PI GUARD ENHANCED DOOR SECURITY WITH RASPBERRY PI

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***Abstract*—There has been a rapid rise in cases of theft; this requires urgent security measures against these crimes. Thieves should be apprehended early and effectively. Here comes a door security system proposed based on Raspberry Pi to handle such matters. It comprises a keypad to provide password authentication, the Pi Camera to take snaps in case of three failures, and a buzzer that is used for sound warnings. In the case of three wrong password attempts, the system captures an intruder's picture and delivers them via email to the resident along with the nearest police station with the help of SMTP. The buzzer rings out with every incorrect attempt. A solenoid or stepper motor acts as a lock for physical security. This system combines affordability, scalability, and efficiency in enhancing responsiveness and deterrence during unauthorized access attempts, providing a practical and modern solution for residential security.**

Keywords: Internet of Things, Raspberry Pi, SMTP Protocol, Real-Time Surveillance.

I. INTRODUCTION

Crime rates are on the rise, which is quite concerning. Thefts and break-ins are becoming more frequent these days. To high-security areas like banks, casinos, garages, and military sites.Door lock security is crucial as it serves as the primary defence for safeguarding valuable assets and individuals. Various types of door lock systems have been developed by intelligent individuals ranging from automatic password based locks to software-based ones used in different environments. These locks come in diverse forms -password-based locks, RFID based locks, smart card-based locks, GSM-based locks, biometric-based locks, Bluetooth-based locks - you name it! Nonetheless, most existing projects fail to provide immediate alerts for unauthorized entries. Monitoring for security purposes often needs to be done manually.Radio Frequency Identification (RFID) utilizes radio waves for automatic identification through reader and tags. However, these systems can be expensive and may not cover extensive surveillance areas effectively. Our system uses a keypad-based password authentication mechanism with a Pi Camera that activates after three consecutive wrong password attempts. The system captures the image of the intruder and sends email notifications to the homeowner and nearby authorities with the captured image. This will ensure quick monitoring and response, which means security is enhanced even when the homeowner is not present.

II. LITERATURE REVIEW

Home security systems have advanced as a result of the widespread use of current technology, particularly microcontrollers such as the Raspberry Pi. The PIGUARD door security system, which uses Raspberry Pi capabilities, is an example of a new approach. This study combines key studies on door security systems, Raspberry Pi security applications, and the use of PIGUARD. Traditionally, door security systems used mechanical locks and rudimentary electrical access controls. However, these systems usually lack features such as real-time monitoring, remote access, and automated alarms. Smart home technology has led to more complex systems integrating keypad, picam and IoT devices, allowing for continuous monitoring and better integration with home automation platforms. The Raspberry Pi, a low-cost single board computer, is gaining popularity in a variety of DIY and professional security applications due to its portability and superior computing power. It is used to efficiently implement complex security algorithms and communicate with sensors and actuators. Research supports its use in surveillance systems, access control and intrusion detection, leveraging internet connectivity and image processing software libraries such as OpenCV. PIGUARD leverages the capabilities of Raspberry Pi for door security, combining facial recognition cameras, motion detection sensors and relay modules to control door locks. When used with Raspberry Pi, PIGUARD offers several benefits, including cost-effectiveness due to its low cost, low power consumption which makes it available worldwide. Users can customize the system to match their own security needs by adding more sen-

-ors or integrating with other home automation systems. The system offers remote monitoring and control over the internet, allowing for real-time updates from anywhere. It also allows for simple scaling by adding additional cameras or gradually increasing coverage to multiple access points.

