Khulna University of Engineering & Technology

Course No: ECE 3200

Project: Face Recognition Using Raspberry Pi

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Objectives of the project:

To design and implement face authenticated real time security system.

- To design and implement face authentication of captured image using camera by OpenCV/ Python platform on Raspberry Pi.
- The captured image is compared and verified with the database, if found matching then the access to locking device is allowed.

Abstract:

Face recognition systems are built on the idea that each person has a particular face structure, and using the facial symmetry, computerized face-matching is possible. The work on face recognition has begun in the 1960's, the results of which are being used for security in various institutions and firms throughout the world. The images must be processed correctly for computer based face recognition. The face and its structural properties should be identified carefully, and the resulting image must be converted to two dimensional digital data. An efficient algorithm and a database which consists of face images are needed to solve the face recognition problem. In this paper, Eigenfaces method is used for face recognition. In the recognition process, an eigenface is formed for the given face image, and the Euclidian distances between this eigenface and the previously stored eigenfaces are calculated. The eigenface with the smallest Euclidian distance is the one the person resembles the most. Simulation results are shown. Simulations have been done using the Matlab program. The success rate for the large database used is found to be 94.74%.

Introduction:

Biometrics refers to metrics related to human characteristics. Biometrics authentication (or realistic authentication) is used in computer science as a form of identification and access control. It is also used to identify individuals in groups that are under surveillance. Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals. Biometric identifiers are often categorized as physiological versus behavioural characteristics. Physiological characteristics are related to the shape of the body. Examples include, but are not limited to fingerprint, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, retina and odour/scent. Behavioural characteristics are related to the pattern of behaviour of a person, including but not limited to typing rhythm, gait, and voice. More traditional means of access control include token-based identification systems, such as a driver's license or passport, and knowledge-based identification systems, such as a password or personal identification number. Since biometric identifiers are unique to individuals, they are more reliable in verifying identity than token and knowledge-based methods.

Among these systems, facial recognition appears to be one of the most universal, collectable, and accessible systems. Biometric face recognition, otherwise known as Automatic Face Recognition (AFR), is a particularly attractive biometric approach, since it focuses on the same identifier that humans use primarily to distinguish one person from another. One of its main goals is the understanding of the complex human visual system and the knowledge of how humans represent faces in order to discriminate different identities with high accuracy. Hence, we have considered face recognition for the implementation of highly secure home locking system.

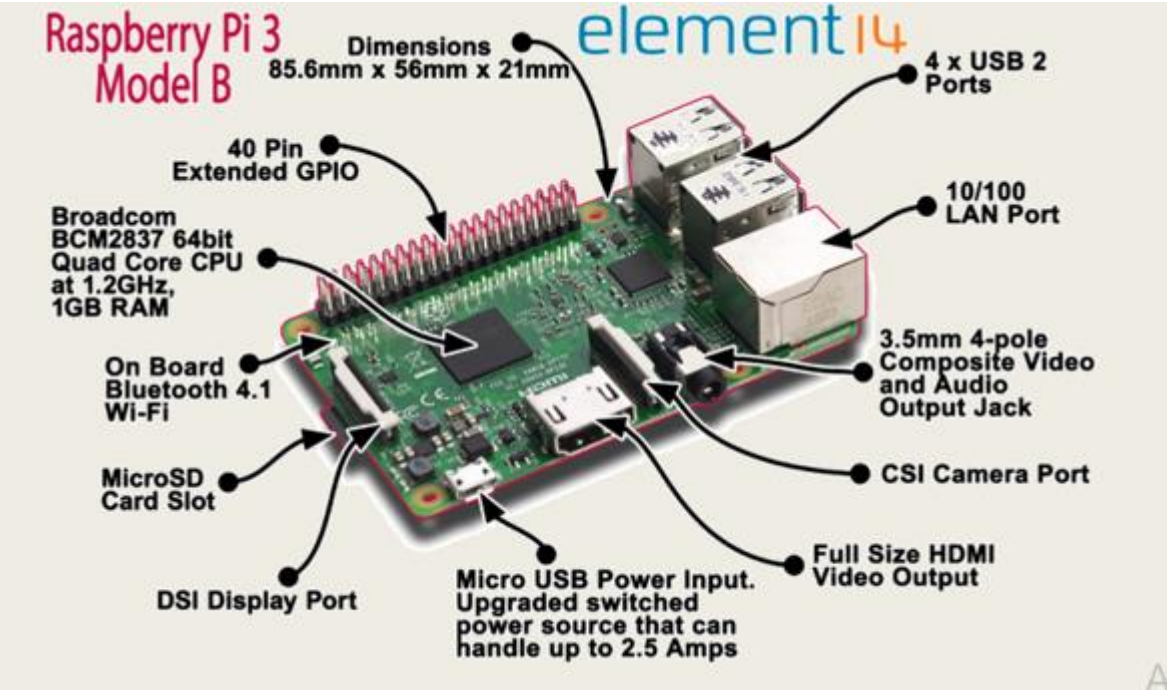


Fig 1: Raspberry Pi Model 3B

Methodology:

The basis of the eigenfaces method is the Principal Component Analysis (PCA). Eigenfaces and PCA have been used by Sirovich and Kirby to represent the face images efficiently [11]. They have started with a group of original face images, and calculated the best vector system for image compression. Then Turk and Pentland applied the Eigenfaces to face recognition problem [12].

