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Real-Time Face Recognition Security System with Email Notification

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Abstract - *Nowadays, security is becoming more important in homes, offices, and colleges. Traditional security methods like keys, passwords, and ID cards are not fully safe because they can be lost or misused. This project presents a* ***Real-Time Face Recognition Security System with Email Notification*** *that provides smart and automatic security using face recognition technology. The system captures live video using a camera and compares the detected face with stored user data. If the face matches with an authorized user, access is allowed automatically. If an unknown person is detected, the system captures the image and sends an instant email alert with the photo and time details to the user. The project is developed using Raspberry Pi, Python, OpenCV, and the LBPH face recognition algorithm. It also includes a motion sensor, webcam, servo motor, and a web dashboard for monitoring and user management. The system helps improve security, reduces manual work, and provides real-time monitoring in an easy and cost-effective way.*

Key Words: Haar Cascade Algorithm, Raspberry Pi, OpenCV, Security System, Email Notification, Real-Time Monitoring, LBPH Algorithm, Smart Security System.

1. INTRODUCTION

In today's modern world, security and automation are becoming very important in daily life. Traditional security systems such as keys, passwords, ID cards, and manual monitoring have many limitations because they can be lost, stolen, forgotten, or misused. These methods also require more human effort and do not provide real-time alerts during unauthorized access. Due to these problems, smart security systems based on biometric technology are becoming more popular.

Face recognition is one of the most useful biometric technologies used for identifying a person by analyzing facial features. It is widely used in mobile phones, attendance systems, surveillance systems, smart homes, and access control applications. Face recognition provides better security because every person has unique facial features that are difficult to duplicate.

The proposed project, "Real-Time Face Recognition Security System with Email Notification," is designed to provide an intelligent and automated security solution.

The system uses a camera to capture live video and detect faces in real time. The detected face is compared with the stored database of authorized users using image processing and machine learning techniques. If the person is recognized, the system grants access automatically. If the face is unknown, the system captures the image and sends an email alert with date and time details to the authorized user.

This project is implemented using Raspberry Pi, Python, OpenCV, LBPH face recognition algorithm, motion sensor, webcam, and servo motor. A web-based dashboard is also developed for face registration, live monitoring, and activity logging. The system works continuously in real time and reduces the need for manual monitoring.

The main aim of this project is to improve security, reduce human effort, and provide instant alerts for unauthorized access. The system can be used in homes, offices, colleges, laboratories, and restricted areas for smart and secure access control.

2. PROBLEM STATEMENT

Traditional security systems such as keys, passwords, ID cards, and manual CCTV monitoring are not fully reliable because they can be lost, stolen, forgotten, or accessed by unauthorized people. These systems also require continuous human monitoring, which increases effort and reduces efficiency. In many cases, there is no instant alert mechanism to inform the owner about unauthorized access, which may lead to security risks.

To overcome these problems, there is a need for a smart and automated security system that can identify authorized and unauthorized persons in real time. The proposed Real-Time Face Recognition Security System with Email Notification is developed to improve security using face recognition technology. The system automatically detects and recognizes faces using a camera and compares them with stored user data. If an unknown person is detected, the system captures the image and sends an instant email alert to the authorized user. This helps in reducing manual work, improving security, and providing real-time monitoring and notification facilities be used. Other font types may be used if needed for special purposes.

3. OBJECTIVES

The main objective of this project is to develop a smart and automated security system using face recognition technology. The system is designed to improve security by identifying authorized and unauthorized persons in real time. It also reduces manual work by providing automatic monitoring and instant email alerts whenever an unknown person is detected. The project focuses on creating a reliable, user-friendly, and cost-effective security solution for homes, offices, colleges, and restricted areas.

- To build a smart security system using face recognition technology.
- To identify authorized and unauthorized persons in real time.
- To provide automatic door access for registered users.
- To send instant email notifications when an unknown person is detected.
- To capture and store images of detected users for security purposes.
- To reduce dependency on manual security monitoring systems.
- To develop a real-time monitoring system using a webcam and Raspberry Pi.
- To create an easy-to-use web interface for face registration and system control.
- To improve security, accuracy, and reliability using image processing techniques.
- To provide a practical and cost-effective solution for homes, offices, and restricted areas.