III. SYSTEM ARCHITECTURE

A. RASBERRY PI 02W

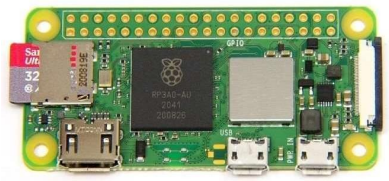

Fig. 1. Raspberry pi 02w

The Raspberry Pi Zero 2 W could be a compact and effective single-board computer planned for a wide run of applications. Measuring fair 65mm x 30mm, it highlights a 1GHz quad-core ARM Cortex-A53 CPU, giving essentially progressed execution over its forerunner, the Raspberry Pi Zero. With 512MB of LPDDR2 SDRAM, the Zero 2 W is able of taking care of different computing assignments effectively. Network alternatives incorporate built-in 802.11 b/g/n Wi-Fi and Bluetooth 4.2, guaranteeing consistent remote communication. The board moreover incorporates a smaller than expected HDMI harbour, two micro-USB ports (one for control, one for information), and a 40-pin GPIO header for meddle with outside gadgets and sensors. It too underpins Cap (Equipment Joined on Best) extension. The little shape figure and improved capabilities make the Raspberry Pi Zero 2 W perfect for IoT ventures, domestic mechanization, versatile gadgets, and instructive purposes. Its flexibility, combined with moo control utilization and reasonableness, offers a vigorous arrangement for specialists and experts alike, empowering imaginative and productive extend advancement.

B. CAMERA MODULE

Fig. 2. Camera module

The camera module, which is seamlessly incorporated into the Raspberry Pi, is critical to the security system since it captures photos of persons attempting to gain access to restricted areas. If illegal access is detected, such as by entering an erroneous password, the camera discreetly activates and captures an image of the invader. This photograph is then securely emailed to certain recipients, such as the user or local police enforcement. The camera module increases the system's capacity to identify intruders by giving visual proof of a security breach, allowing necessary responses to be initiated without notifying unauthorized individuals. Its integration guarantees consistent functioning and effective handling of security incidents, hence improving the system's capacity to safeguard facilities from illegal entry.

C. KEYPAD 4x4

Fig. 3. Keypad 4x4

This keypad is a simple input device integrated with a security system and allows the input of authentication credentials such as passwords or personal identification numbers. It interfaces securely with the Raspberry Pi to provide a secure interface for the user to interact with the system and identify themselves. Entering a password sends information to the Raspberry Pi, whereby it gets matched against the credentials in store. This should be a verification process that defines the form of access rights and grants or rejects them from this system, depending on the authentication results. The solid build of the keypad will ensure reliable operation and easy user interaction for effective access control in residential, commercial, and institutional use. This integration provides greater security because of the physical barrier designation against desired access attempts as part of an overarching security strategy.

D. SOLENOID LOCK

Fig. 4. Solenoid lock

The solenoid lock is an important electromechanical component used within the security system and electronically controlled by the Raspberry Pi. The device works through the conversion of electrical energy to mechanic motion in a way that either engages or disengages the locking mechanism. Integrated with the relay module, the solenoid lock receives signals from the GPIO pins of the Raspberry Pi, either securely locking or unlocking access points as expected, upon receipt of authenticated input. This mechanism provides very outstanding physical security measures, as the system is very effective in allowing entry only to authorized persons. The strength of the solenoid lock and reliability in performance make them useful in many applications for controlled access that were traditionally residential, commercial, and industrial locations. It improves any security system into which it is fitted to provide a reliable solution to the security of premises and very important assets against attempts of unauthorized access.

E. SMTP Protocol

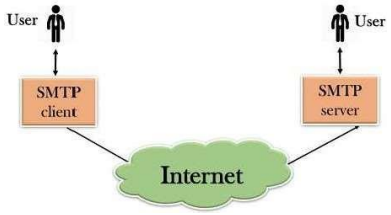

Fig. 5. SMTP protocol

SMTP acts as the important communication protocol inside this security system, through which email alerts will be generated from the Raspberry Pi and sent to concerned users or higher authorities. The system securely sends messages through the inclusion of an SMTP server and using user-provided email credentials. It initiates the camera module with the capture of a picture of the intruder on detecting unauthorized access. The image, along with detailed notification content,is sent immediately via SMTP. By using SMTP, this system ensures that real-time alerts are delivered as quickly as possible in enhancing its ability to respond effectively to security breaches. This protocol proves very vital in preserving the integrity and reliability of this system since it provides an avenue for effective communication of this very sensitive security information without divulgence or system performance degradation. It reflects commitment to robust security measures and proactive incident response through its implementation within the system.