The Principal Component Analysis is a method of projection to a subspace and is widely used in pattern recognition. An objective of PCA is the replacement of correlated vectors of large dimensions with the uncorrelated vectors of smaller dimensions. Another objective is to calculate a

basis for the data set. Main advantages of the PCA are its low sensitivity to noise, the reduction of the requirements of the memory and the capacity, and the increase in the efficiency due to the operation in a space of smaller dimensions.

The strategy of the Eigenfaces method consists of extracting the characteristic features on the face and representing the face in question as a linear combination of the so called 'eigenfaces' obtained from the feature extraction process.

The principal components of the faces in the training set are calculated. Recognition is achieved using the projection of the face into the space formed by the eigenfaces. A comparison on the basis of the Euclidian distance of the eigenvectors of the eigenfaces and the eigenface of the image under question is made. If this distance is small enough, the person is identified. On the other hand, if the distance is too large, the image is regarded as one that belongs to an individual for which the system has to be trained.

The flowchart of the algorithm is shown in Fig. 2

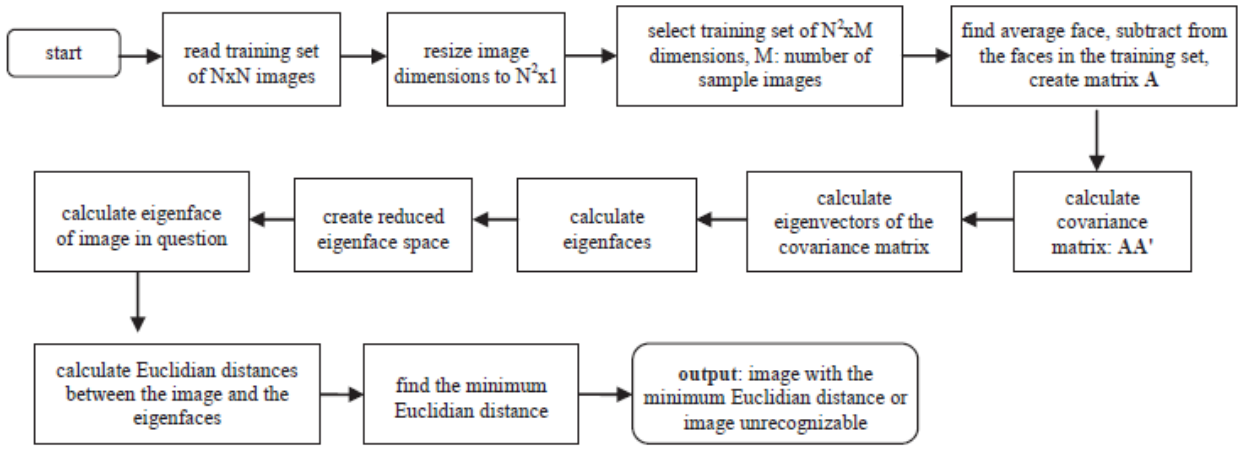
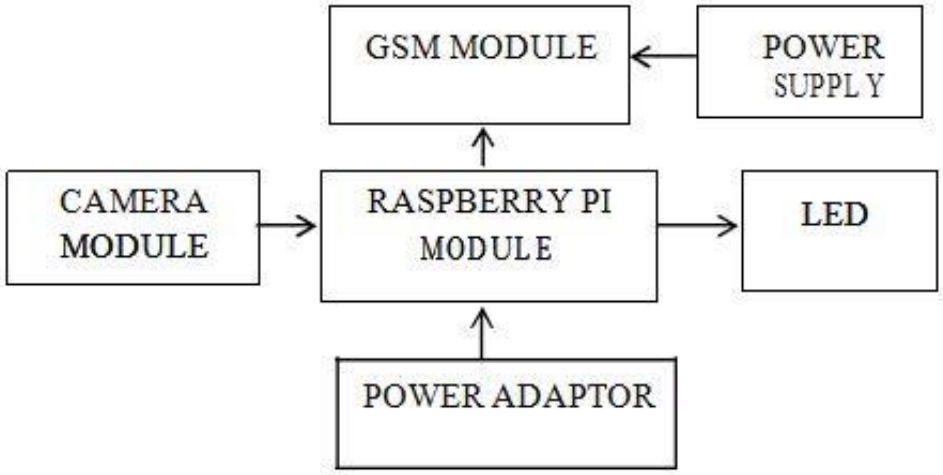


Fig 2: Flowchart of the algorithom of the Eigenfaces Method

Block diagram:



The above figure shows the basic block diagram of the Raspberry pi based face recognition system for door unlocking. The project system can be operated in two different sections, i.e. one for capturing and creating a data base and the other section is to capture the image and which is used for identifying or comparing the images in the database. Here in the second section we use Eigen faces methodology of face recognition for finding the matches.

Camera module: Camera module is Pi camera interfacing to the raspberry pi module.

