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Raspberry Pi Aided Daily Attendance Management System using Face Recognition

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Abstract:- To identify a person in real environment, face is the essential recognizable proof of any human in daily lives. Image processing based attendance system is the simplest way for keeping attendance in many organizations. Traditional way of enrolling one by one on paper takes some time to record attendance and also it is insecure. For each lecture this is inefficient. To avoid these losses, automatic process is intended to use which is processing with image. In this novel approach, biometric identification system of face is used to identify daily attendance and Raspberry Pi is applied as manipulating processor. In the proposed system, Eigen-face algorithm is used because Eigen-face algorithm is less wastage of time and more effective than other algorithms. This system is implemented by using Python with OpenCV library. With the help of this system, time will be saved and it is great convenient to record the attendance at any time throughout the day.

Keywords:- *Haar Cascade, K-Nearest Neighbour (K-NN), Opencv, Principle Component Analysis (PCA), Python and Raspberry Pi.*

I. INTRODUCTION

Today, save system is vital in everywhere of society. Biometric systems are used to identify or verify features of human beings. Face, voice, hand geometry, iris, retina and fingerprint are almost commonly used for authentication.

The attendance systems are used by many organizations to record the start and stop timing of the work done by employees or to record the presence of student in the class. It will take time while recording the attendance of the students and employees in the registers.

However, registering attendance on paper is easy to abuse and can easily mark bogus attendances for each other. Of course, technology had to play its role in this field just as well as it has done in other fields. The attendance management system was explored and it intended to change the way of marking attendances.

The attendance management system is a great help for both parents and teachers when it comes to schools and universities. Then, attendance information can easily be sent directly to respective parents, family teacher and head of department into personal email accounts.

A. Aim and Objectives

The aim of this system are to detect and recognize the student’s face, to display and store the attendance, to produce a sound file whether enrolment process is success or not, and to build the reliable authentication and identification applications for security purposes in the real world. The objectives of the system are as follows:

- To develop a computational model of face recognition that is fast, reasonably simple, and accurate in constrained environments such as university, college or office
- To save the time and be convenient to record the attendance
- To be a great help for both parents and teachers because of soft copy of record system
- To print the information easily or to send a soft copy directly to parents or head of department or family teacher
- To be an effective way not to abuse and not to mark bogus attendances

B. Overview of the System

As in figure 1, the first case is to acquire and detect the face of real time environment followed by the face recognition. The first method is achieved by using Camera to acquire the images of the students who are standing before the camera. Face detection is done using Haar cascade classifier. Then the acquired face is extracted using PCA and compared with the stored data of every student. In this way faces of students are verified one by one with the face database, find out the result and attendance is marked. The database includes name of the students, roll number and their images. The result is displayed on the monitor screen accompanying with a sound file and the attendance will be directly stored in storage device.

