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FACIAL RECOGNITION SECURE DOOR OPERATING SYSTEM USING RASPBERRY PI

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Abstract: Nowadays, everybody is facing security issues in door operating system like unwanted entrance of unauthorize people without permission. In order to resolve these issues an high security system is implemented. Rather than monitoring the door operating system through passwords or pins, unique faces are often made used as they're one's biometric trait. These can't be modified or stolen easily, the extent of security is often raised by using face detection. The proposed system uses face recognition for providing higher security. System uses Haar classifier for face detection, local binary pattern histogram (LBPH) algorithm for face recognition. Whenever the person comes in front of the door, it captures the face and if the captured face is registered then it unlocks the door and if the face isn't registered the door will be in the locked state. The proposed system is trained and tested against 150 images and it has acquired an accuracy rate of 95%.

***Keywords*— Internet of Things, Machine learning, Raspberry pi, OpenCV, Face recognition, Haar cascade classifier.**

I. INTRODUCTION

In this present world many incidents occur like robbery, stealing unwanted entrance happens abruptly. Hence, the security became an important aspect in this lifestyle. People always remain busy in their day-to-day work and also wants to make sure about the safety of their beloved things. Sometimes they seem to forget after their necessary things like keys, wallet, credit cards etc. Without these, they're unable to access their home or anywhere they need. This paper is structured in sections as introduction, background, methodology, testing, results and conclusion.

Traditional security system requires the user a key, a security password, an RFID card, or ID card to possess access to the system. However, these security systems have deficiencies; for instance, they will be forgotten or stolen from unauthorized people. As a result, there is a need to develop a better system for higher security. For many years, people are using non-living thing (Like smart cards, plastic cards, PINS, tokens, keys) for authentication and to urge grant access in restricted areas. So, there are chances that one might forget the pins, keys, cards, etc. but in case face recognition is used for the door operating system then there is a hope of providing higher security.

Face has many features (like eyes, nose, etc.) which are unique and it can reflect many emotions of a person. There are two sorts of biometric as physiological characteristics (face, fingerprint, finger geometry, hand geometry, palm, iris, ear and voice) and behavioral characteristics (gait, signature and keystroke dynamics). Sometimes your behavioral traits may change due to illness, fear, hunger etc. Face recognition system is secured than the other biometrics. The system has four phases which can be named as face detection, feature extraction, face recognition and door operation. In the face detection, the system must classify between face versus non face region, in feature extraction the features of the face are studied using Local binary pattern (LBP), while in recognition process single face image must be matched with multiple images from the input image. The door operation includes locking and unlocking the door based on the signals from the raspberry pi.

The block diagram of the system is as shown in the figure, where the camera and door lock are connected to the raspberry pi.

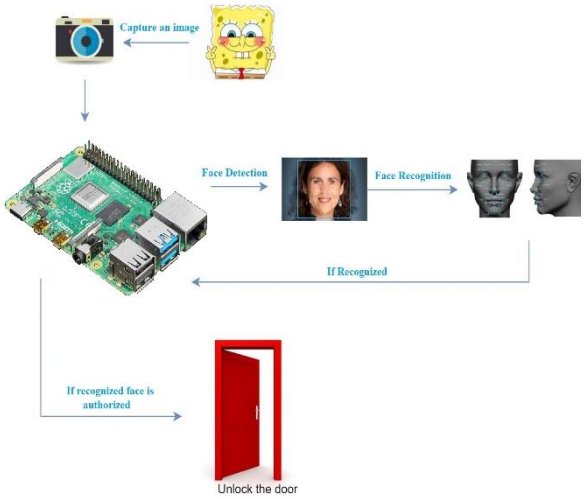

Figure 1 : System architecture for facial recognition door operation system.

IOT - The Internet of Things (IoT) describes the community of bodily gadgets— "things"—which might be embedded with sensors, software, and different technology for the motive of connecting and changing statistics with different gadgets and structures over the internet. These gadgets variety from normal family gadgets to state-of-the-art business tools. With greater than 7 billion linked IoT gadgets today, professionals are watching for this variety to develop to ten billion via way of means of 2020 and 22 billion via way of means of 2025. Oracle has a community of tool partners.

