DESIGN AND VALIDATION FOR A BIOMETRIC SECURITY LOCKER

M.swetha

23TQ1D5503@siddhartha.co.in

Dr srinivas bachu

bachusrinivas@siddhartha.co.in

Siddhartha Institute of Technology & Sciences, Narapally village, Peerzadiguda, Hyderabad, Telangana 500088

ABSTRACT

The proposed system presents a Raspberry Pi–based Smart Fingerprint Authentication and Security System that enhances access control through biometric verification, image monitoring, and automated alert generation. Biometric security has become one of the most reliable methods for personal identification due to its uniqueness and resistance to replication. In this project, a Fingerprint Sensor Module (FPS) is interfaced with a Raspberry Pi 3B+, along with a USB camera, SD card storage, and a relay-controlled lock mechanism. The system authenticates users by capturing and matching fingerprints stored in the local database. When a valid fingerprint is detected, the Raspberry Pi activates the relay to unlock the door or device. Simultaneously, the USB camera captures an image of the authenticated user, which is saved locally for future reference and auditing. If an unauthorized or unmatched fingerprint attempt is detected, the system switches to an intrusion-detection mode. The USB camera instantly captures the intruder's image and sends a real-time photo alert to an authorized user through email or messaging applications. This feature helps in remote monitoring and improves the overall security system responsiveness. The captured image is also stored in the local SD card for evidence and analysis. The system ensures continuous and reliable operation with the help of a 5V DC adaptor, making it suitable for homes, offices, laboratories, and other high-security zones.

KEYWORDS: Raspberry Pi, Pi Camera, 32GB SD card

I.INTRODUCTION:

Security has become a major concern in modern society due to the increasing number of unauthorized access attempts, identity thefts, and property intrusions. Traditional security systems such as keys, PINs, or smart cards are often vulnerable because they can be stolen, duplicated, or forgotten. Biometric security has emerged as a superior alternative, offering authentication based on unique biological traits such as fingerprints, iris patterns, and face recognition. Among these, fingerprint identification is the most widely used because of its accuracy, affordability, and ease

of use.The proposed project aims to design and develop an intelligent fingerprint-based authentication system using a Raspberry Pi 3B+. The Raspberry Pi serves as the central controller and processes data from the Fingerprint Sensor Module (FPS) and a USB camera. When a user places their finger on the sensor, the system captures the fingerprint, processes it, and compares it with pre-stored templates. If the fingerprint matches, the Raspberry Pi triggers a relay module that unlocks the connected door or lock mechanism. Simultaneously, the USB camera captures an image of the authenticated user. This image is stored locally on the SD card, allowing administrators to maintain access logs with visual proof.In contrast, when an unauthorized fingerprint is detected, the system enters security mode. It captures an image of the intruder and immediately sends a photo alert to an authorized person through email, Telegram, or other notification platforms. This enables remote monitoring and helps authorities or owners take timely action. The local storage of images also helps in post-event analysis and strengthens the evidence

II.LITERATURE SURVEY

Traditional security systems such as mechanical locks, passwords, and RFID cards are increasingly vulnerable to theft, duplication, and unauthorized use. These systems lack intelligent monitoring features and cannot provide evidence or real-time alerts during security breaches. As a result, unauthorized access attempts often go unnoticed, leading to potential threats to property, sensitive areas, and personal safety. There is a need for an automated, reliable, and intelligent security system that can verify users biometrically, maintain access logs, detect intruders, and instantly alert authorized personnel. Current fingerprint-based systems only allow or deny access but do not capture visual proof of the user, nor do they send real-time intrusion alerts. Moreover, many systems lack integration with modern IoT capabilities such as remote monitoring, camera-based evidence collection, and instant notifications.

BLOCK DIAGRAM:

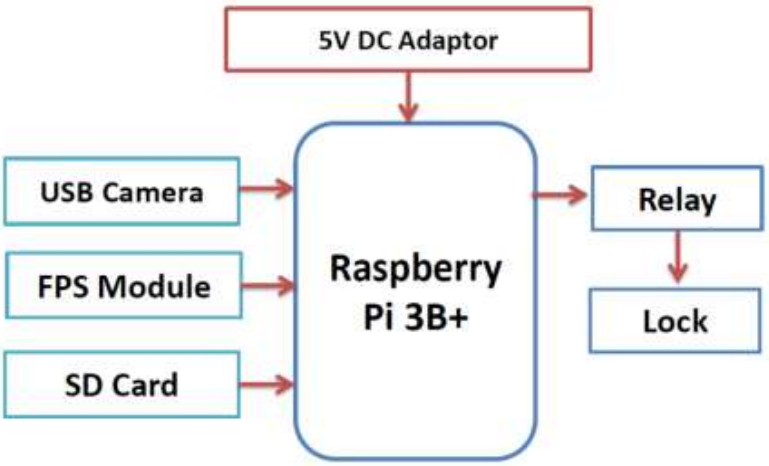


Fig. 2.1 Block Diagram

HARDWARE TOOLS:

- Raspberry Pi
- Pi Camera
- 32GB SD card
- 5V/2.4A Power Adaptor

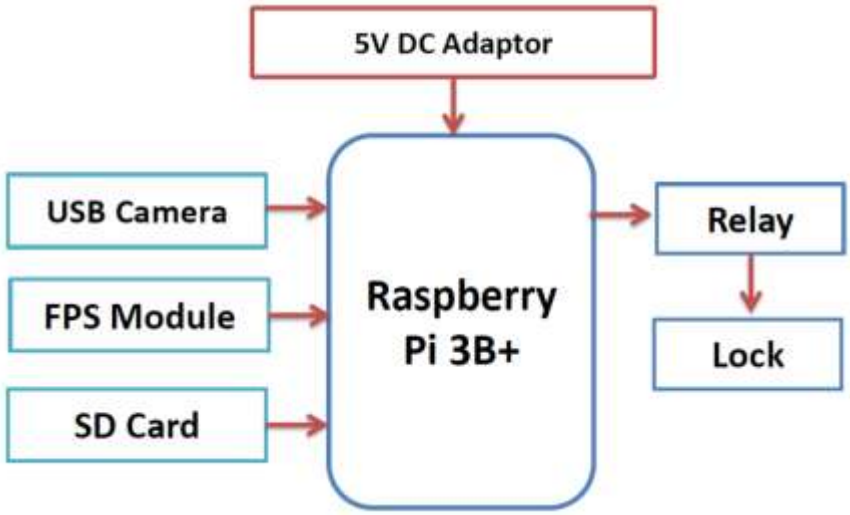
SOFTWARE TOOLS:

- Python Programming Language
- OpenCV
- Dlib

III. PROPOSED METHODOLOGY:

The proposed system implements an intelligent fingerprint-based access control and monitoring solution using Raspberry Pi 3B+. The methodology involves the following steps:

SYSTEM ARCHITECTURE:



The block diagram represents the architecture of a Raspberry Pi–based Fingerprint Authentication and Security System designed to verify user identity, control access, capture visual records, and provide real-time intrusion alerts. At the center of the system is the Raspberry Pi 3B+, which functions as the main processing unit responsible for biometric verification, camera control, relay switching, and communication tasks. The Raspberry Pi is powered by a 5V DC adaptor, ensuring stable and uninterrupted operation. It houses the operating system and project files on the SD card, which also stores captured images, logs, and fingerprint databases. The SD card plays a crucial role in maintaining data integrity and enabling quick access to stored information during the authentication process. Connected to the Raspberry Pi is the Fingerprint Sensor (FPS Module), which is responsible for acquiring the fingerprint impression from the user. When a finger is placed on the sensor, the module captures and sends the fingerprint data to the Raspberry Pi for processing. The Pi compares it with pre-stored templates and determines whether the fingerprint matches an authorized user.A USB Camera is integrated into the system for image capturing. Depending on the fingerprint result, the camera performs two actions:

1. If the fingerprint matches, the camera captures the authorized user's image and stores it locally.

2. If the fingerprint does not match, the camera captures the intruder's image and sends it as an alert to an authorized person via email or messaging applications.

For physical access control, a relay module is connected to the Raspberry Pi. When an authorized fingerprint is detected, the Raspberry Pi activates the relay, unlocking the electronic lock momentarily. The relay acts as an electrical switch that isolates the high-voltage lock circuitry from the low-voltage Raspberry Pi pins, ensuring safe operation.

All communication between modules—fingerprint sensor, camera, SD card operations, and relay control—is managed by the Raspberry Pi's GPIO pins and USB interfaces. The integration of these components allows seamless coordination between verification, monitoring, and alerting functions. Thus, the block diagram illustrates a complete intelligent security system where the Raspberry Pi is the core controller, the FPS module handles identification, the USB camera provides visual monitoring, and the relay manages physical access. The architecture ensures reliability, automation, and real-time response, making the system suitable for secure environments such as homes, offices, and restricted-access laboratories.