F. BUZZER

Fig. 6. Buzzer

The buzzer is a vital component of the door security system, which issues an audible alarm in case an unauthorized person tries to get into the house. In addition, it is also a deterrent and warning system that alerts people to suspect activities as soon as possible. The buzzer is connected to the Raspberry Pi, and once an incorrect password has been entered on the keypad, it gets activated. The alarm bell sounds loudly and steadily till the correct password is given, thus serving two purposes; it discourages possible burglars from further access while on the other hand calls out other people's attention for an instant call upon their neighbors. The buzzer plays a significant role in the reinforcement of the system's deterrent mechanism; its continuous ringing acts as an alert for the resident or anyone around, to intervene in a timely fashion. The simple yet very effective sound alert by the buzzer adds to the overall security, thus making it an integral component of the project.

IV. METHODOLOGY

The methodology of the door security system project based on Raspberry Pi is the integration of hardware and software elements to create a productive and real-time security solution. The approach includes design, implementation, testing, and evaluation of the system so that it could provide reliable security. The core component of the system is the Raspberry Pi, which acts as the central processing unit of the project. It manages input from the keypad, controls the buzzer, activates the Pi Camera for image capture, sends email notifications, and manages the lock mechanism. The system makes use of a 4x4 matrix keypad, where users can enter a password. The system then compares the input password with a previously stored password and performs different operations according to the result. When the input password matches the stored one, the system makes the door open by operating the stepper motor or the solenoid lock. On the other hand, in case the input password does not match, the system switches to alert mode. On failing password entry, it turns on the buzzer. This buzzer will keep beeping until a correct password is entered and thus anyone nearby, such as neighbors, is alerted to this access attempt. The buzzer plays the role of discouraging the intruder, and it notifies people near the place of the attempted access, and perhaps they try to find out what happened or alert someone in authority. In the event that the intruder inputs the wrong passwords to unlock the door thrice consecutively, it

activates the Pi Camera. The camera takes a photograph of the intruder and instantly emails it to the owner and the nearest police station. This is done through SMTP protocol in such a way that the captured image will be sent in the shortest possible time while maintaining security. This process is integral in providing evidence of identity immediately, the homeowner responds much faster to law enforcement efforts. The locking mechanism is another main part of this system. The system employs either stepper motor or a solenoid lock depending on the decision of the choice of design control of the locking and unlocking of the physical door. The lock operation is also performed by the Raspberry Pi to manage the unlocking of doors depending on the authenticity of entering passwords. That is to say, during correct key in, the stepper motor/solenoid may unlock with it allowing accessibility to whatever, while the locks stay fixed at the error input stage of the key. The software design of the system is done with Python, with several integrated libraries to allow communication between Raspberry Pi and components. Built-in GPIO libraries are employed for interacting with the keypad, buzzer, and the lock mechanism, while for image capture, the Picamera library is used. An smtplib library is applied for sending an email notification once the images are captured. Once the system design and integration are done, complete testing is done to ensure functionality in each component. Password verification tests are done to validate accuracy in authentication, and a test is done on the buzzer to ensure proper sound output. A test is done on the camera to ensure that the camera captures clear images in case of three failed attempts, and a test on the email notification system is ensured for timely and accurate delivery of images. The lock mechanism is also tested to verify its reliability in responding to correct password inputs. After these tests, the system is deployed in a real-world setting for monitoring and further evaluation.

