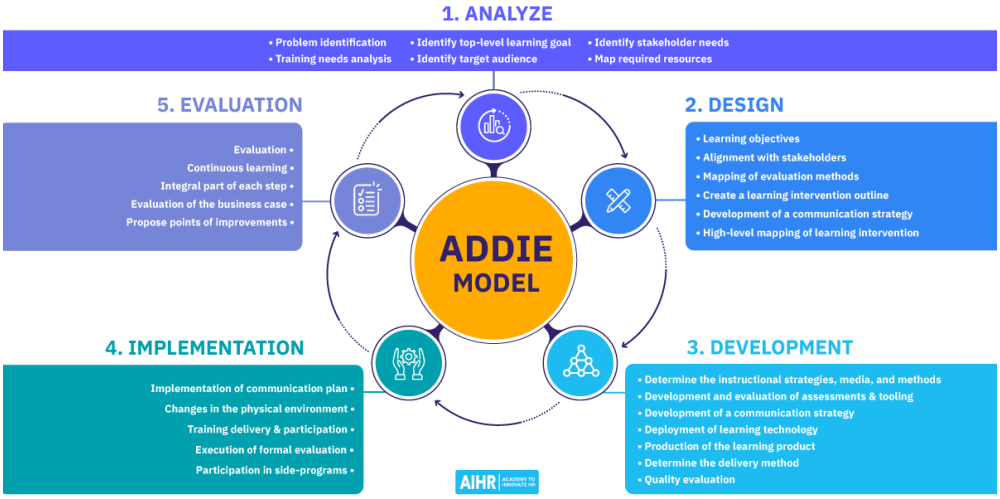

Figure 1. Addie Method

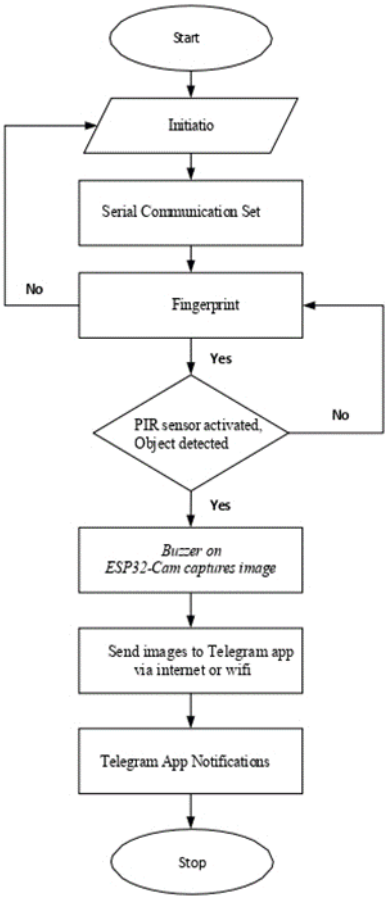

Figure 2. Flowchart System Development

The system flowchart design used in the design of IoT (Internet of Things) based smart security. The system is equipped with a PIR sensor that is active the detected object has been connected to the NodeMCU ESP32-Cam microcontroller and a fingerprint sensor [13]-[14]. The fingerprint sensor here stands alone with its own process, installed separately at the entrance to the server room. If the fingerprint sensor detects the fingerprint of a server room member, the door will automatically open. If the fingerprint sensor detects not from a member of the server room, the door will not open. Furthermore, if the motion sensor or PIR sensor detects an indication of movement, the NodeMCU ESP32-Cam microcontroller will automatically record or capture the object and the buzzer will sound. The buzzer in this system is installed to find out the initial notification that the system has detected movement without seeing the telegram message application first. After the image is captured and processed by the NodeMCU ESP32-Cam microcontroller, it will then be sent to a smartphone or computer (laptop) through the telegram message application media in the form of a notification connected via an internet network (wifi) [15].

3. Results and Discussion

The mechanical system designer of this smart security tool is the application of the system block diagram into a picture by applying software and hardware in place. This mechanical design consists of a list of materials for making software tools that will be used.

Figure 3. Mechanical design of ESP32-Cam and fingerprint microcontroller

In the mechanical design of the ESP32-Cam microcontroller, it uses an additional mount or cover as a protector of the main components used, namely the ESP32-Cam microcontroller, PIR sensor and several wiring circuits as a link between 1 component and other components. This cover uses PLA (polylactic acid) material which is bio degradable, which decomposes faster and fingerprints are installed on the server room door.