Machine learning - IoT and Machine mastering supply insights in any other case hidden in statistics for rapid, automatic responses and progressed choice making. Machine mastering for IoT may be used to assignment destiny trends, discover anomalies, and increase intelligence via way of means of consuming image, video and audio.

Raspberry Pi - Is a small unmarried board laptop. By connecting peripherals like Keyboard, mouse, show to the Raspberry Pi, it'll act as a mini private laptop. It is popularly used for actual time Image/Video Processing, IoT primarily based totally packages and Robotics packages. Though it is slower than pc or laptop however continues to be a laptop that can offer all of the predicted capabilities or abilities, at a low energy consumption.

OpenCV - OpenCV (Open-Source Computer Vision Library) is a library of open-source computer vision and computer software. OpenCV was created to provide a common infrastructure for computer vision applications and to accelerate the use of automatic recognition in commercial products. As a BSD license, OpenCV allows companies to easily use and modify its code.

Face recognition - Facial popularity is a technique of the use of faces to pick out or affirm an individual's identity. Facial popularity structures may be used to pick out humans in photos, videos, or in actual time.

Face popularity is a sort of biometric safety. Other kinds of biometric software program consist of voice popularity, fingerprint popularity, iris or retina popularity. This generation is commonly used for safety and regulation enforcement, however there's developing hobby in different makes use of as well.

Haar cascade classifiers - Object Detection The use of purely Haar feature-based cascade classifiers is a powerful element detection method proposed in Paul Viola and Michael Jones' article "Object Detection". A quick object with a simple feature cascade "In 2001, this is a tool that lets you know a completely based method with layering capabilities, including many large and trivial images. Used to search for elements in the image.

II. BACKGROUND

The proposed method is based on Door security system. The extensive literature survey is carried out based on this technique. This led exposure to so many earlier methodologies and technologies proposed by many authors in the field of security.

Park Tae.Y et al. (2009) prototyped a smart digital lock system for home automation. A digital door lock system is equipment that uses the digital information such as a secret code, semi-conductors, smart card, and finger prints as the method for authentication instead of the legacy key system. The proposed system is built over a wireless sensor network, which makes it a cheap, flexible, and easily installable system without any overhead such as careful planning, cabling, and construction works. However, it requires specialized installation and maintenance techniques which is cabling and construction works, However, it requires specialized installation and maintenance techniques which makes it vulnerable to high maintenance requirement

Ilkyu Ha (2015) proposed a digital door lock system based on Internet of Things The proposed system provides strengthened security functions that can transfer recorded images to a user's mobile device when an invalid user attempts an illegal operation; it can also deliver alarm information to the mobile device when the door lock is physically damaged. The proposed system enables a user to check the access information and remotely operate the door lock to enhance convenience. Though the improve user convenience by allowing him to check the image of a valid visitor and open or close the door lock remotely. It lags behind when it comes to capturing like in the case where an incorrect password is entered, if the invader intentionally covers the camera lens or deviates the focus from him, it will be impossible to collect an accurate image.

Similarly, Negi.L et al. (2017) proposed an enhancing security system using Finger Print based Authentication, this paper represents a finger print recognition biometrics system based on real time embedded system which will provides a complete security solution lives and properties. The system is embedded with a finger print module with Arduino microcontroller along with buzzer, keypad and an LCD System, making it very expensive compared to other systems in the market even when the system works efficiently.

Umar,B.U et al. (2018) proposed yet another paper with an idea of fingerprint enabled door access control system. This design will aid the development of a fingerprint door access control system with a buzzer alarm. This system will help the user to maintain high level of confidentiality and security of life and properties thereby reducing the rate at which intruders access other people's belongings or asset. But the system is highly dependent on power supply which makes power failure one of the biggest drawbacks for the system failure.

