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RASPBERRY PI-POWERED DOOR LOCK WITH FACIAL RECOGNITION

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***Abstract*—Facial recognition is a widely-used process that aims to detect and verify an individual's identity. This technique is employed in various applications, such as image and video analysis, surveillance, and security systems. OpenCV is a computer vision technique that enables users to comprehend the storage, modification and feature extraction of images and videos. The advancement of artificial intelligence is heavily reliant on computer vision techniques, particularly in self-driving cars, robotics, and image-editing software. The OpenCV Library is a valuable tool for processing and displaying camera images. This research utilizes the Haar Cascade Classifier, a machine learning-based algorithm, to process a user's face image and detect faces accurately.**

Keywords*—*Facial recognition, Haar Cascade Classifier, OpenCV, computer vision, machine learning, image processing, self-driving cars, robotics, security systems.

I. INTRODUCTION

Security is an important part of our lives, and it's necessary to make sure that only authorized individuals can access certain areas. In this article, we present a model for a secure access control system that uses face recognition. The system consists of a camera that can detect and recognize faces and an electromechanical bolt that controls access to the room.

Whenever someone wants to enter the room, the camera will capture their image and compare it to a database of authorized users. If the person is recognized and has access privileges, the electromechanical bolt will open and allow them to enter. However, if the person is not recognized or doesn't have access privileges, the bolt will remain locked, and an alert will be sent to the owner.

Overall, this system provides a reliable and secure way to control access to a room, ensuring that only authorized individuals are allowed in. By using the proposed system, the identity of a person can be identified in real time and can access the system

II. COMPONENTS

A. Raspberry Pi 3B with camera

As the primary handling chip, we are employing a Raspberry Pi 3B in fig 1 with Wi-Fi and GSM support. This raspberry pi module can compute results in the same way as a computer does but on a much **smaller scal**e. We used a 32GB micro SD card as inner memory to keep starting logs and install the Raspbian operating system. Raspberry Pi reduces power consumption to extend battery life or reduce overall energy usage. Its contribution is made possible by the continuous capturing of images via webcam. This webcam is linked to the Raspberry Pi module through the USB port.

Fig.1 Raspberry pi

B. Electro-mechanical lock and Relay

We are using an electromechanical lock in fig. 2 to open and close the door. An electromechanical lock is an electrical locking & unlocking device. It is accessible in two combinations: unlocking in power-on mode and locking and keeping in power-on mode, which may be utilized selectively for different scenarios.

Fig.2 Electromechanical lock and relay

C. IR-Sensor

A tool that can identify infrared radiation is an infrared sensor. Electromagnetic radiation that cannot be seen by the human eye is infrared radiation. Face and person detection are just a couple of the uses for infrared sensors. Automatically spotting faces in a photo or video is a method known as face detection. Automatically spotting people in a picture or video is a process known as person detection. Because infrared sensors can perceive heat, which is released by all objects, they can be used to recognize faces and people. In situations where visible light is scarce or unreliable, such as at night or in low light, infrared sensors are the best option.

Fig.3 IR Sensor

D. USB Camera

A video camera that attaches to a computer via a USB port is known as a USB camera. Typically, video conferencing,

video chat, and photo-taking are done with USB cameras. They can also be utilized for other things, like video recording, live streaming, and security monitoring.

Fig. 4. IR Sensor

III. METHODOLOGY

firstly we have developed software for microcontrollers which includes code for sensor interfacing, data acquisition, and communication protocols.

Further, our hardware components and software help us to collect data and get ready for processing and pass it through an algorithm. Data collection starts from the IR sensor when input is fed to the IR sensor the overall system starts. USB camera is the main component in the collection of data. The camera is used to collect facial data images to further create a dataset.

So algorithm will use data from the existing dataset to compare data fed into the system. Here the software used is OpenCV Library which is useful to display and process the image produced by a webcam OpenCV provides a set of basic image processing functions as well as more advanced functions, such as feature detection and matching.

OpenCV provides several algorithms and techniques for identifying and recognizing images from a dataset such as:

Convolutional Neural Networks (CNNs): CNNs are a type of deep learning algorithm that has been shown to be very effective in image classification tasks. They work by learning features from the image data itself, rather than relying on handcrafted features like Haar cascades or SIFT descriptors.

-Haar cascades: A cascade classifier is a type of object detection algorithm that uses Haar features to identify objects in an image. Haar features are simple rectangular features that can be computed quickly and efficiently. Haar cascades use a hierarchical approach to classify images, where each stage of the cascade filters out false positives.

In this, we have used the Haar cascade algorithm for the identification and recognition of faces from the dataset.

to provide a user-friendly interface, the system includes a graphical user interface (GUI) application that allows the user to perform the necessary tasks with ease. The GUI comprises a label frame for processing, an entry box for entering a user ID, and three buttons for creating a dataset, training the recognizer, and testing the system.