This electrical system designer makes wiring on a diagram that aims to facilitate the implementation for the manufacture of the arduino IDE program tool design. At this stage, it will be described one by one wiring of each component that is part of making the tool. This electrical system designer, the hardware components used are NodeMCU ESP32-Cam, HC-SR501 PIR sensor, buzzer, FT232RL USB to TTL FTDI downloader, USB to 5 pin or Mini USB cable and jumper cable.

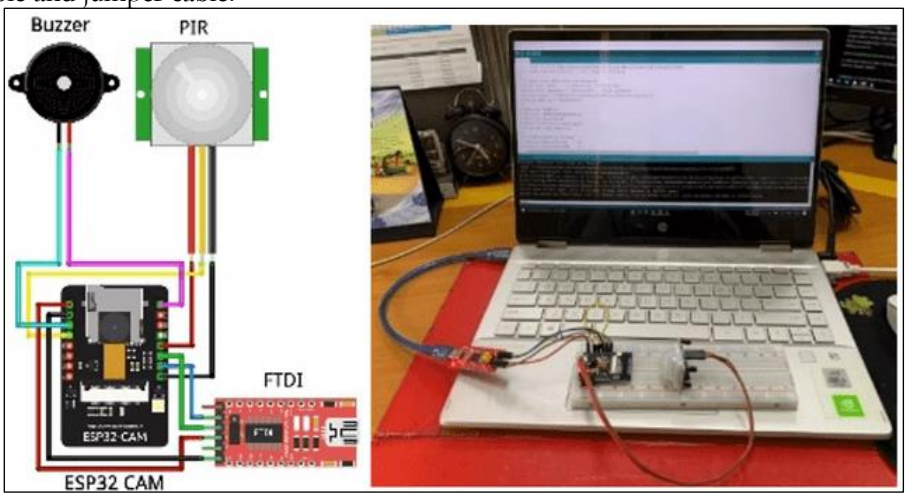

Figure 4. Electrical designer on NodeMCU ESP32-Cam and arduino IDE programme

The process of sending programs to the ESP32-Cam requires additional devices, because the NodeMCU ESP32-Cam does not have a special port, namely a microcontroller that has a micro mini USB port available for sending programs by uploading programs from the arduino IDE to the NodeMCU ESP32-Cam. So that an additional device is needed to send this programme. The additional device that can be used is FTDI FT232RL. This FTDI functions to make it like a port connected by USB (USB to 5 pin or Mini USB) connecting the computer (laptop) used for the programme and the NodeMCU ESP32-Cam microcontroller. After that, the tool can be used as a function of the system that has been made.

a. Connecting the NodeMCU ESP32-Cam Microcontroller with the Telegram BOT
   Send and receive commands on object image data and text remotely to the NodeMCU ESP32-Cam microcontroller, the author uses BOT telegram. Can use telegram messages, the author first registers BOT, BotFather is to create and manage your own bot. Below is a picture of the BotFather display in the telegram application.

