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IoT System Design for Money Drawer Security Using Keypad and Selenoid Lock with Telegram Notification

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ABSTRACT

The security of cash storage remains a crucial issue, especially for households and small-scale businesses that frequently handle cash transactions. Conventional storage methods often lack advanced security features, making them vulnerable to unauthorised access. To address this problem, this study focuses on the design and development of an Internet of Things (IoT)-based security system specifically for a cash drawer. The system employs a keypad as the primary input device for authentication, combined with a solenoid lock that functions as the locking mechanism. In addition, users receive real-time notifications through the Telegram application whenever the drawer is opened or closed, thereby enhancing user awareness and security monitoring. The hardware architecture integrates the NodeMCU ESP8266 microcontroller, which serves as both the central processing unit and the module for internet connectivity. System testing was carried out under several scenarios, such as successful PIN entry, incorrect PIN input, and simulated break-in attempts. The results demonstrate that the proposed IoT-based system is capable of increasing the security level of cash storage while providing convenience through real-time monitoring.

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1. INTRODUCTION

A cash drawer is an important component for storing daily transaction proceeds. Its main function is to securely and systematically store cash, coins, transaction receipts, and other financial documents. However, with the increase in transaction activity and employee mobility, cash drawer security has become an increasingly crucial issue. Many cash drawers still use conventional manual locking systems that are easy to duplicate or break into. In addition, the lack of a monitoring system for drawer access is also a weakness that can be exploited by irresponsible parties. One example of IoT implementation is a home security system that uses a solenoid lock and magnetic sensor connected to the Telegram app. This system allows users to receive instant notifications when the door is opened and provides remote access control, significantly improving security[1]. A similar system was also implemented in safe security using fingerprints and NodeMCU ESP8266 with Telegram notifications. This system emphasizes the importance of biometric authentication in improving safe access security, as well as the use of notifications to monitor activities in real time[2]. By using this system, users can ensure that only authorized persons can access the cash drawer, and receive immediate notification

in the event of an unauthorized access attempt. This will certainly reduce potential losses due to theft or negligence in maintaining the security of the cash drawer.

2. METHOD

2.1 Internet of Things

The Internet of Things (IoT) is a technology that enables devices to connect and communicate with each other, which will continue to evolve and change various aspects of people's lives. The Internet of Things allows devices to share information in the form of images, audio, video, and coordinate decision-making. IoT is a system of interconnected computer devices between machines, objects, animals, or humans that complement each other and transfer data through a network without requiring human-to-human or human-to-device interaction[3].

Figure 1. Internet of Things

2.2 Telegram

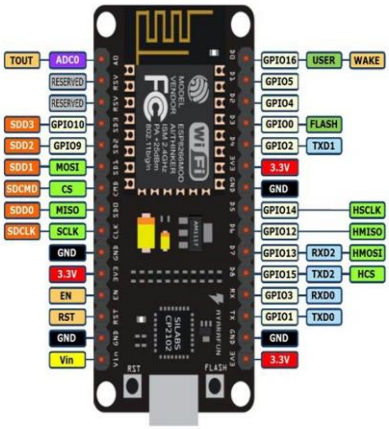
Telegram Messenger is an instant messaging app with end-to-end encryption to ensure the security of the messages you receive or send. This cloud-based application can be installed on smartphones, tablets, and computers. While some similar applications only allow you to send and receive images or videos, Telegram Messenger provides the ability to send documents and locations to your friends who also have this application on their devices. To date, many people are satisfied with Telegram because it allows them to send messages quickly, conveniently, and free of charge or advertisements that are commonly found in other applications[4].

Figure 2. Telegram

2.3 Nodemcu Esp8266

Nodemcu is an open-source IoT platform. It consists of hardware in the form of an ESP8266 system on chip from Espressif Systems, as well as firmware that uses the Luas scripting language. The term Nodemcu actually refers to the firmware used rather than the hardware development kit. NodeMCU can be likened to the Arduino board for ESP8266. In the ESP8266 embeddednesia tutorial series, we discussed how programming ESP8266 can be a bit troublesome because it requires several wiring techniques and an additional USB to serial module to download the program. However, Nodemcu has packaged the ESP8266 into a compact board with various features similar to a microcontroller, plus the ability to access Wi-Fi and a USB to serial communication chip. Therefore, to program it, you only need a USB data cable extension, exactly the same as the one used as a data cable and charging cable for Android smartphones[5].

