International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 03 | March - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Home automation security system based on face detection and recognition using raspberry pi and python with RFID reader

Prof.Prachi Upasani[*1], Sakshi Gujar[*2], Tejas Pokharkar [*3]
[*2,3,4,] Student, Zeal College Of Engineering And Research Narhe, Pune, India.
[*1] Faculty of Zeal College Of Engineering And Research Narhe, Pune, India

ABSTRACT

This project presents a Home Automation Security System that integrates face detection and recognition with RFID technology using a Raspberry Pi. The system aims to enhance security and access control in homes by automating the process of user authentication through facial recognition and RFID tags. The system utilizes a Raspberry Pi as the central control unit, a camera module for face detection and recognition, and an RFID reader to scan RFID tags for additional access control. The system functions by scanning an RFID tag, and upon detection of a valid tag, it activates the camera to capture the face of the person requesting access. The captured image is then processed using OpenCV and face_recognition libraries in Python to match the face with a pre-stored database of authorized individuals. If both the RFID tag and face match the stored data, the system grants access by performing automation actions such as unlocking doors or turning on lights.

Keywords- Raspberry Pi, Pi Camera, Face Detection, Face Recognition, RFID Technology, RFID Tag Verification.

INTRODUCTION

The "Home Automation Security System Based on Face Detection and Recognition Using Raspberry Pi and Python with RFID Reader" is a project aimed at enhancing home security using modern technologies. The system leverages a combination of face recognition, an RFID reader, and a Raspberry Pi to provide a secure and efficient method for managing access to a home. This solution not only strengthens security but also offers a hands-free, automated way of recognizing and authorizing individuals, making it a convenient addition for smart homes.

In this project, a Raspberry Pi microcomputer is used as the main device to run the face detection and recognition system. The Raspberry Pi is chosen because it is affordable, compact, and can perform complex computations needed for face recognition. Python programming is used for coding and implementing algorithms for both face recognition and RFID card scanning. Python is known for its simplicity and vast libraries, making it a popular choice for such applications.

The face detection and recognition part of the project uses a camera module attached to the Raspberry Pi. The camera continuously monitors the entrance and captures images of people trying to access the home. When someone approaches, the camera captures their face, and the face recognition algorithm compares it with the images stored in the system's database. If the face matches one of the authorized faces in the database, the system grants access, triggering the door lock to open automatically. To add an extra layer of security, an RFID reader is integrated with the system. RFID (RadioFrequency Identification) uses electromagnetic fields to identify and track tags attached to objects, and in this case, it is used to identify RFID cards assigned to authorized individuals. Each person can carry an RFID card that must be scanned in addition to face recognition for added security.

The RFID reader scans the card, and if the card is recognized as authorized, it allows the system to proceed with face recognition. This two-step verification process ensures that even if someone's face is recognized, they also need to have the correct RFID card for access. This system is designed to be highly secure and efficient. By using both face recognition and RFID, it becomes harder for unauthorized individuals to gain entry. Face recognition alone can sometimes be fooled by photos or similar-looking faces, and RFID cards can be lost or stolen, but combining the two methods makes the system much more reliable. The system can store multiple authorized faces and cards, allowing family members and trusted visitors to access the house while keeping strangers out. The main benefits of this project include enhanced home security, ease of access for authorized individuals, and the ability to automate entry.

Since the system is built with Raspberry Pi, it can be further developed to connect with mobile devices or smart home systems, offering more control over home security even when you are not home. Overall, this project demonstrates how low-cost, open-source hardware and software, like Raspberry Pi and Python, can be used to build sophisticated and secure home automation systems.