Hendra.A et al (2018), that enhanced the idea of using Bluetooth technology for design of Smart Lock System for Doors. This framework works by utilizing gadget that actuates Bluetooth to recognize the client situated close to the Bluetooth signal region. A little bother of this new innovation is that you need to dispatch the application without fail. It's not as straightforward as having your telephone on your body and just strolling by the card peruse.

Orji E.Z et al. (2019) prototyped a microcontroller based digital door lock security system consisting of a digital door lock system is written in C programming languages using Arduino IDE and uploaded to the microcontroller, which commands the functioning of the hardware that is microcontroller, which helps to incorporate the information from the code to the various hardware parts of the digital door lock. The main inconvenience caused is during rush hour to get into the room or building it will be difficult to again access.

Jogin kook (2019) proposed an implementation of a One-time password (OTP)-based IoT Digital Door-lock System. The paper emphasized on using an IoT-based remote validation door lock framework utilizing OTP to solve crime exposure harm, to ease anxiety, and to offer the comfort of visit in nonattendance. It comprises of a door lock with functions, for example, OTP generation, controller of locks, picture storage and continuous streaming, and a cell phone application with ongoing video checking, entryway lock control and occasion logging. Nonetheless, it is reliance on network can turn into an issue for OTP deliver.

III. PROPOSED SYSTEM

In this section, the description of the proposed system is provided. The new system is designed with the help of facial recognition module which is supported with and external camera module that is attached to raspberry pi. Raspberry pi offers many features for users that can be used in different smart applications.

The raspberry pi is trained to recognize faces and differentiate between authorized and unauthorized faces by making use to training data set. Once, the Raspberry pi successfully recognizes the face in front of the camera as authorized or unauthorized, relay is triggered to open the door or to keep it locked.

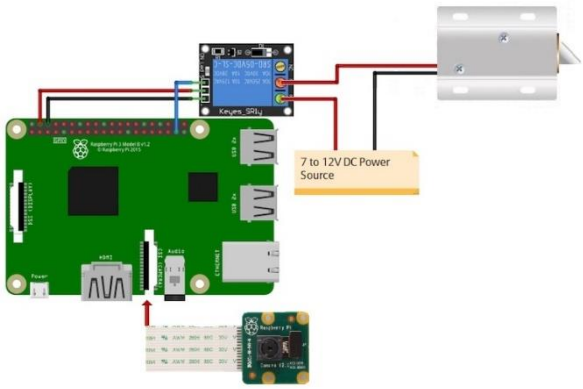

Figure 2: Circuit diagram

The overall integration of the modules in the proposed system can be seen as shown in the figure 2

IV. METHODOLOGY

The important concept of this project can be explained in four main phases: face detection, feature extraction, face recognition and door operation.

i. Face detection

The face detection is done by using HAAR classifier. HAAR classifier converts the given image into a grey scale image after which studies the Haar features of the image. It then creates array reference for each sub rectangle. This image is then fed to the ADA boost algorithm, which helps in choosing the best features of the image. The classifier predicts the positive and negative images. This can be represented in the following figures

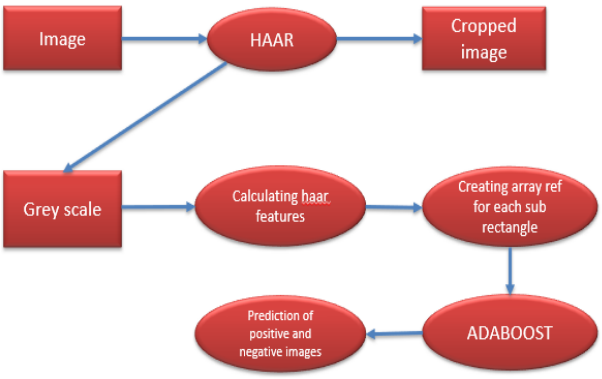

Figure 3: Data flow of face detection process.