Figure 3. Nodemcu Esp8266



2.4 Keypad 4x4

The 4x4 keypad functions as a commonly used input device for input purposes in various projects. This keypad includes a total of 16 keys arranged in a grid pattern with rows and columns. These keys are connected via conductive paths. Normally, there is no electrical connection between the rows and columns. However, when a key is pressed, a connection between the specific row and column will be initiated. Interestingly, this keypad operates efficiently with only 8 GPIO pins from the microcontroller[6].

Figure 4. Keypad 4x4

2.5 Selenoid Lock

A solenoid is an electromechanical locking device that uses a magnetic induction system through a coil as its drive. When the coil receives voltage (AC or DC), it turns into a magnetic field that moves the piston inside it. The solenoid used has a normally closed (NC) principle, meaning that when not affected by electrical current, the solenoid remains in the locked mode[1].

Figure 5. Selenoid Lock

3. RESULTS AND DISCUSSION

This stage is the first step in designing a system or application, which aims to identify the requirements, limitations, and relationships of the necessary parts of the system.

3.1. Flowchart System

Flowcharts can help analysts and programmers break down problems into smaller segments and assist in analyzing other alternatives in operation.[7]

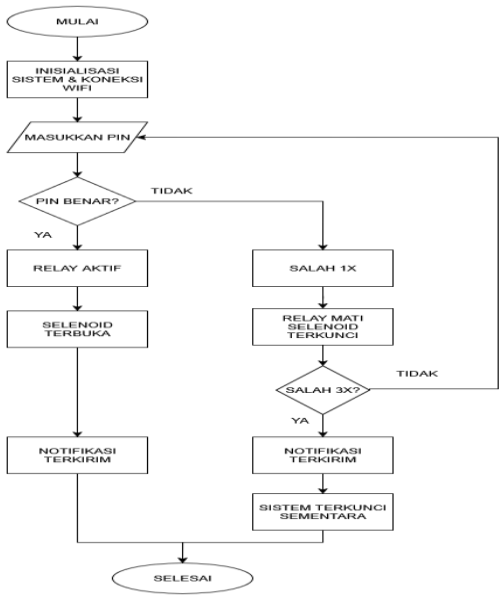


Figure 6. Flowchart System

Here is an explanation of the system flowchart from the image above:

1. Start
2. Wifi connection
3. Enter pin
4. If the pin is correct, the relay activates and the solenoid opens and sends a notification to Telegram.
5. If the pin is incorrect, the relay turns off and the solenoid locks.
6. If the pin is incorrect 3 times, the system sends a notification to Telegram and the system locks temporarily.

3.2. Activity Diagram

Activity diagrams illustrate the various activity flows within the system being designed, how each flow begins, the decisions that may occur, and how they end[8]. By creating an activity diagram, the logic behind a system's operation can be easily studied and understood.

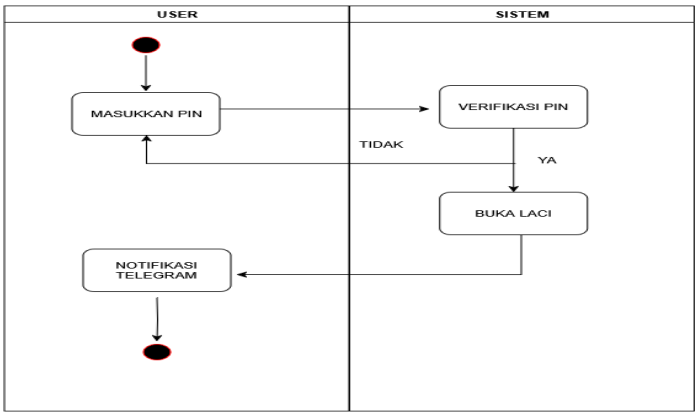


Figure 7. Activity Diagram

3.3. Overall View of the Device

The physical design is kept as simple as possible so that users can understand how the device works without difficulty.

Figure 8. View of the Device

3.4. System Testing

System testing is conducted to ensure that all system functions are operating as required :

1. Enter the correct PIN and the drawer will open and send a Telegram notification.
2. Enter the wrong PIN 3 times and the drawer will not open and will be temporarily locked, and a Telegram notification will be sent.
3. If the drawer is forced open, a Telegram notification will be sent.

Figure 9. System Testing

4. CONCLUSION

1. Integration with Telegram has been successfully implemented so that every time the drawer is opened and closed, the system will send a notification.
2. If the PIN is entered incorrectly 3 times, the system will be temporarily locked.
3. When the drawer is forced open, the system will send a warning notification and alarm.

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