LITERATURE SURVEY

The authors [3, 14], have proposed the face detection framework using Principal Component Analysis (PCA). The system is fast and efficient, but algorithm was run on MATLAB which uses very high memory and processing power. So, it is costly and also having low processing speed. We use Linus Base Operating System

that is more efficient. Senthilkumar et al. [4], implemented the embedded images taking system via raspberry-pi. In this work, they took the picture and contrasted it with database, but have the problem of inefficiency the low light state. We Compared the Particular picture with 500 Database and results are 95% accurate. Sowmiya et al. [5], proposed the system of based on IoT. In this framework, they used PIR (passive infrared) sensor and camera. PIR sensor was exploited for identifying individual and camera utilized for Table 1. United Nations statistics on drugs and crime Theft case reports at national level 2012 2013 2014 2015 Pakistan Count Rate Count Rate Count Rate Count Rate 49,148 27.62 45,494 25.04 42,747 23.04 38,902 20.54 United States of America 6,168,874 1968.78 6,019,500 1907.70 5,809,100 1828.38 5,723,500 1788.99 Robbery case reports at national level 2014 2015 2016 2017 Count Rate Count Rate Count Rate Count Rate Pakistan 18,107 0.18 15,164 0.15 13,088 0.13 12,458 0.12 United States of America 322,900 3.23 328,100 3.28 332,800 3.33 319,400 3.19 68 S. Ghafoor et al. capturing the video of the individual who comes at the entrance. But their proposed model did not give the ability of sending messages to the concerned persons. We will develop a system that will not only send message via Email but also send message on Number. Karri and Daniel [6, 7] proposed SMS based system using GSM, which send notifications via SMS to the house owner replacing conventional SMS. Jayashri and Arvind effectively implemented finger authentication for unlocking of doors. This system prevents unauthorized person and this can be monitored. This system includes extra protection features like leakage of smoke and gas detection. Fingerprint scanning may be costly and costly to some extend. Some experts think it's not a wise decision to rely only on fingerprint seniors because it's easy to replicate them, this can be overcome by addition of PIN password, voice detection or any other technique.

Dwiet et al. [8], have proposed the system of face recognition which used MyRIO 1900 controller. The controller has the program for detection of face. Personal computer is used to display the output and LabVIEW is used for programming. But the problem is that the MyRIO module is very costly. We used Raspberry Pi which is very cheap nd easy to use. Kodali et al. [9], have proposed a system of home security by using TI-CC3200 Launchpad board which uses Wi-Fi and internet to control and manage home appliances. But the limitation is that TI-CC3200 Launchpad board has limited memory, processing power and features than that of raspberry-pi. The earlier face recognition systems used nose, mouths and eyes for identification. These systems used classifier based on use of faces and datasets. These methods were not producing good

results due to its low quality and low amount of information [10]. Ramanan et al. [11], proposed a system based on Algorithm of support vector machine (SVM). The algorithm for face scanning and detection upon functioning of static face image or color image. For color image, the colors of image increase in size of data available while mapping on pixels which efficiently reduce processing speed. There are multiple solutions proposed for the security system provided with IoT facilities that have been proposed and invented in the literatures which helps the solid security system improve the quality of service delivery. Researches in [1] Deepak.S.Kumbhar, H.C.Chaudhari, Shubhangi M.Taur, Shubhangi S.Bhatambrekar make use of the Linux environment Raspbian OS for implementing the python code. From [2] the feature based Haar cascade face detection classifier algorithm is used for detecting faces, edges and lines. R Gurunath , Mohit Agarwal, Abhrajeet Nandi, Debabrata Samanta from [3] made use of BOT NET to function the controlled IoT devices.

METHODOLOGY

The home automation security system based on face detection and recognition using Raspberry Pi and Python combines multiple technologies to ensure secure access and monitoring. The system begins with capturing the face data using a camera connected to the Raspberry Pi. Python libraries such as OpenCV are utilized for face detection, which identifies and isolates the face in real-time. Once a face is detected, it is then compared with a pre-stored database of authorized faces using facial recognition algorithms like Haar Cascades or deep learning-based models. If the detected face matches any of the registered faces in the system, access to the home automation system is granted, allowing users to control smart devices like lights, doors, or security systems.

To enhance security further, an RFID reader is incorporated into the system. The RFID reader scans the tags of authorized individuals, adding an additional layer of authentication. When both the RFID tag is recognized and the face is validated, the system grants access. This multi-factor authentication ensures that only individuals with both the correct face and RFID tag can control the system. Python, along with libraries like RPi.GPIO for interfacing with the Raspberry Pi's hardware, manages the entire process, while integration with IoT protocols allows the seamless operation of smart devices within the home. This methodology combines facial recognition with RFID technology to create a robust and secure home automation solution.

