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Face Recognition Locker

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***Abstract*: Face recognition has been one of the most interesting and important research fields in the past two decades. The reasons come from the need of automatic recognitions and surveillance systems, the interest in human visual system on face recognition, and the design of human-computer interface, etc. The use of face recognition can be used in locker for the security purpose. By using face recognition locker, the locker can be opened by recognizing the face of user. Therefore, for face recognition the concept of image processing can be implemented.**

***Keywords*: face recognition, openCV, raspberry pi-4, security.**

1. Introduction

The ultimate goal of face Recognition system is image understanding - the ability not only to recover image structure but also to know what it represents. A general statement of automatic face recognition can be formulated as given still or video images of a scene, identify or verify one or more persons in the scene using a stored database of faces. The solution to the problem involves segmentation of faces (face detection) from cluttered scenes, feature extraction from the face regions, recognition or verification. For identification, the input is an unknown face, and the system reports back the determined identity from a database of known individuals, whereas in verification problems, the system needs to confirm or reject the claimed identity of the input. Face recognition system is widely used for human identification particularly for security functions. The project deals with the look and implementation of secure automatic door unlock by using Raspberry Pi. Pi Camera for capturing the images from the video frame is operated and controlled by raspberry pi using Open CV Python library to train and store human faces for recognition. In this project we are using Raspberry Pi as face recognition module to capture human images and it will compare with stored data base images. If it matches with authorized user then system allows to supply power to electromagnetic lock to create magnetic field for unlocking the locker. The need for facial recognition system that is fast and accurate is continuously increasing which can detect intruders and restricts all unauthorized users from highly secured areas and aids in minimizing human error. Face recognition is one of the most Secured System than the biometric pattern recognition technique which is used in a large spectrum of applications.

2. Literature Survey

Face recognition is one of the few biometric methods that possess the merits of both high accuracy and low intrusiveness. It has the accuracy of a physiological approach without being intrusive. Over past 30 years, many researchers have been proposed different face recognition techniques, motivated by the increased number of real world applications requiring the recognition of human faces [1]. There are several problems that make automatic face recognition a very difficult task. However, the face image of a person inputs to the database that is usually acquired under different conditions. The important of automatic face recognition is much be cope with numerous variations of images of the same face due to changes in the following parameters such as pose, illumination, expression, motion, facial hair, glasses, and background [4]. Face recognition technology is well advance that can applied for many commercial applications such as personal identification, security system, image-film processing, psychology, computer interaction, entertainment system, smart card, law enforcement, surveillance and so on[3]. A general problem of face recognition can be done in two formulate both a still image and video image of a scene. There have divided into two basic application: identification and verification. In the identification problem, the face to be recognized is unknown and matched against face of a database containing known individuals. In the verification problem the system confirms or rejects the claimed identify of the input face. However, before face recognition is performed. The system should determine whether or not there is a face in a given image or given video, a sequence of images. This process is called face detection. Once a face is detected, face region should be isolated from the scene for the face recognition [1]. The Author Vijaylakshmi. M “Face Recognition Door Unlock System” (2019) [2] he’s project deals with door with the look and implementation of secure automatic door unlock by using Raspberry Pi. Web camera for capturing the images from the video frame is operated and controlled by raspberry pi using OpenCV Python library to train and store human faces for recognition. The Author Kuldeep Soni[5] developed a system with an advanced surveillance camera capable of face detection and at the same time recognition the Eigen face methodology and these all processing has been done on Raspbian OS on Raspberry Pi 2 B+. The Author Tony Di Cola – “Raspberry Pi Face Recognition in Treasure Box” (2014)[6] he’s project was a great example how to use the Raspberry Pi and Pi camera with open CV computer vision algorithm’ s. By compiling the latest version of OpenCV it can get access to latest and most interesting computer vision

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algorithms like face recognition.

