

Smart Door using Face Recognition

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Abstract - The extent of this task is to make up a security system to control application in for face acknowledgment. Entryways are normally controlled and opened utilizing keys, Passcodes, Patterns, Keycards and Fingerprints. These frameworks can be split at some degree yet we utilize face acknowledgment framework in which entire Face is utilized to grant permission to enter inside. Face is a complex multidimensional structure and needs extraordinary enrolling systems for area and affirmation it is hard to part. Face acknowledgment frameworks have redesigned individual perceiving confirmation and attestation, expecting an essential part in individual, national, and general security. At first the approved Faces are prepared into a neighborhood database. These Database faces are contrasted and the caught test picture. The entrydoorl opens for the authorized individuals because of the command of the Raspberry Pi to the entryway engine.

The face is detected by the cascade classifier and face recognition is enforced by the Local Binary Patterns Histograms(LBPH). Face Recognition supported LBPH is to foreshorten the near structure in an exceedingly image by contrasting each constituent pixel and its neighbourhood, so as to attain the next accuracy and effectiveness we tend to use OpenCV libraries and python language.

Key Words: Face Recognition, LBPH, OpenCV, Python

1. INTRODUCTION

Face recognition could be a terribly difficult analysis space in pattern recognition because of variations in face expressions, poses and illumination. Many rising applications, from enforcement to industrial tasks, demand the trade to develop economical and automatic face recognition systems.

To avoid thefts and identity fraud, a face recognition system should be established. The objective of the project is to develop a security management application supported by face recognition. The haar-like cascade features is employed for face detection and LBPH rule is employed for face recognition. For attaining the accuracy and effectiveness we tend to use OpenCV libraries and python computer-oriented language. Training and identification is finished in embedded device called Raspberry Pi.

Face recognition has conjointly proved helpful in different transmission science areas. Identity verification analyze the characteristic of face pictures input from a digital video camera or on-line face capturing. Currently we want to maintain security in each organization and each individual needs to enhance their security system. Most of the

individuals would like higher security system which supplies complete security solution.

2. RELATED WORK

This paper is inspired by the analysis of research papers written by the individuals listed below:

[1] K.Gopalakrishnan, V. Sathish Kumar: They suggested a picture capturing technique in associate embedded system supported Raspberry Pi board and Considering the wants of image capturing and recognition rule, Raspberry Pi process module and its peripherals, implementation supported this platform.

[2] Tony Di Cola: His project is a nice example of how to use the Raspberry Pi and Pi camera module with OpenCV algorithms. By aggregating the newest version of Open CV, it will get accessible to the newest and most attention-grabbing pc vision algorithms like face recognition. Conjointly he used a coil double action lock that is lock/unlock victimization key when power off.

[3] Kuldeep Soni: He developed a system with a complicated police work camera capable of face detection along with it, at an equivalent time recognize faces detected by Open-CV library, Eigen face methodology and this whole process has been done on Raspbian OS on Raspberry Pi. For capturing the photographs, he used Pi Camera Board. With the assistance of face recognition capability he established that the advanced police work camera system victimization face detection and at an equivalent time recognizing the face detected is extremely secured system.

[4] MedakTeenaRavali, Prof. Ranga Sai Komaragiri: They projected that a more affordable option for DSP kits for image processing by Raspberry board with Open-cv package. During this projected work, the platform for image processing and rule for face recognition is enforced on principal component analysis.

[5] Anoop Mishra, Arshita Dixit: They projected their work on Raspberry pi B+ model with camera interface to capture a picture and convert this captured picture into grey image with digital image processing rule. They conclude that the much applied result's are rational and designed system is technically smarter compared to the image interfacing system on a private pc.

[6] Kandla Arora: He projected the real time application of Face Recognition conception by generating a matlab code by image capturing tool box on the essential approach used is PCA and Eigen faces.

[7] Sanjana Prasad, P. Mahalakshmi, A. John Clement Sunder, R.Swathi: They implement police work observation system on Raspberry pi and PIR sensors for mobile devices. Conjointly their projected work implements home security system captures information and transmits it via a 3G electronic device to a sensible phone application. Raspberry pi does the operation and control motion detectors and video cameras for remote sensing and police work, streaming live video and recording it for future playback.

[8]Ajinkya Patil, Mrudang Shukla:They used their face recognition system for student attendance in their class for avoid wastage of your time by automatic method that is predicated on image processing and face detection and recognition system. This face detection distinguishes faces and non-faces and is thus essential for correct group action. The other strategy include face recognition for the students attendance. The student information is collected. The information included name of students , their pictures and id.