IV.TESTTING SIMUALTION RESULTS

```
startx
```

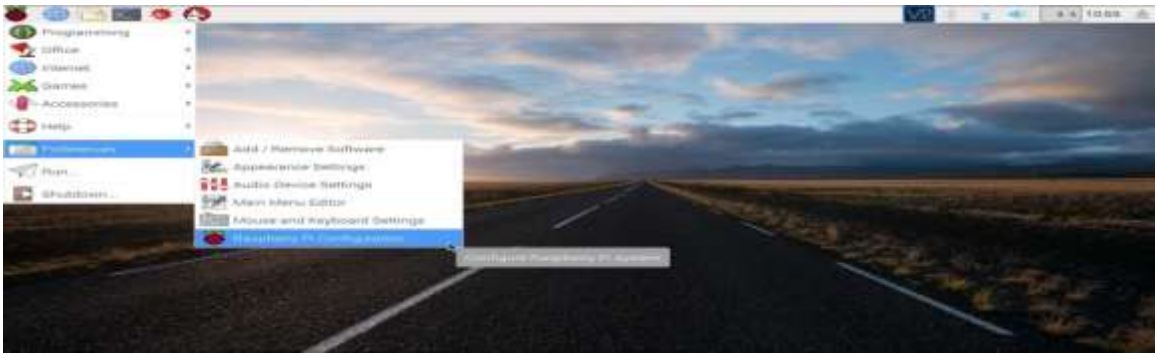
And we will get Home Screen of Raspberry Pi as shown below:

On display, there is a symbol of **raspberry** to the top-left corner of display. After clicking on it, we will get menu as shown below.

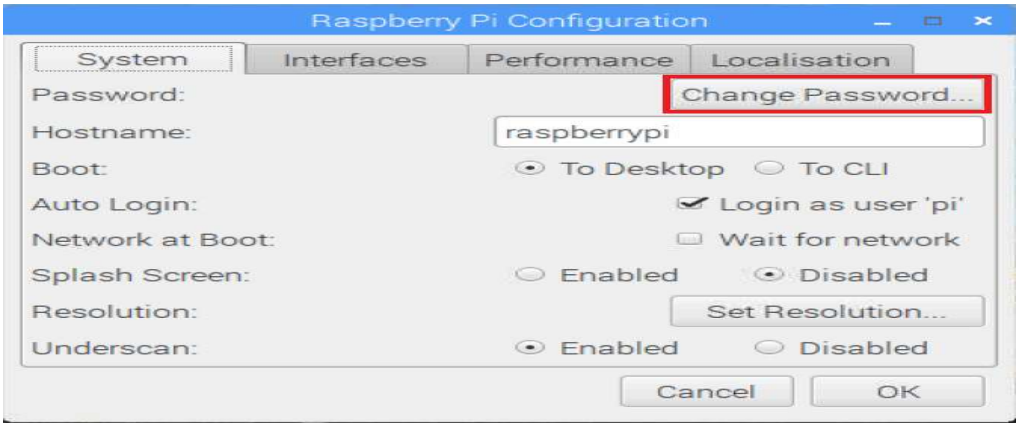
- As we can see, the Raspbian OS has installed Python 2 & 3. It also has different programming IDE like Geany, BlueJ Java IDE, etc. As raspberry pi 3 has On-chip Wi-Fi, we can connect it to the network and will get access over Internet.

- We can also change password of "Pi" user.

- To change password, click on **preferences** and then select **Raspberry Pi Configuration** which will provide a pop-up window.



- Then, click on change password option shown below.



Now, we are quite familiar with Raspberry Pi OS.

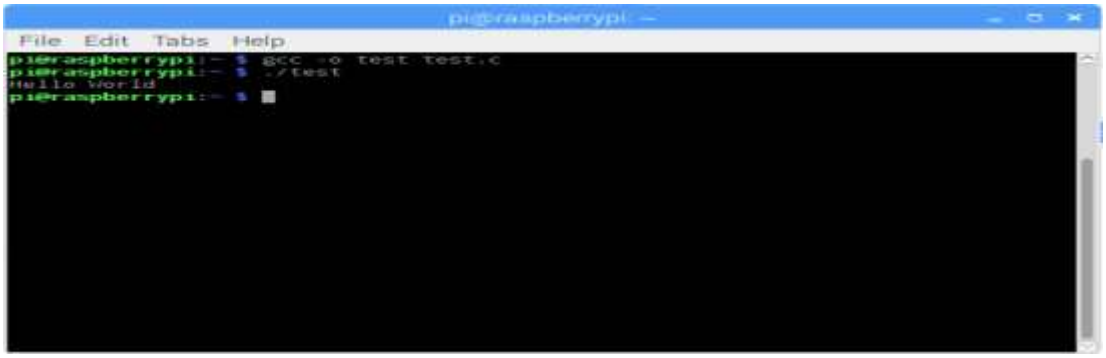
How to write C program on Raspbian OS

- So, let's write our First C code on Raspbian and execute it.
- First Create Empty file and label it with .c extension.
- Now write a small program to print "Hello World"

Program

```
#include<stdio.h>
int main(){
    printf("Hello World");
    return 0;
}
```

After writing the code, open terminal (ctrl+alt+t) to execute it. Then, type following commands for compiling and execution.



