Designing an Internet of Things-Based Automatic Door Lock System Using Esp32 Cam, Keypad, Fingerprint with Telegram Notifications at PT. Hosana Inti

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Article Info	ABSTRACT
Corresponding Author: Icha Novalita Nainggolan E-mail: ichanainggolan298@gmail.com	This study aims to design and build an Internet of Things (IoT)-based automatic door lock system using ESP32 Cam, keypad, and fingerprint sensor equipped with notifications via the Telegram application at PT. Hosana Inti. The development method used is a prototype model, which includes the stages of requirements gathering, hardware and software design, prototype development, and system evaluation and improvement. This system utilizes dual authentication in the form of fingerprint and PIN to enhance access security. The ESP32 Cam captures images of users every time the door is opened and sends them to a specified Telegram account in real time. Test results show that the system works as designed: the door can be opened through fingerprint or PIN authentication, and notifications along with user photos are successfully sent to Telegram. The main obstacles found are the sensitivity of the fingerprint sensor and network connection stability. Overall, this system can be a practical and efficient security solution for companies and homes, with the potential to develop access data storage features to improve monitoring. **Keywords:** Internet of Things (IoT), ESP32 Cam, Keypad, Fingerprint, Automatic Door Lock System, Telegram Notification

INTRODUCTION

Automatic doors have become a crucial innovation in everyday life, particularly in environments such as shopping malls, hospitals, airports, and office buildings. Automatic doors allow for more efficient and convenient access and provide added comfort for users, particularly in situations where users are carrying items or are physically restricted. However, as technology advances, the need for more sophisticated and secure automatic doors is increasing.

Traditional automatic doors typically rely solely on simple sensors such as motion sensors or infrared sensors to detect user proximity. While these systems are quite effective, they still face several challenges, such as reliance on sensors that are not always accurate in various environmental conditions, operational issues in high-traffic areas, and threats to user security and privacy. Technology makes everything easier.

Humans always try to create something that can make their activities easier, this is what

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drives the development of technology which has produced many tools as tools to make human activities easier and even replace the role of humans in certain functions.

Automatic control systems in science and technology have recently developed rapidly, with advances in science and technology playing a crucial role in today's modern era, where technology has become an inseparable part of everyday life. This can be seen in the range of applications ranging from small businesses to large corporations. The control system used is a microcontroller combined with several sensors as input to control other supporting devices.

A door is a structure or part of a building that serves as access for entering or exiting a room, area, or the building as a whole. Locks play a crucial role in a security system. Security systems using conventional locks, which are widely used by the public, are easily defeated by criminals. Furthermore, using conventional locks in a security system is also less reliable because they are easily lost during use, making this system impractical and vulnerable to theft.

The increasing number of burglaries has made people concerned about storing important items, both at home and in the office. Therefore, an automatic door lock system using fingerprints and PINs can minimize the possibility of burglaries, as they prevent just anyone from opening the door; only certain fingerprints can be used.

Internet of things (IoT) is the concept of a network of connected physical devices that can communicate over the internet. This technology allows devices to share data without human intervention. With the development of internet infrastructure, more and more physical objects can be connected to the internet, not just smartphones and computers.

The Telegram Massager app can be connected to the ESP32 Cam, which allows the bot system to function as a controller and command and allows people to communicate, exchange messages, and take pictures, voice messages and document files.

Here, the author conducted research on an automatic door security system that utilizes the Telegram app's chat bot feature. This system utilizes Internet of Things (IoT) methods. This system is expected to improve home and business security by inputting fingerprints and a PIN into a microcontroller. If the fingerprint and PIN are correct, a notification will be sent to the appropriate Telegram account.

METHODOLOGY

Research Procedures

According to Yanuarti (2020), a prototype is an approach in software engineering that directly demonstrates how software or software components will work in their environment before the actual construction phase begins. Prototype models are used as indicators of future development and differentiate between the two functions of exploration and demonstration.

According to Shalahuddin (2020), the prototype method (prototyping model) begins by gathering customer requirements for the software to be developed. Then, a prototype program is created to better visualize what the customer actually wants. This prototype program is evaluated by the customer or user until specifications are found that meet their expectations.