BLOCK DIAGRAM OF SYSTEM

Fig.1 shows a Block diagram of an existing system by using Raspberry Pi and sensors. The main controlling operation is carried out in given system is Raspberry Pi which is interfaced with different input and output components which is briefly explained in the following ways,

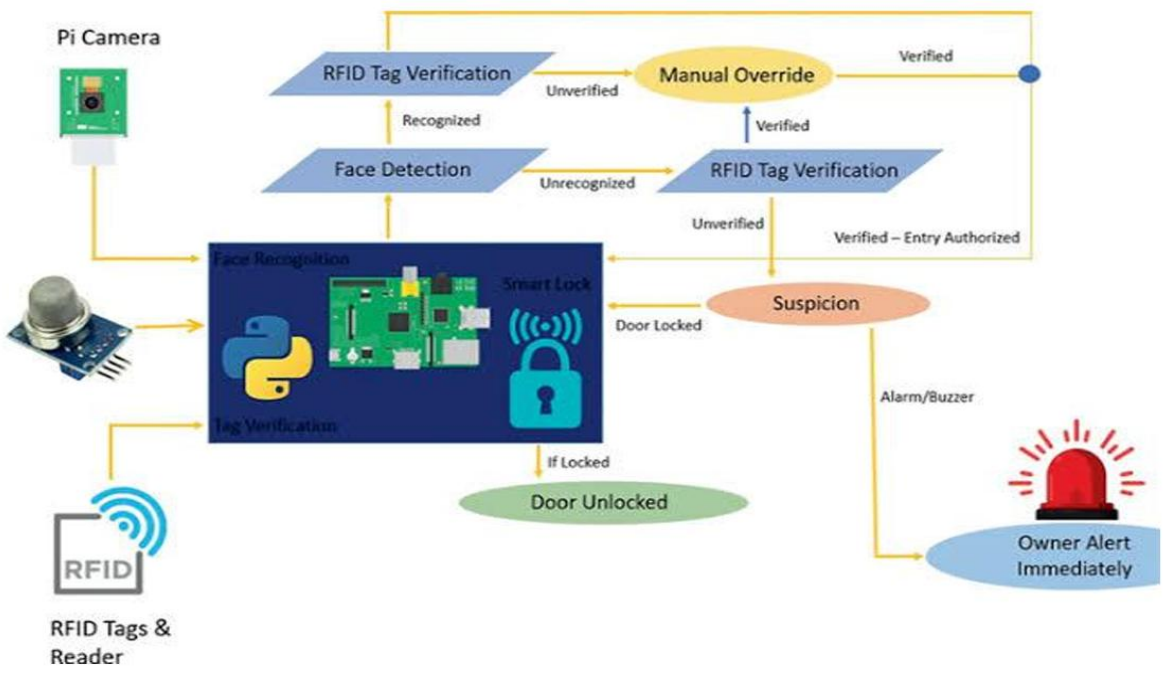

Figure 1: *Block Diagram of System.*

This Block Diagram represents a home automation security system project centered around face detection and recognition, utilizing a Raspberry Pi, Python, and an RFID reader. The system employs multiple layers of security, starting with an RFID tag reader for initial verification. If the tag is recognized ("Verified"), entry is authorized. In case of an unverified tag, the system proceeds to face detection using the Pi Camera. A recognized face ("Recognized") also grants entry. However, an unrecognized face triggers a "Suspicion" alert, activating an alarm/buzzer and immediately notifying the owner. A manual override option is available for specific situations. The core processing is done on the Raspberry Pi, indicated by the central board with the Python logo, where face recognition and smart lock control occur. The system's status, such as "Door Locked" or "Door Unlocked", is clearly displayed. In essence, the image outlines a multi-faceted security system leveraging RFID and facial recognition, with Python on a Raspberry Pi acting as the central control and processing unit.