V. BLOCK DIAGRAM

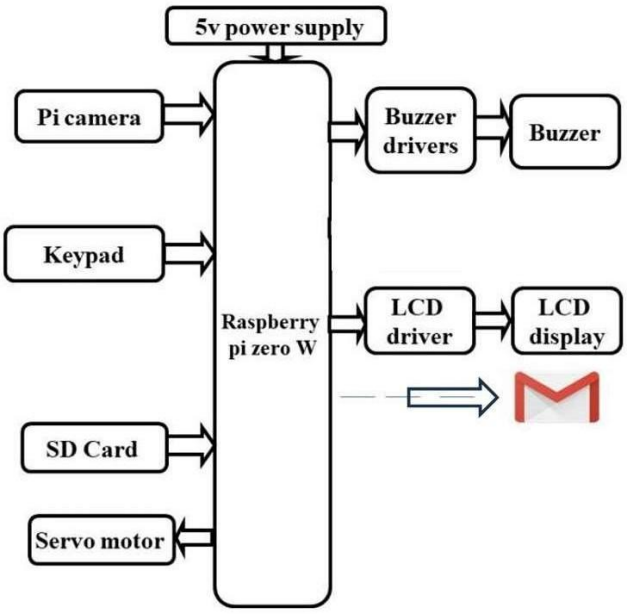

Fig. 7. Block diagram

VI. RESULTS

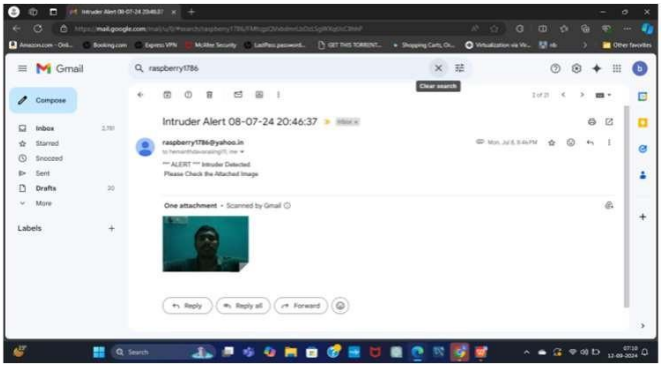

Fig. 8. Screenshot of mail received

The door security system was installed and tested and proved to be in excellent working condition. The system took the correct password correctly for unlocking the door and raised the buzzer whenever it received an incorrect input from the password. This meant that the surrounding area became aware of the intruder's presence, and the intruder's attempt was thwarted due to the alarm produced. After three successive failures, the Pi Camera managed to take a clear picture of the person and email both the homeowner and the local police station. The email notification system worked efficiently, in that the image was transmitted promptly. Figure 9 Screenshot of the email sent to the homeowner containing the picture captured by the Pi Camera after three incorrect attempts. The lock mechanism functioned properly, locking the door when incorrect passwords were submitted and unlocking it when the right password was entered. At every point, the overall system functioned correctly without a hitch.

VII. CONCLUSION AND FUTURE WORKS

The proposed security system with Raspberry Pi is composed of a camera, keypad and solenoid lock in conjunction, making this an all-in-one introduced approach to the intended door lock automation and to alert burglars. With the combined power of the mentioned components above, the system guarantees a strong keyless entry characterized by effective control and notification issuance in case of unauthorized access. This project effectively deals with the existing security challenges while giving a reliable and innovative approach towards safeguarding premises from unauthorized entry. Therefore, it is promised to integrate the variety of technologies of which appreciable potential in an upgrade to the system in general security and automation context is shown.

Other future enhancements for the proposed security system would be exploiting advanced facial recognition to improve user identification accuracy. If machine learning algorithms are embedded, it can provide predictive analytic to the proposed system so that users can avoid and get alerts on threats beforehand. Extended IoT capabilities will allow remote monitoring and control through mobile applications with live updates of information. Other sensors like smoke detectors can be added to make the system fully-fledged in home automation. On the communication protocol level, it will

offer secure transmission of data. An easy-use interface to manage the system would enhance the overall user experience.

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