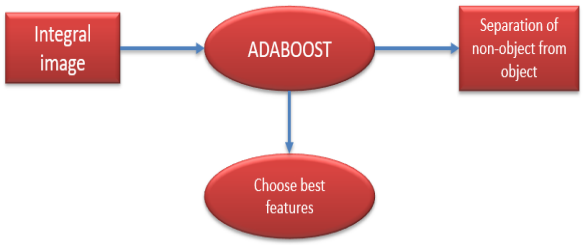

Figure 4: data flow for Adaboost algorithm

ii. Feature extraction

This is done by the Local binary pattern (LBP) operation. In this operation, the cropped grey scale image is divided into 3*3 pixels. They are then converted into intensity value matrix and threshold values are calculated for these matrices. These matrices are converted into binary matrices using the threshold values. The binary values are converted to decimal values for each of these matrices which are called as grid values.

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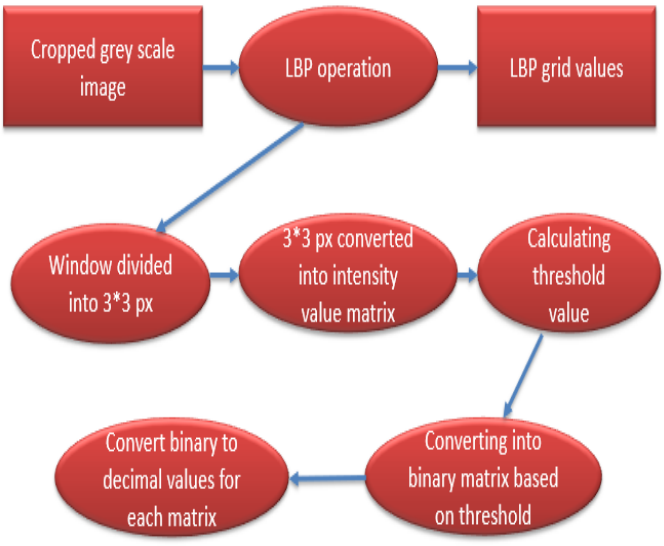

Figure 5: Data flow for feature extraction

iii. Face recognition

After the grid value calculation, the system makes use of Local Binary pattern histogram (LBPH) algorithm for face recognition. The grid values are represented as histograms. All these histograms are concatenated into one histogram. This histogram differs for each image which is mainly used in facial recognition.

The histogram of the given image is compared to the trained image histogram. System then calculate the confidence value which is then compared to the threshold value. If the confidence value is less than the threshold value then the image is an authorized image.

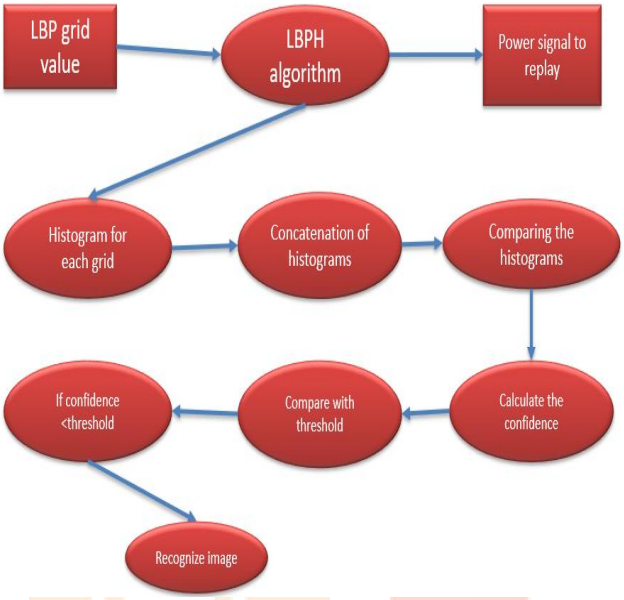

Figure 6: Data flow for face recognition

iv. Door Operation

If the image is recognized as an authorized person, then the raspberry pi sends the signal for the door lock through the relay to unlock it. If the recognized face is not an authorized person, then the door remains in the locked state. The below figures show the door locking and unlocking operations.