The diagram clearly illustrates the flow of information and actions. Starting with the RFID tag verification, the process branches into two paths based on whether the tag is recognized or not. The "Manual Override" acts as a bypass, likely a physical key or keypad, offering an alternative entry method. The facial recognition component, labeled "Face Recogiitioف" (likely a misspelling of "Face Recognition"), processes images from the Pi Camera. The "Smart Lock" is the physical locking mechanism, controlled by the Raspberry Pi based on the verification results. The "Suspicion" branch leads to both an audible alarm/buzzer and a notification to the owner, emphasizing the system's security focus. The system also provides clear status indicators, showing whether the door is locked or unlocked. In essence, the image outlines a comprehensive security system designed to protect a home. It leverages two common identification methods, RFID and facial recognition, to create a robust access control system. The Raspberry Pi acts as the brain, integrating these components and making real-time decisions.

FLOW CHART OF SYSTEM

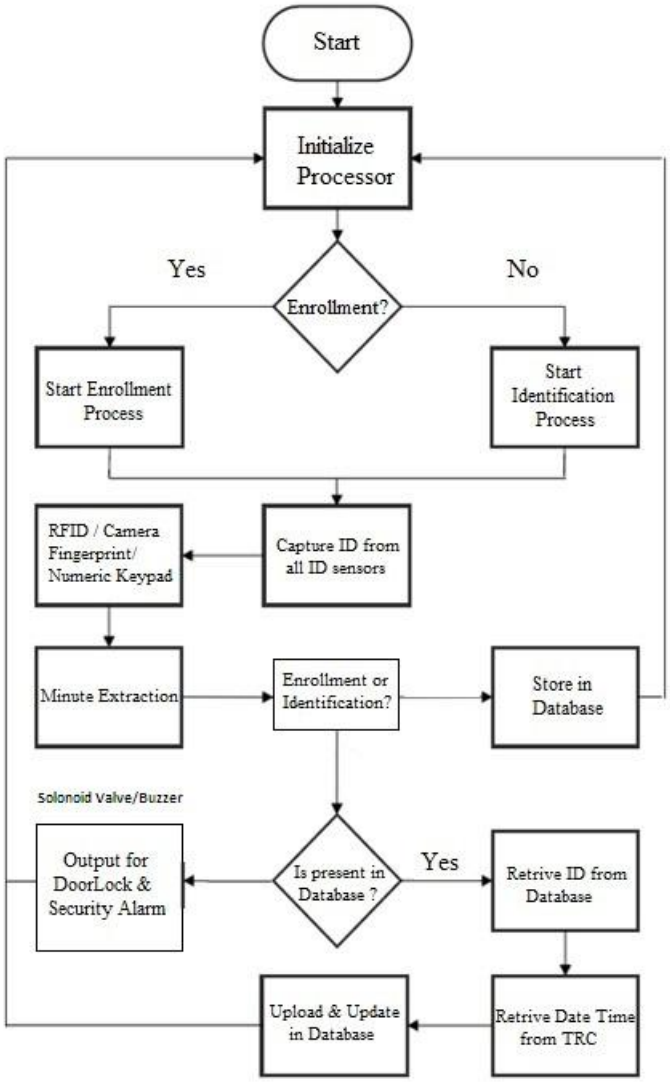

Figure 2: *Flow chart of the system*

This flowchart depicts a home automation security system that utilizes face detection and recognition along with an RFID reader for authentication. The system starts by initializing the Raspberry Pi and then branches into two main processes: enrollment and identification. During enrollment, the system gathers data from various identification sensors, including an RFID reader, camera, fingerprint scanner, and keypad. This data is then processed to extract relevant features, which are stored in a database for future use.

In the identification process, the system captures ID data from the chosen sensor. It then queries the database to check if the captured data matches any stored records. If a match is found, the system retrieves associated information and triggers corresponding actions, such as unlocking the door if the identified individual is authorized. If no match is found, the system may trigger an alarm or deny access. The system also includes functionality to upload and update data in the database, potentially incorporating date and time information from a real-time clock. This ensures that the system remains current and can track access attempts effectively.