4. LITERATURE SURVEY

Many researchers have worked on face recognition technology for smart security systems. Turk and Pentland introduced the Eigenfaces method for face recognition, while later researchers improved accuracy using machine learning and deep learning techniques. Recent systems combine face recognition with real-time alert features such as email notifications for unauthorized access. These studies show that face recognition systems provide better security, automation, and reduced manual monitoring. The proposed project uses face recognition with email alerts to develop a smart and efficient security system.

4.1. Comparative Analysis of Previous Research:

Author/ Year	Main Focus	Short Description
Kumar & Zhang (2012)	Neural Network Recognition	Used ANN to improve face recognition under different conditions.
Taigman et al. (2014)	Deep Learning	Developed CNN-based face recognition with high accuracy.
Patel & Shah (2018)	Security System	Created a real-time face recognition security system.
Singh et al. (2020)	Alert System	Added instant alert notification for unauthorized access.
Deshmukh & Joshi (2022)	Email Notification	Developed a system that sends email alerts with captured images.

5. PROPOSED SYSTEM

The proposed system is a Real-Time Face Recognition Security System with Email Notification designed to provide smart and automatic security. The system uses a webcam to capture live video and detect human faces in real time. The detected face is compared with the stored dataset of authorized users using face recognition techniques.
If the face matches with a registered user, the system grants access automatically by controlling the door lock using a servo motor. If the detected face is unknown, the system captures the image and sends an instant email alert with date and time details to the authorized user.

The system is implemented using Raspberry Pi, Python, OpenCV, and the LBPH face recognition algorithm. It also includes a motion sensor for detecting human movement and a web dashboard for face registration, live monitoring, and activity logs. The proposed system improves security, reduces manual work, and provides real-time monitoring for homes, offices, colleges, and restricted areas.

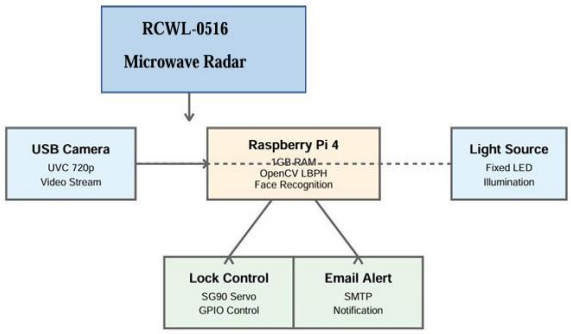


Fig.1. Real-Time Face Recognition Door Access System

6. METHODOLOGIES

The methodology of the proposed system is based on real-time face detection, recognition, and email notification for security purposes. The system continuously monitors live video and verifies the detected person with the stored face database. The complete working process is explained below:

1: System Initialization
The system starts by initializing the Raspberry Pi, webcam, database, and face recognition modules.

2: Live Video Input
The webcam continuously captures live video frames for monitoring the surrounding area.

3: Face Detection
The system detects human faces from the live video using OpenCV Haar Cascade classifier. If no face is detected, the system continues monitoring.

4: Face Preprocessing
After detecting the face, the image is preprocessed to improve recognition accuracy.

5: Face Comparison with Database
The detected face is compared with the stored face database using the LBPH face recognition algorithm.

6: User Authorization
The system checks whether the detected person is an authorized user or not.

- If the face matches with the database, access is granted to the user.
- If the face does not match, the system identifies the person as unauthorized.

Step 7: Unauthorized Access Alert
For unauthorized users, the system captures the image, generates an alert message, and sends an email notification with the captured image and time details to the authorized user.

Step 8: Continuous Monitoring
After completing the process, the system continues monitoring continuously for real-time security and surveillance.