3. System Level Architecture

In fig.1 shows the block diagram of Face Recognition locker system. .It consists of the power supply which provides power for the operation of the different components in the hardware. Raspberry Pi 4 board is the controller used in the hardware; it controls the different actions in the working of the Face recognition Locker. Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry Pi run. There are different components interfaced to the controller which gets ON which it receivers high input from the Raspberry Pi 4. The Pi camera module is a portable light weight camera that supports Raspberry Pi. It communicates with Pi using the MIPI camera serial interface protocol. A keypad is a set of buttons or keys arranged on a pad that bear digits, symbols, or alphabetical letters, which can be used as an efficient input device. A keypad may be purely numeric that is found on most computer keyboards, allowing an individual to easily enter numeric values into a computer. Relays are switching that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. A solenoid is an essential coil of wire that is used in electromagnets, inductors, antennas, valves, etc. A solenoid is used to control a valve electrically.

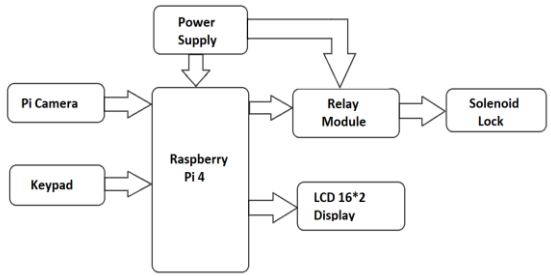


Fig. 1. Block diagram of face recognition locker

1) *Face Recognition Locker Logical Structure*

The project is extremely easy to operate and can easily be modified according to future scopes. Facial recognition is a way of identifying or confirming an individual's identity using their face. Facial recognition systems can be used to identify people in photos, videos, or in real-time. Typically, facial recognition does not rely on a massive database of photos to determine an individual's identity. It simply identifies and recognizes one person as the sole owner of the device, while limiting access to others. Beyond unlocking phones, facial recognition works by matching the faces of people walking past special cameras, to images of people on a watch list. The watch lists can contain pictures of anyone, including people who are not suspected of any wrongdoing, and the images can come from anywhere even from our social media accounts.

Facial technology systems can vary, but in general, they tend to operate as following steps.

2) *Step 1: Gathering Data*

Here we create a data set folder and identify faces and store it in dataset folder with image name as user_userid. imgno jpg.

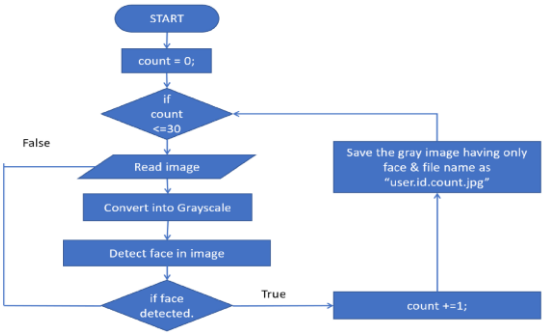


Fig. 2. Flowchart for dataset

3) *Step 2: Training the Data Set*

Thanks to OpenCV, coding facial recognition is now easier than ever. OpenCV has three built-in face recognizers and thanks to its clean coding 8], you can use any of them just by changing a single line of code. Here are the names of those face recognizers and their OpenCV calls:

EigenFaces – cv2.face.createEigenFaceRecognizer ()
FisherFaces – cv2.face.createFisherFaceRecognizer ()
Local Binary Patterns Histograms (LBPH) – cv2.face.createLBPHFaceRecognizer ()

4. Eigen Faces Face Recognizer

This algorithm considers the fact that not all parts of a face are equally important or useful for face recognition. Indeed, when you look at someone, you recognize that person by his distinct features, like the eyes, nose, cheeks or forehead; and how they vary respect to each other [9]. In that sense, you are focusing on the areas of maximum change. For example, from the eyes to the nose there is a significant change, and same applies from the nose to the mouth. When you look at multiple faces, you compare them by looking at these areas, because by catching the maximum variation among faces, they help you differentiate one face from the other. In this way, is how Eigen Faces recognizer works? It looks at all the training images of all the people as a whole and tries to extract the components which are relevant and useful and discards the rest. These important features are called principal components. Below is an image showing the variance extracted from a list of faces.