3. PROPOSED SYSTEM

The projected work is as per the following:

- 1) Interfacing of camera module to catch live Face image.
- 2) Produce dataset of approved individuals.
- 3) Produce a yml file to be loaded into recognizer , for training of the recognizer.
- 4) Capture current face and compare with dataset images.
- 5) For approved individual, open the approach entryway by turning on the motor.

3.1. System Analysis

The basic flow of the face recognition system is that the image is captured by camera. The Viola jones methodology can establish the face within the image utilizing Haar cascade classifiers and features are extracted from the face. After the extraction, system matches the captured pictures with information base pictures.

The Matching of the captured pictures and information base pictures is finished by LBPH rule. The thought is to not take a gose at the complete image as a high-dimensional vector like in Eigen Faces and also the Fisher Face Recognizer algorithms but it's to depict simply neighborhood parts of a matter. The LBPH rule is additional correct than the Eigen Faces. The complex calculation in Eigen Faces or PCA is reduced due to the LBPH algorithm. The parts you untangle on these lines can have a low-dimensionality verifiably. Within the event that a face is remembered, it's known , else it's obscure. The approach can open door consequently for the authorised individuals due to the command of the Raspberry Pi to approach Motor.

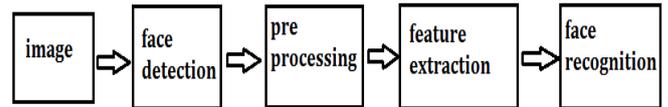


Fig 3.1 : Face recognition process

Face Detection:

Face detection involves dividing image windows into 2 classes; one containing faces. It is troublesome as a result of though commonalities appear between faces , they will vary significantly in terms of skin color and face expression. The matter is additionally difficult by differing lighting conditions, image qualities and geometries, additionally because the chance of partial occlusion and disguise. A perfect face predictor would therefore be ready to detect the presence of any face in any set of lighting conditions, upon any background.

The face detection task is done usually in a pair of steps. The first step may well be a classification task that takes some discretionary image as input and outputs a binary value of yes or no, indicating whether or not the area unit has any faces offered inside the image. . The second step is that the face localization task that aims to get a picture as input and output the situation of any face or faces among that image as some bounding box with (x, y, width, height).

The main aim of this step is to discover the face from capture image or the chosen image from the dataset. This face detection method truly verifies that whether the given image has face image or not, after detective work the face ,this output are going to be additionally given to the pre-processing step.

Pre-Processing:

During this step the unwanted noise, blur, variable lightening condition, shadowing effects are often take away victimization pre-processing techniques .once we've fine swish face image then it'll be used for the feature extraction method.

To reduce the variability within the faces, the pictures are processed before they are feed to the network. All positive examples i.e. the face pictures are obtained by cropping pictures with frontal faces to incorporate solely the front read. All the cropped pictures undergo correction for light through normal algorithms.

Feature Extraction :

In this step features of face are often extracted victimization feature extraction rule. Extractions are performed for doing information packing, dimensionality reduction, strikingness extraction, and noise cleanup. Next to this step, a face patch is sometimes reworked into vector along with mounted dimensions or a collection of fiducial points and the corresponding locations.

Feature extraction remains key step in any recognition system wherever pictures are collected which can embrace each positive and negative pictures. Discarding of negative pictures limits the extraction to well outlined purpose for feature choice and extraction. Principal Component Analysis (PCA) are often needed to approximate the initial information with lower dimensional feature vectors. By taking binary values of available units of pictures i.e. image pixels so taking binary values, these are tagged by thresholding every constituent of a picture with summation of 3x3 neighborhoods and utilizing these calculated values.

The histograms of the labels are often used as a texture descriptor. LBP is additional strong to cause changes as a result of it depends additionally on histograms of the pattern in an exceeding region. LBP handles minor variations in pose and achieve perfect rate of recognition if the rotations are below 15 degree. With a maximum of 2 bit wise transitions from zero to one or the other way around in circular binary string, a Local Binary Pattern is named uniform pattern. Feature Extraction is finished for the testing face pictures additionally for the train image set.