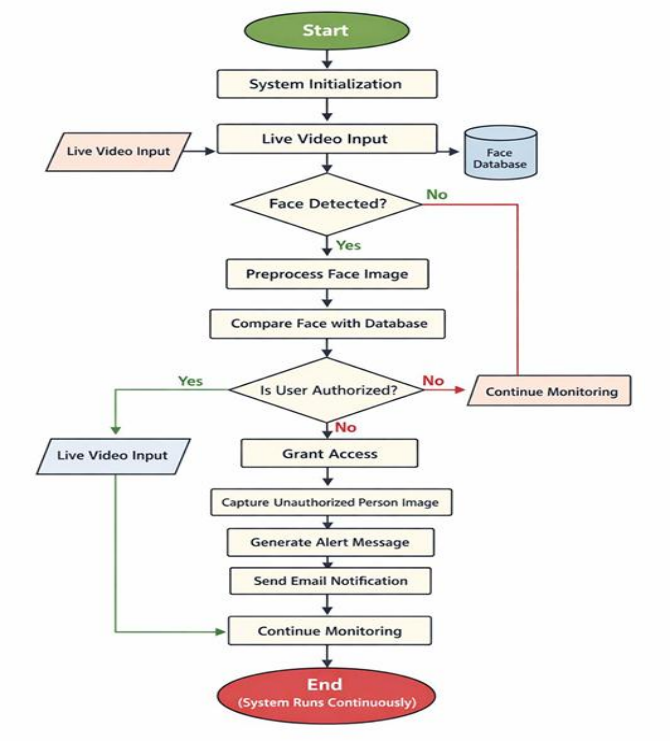


Fig.2. System Flowchart

7. HARDWARE DESIGN:

The hardware design of the proposed system is based on Raspberry Pi 4B, which works as the main processing unit of the system. Different hardware components such as a webcam, RCWL-0516 motion sensor, and SG90 servo motor are connected to the Raspberry Pi for real-time face recognition and automatic security control. The hardware circuit is designed to provide continuous monitoring, face detection, and email alert functionality.

1. Raspberry Pi 4B

Raspberry Pi 4B acts as the central controller of the system. It processes the live video captured from the webcam, performs face detection and recognition using Python and OpenCV, and controls all connected hardware devices.

2. USB Webcam

The USB webcam is connected to the Raspberry Pi through the USB port. It captures live video continuously and sends image frames to the system for face detection and recognition.

3. RCWL-0516 Motion Sensor

The RCWL-0516 microwave motion sensor is used to detect human movement near the security area. When motion is detected, the sensor sends a signal to the Raspberry Pi to activate the face recognition process. This helps reduce unnecessary processing and improves system efficiency.

4. SG90 Servo Motor

The SG90 servo motor is used as the door locking and unlocking mechanism. If the detected face matches with the authorized user database, the Raspberry Pi sends a control signal to the servo motor to unlock the door automatically.

5. Power Supply

A 5V power supply is provided to the Raspberry Pi, motion sensor, and servo motor for proper operation of the system.

Working of Hardware Circuit:

The webcam captures live video while the motion sensor continuously detects movement. The Raspberry Pi processes the captured images and compares the detected face with the stored database. If the face matches, the servo motor unlocks the door. If the face is unknown, the system captures the image and sends an email notification to the authorized user.