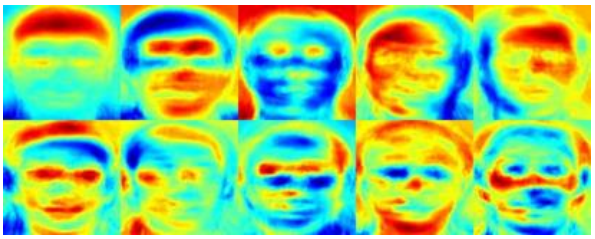


Fig. 3. List of variance extracted faces

So, Eigen Faces recognizer trains itself by extracting principal components, but it also keeps a record of which ones belong to which person. Thus, whenever you introduce a new

image to the algorithm, it repeats the same process as follows [7]

1. Extract the principal components from the new picture.
2. Compare those features with the list of elements stored during training.
3. Find the ones with the best match.
4. Return the 'person' label associated with that best match component.

However, one thing to note in above image is that Eigen Faces algorithm also considers illumination as an important feature. In consequence, lights and shadows are picked up by Eigen Faces, which classifies them as representing a 'face.'

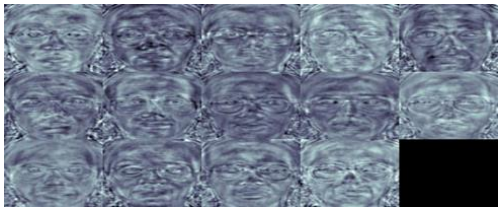
1) Fisher faces face recognizer

This algorithm is an improved version of the last one. As we just saw, Eigen Faces looks at all the training faces of all the people at once and finds principal components from all of them combined. By doing that, it doesn't focus on the features that discriminate one individual from another [7]. Instead, it concentrates on the ones that represent all the faces of all the people in the training data, as a whole. Consider the lighting changes in following images.

Since Eigen Faces also finds illumination as a useful component, it will find this variation very relevant for face recognition and may discard the features of the other people's faces, considering them less useful. In the end, the variance that Eigen Faces has extracted represents just one individual's facial features [9].

2) How to fix this issue

We can do it by tunning Eigen Faces so that it extracts useful features from the faces of each person separately instead of extracting them from all the faces combined. In this way, even if one person has high illumination changes, it will not affect the other people's features extraction process. Precisely, Fisher Faces face recognizer algorithm extracts principal components that differentiate one person from the others. In that sense, an individual's components do not dominate (become more useful) over the others. Below is an image of principal components using Fisher Faces algorithm.



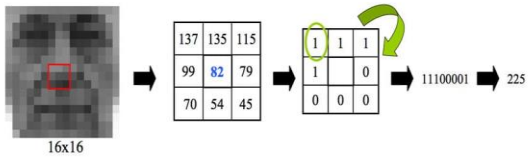
One thing to note here is that Fisher Faces only prevents features of one person from becoming dominant, but it still considers illumination changes as a useful feature. We know that light variation is not a useful feature to extract as it is not part of the actual face. Hence, we use LBPH recognizer.

3) Local binary patterns histograms (LBPH) Face Recognizer

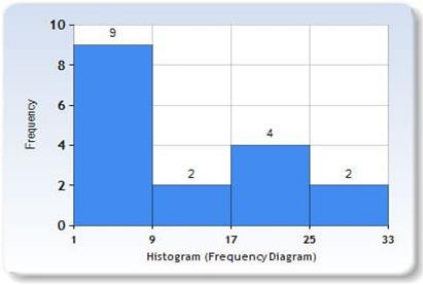
We know that Eigen faces and Fisher faces are both affected by light and, in real life, we can't guarantee perfect light conditions. LBPH face recognizer is an improvement to overcome this drawback. The idea with LBPH is not to look at the image as a whole, but instead, try to find its local structure by comparing each pixel to the neighboring pixels.

4) The LBPH Face Recognizer Process

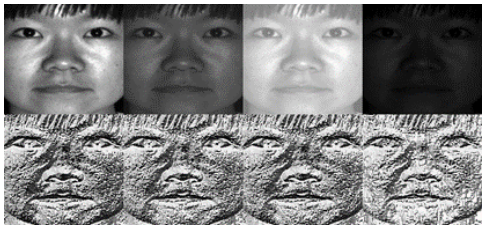
Take a 3×3 window and move it across one image. At each move (each local part of the picture), compare the pixel at the center, with its surrounding pixels. Denote the neighbors with intensity value less than or equal to the center pixel by 1 and the rest by 0 [10]. After you read these 0/1 values under the 3×3 window in a clockwise order, you will have a binary pattern like 11100011 that is local to a particular area of the picture. When you finish doing this on the whole image, you will have a list of local binary patterns.