CIRCUIT DIAGRAM

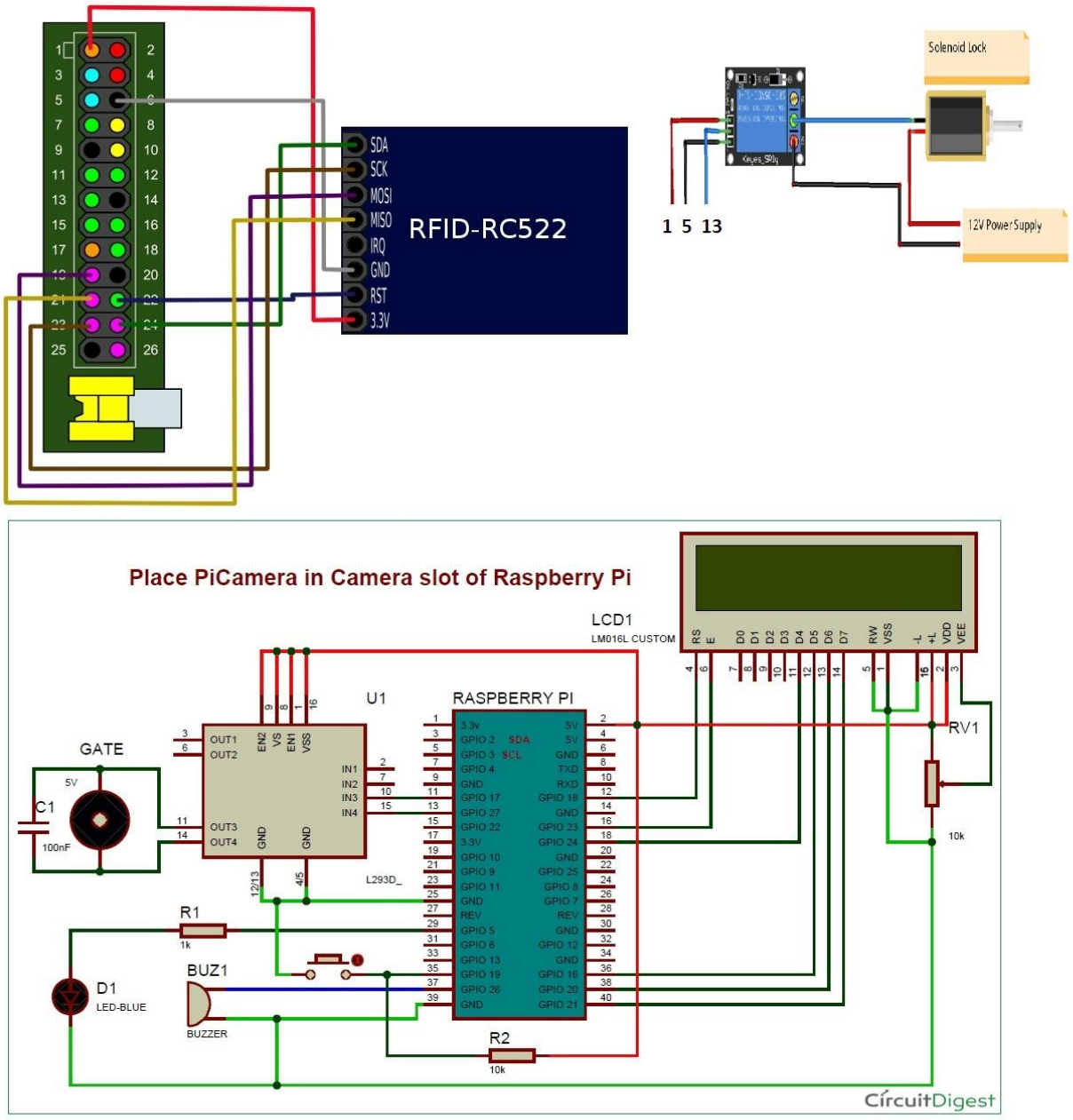

Figure 3: Circuit Diagram f Project.

Fig. 3 Circuit Diagram of Project.