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According to Rohmat Taufiq, at all (2023) the stages required in creating a prototype method are as follows
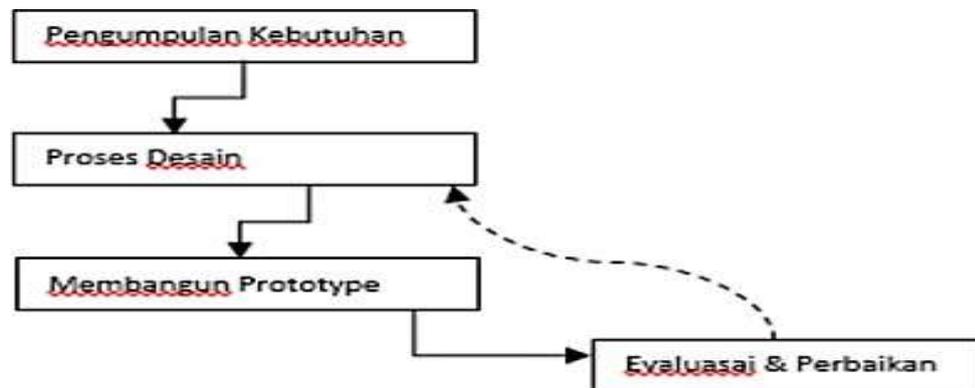
Figure 1 Research Procedure Flow

Requirements Gathering

Gathering user requirements is a crucial step in product development. This process involves identifying and deeply understanding the needs, preferences, and problems faced by users. By conducting effective and comprehensive data collection, the development team can create more relevant and satisfying solutions. The success of a product often depends on the extent to which we understand user needs. Therefore, it is crucial for the development team to conduct in-depth research and interact directly with users to ensure that the product being developed truly meets their needs. Therefore, gathering user requirements is not just a preliminary step but also a strong foundation for creating a successful and satisfying product.

This process involves collecting data to create an automated door lock using an ESP32 Cam, keypad, and fingerprint sensor based on the Internet of Things (IoT). This greatly assists users in locking doors and eliminating the need for manual door opening and closing.

Design Process

The application design process is a crucial step in software development. In this process, the design team is tasked with deeply understanding user needs. They conduct a comprehensive analysis to identify user preferences and expectations.

The primary goal of the application design process is to create a good user experience. A well-designed application will provide a convenient, efficient, and satisfying experience for users. This research designs an IoT-based ESP32 key system with two main components:

1. Hardware Design
   In this design, hardware consisting of ESP32 Cam, keypad, fingerprint, solenoid doorlock, LCD and other supporting devices such as breadboard and jumper cables are used.
2. Software Design
   Software design consists of creating the main program using the Arduino IDE program to the ESP32 Cam

Building a Prototype

Coding an application is a crucial stage in software development. This stage involves developers using programming languages to create applications that are not only functional

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but also efficient. During this process, special attention is required to design, security, and code quality to ensure the resulting application runs smoothly and meets all user needs. To create a quality application, developers must also ensure that the code they write is easy to understand and maintain by future development teams.

Evaluation and Improvement

After the initial prototype is completed, an evaluation of the system's functionality is conducted. At this stage, the prototype is tested by developers and users to determine whether it meets initial requirements. The evaluation includes things such as:

1. Is the keypad receiving input correctly?
2. Did the system successfully unlock and lock the door as instructed?

If there are any deficiencies, suggestions or feedback from this evaluation will be used to refine and further develop the prototype. Prototype Improvement and Refinement After receiving feedback from the evaluation, improvements and refinements are made to the prototype. At this stage, any suboptimal aspects or imperfect features will be fixed. Activities carried out include:

1. Modify hardware or add new components if necessary.
2. Updating the Arduino IDE program code to fix issues or improve keypad locking and input logic.
3. Optimizing the security aspects of the system, such as limiting incorrect input attempts and adding a temporary locking feature after several failed code entry attempts.
4. Refining the physical appearance of the prototype to more closely approximate the final form, for example by placing components in a casing.