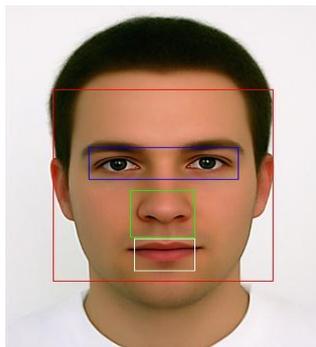


Fig 3.2: Facial features

Face Recognition:

Face recognition could be a terribly difficult analysis space in computervision and pattern recognition because of variations in facial expressions, poses and illumination. Many rising applications, from enforcement to industrial tasks, demand the trade to develop economical and automatic face recognition systems. Although, several researchers have worked on the matter of face recognition for many years still several challenges must to be solved . Distinction in illumination of the scene, changes in cause, orientation and expression ar samples of a number of the problems to be dealt rigorously.

Facial recognition analyzes the characteristics of individual's face pictures input through a digital video camera or on-line face capturing. In current scenario we want to keep up world information secure, in each organization or individual needs to enhance their existing security system .

3.2. System Study

Local Binary Pattern Histograms (LBPH):

The Local Binary Patterns Histograms (LBPH), projected in 2006 , is associate rule used for face recognition, that is predicated on the native binary operator . It is a really standard algorithm, used due to its discriminative power and computation simplicity.

Concerning the practicality, a $N \times M$ sized image is employed and is split into regions. An equivalent size is most popular, in each breadth and height, leading to $m \times m$ regions. In every region, the native binary operator is employed . This operator, once applied on pictures, compares a constituent to its eight neighbor pixels. The comparison checks if the value of the neighbor constituent is more than the middle constituent, returning a value of "1" in this case. In the other case, a "0" value is returned.

Applying this method to any or all eight neighbors, eight binary values ar derived. Associated 8-bit binary value is made, by merging those values along. The obtained binary number are often translated into a decimal equivalent, known as the constituent LBP number, which exceedingly varies between 0-255. The method represented, is performed for each constituent within the region.

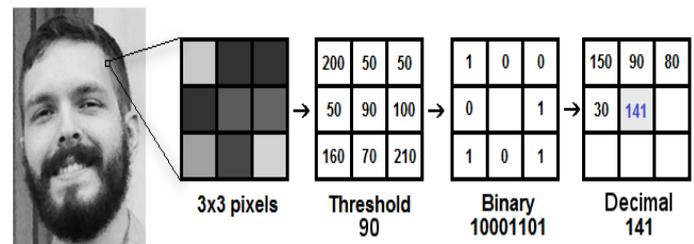


Fig 3.3: LBPH operation

The histogram for this region is then created, by calculative analysis of the quantity of repetition of all the LBP values within this region. Through this method, the histograms for every region consists of 256 bins. This method is described through the subsequent equation:

$$H_i = \sum_{x,y} I\{LBP(J(x,y)) = i\}, i = 0, \dots, 255 \quad (1)$$

where H_i is the bin of value i , $J(x,y)$ is the (x,y) pixel of the image and I is a conditional operator, returning '1' if the statement is true or '0' otherwise. Once the histograms for all regions have been calculated, a single histogram is created by unifying all the histograms for each section. This final histogram will contain $256 * m * m$ bins and is defined as the feature vector of the image.

To proceed with facial recognition, a database (db) of feature vectors corresponding to face images is required. The distance between the various feature vectors are then calculated. The image that is corresponding to the feature

vector with the nearest distance is returned as the best match for the probe image. This can be derived from the following equation:

$$(M, Index) = \min(dst[db\ size]) \quad (2)$$

where *dst* is the array of the calculated distances and *min* is a function returning the minimum value (*M*) of the array and the value's index (*Index*).

As stated above, Local Binary Patterns is a very popular model, with multiple, differently modified, implementations over time. Therefore, the proposed system introduces a novel LBPH implementation for face recognition.

LBPH Algorithm Steps:

I. Parameters: the LBPH uses 4 parameters:

- **Radius:** the radius is employed to create the circular native binary pattern and represents the radius round the central constituent. It is typically set to one.
- **Neighbors:** The quantity of instace points to make a circular local binary pattern. Remember that the more instance points you embrace, more is the computating cost. It is typically set to eight.
- **Grid X:** The quantity of cells within the horizontal direction. If cells are more, the grid will be finer, and also greater spatiality of the feature vector will be resulted It is typically set to eight.
- **Grid Y:** The quantity of cells within the vertical direction. If cells are more, the grid will be finer, and also greater spatiality of the feature vector will be resulted It is typically set to eight.