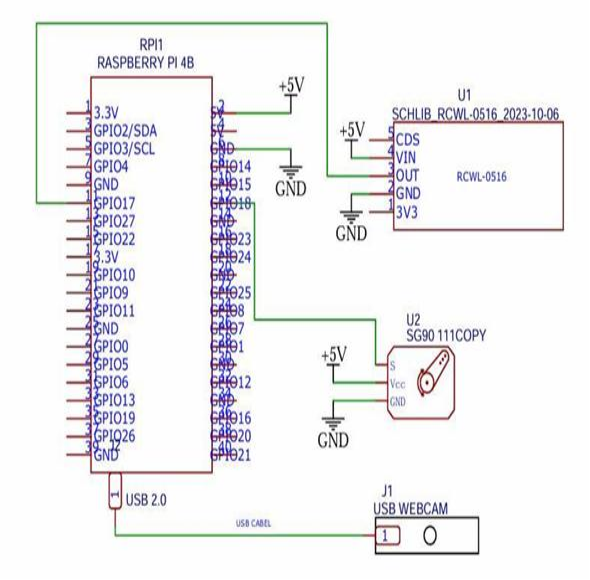


Fig. 3. Schematic of Real-Time Face Recognition Door Access System

8. SYSTEM ARCHITECTURE

The system architecture of the proposed project is designed to perform real-time face recognition, access control, and email notification for security purposes. The complete system is divided into hardware and software modules that work together to provide automatic monitoring and secure access.

The system starts with the webcam and motion sensor connected to the Raspberry Pi 4B. The motion sensor detects human movement and activates the webcam to capture live video. The captured video frames are processed using OpenCV for face detection. After detecting the face, the system uses the LBPH face recognition algorithm to compare the detected face with the stored database of authorized users.

If the detected face matches with the trained dataset, the system identifies the user as authorized and sends a signal to the servo motor to unlock the door automatically. If the face does not match with the database, the system captures the image of the unknown person and sends an email notification with image, date, and time details to the authorized user.

All activity logs, monitoring data, and alert records are stored in the database and displayed on the web dashboard. The dashboard allows the admin to register users, train datasets, monitor live activity, and manage the security system in real time.

The proposed architecture provides a smart, automated, and efficient security solution with real-time monitoring and alert functionality.

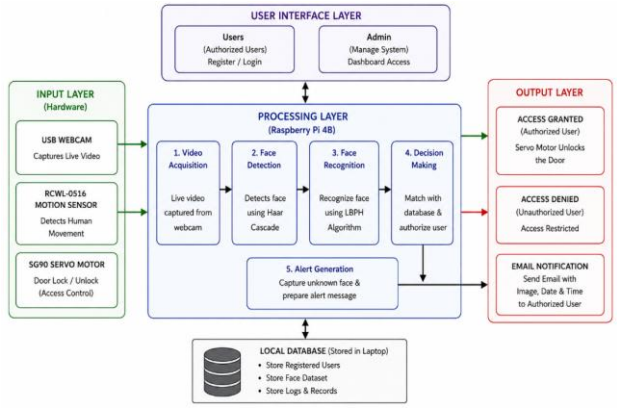


Fig. 4. System Architecture

9. IMPLEMENTATION

The implementation of the proposed system is carried out using both hardware and software components to provide real-time face recognition and security monitoring. Raspberry Pi 4B is used as the main controller of the system. A USB webcam is connected to the Raspberry Pi for capturing live video, while the RCWL-0516 motion sensor is used to detect human movement near the security area. The SG90 servo motor is connected for automatic door locking and unlocking.

The software implementation is done using Python programming language and OpenCV library for image processing and face detection. The Haar Cascade classifier is used to detect faces from the live video stream, and the LBPH (Local Binary Pattern Histogram) algorithm is used for face recognition. The system first captures face images of authorized users and stores them in the dataset. After that, the dataset is trained to create a face recognition model.

During real-time operation, the webcam continuously captures video frames. When a face is detected, the system compares it with the trained database. If the face matches with an authorized user, the Raspberry Pi sends a signal to the servo motor to unlock the door automatically. If the face is not recognized, the system captures the image and sends an email notification with the image, date, and time details to the authorized user.

A web-based dashboard is also implemented for user registration, dataset training, live monitoring, and activity log management. All records and alerts are stored in the database for future reference. The complete system works continuously in real time to provide smart and secure access control.