IV. ARCHITECTURE AND DESIGN

Block diagram for system is shown in fig.5, where flow of data is mentioned very briefly as well connection with Raspberry-pi.

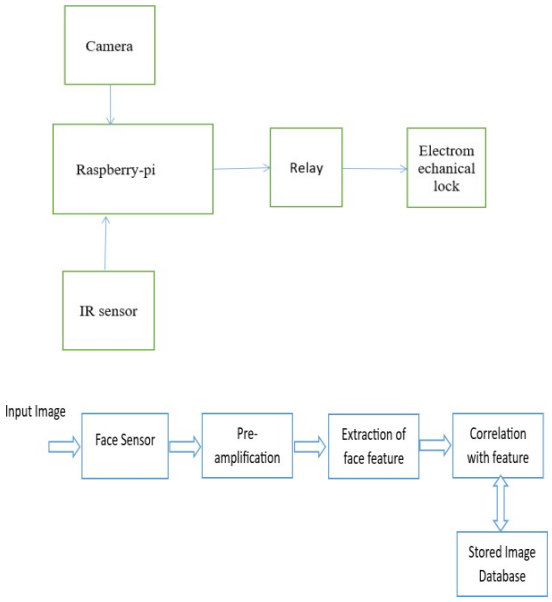

Fig.5 Block diagram of the proposed system.

Fig. 5 also depicts the framework of a secure room access System that utilizes face recognition technology. The System works in the following way:

When a user wants to enter the room, a webcam positioned at the entrance captures their face. The essence of face detection lies in its ability to selectively concentrate on the facial regions of the human body while disregarding extraneous areas, streamlining the analysis to solely relevant aspects of the image.

The captured image is then processed by the Raspberry Pi, which compares it to a database of authorized users. If the user's face is identified and matches the database, the Raspberry Pi sends a signal to a relay, which in turn activates an electromechanical door lock to open the room's door. This allows the user to enter the room.

If the user's face is not recognized by the system, the door remains locked, and an alert is sent to the owner of the room. This ensures that only authorized individuals can access the room, enhancing its security.

Once the user enters the room, the electromechanical door lock automatically closes the door behind them, providing an added layer of security.

Overall, the system provides a convenient, secure, and efficient way of controlling access to a room, and the use of face recognition technology adds an extra layer of security to the process

Fig.6 shows the flowchart, which is the step-by-step approach that was followed:

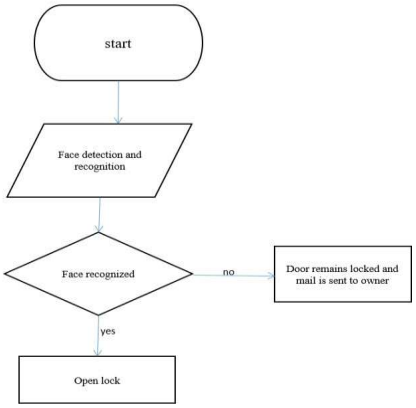

Fig 6 flowchart of the proposed system.

V. IMPLEMENTATION OF PROJECT

Fig. 7 OpenCV

A. FACE RECOGNITION

Fig. 8 Capturing Image

B. CAPTURING FACE FOR DATABASE

Fig. 9 Capture 41 images for the dataset

VI. RESULT

The testing functions of the system are shown in the table below. Utilizing facial recognition for authentication offers heightened reliability due to the distinctive nature of the human face, providing a discernible feature that distinguishes individuals effectively. This technology not only facilitates identification but also enables verification processes. The Pi camera captures facial images, employing them for the training and enhancement of the system.
The testing result has shown that all the functions 100% work properly except the unlocking door via email. 10% of errors are occurring in case.

TABLE I. TESTING RESULT

Testing function	Number of Testing	Success	% of Success
User identification function	50	50	100%
Lock/unlock function	50	50	100%
User adding and right management	50	50	100%
Send message to owner via email	50	50	100%
Unlocking door notification via email	25	2	partial pass

TABLE II. TESTING RESULT wrt FACE ANGLE

Sr. No.	Face Angle	Recognition (%)
1	900	Unrecognized
2	700	Unrecognized
3	500	Unrecognized
4	400	Recognized (44%)
5	200	Recognized (55%)
6	00	Recognized (62%)
7	-300	Recognized (58%)
8	-500	Unrecognized
9	-600	Unrecognized
10	-900	Unrecognized

VII. CONCLUSION

This work contains a Secured System for Door Locks Face detection And Recognition Using the Raspberry Pi. We developed a system that provides customers with door security locks, convenience, and improved security. This technique may be used to check identities at home or other public places. This system was built with a camera, Raspberry Pi microcontroller, relay, and electromechanical door lock. We used the Haar Cascade classifier technique to

detect the face and the LBPH approach to recognize the face. Several procedures have been tested successfully, and the outcomes have been reported.

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