II. Training the Algorithm: First, we want to train the rule. To do so, we want to use a dataset with the facial pictures of the individuals we would like to acknowledge. We want to conjointly set associate ID(or the name of the person) for every image, therefore the rule can use this info to acknowledge associate input image and provides you associate output. pictures of an equivalent person should have an equivalent ID.

III. Applying the LBP operation: The primary step of the LBPH is to create an associated intermediate image that describes the initial image in a accurate way, in which the facial characteristics are highlighted. To do it, the algorithm makes use of a sliding window concept which is based on the parameters, like radius and neighbors.

IV. Extracting Histograms: This is done by utilizing the image generated in the previous step, we can use the **Grid X** and **Grid Y** parameters to separate the image into multiple grids, as it can be seen in the following image:

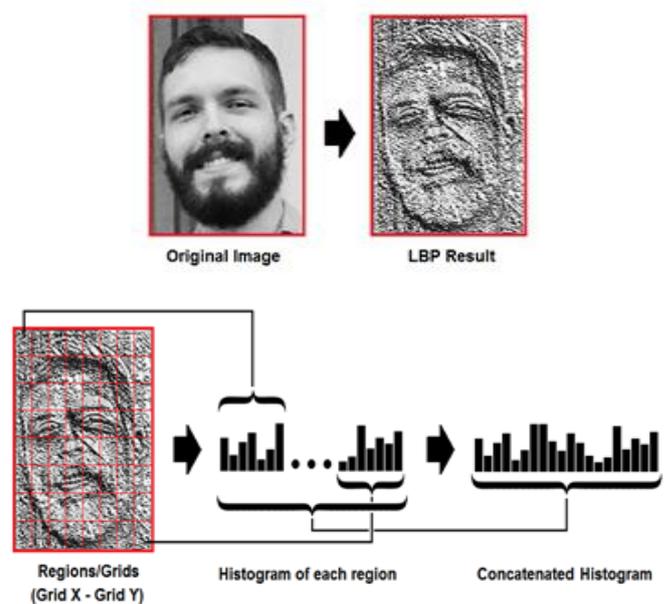


Fig 3.4: Extracting histogram from image.

Based on the image above, we are able to extract the histogram of every region :

- As we have a picture in grayscale, every histogram (from each grid) must contain solely 256 positions (0~255) representing the appearances of each pixel intensity.
- Then, we should concatenate every histogram to make a new and larger histogram. Assuming that we have 8x8 grids, we will have 8x8x256=16.384 positions in the final histogram, which will be representing the characteristics of the initial image.

V. Performing the face recognition: In this step, the algorithm is already trained. Each histogram thus made, is employed to represent each image from the training data. So, given the input image, we tend to perform the steps once more for the newly captured image and create histogram that will be representing the current image. So to seek out the image that matches the input image we got to compare two histograms and return the image with the appropriate histogram.

Comparison of various Face Recognizers Algorithms like Eigen faces, Fisher faces and LBPH :

- **Independency:** Eigenfaces and Fisherfaces notice a mathematical description of the foremost dominant features of the training set as a whole. LBPH analyzes every face within the training set singly and independently.
- **Simplicity:** The method that we tend to analyze the images is by characterizing the local patterns in every location within the image.

- **Light Affected:** Eigenfaces and Fisherfaces are both plagued by light. You will be able to see that the LBP images are not plagued by changes in different light conditions.