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Figure 7: Door Unlocking

Figure 8: Door locked

V. TESTING

The door lock system is trained to with a data set which consisting of 150 images. The facial image data set is created of which 70% of the dataset was used for training, and the remaining 30% is used for testing the model. The system has given a successful outcome which yields an accuracy rate of 95%.

The system is tested with different scenarios of authorized faces. In case the face in front of camera module of the system is recognizable by the system, then the door will be unlocked, if the face in front of the camera module is not recognized by the system the door will remain locked.

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Sl no	Action	Input (no of person)		Expected output	Action output	Test result	Test comments
		authorize	Unauthorize				
1	Single authorization	0	0	locked	locked	success	No authorize face detected
2	Single authorization	1	0	unlocked	unlocked	success	authorize face detected
3	Single authorization	0	1	locked	locked	success	No authorize face detected
4	Single authorization	1	1	unlocked	unlocked	success	authorize face detected
5	Multiple authorization	2	0	unlocked	unlocked	success	authorize face detected
6	Multiple authorization	0	2	locked	locked	success	No authorize face detected
7	Multiple authorization	1	2	unlocked	unlocked	success	authorize face detected
8	Multiple authorization	2	2	unlocked	unlocked	success	authorize face detected

Table1:test result

VI. RESULT

The propose system uses the web camera to capture the images. The registered users and their images are stored in the data samples as authorized users. For each of these users 5 facial images with different poses and expressions are captured. When the system is tested against the data sample, an accuracy rate of 95% is aquired.

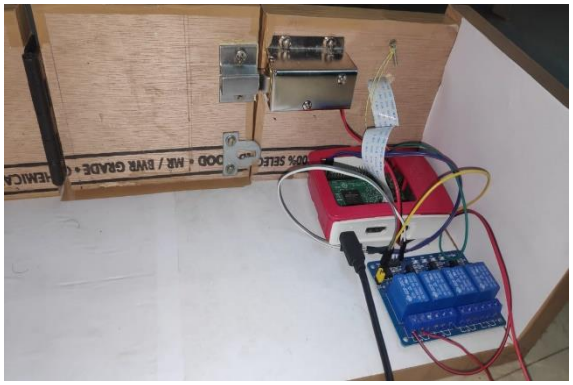

Figure 9: Hardware implementation.

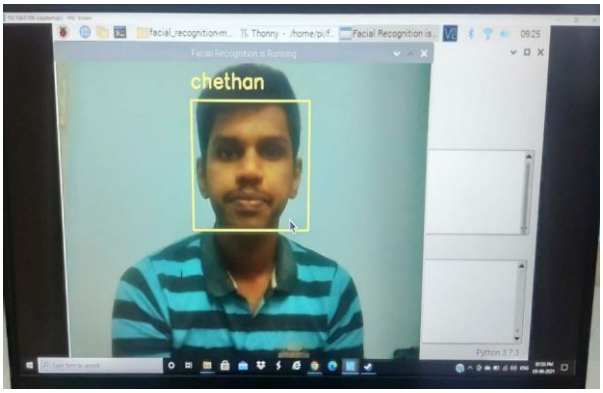

Figure 10: Authorized face recognition

VII. CONCLUSION

The proposed facial recognition secure door operating system is built, in which an Haar classifier is used for face detection, local binary pattern histogram algorithm for facial recognition, camera to capture the images and raspberry pi for processing these operations along with sending the signals to relay for door locking and unlocking.

The door lock system is trained to with a data set which consisting of 150 images. The facial image data set is created of which 70% of the dataset was used for training, and the remaining 30% is used for testing the model. The system has given a successful outcome which yields an accuracy rate of 95%.

When the image is not captured under proper ambient lighting then the proposed system is vulnerable. As future enhancement of the module, The system can be trained and tested on a larger dataset to verify the accuracy. The application of the proposed system can be implemented for commercial and residential purposes.

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