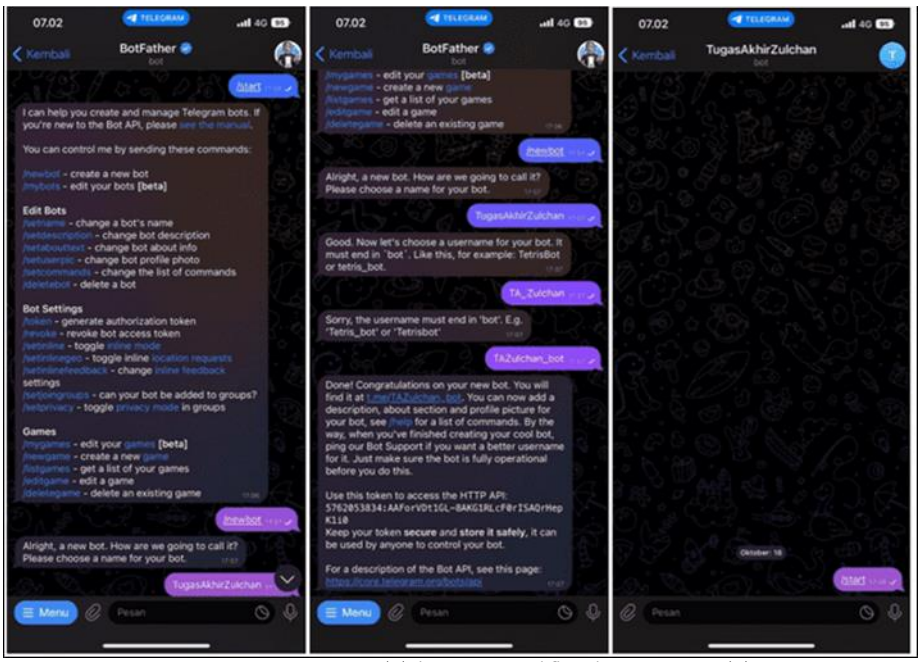

Figure 5. Telegram notification app BOT

Send the automatic message will be sent by the botfather according to the sign or API (Application Programming Interface) that has been made, then this sign or API will be entered into the arduino IDE programme and then uploaded to the NodeMCU ESP32-Cam microcontroller.

Overall, testing the design of the NodeMCU ESP32-Cam-based smart security tool using fingerprint and pear sensors with telegram messages aims to find out that the tool works with good performance, is effective and plays an important role in increasing security and reliability in the server room.

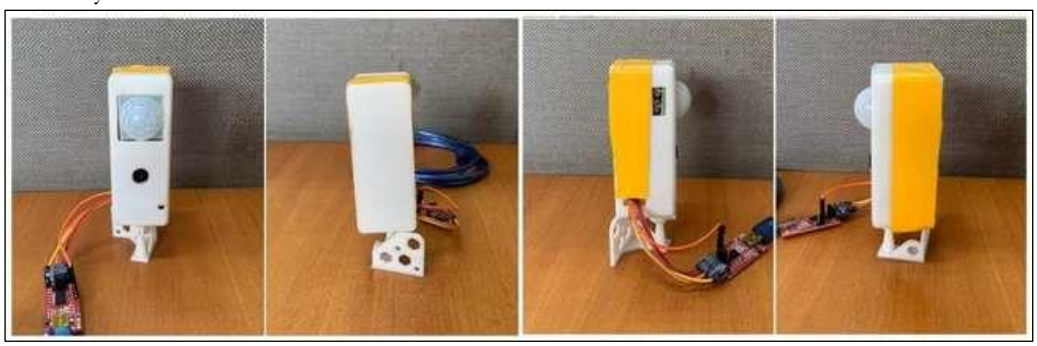

Figure 6. Final tool design

You can see the front, back, left side and right side of the tool. There is a NodeMCU ESP32-Cam and a PIR sensor embedded in a cover or mount as a protector of the main components of the tool connected with a jumper cable connected to the FT232RL USB to TTL FTDI downloader to a computer (PC) or laptop. If the programming is finalised or fixed, the FDTI can be replaced using a 5VDC power adapter.

Figure 7. Before and after fingerprint installation

The left door of the server room before installing the fingerprint and the right door of the server room after installing the fingerprint which is used as the main protection or security at the entrance to the server room.

Figure 8. Location of smart security devices in the server room

The location of the smart security device inside is marked with a red arrow. The tool is placed facing the server room door, with the aim that if people are detected entering the server room, the PIR sensor will immediately detect the movement. Because the server room is a sterile space from human activity, human movement only comes in and out on certain days or during routine maintenance.

b. Tool and System Testing

Before checking with data collection on the tool, the first thing to do is to check all connections in each circuit. This test is carried out with the aim of knowing the performance of the tools that have been made both in terms of hardware and software. The following are the testing steps of each tool that has been made.

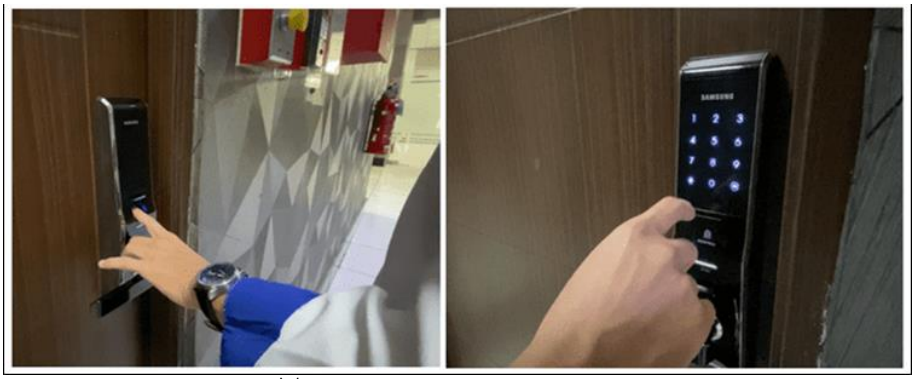

Figure 9. Testing digital and analogue fingerprint codes

This test was conducted to determine the performance of the telegram message application connected to the ESP32-Cam microcontroller and PIR sensor by sending images.