It isused for capturing an image and send captured image to the Raspberry pi module.

Raspberry pi module: Raspberry pi module is small computer board. When image taken bythe raspberry pi it is compared with Eigen face image. At the first time when we capture the image to create a data base, raspberry pi module captures six types of the images to create a data base in the system and this data base is compared with the live captured image. After comparing two images output is positive/negative then it gives commands to GSM module.

Dataset Creation:

```
from picamera import PiCamera
from time import sleep

cam=PiCamera()

for  i in range(50) :
    cam.resolution =(512,512)
    print(i)
    print('taken\n')
    cam.start_preview()
    sleep(2)
    cam.capture('data/'+str(i)+'.jpg')
```

By using this code we took pictures and created our dataset.

Training with SVM Model:

Face recognition is a K class problem. where K is the number of known individuals; and support vector machines (SVMs) are a binary classification method. By reformulating the face recognition problem and reinterpreting the output of the SVM classifier. we developed a SVM -based

face recognition algorithm. The face recognition problem is formulated as a problem in difference space. which models dissimilarities between two facial images. In difference space we formulate face recognition as a two class problem. The classes are: dissimilarities between faces of the same person. and dissimilarities between faces of different people. By modifying the interpretation of the decision surface generated by SVM.

we generated a similarity metric between faces that is learned from ex-

amples of differences between faces. The SVM-based algorithm is compared with a principal component analysis (PeA) based algorithm on a

difficult set of images from the FEREf database. Performance was measured for both verification and identification scenarios. The identification

performance for SVM is 77-78% versus 54% for PCA. For verification. the equal error rate is 7% for SVM and 13 % for PCA.

Face Recognition:

```
import picamera
from time import sleep
from PIL import Image
import numpy as np
from PIL import Image
import pickle
from sklearn.decomposition import PCA
from sklearn import svm
#confidence check with same class for continuous 3 frames
v1=0
v2=0
v3=0
model_path='/home/pi/Downloads/svm_model.sav'
pca_path='/home/pi/Downloads/pca_uns.sav'
model1=pickle.load(open(model_path,'rb'))
pca=pickle.load(open(pca_path,'rb'))
print('------------------------------------------------------------\n')
xx=input('The program will run for X frames,Enter X(Example 100): ')
xx=int(xx)
camera=picamera.PiCamera()
for fr in range(xx):
        camera.resolution=(512,512)
        camera.start_preview()
        sleep(2)
        camera.capture('cur_frame.jpg')
        sleep(2)
```

```
        camera.capture('cur_frame.jpg')
        x=cur_frame.jpg
        temp_img=''/home/pi/data/Imran/02/6.jpg'
        im=Image.open(x).convert('L')
        im=im.resize((224,224),Image.ANTIALIAS)
        a=np.array(im,dtype='float32')
    a=np.reshape(a,(1,224*224))
    a=a/255
    n_com=224
    a_pca=pca.transform(a)
    pr=model1.predict(a_pca)
    pr=pr[0]
    v1=v2
     v2=v3
     v3=pr
     if(v1==1 or v2==1 or v2==1):
        print('Imran (Class 1) seen on camera')
        print('\n')
    elif(v1==2 or v2==2 or v2==2):
         print('Sadman(Class 2) seen on camera ')
         print('\n')
    else:
          print('Background or Unknown face!')
          print('\n')
```

Results and conclusion:

The experimental results shows two different cases like if it is an authenticated person then we can see the authenticated person was seen on camera automatically and in the case of unauthenticated person we can see background or Unknown face. The snap shot of the authenticated person is taken. The captured image is compared with the image in the database, by extracting the eigen face and eigen values. With these features the image is decided to be an authenticated one.

Among the other bio-metric techniques, face recognition approach possess one great advantage which is user friendliness. The technique of Eigen faces has been applied into the system which makes the system more secure. As future efforts, improving the reliability and robustness in both the recognition and detection process can be concentrated more.The Face recognition algorithm is applied on a wide variety of images taken under different lighting conditions and with different backgrounds. The images also have pose variation, emotions etc. The training set contained different set of people belonging to different races. The various stages in the algorithm are explained using the training set of RGB images. Now convert RGB image into gray image for preprocessing steps. First of all train the gray size image. Now normalized the training set using many pre-processing steps. The mean image of normalized training sets is determined. Eigen faces of normalized training set is calculated. The reconstructed image from input image is used for recognizing, it is in database or not.

Scope and future work:

- The proposed system will further extended to provide the notices from long distance by providing the internet connectivity which will allow the system to update notices, anywhere in the world.

- Using raspberry pi the current project can be modified by an Infrared camera interfacing it can be used in Smart Surveillance Monitoring security system which any type of public security is using Living body detection or spying, Also it can be used in Attendance system of the class, Also some profound applications can be implemented using interfacing of Raspberry pi and Arduino UNO board like sensor application of smartcard swapping, finger detection, alcohol detection, agriculture humidity sensing, Temperature sensing using web server, and many more.

- Internet of households where we can attach other devices of house with internet.
- Industrial automation and control through internet.

- Automated fire exit systems can be build.
- Improvement in the security issues in highly restricted areas.