9.1. Hardware Model Implementation:

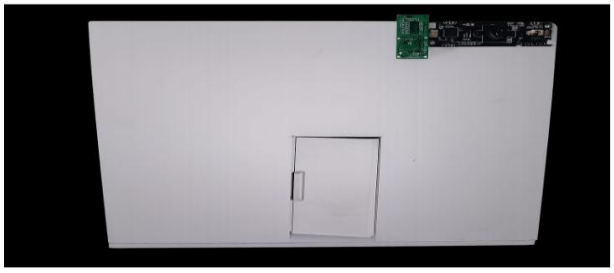


Fig.5. Hardware Model

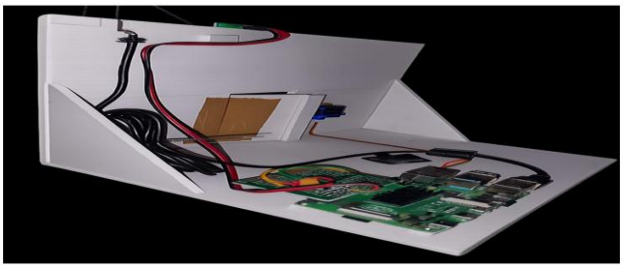


Fig.6. Hardware Model

9.2. Web Dashboard:

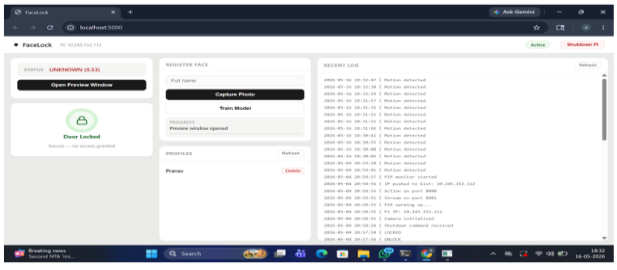


Fig.7. Web Dashboard

10. RESULT

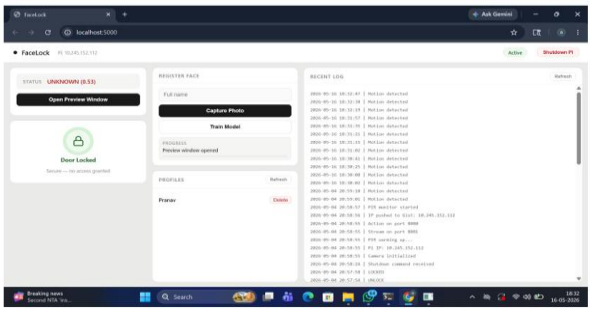
The proposed Real-Time Face Recognition Security System with Email Notification was successfully implemented and tested using Raspberry Pi 4B, OpenCV, Python, webcam, motion sensor, and servo motor. The system was able to detect and recognize faces in real time with good accuracy under normal lighting conditions.

During testing, the system correctly identified authorized users and automatically unlocked the door using the servo motor. When an unknown person was detected, the system captured the image and successfully sent an email notification with the image, date, and time details to the authorized user.

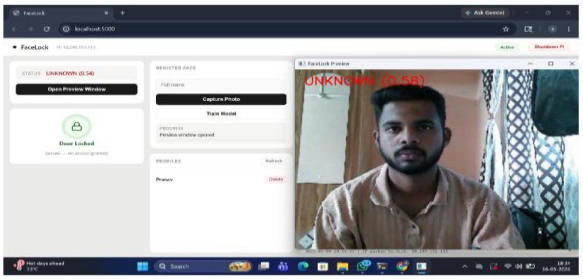
The web dashboard also worked properly for face registration, live monitoring, and activity log management.

The system reduced manual monitoring and provided fast and automatic security control. The overall performance of the system was reliable, cost-effective, and suitable for smart home, office, and restricted area security applications.

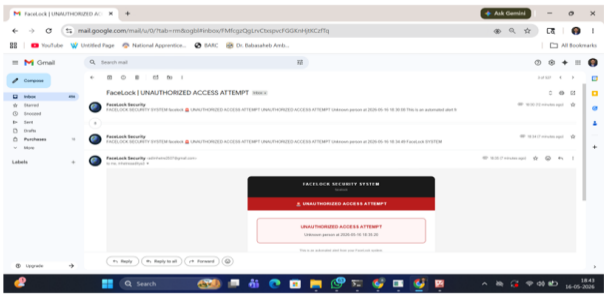
10.1. Web Dashboard with Recent Log:



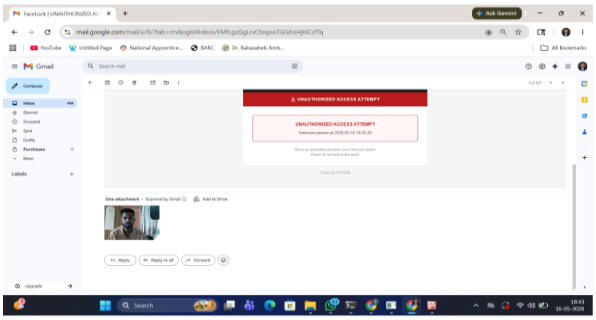
10.2. Web Dashboard with Live Preview of Unknown User:



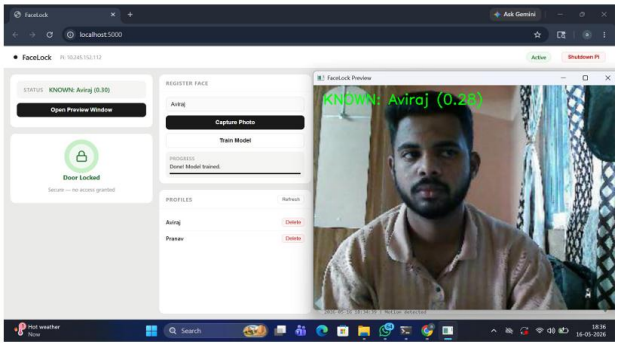
10.3. Unauthorized Access Mail Alert System 1:



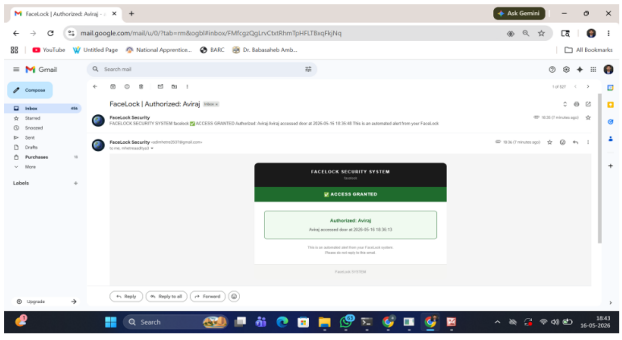
10.4. Unauthorized Access Mail Alert System 2:



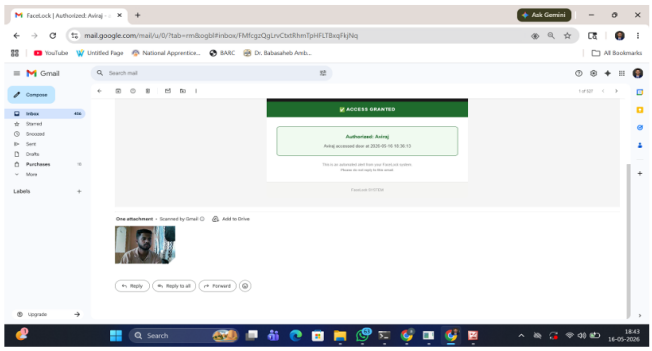
10.5. Web Dashboard With Live Preview of known User.



10.6. Authorized Access Mail System 1:



10.7. Authorized Access Mail System 2:



11. CONCLUSION:

The proposed Real-Time Face Recognition Security System with Email Notification was successfully developed and implemented using Raspberry Pi, Python, OpenCV, and the LBPH face recognition algorithm. The system is capable of detecting and recognizing faces in real time and provides automatic access control for authorized users.

The project improves security by reducing manual monitoring and providing instant email alerts when an unauthorized person is detected. The integration of a webcam, motion sensor, and servo motor makes the system fully automated and efficient for real-time applications.

The developed system is low-cost, user-friendly, and suitable for use in homes, offices, colleges, and restricted areas. Overall, the project provides a smart and reliable security solution using face recognition technology and real-time monitoring features.

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