Table 1. Overall circuit testing

No	Name	Results Finger print	Distance (m)	Reading result PIR sensor	Door server	Telegram notification	Buzzer
1	Hadi P (Member)	Read	3	Detected	The door open	OK, it works	*ON*
2	Mayco L (Member)	Read	2	Detected	The door open	OK, it works	*ON*
3	Arriza (Member)	Read	3	Detected	The door open	OK, it works	*ON*
4	Eko (Member)	Read	1	Detected	The door open	OK, it works	*ON*
5	Abdul R (Non-member)	Unreadable	5	Not detected	The door not open	*Not OK, not successful*	*OFF*
6	Zulchan A (Non-member)	Unreadable	4	Not detected	The door not open	*Not OK, not successful*	*OFF*

The implementation of this tool design obtained the result that the reliability of the server room increased as shown in the figure below. In Figure 11 as a sample in May 2022 where before the implementation of the Smart Security Tool design, the reliability of the server was reduced marked by the trending internet bandwidth of the server which was broken due to interference by outside members of the server room. Meanwhile, in Figure 12 the internet bandwidth trending in November 2022 where after the implementation of the Smart Security tool design is monitored to increase its reliability marked by the internet connection bandwidth of the server which is smooth without any internet breaks. This reliability is influenced by technical disturbances and non-technical disturbances such as for example foreign parties or non-members of the server who enter the server room. This internet server interference is mostly influenced by foreign parties or non-members of the server who are not responsible for disrupting the reliability of the server.

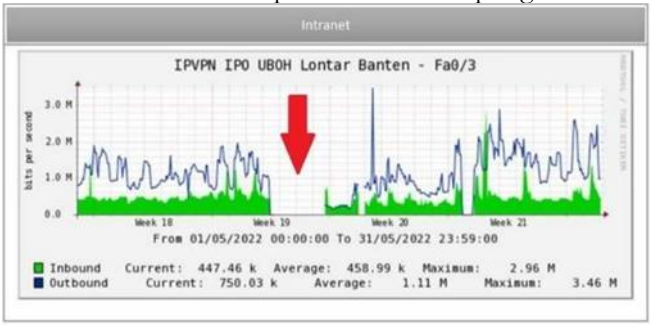

Figure 10. Trending server bandwidth monitoring before implementation

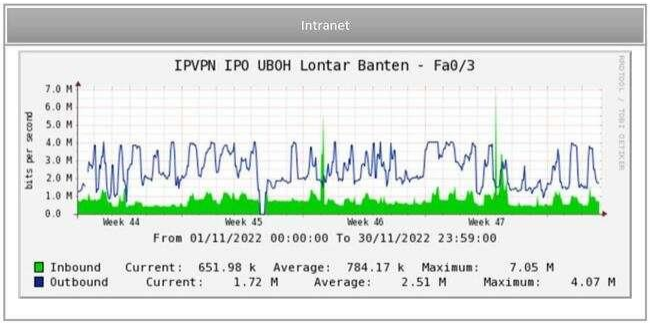

Figure 11. Trending server bandwidth monitoring after implementation

4. Conclusions

The design of smart security tools has been successfully made and run well, effectively and optimally, this tool is done by designing NodeMCU ESP32-Cam microcontroller components, fingerprint and PIR sensors and several other supporting components. The results of testing, the PIR sensor is able to detect movement at a distance of about 0 to 7 metres marked by the active buzzer with the appearance of telegram notifications on smartphones, computers (PCs) and laptops with an average time delay of about 1 to 3 seconds in total storage data usage for 1 month required on average is 3.1 MB. The system in this smart security can also find out by distinguishing members of the server room and those who are not members of the server room. Implementation of smart security tools in this server room, it can increase security and reliability in the optimal server room. This smart security tool was successfully tested for one full month and can distinguish access between server room users and non-members of the server room, so as to increase security and reliability in the server room. The results of trending bandwidth monitoring in the server room before and after implementation, there is an increase in security on the evidence of object images in the server room marked by uninterrupted connections.

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