V.CONCLUSION

The Raspberry Pi–based fingerprint authentication and security system successfully integrates biometric verification, camera-based monitoring, and real-time alert mechanisms into a single unified solution. The system reliably distinguishes between authorized and unauthorized users through fingerprint matching, ensuring high security and user convenience. The addition of a USB camera for image capture provides visual proof for every access attempt, greatly enhancing monitoring and accountability.

Real-time alerts delivered through email or messaging applications enable faster response to intrusion attempts and strengthen security effectiveness. Local storage of logs on the SD card ensures that both valid and invalid access attempts are permanently recorded for future reference.

Overall, the project demonstrates that low-cost hardware components combined with efficient software logic can produce a powerful, intelligent, and fully automated security system suitable for a wide range of applications. The system is reliable, scalable, and energy-efficient, making it a viable alternative to commercial biometric access solutions.

REFERENCES

[1] D. Peralta, “A survey on fingerprint minutiae-based local matching,” *Pattern Recognition Letters*, vol. 82, pp. 52–61, 2016.

[2] M. Tico and P. Kuosmanen, “Fingerprint recognition using wavelet features,” *Proc. IEEE Int. Conf. Acoustics, Speech, and Signal Processing (ICASSP)*, Hong Kong, 2003, pp. II–193–II–196.

[3] A. Kumar and D. Zhang, “Personal authentication using multiple palmprint representations,” *Pattern Recognition*, vol. 38, no. 10, pp. 1695–1704, 2005.

[4] S. K. Singh and R. Kumar, "Fingerprint recognition for person identification and verification using minutiae matching," *Proc. IEEE International Conference on Advances in Computing and Communication (ICACC)*, 2016, pp. 169–173.

[5] R. A. Nadafa and S. S. Yellur, "Home Security Against Human Intrusion Using Raspberry Pi," *Procedia Computer Science*, vol. 171, pp. 286–293, 2020.

[6] M. Zuma, A. Govender, and T. Adeliyi, "Intrusion Detection System using Raspberry Pi," *Proc. ACM International Conference on Computing and Applied Informatics*, 2021, pp. 1–6.

[7] M. N. Osman, S. Abdullah, and N. M. Saad, "A Low-Cost Home Security Notification System Using IoT and Telegram Bot," *Journal of Computing Research and Innovation*, vol. 7, no. 2, pp. 55–63, 2022.

[8] F. F. Majid, N. Zaini, and M. A. Rahman, "Development of Surveillance System with Automated Email and Telegram Alerts," *International Journal of Engineering Research and Technology*, vol. 11, no. 6, pp. 450–455, 2022.

[9] S. Patil and R. Kshirsagar, "Enhanced Minutiae-Based Fingerprint Matching Algorithm," *International Journal of Computer Applications*, vol. 176, no. 42, pp. 34–40, 2020.

[10] K. V. Suresh and K. K. Rao, "Smart Building Security System Using Raspberry Pi and IoT," *International Research Journal of Engineering and Technology (IRJET)*, vol. 7, no. 12, pp. 1120–1125, 2020.

[11] M. R. Ali and A. Rahman, "IoT-Based Smart Home Intruder Detection and Alert System," *Journal of Computer Science*, vol. 15, no. 5, pp. 650–660, 2019.

[12] S. B. Bharati and A. M. Patil, "Real-Time Video Surveillance Using Raspberry Pi and IoT," *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 9, no. 2, pp. 120–125, 2020.

[13] A. K. Das and S. Banerjee, "Biometric Authentication Using Raspberry Pi and Cloud Integration," *International Journal of Engineering Research & Technology (IJERT)*, vol. 9, no. 5, pp. 1–5, 2020.

[14] Y. Kim and H. Park, "Design of a Smart Door Lock System based on Raspberry Pi," *International Journal of Smart Home*, vol. 10, no. 5, pp. 1–10, 2016.