Now, after you get a list of local binary patterns, you convert each one into a decimal number and then you make a histogram of all of those decimal values. A sample histogram looks like this:



In the end, you will have one histogram for each face in the training data set. That means that if there were 100 images in the training data set then LBPH will extract 100 histograms after training and store them for later recognition. Remember, the algorithm also keeps track of which histogram belongs to which person. Below is a group of faces and their respective local binary patterns images. You can see that the LBP faces are not affected by changes in light conditions:



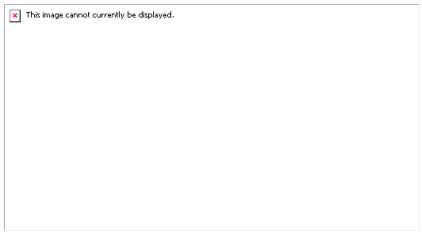


Fig. 3. Flowchart for Training

5) Step 3: Recognition

1. Feed a new image to the recognizer for face recognition.
2. The recognizer generates a histogram for that new picture.
3. It then compares that histogram with the histograms it already has.
4. Finally, it finds the best match and returns the person label associated with that best match.

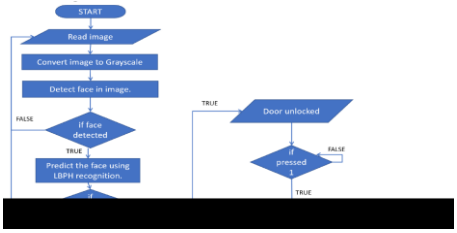


Fig. 4. Flowchart for Face Recognition.

6) Hardware

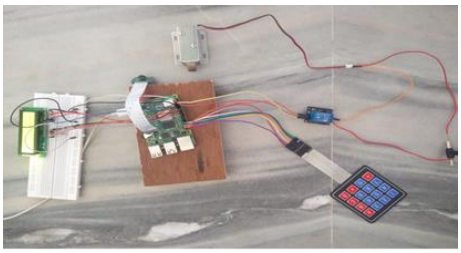


Fig 3-1b: Hardware implementation

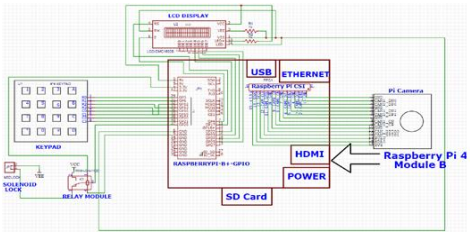


Fig 3-1c: Circuit diagram of hardware

5. Applications

A lot of applications of the face recognition system have been visualized in our day-to-day life. Some of the applications of this technology are listed below.

1. Face Identification.
2. Access Control.
3. Security.
4. Image Database Investigation.
5. General Identity Verification.
6. Surveillance.

6. Conclusion

This paper present, a face recognition locker system using Raspberry Pi 4. The recognition rate is around 50-70% when tested. This proposed system is connected using Internet to the smart home system for the added security purpose in lockers, home security, etc. Further research includes optimization of hierarchical image processing, use different features extraction and classifier, or use parallel Raspberry Pi clusters to speed up the computation. It is important to sew that the product so developed has a wide, spread applications, such as bank locker, door lock, and also private home locker system. In a Face Recognition Locker system which maps and individuals, facial features mathematically and store the data as a face print, Face detection data is required for the algorithm. Improved security. Face detection improves surveillance efforts and helps track down criminals and terrorists. Personal security is also enhanced since there is nothing for hackers to steal or change, such as passwords. Easy to integrate. Face detection and facial recognition technology is easy to integrate, and most solutions are compatible with the majority of security software. If the saved photo copy is shown in front of camera the locker will locked.

7. Future Work

Future improvements and modifications can be done for face recognition locker system that would make it more efficient. To overcome the insecurity problem in face recognition locker system we can capture the physical appearance of the person then only the locker will get opened. In case the person enters invalid password three times the camera will capture the image of a person and send the image to the owner of the locker. This project can also be used for security purpose like home locker or door lock, bank lockers, office lockers, etc. So, some other technics can be incorporated to increases its efficiency.

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