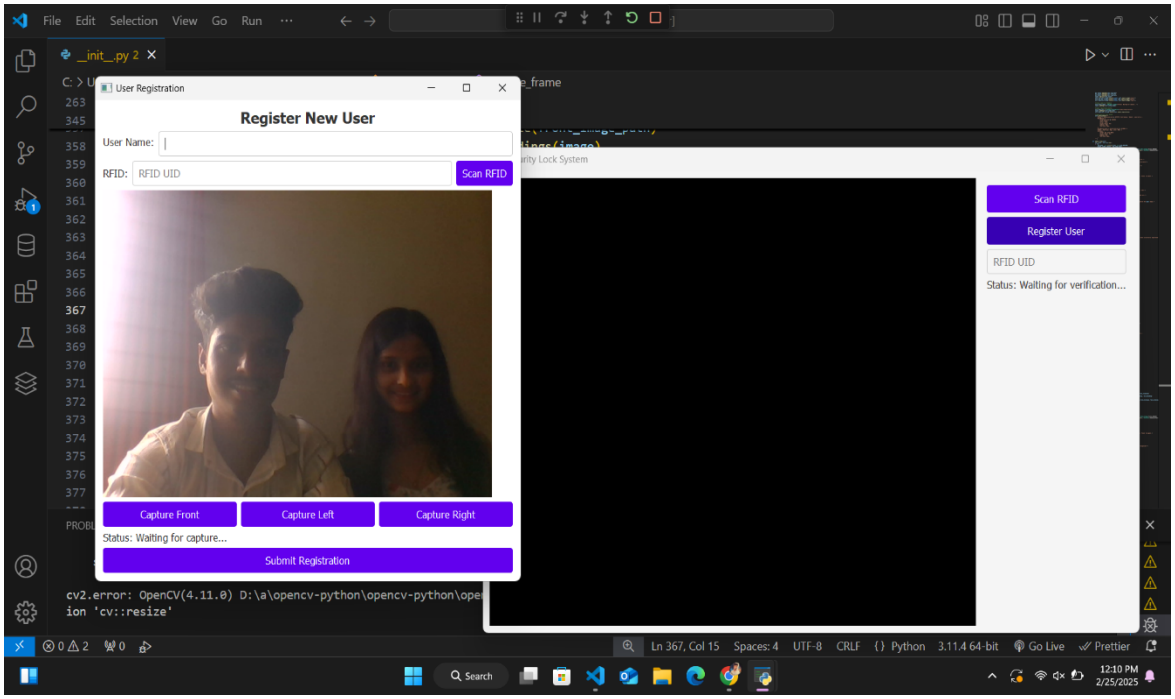

Figure 4: *Software result of New Registration To database.*

Fig. 4 shows that the database of registered users. After the login and register all the data of users will store in firebase which will view like this.