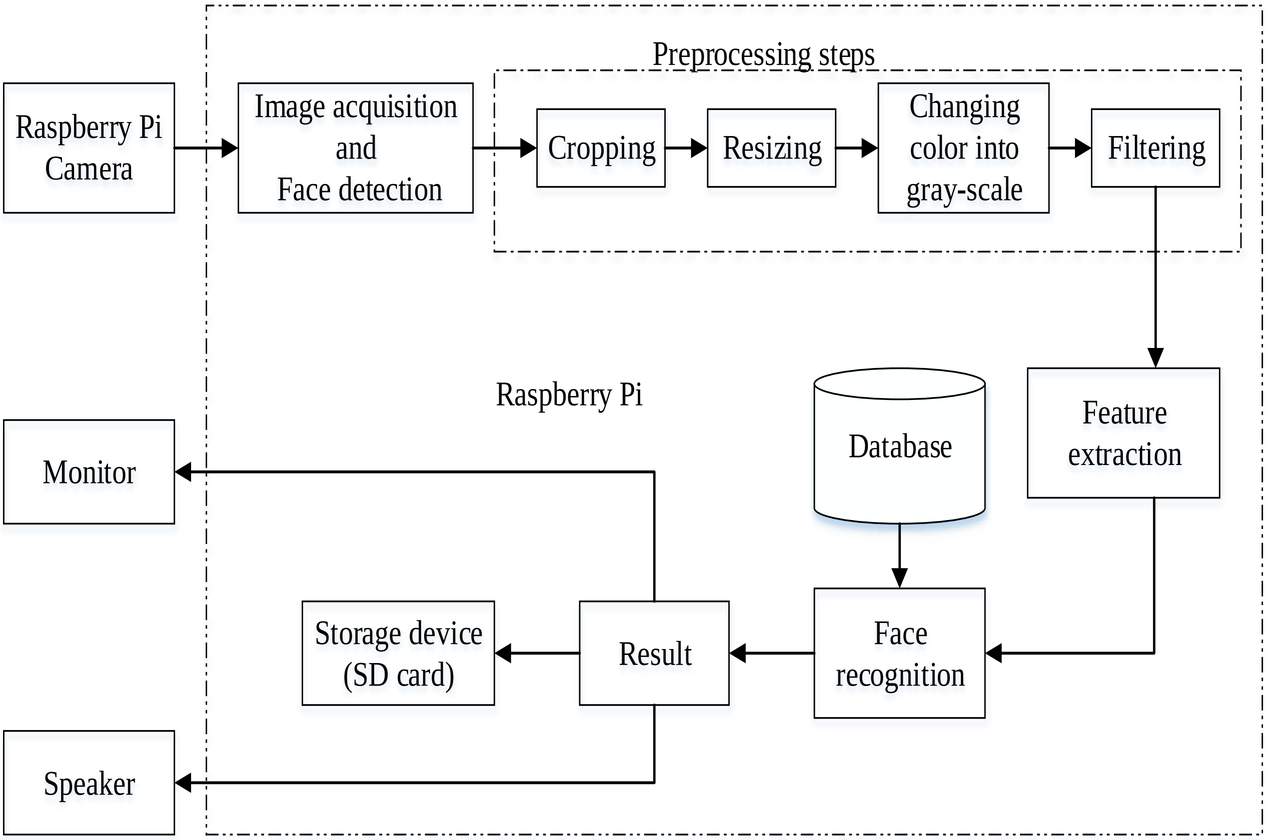


Fig 1:- The Overall Block Diagram of the System

II. RELATED WORKS

There are many person identification methods and there are many existing systems to identify or record for the various purposes. Some attendance systems are based on Radio Frequency Identification (RFID) methods whereas some are based on biometric modalities such as iris, retina, fingerprint and so on.

RFID technology simplifies digital active and passive identifications with appropriate readers. An RFID based fare cluster system has the potential of seriously violating human's security or privacy. RFID strategies allow each person to analyze with primary data base. This type of environment will be under attack of hackers if the RFID receiver and reader are not properly matched and so less reading rate can occurs [2].

Fingerprint attendance system is leading in biometric fields today, but recognition of each fingerprint is a time wastage process. The fingerprint system shows no data about the original fingerprint of respective person [2].

G.Lakshmi Priya, M.Pandimadevi and G.Ramu Priya proposed Implementation of Smart-FR Attendance System using Viola–Jones algorithm with the help of Local Binary Pattern (LBP) [7]. In this paper, Raspberry Pi was used as the processor. This paper tried to make surface classification with LBP and then Wiener filter and Viola–Jones algorithm were used as evaluation of the strong classifiers. The accuracy of this system was mentioned about 68%.

Lalitha.E presented Linux Based Attendance Management System. For face detection Haar cascade classifier was used and for face recognition Speeded Up Robust Features (SURF) algorithm was used. Attendance system was kept on the server therefore anyone will access it [8].

Shrutika V. Deshmukh focused on Face Detection and Face Recognition System applying with Haar-like features for face detection. Histogram of oriented gradients (HOG) together with support vector machine (SVM) algorithm was used for face recognition. The system was programmed using Python programming language and the author described that it can be used for face detection even from poor quality images [9].

Ch.S.R.Gowri discussed Automated Intelligence System for Attendance Monitoring based on Internet of Things (IOT). In this paper, Viola–Jones algorithm with the help of Local Binary Pattern (LBP) was used [10]. This system tried to display in the webpage through IOT. It was mainly based on IOT and hence it would be excellent if the internet connection was not failed.

In ensuing days for any systems security, privacy and accuracy are mainly calculating parameters. It is vital to design a system with highly secured and accurate.

III. SYSTEM HARDWARE AND SOFTWARE REQUIREMENTS

A. System Hardware Requirements

- *Power Supply*

Raspberry Pi needs external power supply rated at 5Vdc and a current of 2A.

- *Raspberry Pi Camera*

It is used to capture the image and connected to CSI camera port on Raspberry Pi board.

- *Monitor*

It is used to display GUI, also to check the attendance information, and connected to HDMI port on Raspberry Pi board.

- *Raspberry Pi 3 Model B*

It is the main core of the system and used as a manipulating processor. The job of Raspberry Pi in this system is to detect the student's face and to process large quantities of data and also it will keep attendance of the students with roll number, name, date and time in the storage device. It has many advantages such as low power consumption**,** built-in HDMI capable graphics, expansion capabilities, huge community supports, no noise, etc. Raspberry Pi 3 Model B is shown in figure 2.