SYSTEM ANALYSIS AND DESIGN

System Analysis

In today's digital era, efficient and automated security systems are essential, especially in industrial and office sectors, such as PT. Hosana Inti. This IoT-based automatic door lock system is designed to provide easy access while ensuring the security of restricted areas. By integrating fingerprint biometric technology and a keypad as access methods, this system allows users to open the door in two ways: scanning a fingerprint or entering a PIN code.
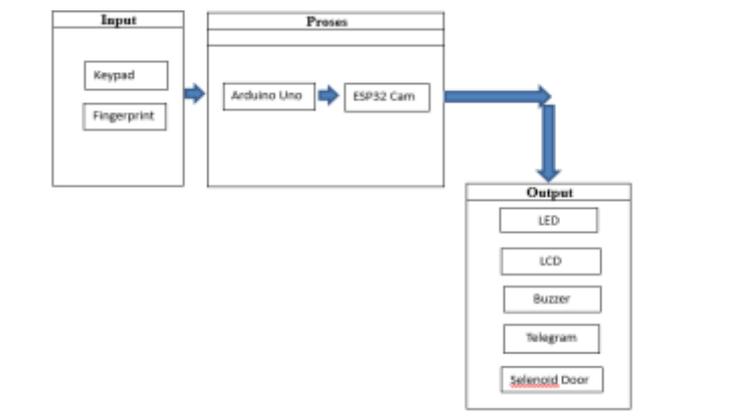
ESP32 Cam technology is used as the main module because it not only processes data but also captures images when the door is opened and sends notifications to Telegram, including images of the user who successfully opened the door. With this notification system, security officers or owners can monitor who accesses the door in real time.

System Design

System design is divided into three parts: Block Diagram, Hardware, Software

Block Diagram

Block diagram used to describe the activities within a system. To better understand the system to be created, a description of the system in operation is required. The following is a block diagram of the research.

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Table 1 Block Diagram

Information :
1. The keypad is used to activate the fingerprint sensor circuit displayed on the LCD.
2. If the code entered is correct, the Arduino Uno will process/turn on the fingerprint sensor.
3. The fingerprint sensor will test the image/picture of the registered/previously saved fingerprint.
4. If the fingerprint image matches, Arduni Uno will activate:
   a. *Relay module* so the solenoid door will open
   b. *Buzzer* will sound
   c. *LED* will light up
5. Next, the ESP32 Cam will work to capture the image in front of it and at the same time send the image to the Telegram application.

Hardware

Here we will describe the table of system hardware components.

Table 2 Hardware Components

No	Component	Amount	Type
1	Main Microcontroller	1	Arduino Uno
2	Notification Microcontroller	1	ESPCam32
3	Breadboard	1	Large
4	Fingerprint Sensor	1	AS608
5	Keypad	1	Burning
6	Male-male Jumper	50	-
7	Jumper Famale-famale	50	-
8	Male-female jumper	50	-
9	Solenoid Door	1	12 Volt
10	Buzzer	1	-
11	LED	1	-
12	Acrylic Board	1	20 cm x 20 cm Transparent
13	12 Volt Adapter	1	JMC 12 Volt Adapter
14	Relay Module	1	1 Channel 5 Volt Relay
15	Keypad Bracket	1	8 cm x 8 cm

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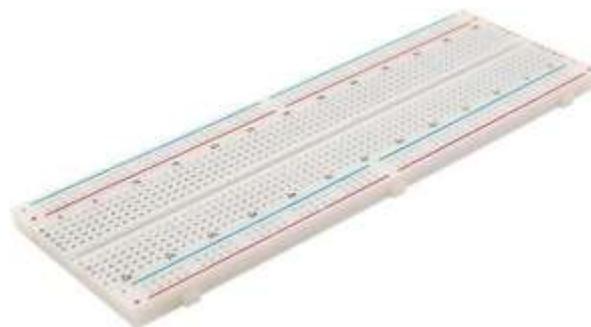| No	Component	Amount	Type
16	Resistor	5	220 Ohm - 1k Ohm
17	Potentiometer	1	1k Ohm
18	16X2 LCD	1	LCD Module I2C 5 Volt

The components described in the table above will be described again in the form of a design image as follows:
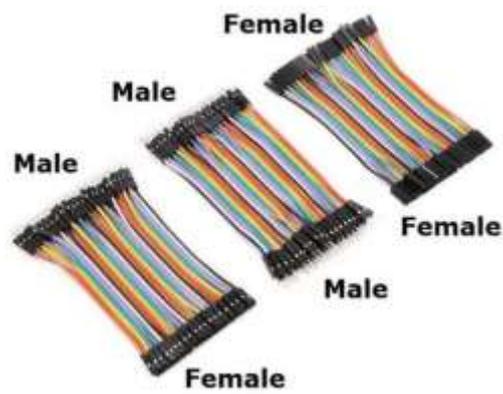