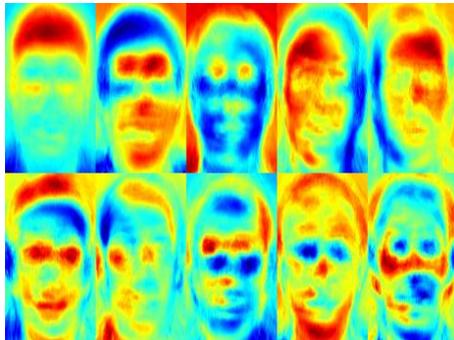


Fig 3.5: Eigen Faces Recognizer

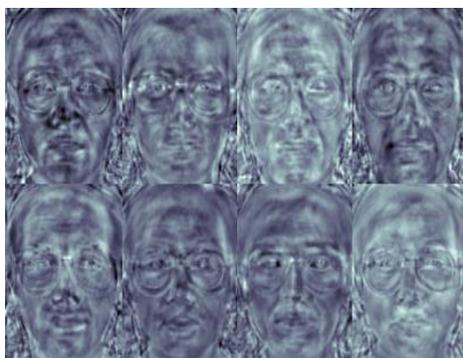


Fig 3.6: Fisher Faces Recognizer

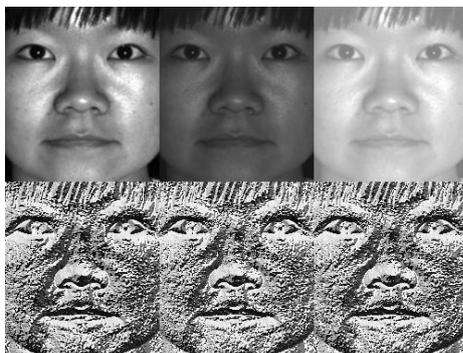


Fig 3.7: LBPH Faces Recognizer

3.3 Implementation

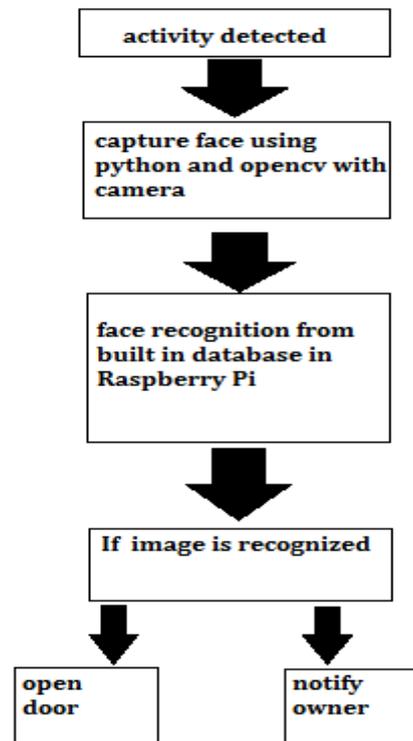


Fig 3.8: Flowchart of Smart Door System

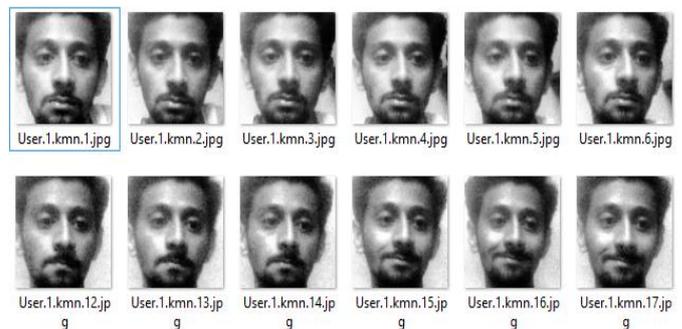


Fig 3.9: Created database

Table for comparison:

CRITERIA	EIGEN FACE	FISHER FACE	LBPH
Confidence factor	2000-3000	100-400	2-5
Threshold	4000	400	7
Principle of dataset generation	Component-Based	Component-Based	Pixel Based
Basic Principle	PCA	LDA	Histogram
Background Noise	Maximum	Medium	Minimum
Efficiency	Low	Better than Eigen Face	Highest



Fig 3.10: Successfully Recognized face image

3.4 Hardware used

The System has following Main components:

A. Raspberry Pi:

It is the central core part of whole system. It is used to get command from either android tablet or PC and according to the command, control the appliances connected to it on the output port. It is connected to android tablet or phone via a router by using Wi-Fi or Ethernet cable. It is also used as a webserver to store to status of appliances in the database and provide it to the php web application to display on the webpage.

B. Pi Camera:

It is connected to Raspberry pi for observing the door. When there is somebody at the door, by using intelligent face recognition software, one will facilitate in providing security to home. Its resolution is 5-megapixel and still picture resolution 2592 x 1944, Max image transfer rate 1080p: 30fps.

C. DC Motor:

The DC Motor is connected to the entryway for opening and shutting the entryway, motor turns in clockwise bearing to open the entryway waits for sometime to let person enter inside and then motor turns in anticlockwise direction to close the door.

4. CONCLUSION

The plan of the Face acknowledgment framework utilizing Raspberry pi will build the lighter and with lower control utilization, thus it is more helpful than the PC-based face acknowledgment framework. In light of the open source code, it is more liberated to do programming advancement on Linux. We utilize Local Binary Patterns Histogram algorithm for the face recognition purpose. The door will open for authorized person. The created plan is shoddy, quick, and profoundly dependable and gives enough adaptability to suit the prerequisites of various frameworks.

The system is programmed by using python programming language. The potency of the system was analyzed in terms of face detection rate. The analysis revealed that the present system shows excellent performance efficiency and can be used for face recognition even from poor quality image.

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