Fig 2:- Raspberry Pi 3 Model B

- *Speaker*

It is used to produce sound file whether the enrolling process is success or not and is connected to audio out jack on the Pi board. If the incoming person is unknown person, a sound wave file will be produced as like “Failed! Please try again”. If the incoming person is a known one, a sound will be produced as like “You are successfully enrolled!”

B. Connection of System Hardware Devices

All the hardware devices are connected as shown in Figure 3.

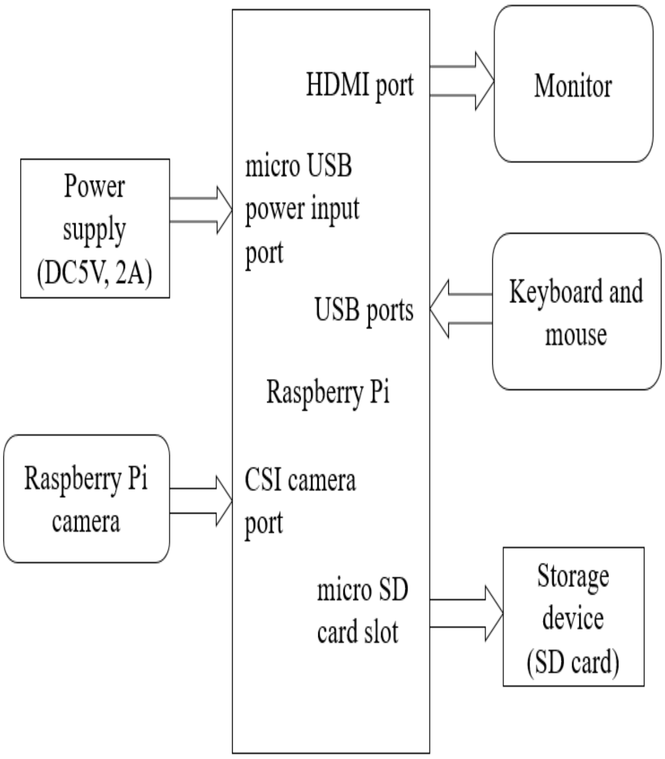


Fig 3:- Hardware Devices Connection

C. System Software Requirements

- *Python*

Python is a high level, interpreted, interactive and scripting language. It is easy to learn, easily understand and can be implemented very easily in web or database or GUI applications. It is not confused and readable syntax. It has strong introspection capabilities and it is exception- based error handling. It can support imperative and functional styles of programming. It is used to create Web applications and dynamic Web content. It can run on Mac, Windows, and Linux systems and has also been ported to Java and NET virtual machine [3].

- *OpenCV*

OpenCV stands for open source computer vision to transform data from a still camera or video camera into a new representation. It is a library of programming functions for real time computer vision. It has great powerful image processing functions and is used to demonstrate the algorithms. The main goal of OpenCV is to support a simple-to-use infrastructure of computer vision that helps people to apply fairly sophisticated vision quickly.

In OpenCV there are four mainly used modules: main functions of OpenCV, algorithms of image processing, vision algorithms and high-GUI: GUI functions, Image and Video I/O [2]. There is so far no video processing library in Python. OpenCV can thus provide the necessary platform to achieve image processing. Using this OpenCV, we will load images captured by camera and it is very easy to install and can be used in real time application in a quick manner.

IV. METHODOLOGY

For the proposed system, two-steps of mechanisms are used. First comes to be face detection then followed by face recognition. In the case of face detection, Haar cascade classifier is used and then image acquisition and pre-processing steps have to be passed while for face recognition Eigen-face algorithm is used from PCA and then classified by k-Nearest Neighbour (k-NN).

A. *Face Detection*

Face poses many problems than other biometric objects as human face is a dynamic object that can come in many forms and colors. However, face detection and tracking will provide a lot of benefits. Facial recognition is not possible if the face is not isolated from the background. Haar cascade classifier is used and the following steps have to be done for the case of face detection:

- *Image Acquisition*

It refers to the process of capturing real-world images and restoring them into the device. Scanner, digital camera or other digital input devices are image acquisition devices. In the proposed system, Raspberry Pi camera is used to acquire the image and it is connected to CSI camera port on Raspberry Pi board.