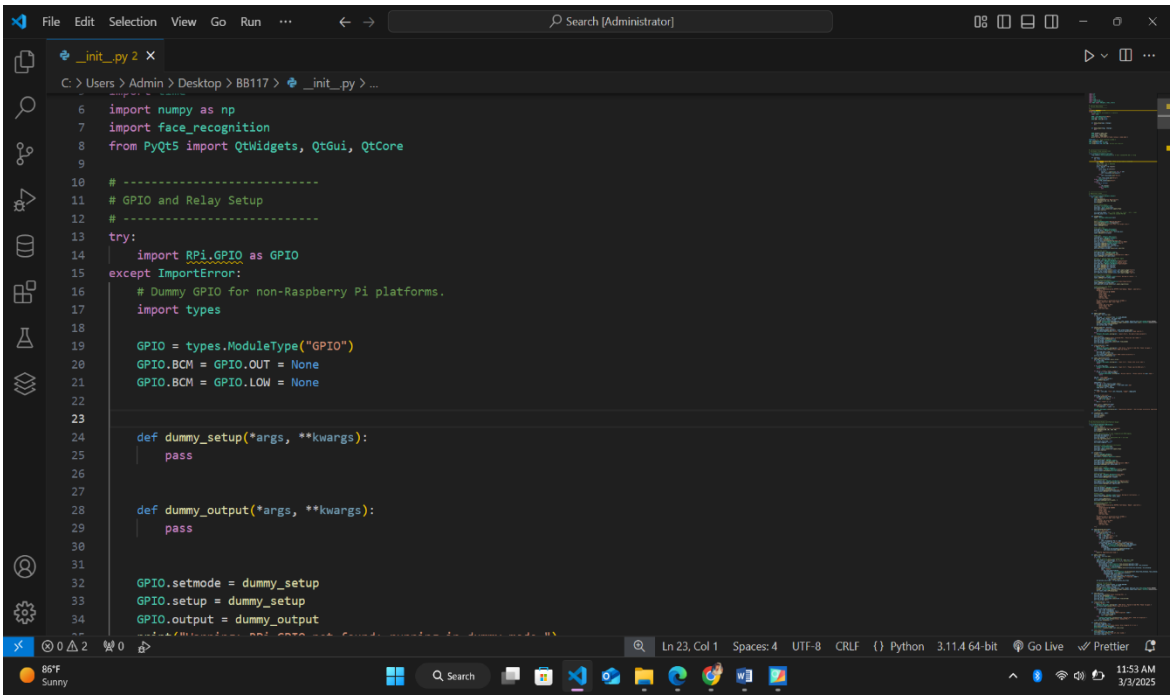

Figure 5: *Snapshot of Code.*

CONCLUSION

In conclusion, the Home Automation Security System based on Face Detection and Recognition, RFID Technology, and Raspberry Pi offers a robust, secure, and cost-effective solution to modern home security challenges. By combining advanced technologies such as biometric face recognition and RFID authentication, the system enhances home security, ensures convenient access control, and integrates home automation functionalities for an improved living experience.

The system's use of face recognition provides a high level of security by verifying individuals based on unique facial features. This biometric approach is far more secure than traditional methods like passwords or PIN codes, as it cannot be easily guessed or stolen. Moreover, the addition of an RFID reader offers a backup method for identification, ensuring that multiple layers of security are in place.

This dualauthentication system, combining face recognition and RFID, minimizes the risk of unauthorized access and strengthens the overall security of the home. One of the main advantages of the system is its ease of use. Homeowners do not need to carry keys or remember passwords. The face recognition feature allows quick, touchless access, while the RFID tags serve as a convenient alternative for authorized individuals. This reduces the complexity of traditional locking mechanisms, making it simpler and more intuitive to use. The system automatically takes action upon detecting authorized individuals, further streamlining the process of accessing the home.

Compared to traditional security systems or commercial smart home setups, this project is highly costeffective. The use of a Raspberry Pi as the central processing unit keeps the cost low, while also providing flexibility and scalability. Raspberry Pi's compatibility with numeroussensors and devices means the system can be easily expanded or modified to meet future needs. Whether adding more cameras, sensors, or even integrating new home automation features, the system can grow with the user's requirements, offering longterm value without requiring expensive upgrades.

REFRENCE

1. *United Nations Office on Drugs and Crime (2017). https://dataunodc.un.org/crime/*

2. *Patel, K.K., Patel, S.M.: Internet of Things-IOT: definition, characteristics, architecture, enabling technologies, application & future challenges. Int. J. Eng. Sci. Comput. 6(5), 1–2 (2016)*

3. *Chin, H.: Face recognition based automated student attendance system. Diss. UTAR (2018)*

4. *Senthilkumar, G., Gopalakrishnan, K., Kumar, V.S.: Embedded image capturing system using raspberry pi system. Int. J. Emerg. Trends Technol. Comput. Sci. 3(2), 213–215 (2014)*

5. *Sowmiya, U., Mansoor, J.S.: Raspberry pi based home door security through 3G dongle. Int. J. Eng. Res. Gener. Sci. 3, 138–144 (2015)*

6. *Karri, V., Lim, J.D.: Method and device to communicate via SMS after a security intrusion. In: 1st International Conference on Sensing Technology, vol. 1, pp. 664–668 (2005)*

7. *Bangali, J., Shaligram, A.: Design and implementation of security systems for smart home based on GSM technology. Int. J. Smart Home 7(6), 201–208 (2013)*

8. *Wati, D.A., Abadianto, D.: Design of face detection and recognition system for smart home security application. In: 2017 2nd International conferences on Information Technology, Information Systems and Electrical Engineering (ICITISEE), pp. 342–347. IEEE (2017).*