Figure 2 Arduino Uno

Figure 3 ESP 32 Cam

Figure 4 Breadboard

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Figure 5 Keypad

Figure 6 Jumper Cable

Figure 7 Solenoid Door

Figure 8 Buzzer

Figure 9 LED

Figure 10 Acrylic Board

Figure 11. 12 Volt Adapter

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Figure 12 Relay Module

Figure 13 Keypad Bracket

Figure 14 Resistor

Figure 15 Potentiometer

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Figure 16 16×2 LCD

Software Design

The software used in the design and implementation of this system plays a crucial role in programming, testing, and monitoring hardware performance. Each software component has its own function and role in supporting the success of the designed system. The list of software components used and their functions is outlined below:

Table 3 Software Components

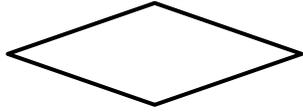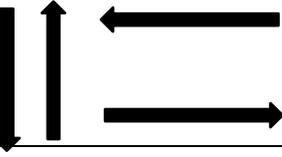| No	Component	Function
1	*Arduino IDE*	Control the entire process, including fingerprint checking, PIN code input, lock mechanism control, image capture, and notification sending via Telegram.
2	Telegram API Integration	to send messages and images to security officers.
3	If-else algorithm	determine access based on the selected method and verification results.

Script The created system will monitor input from the fingerprint scanner and keypad. If valid, the door will open, and the ESP32 will automatically capture the user's image. The image data is then sent to Telegram along with a notification message.

Flowchart Tool

Flow chart is a flowchart that describes the sequence of steps in a program in a section with predetermined section symbols. The following is a flowchart image in this study which can be seen as follows:

Table 4. Explanation of Image Symbols in Flowcharts

No	Symbol	Name	Function
1		Terminator	Declaring the beginning or end of a program
2		Input/output	State the input and output processes regardless of type the equipment
3		Process	State an action (process) carried out by a computer
4		Decision	Indicates a certain condition Which

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No	Symbol	Name	Function
5			will produce two possibilities answer yes/ No
		Predefined process	State provisionstorage place for processing to provide initial value
6		Flow	State the way channela process

Hardware Implementation

The hardware installation process is carried out by following the designed circuit diagram. The ESP32 Cam is connected directly to the fingerprint sensor and keypad with jumper cables according to the recommended pinout. The lock mechanism is operated by a servo motor or solenoid controlled via the GPIO pins on the ESP32. The device is assembled in a sealed box placed in the door area. The fingerprint sensor and keypad are placed in a position that is easily accessible to users.

Software Implementation

The main steps in software implementation are as follows:
1. Connect the ESP32 to a WiFi network and ensure a stable connection.
2. Integrate the fingerprint module with the main program for the authentication process.
3. Integrates keypad and reads PIN code input from user.
4. If fingerprint or PIN code verification is successful, control the motor lock. to open the door.
5. Take an image using ESP32 Cam and save it temporarily.
6. Sending images and notification messages to Telegram via the pre-built bot API. Examples of the program code used include fingerprint and keypad login functions, as well as taking pictures and sending Telegram messages.

Results Analysis and Evaluation

Based on initial testing, the system is capable of performing its core functions automatically and in real-time. Users can unlock the door using their fingerprint or PIN. After successful authentication, a user image is captured and sent to Telegram as proof of access. The system is also capable of providing automatic notifications whenever the door is opened.

The constraints found include:
1. The accuracy of the fingerprint sensor sometimes fails to identify due to distance or humidity.
2. WiFi network performance is the main factor in data delivery speed to Telegram.
3. It is necessary to adjust the position of the sensor and camera module to work optimally.

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CONCLUSION

Based on the results of the design, implementation, and testing of the Internet of Things (IoT) based automatic door lock system at PT. Hosana Inti, it can be concluded that: This IoT-based automatic door lock system was successfully designed and implemented using ESP32 Cam, fingerprint scanner, keypad, and Telegram notification integration. This system provides an efficient and practical security solution, facilitating real-time door access monitoring. Further development can be done by adding additional authentication features and improving sensor reliability. The system runs stably both in terms of reading data from fingerprints and keypads as well as sending notifications via the available internet network. This implementation is very suitable for use in an environment such as PT. Hosana Inti, because it can increase supervision and security of access in and out of the room while providing comfort to authorized users. From the results of this final assignment, even though this system is running well, there are still many things that need to be developed, including: The author suggests that this system be equipped with a data storage facility to record who opened the door and when they accessed it. This would be helpful if needed in the future. The author hopes that the tools and programs can be further developed to be even better so that these tools and programs become more effective.

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