- *Haar Cascade Classifier*

Haar-like features are the core of Haar cascade classifier for object detection and these features, rather than using the intensity values of a pixel, use the values of contrast change between adjacent pixels. The variances of contrast between groups of pixel are used to seek determination of relative dark and light areas. Adjacent groups about two or three with a relative contrast variance form a Haar-like feature. Haar-like features as shown in Figure 4 are used to detect face region of an image [8]. Haar features can be scaled to examine by increasing or decreasing the size of the pixel group. This allows features to be used to detect various sizes objects.

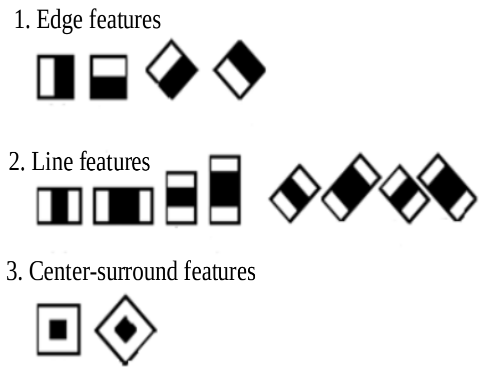


Fig 4:- Common Haar Features

It is trained from many positive images (with faces) and negatives images (without faces). Each window is placed on the image to get single feature calculation. For example in figure 5, the first feature focuses on that regional area of the eyes is often darker than its surroundings. The middle of nose is darker than its sides. The mouth is darker than the bridge of the cheek. When used on the cheeks, the windows become irrelevant and all sectors here are the same. With edge and line features, face is easily detected to identify where the face is.

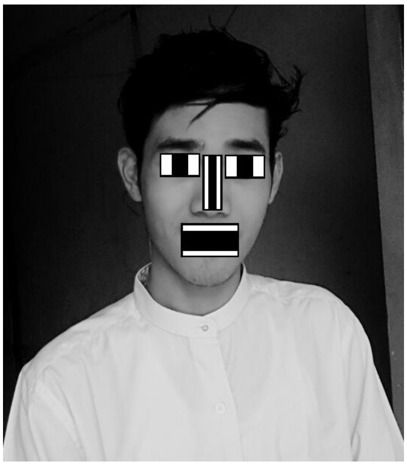


Fig 5:- Example of Different Stages in Visualization with Haar Features

- *Pre-processing Steps:*

- *Cropping*:

The original image is required to crop or remove the unnecessary region and background. The incoming image is cropped to obtain the required area.

- *Resizing*:

The face image is needed to resize a uniform size after cropping the faces images in order to train easily.

- *Changing Color to Gray Scale*:

It is needed to change the colour image into gray scale image because different colours may difficult to train a system for recognition.

- *Noise Filtering*:

Noise may exist in the input image when it is captured from the camera. There are many techniques to remove noise. In the proposed system, median filtering is used for the removal of noise in the original image.

B. Feature Extraction and Face Recognition

➢ *Principal Component Analysis (PCA)*

After having pre-processing steps, it is needed to extract feature vectors by means of Principal Component Analysis (PCA). PCA is one of the most useful and successful method that have been applied in image compression in recognition. The aim of PCA is to extract the features and also to reduce the dimension of the data set while retaining the majority of the variation presented in it. When all face images are converted into vector forms, they will group at a certain location in the image space since they have similar structure of having eye, nose and mouth in a common and also their relative position are correlated. This correlation is the useful factor to begin the Eigen-face analysis.

The Eigen-face algorithm makes to find a lower dimensional space in order to represent the face images by removing the variance of negative images; that is, it will focus on just coming out of the variations between the face images. Hence, Eigen-face algorithm aims to build a better description of the face space. These basis vectors of face space are called the principal component and the Eigen-face algorithm is the implementation of Principal Component Analysis (PCA) over images [4].

Using Eigen-face algorithm, face recognition is done by following steps [2]:

Step 1: Create training set of face images, named like I_1, I_2, I_3, …, I_M where M is the number of the training images. Convert face image to face vector.

Step 2: Compute the average face vector Ψ

$$\Psi = \frac{1}{M}\sum_{i=1}^{M} \Gamma i$$

Let the training set be denoted by Γ.

Step 3: Subtract the average face vector that is the difference between original image and mean image. Mean subtracted image is,

$\varphi_i = \Gamma_i - \Psi$

Step 4: Compute Eigen vectors of the covariance matrix C,

$$C = \frac{1}{M}\sum_{n=1}^{M} \Phi n \Phi n^T = AA^T$$

where difference matrix $A = [\Phi_1\ \Phi_2\ ...\ \Phi_M]$

Step 5: Reduce the dimensionality of the data set by calculating Eigen vector v_i of covariance matrix L,

$L = A^TA$

Step 6: Produce Eigen faces by selecting X best Eigen faces such that X<M to represent the whole training set after arranging descending order.

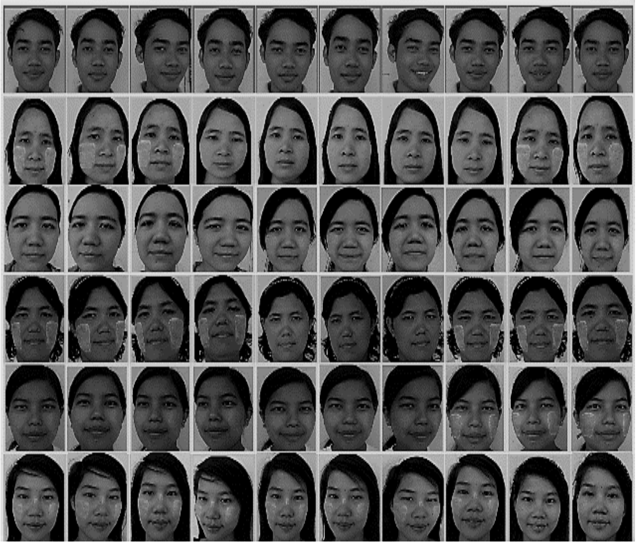


Fig 6:- Samples of Images to Store in Database

For creating the database, the face images must have different expressions, different poses and also different position degree as in figure 6 in order to get the excellent result and also to achieve the best recognition rate. In the proposed system, sixty different images of six students i.e. ten different images for a student are taken and then extract the face, convert it into gray scale and save it to the database folder with its name and roll number. Samples of Eigen-faces are shown in figure 7.

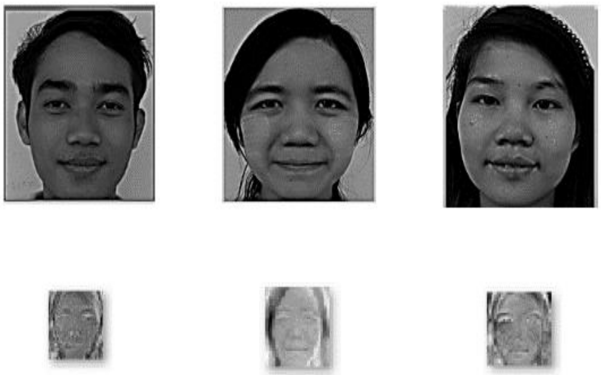


Fig 7:- Samples of Eigen-Faces

This algorithm considers the fact that not all parts of a face are equally important or useful for face recognition**.** Face recognition picks up on human things of two eyes, a nose and a mouth dominating with shapes and shadows. It finds out all the training images of all people and tries to extract the relevant components and then discards the rest. But it also keeps a record of which ones belong to which person.

However, one factor to note is that Eigen-face algorithm also assumes illumination as a crucial feature. So light and shadows are picked by Eigen-face up, which identifies to represent a face. So, it is needed to place the camera where the light, shadows and backgrounds should be in moderate conditions.

- *k-Nearest Neighbor (k-NN) Classifier*

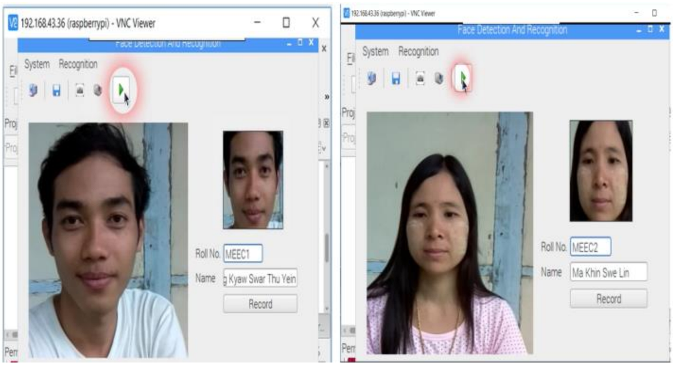
K-NN is one of the algorithms for data classification that saves all of the available cases and classifies new cases upon a similarity measure [5]. It is an algorithm that tries to determine a data point is in what group by finding out the data points around it. It is easy to compare the results of other classification methods to k-NN results. By looking, for instance, at one point on a grid, it is trying to determine the states of the points if a point is in group A or B that are near it. The range is arbitrarily considered, but the point is to get the data sample. If the majority of the points are in group A, then it is likely assuming that the incoming data point will be A rather than B, and vice versa. Therefore, it compare the face captured by camera with all the Eigen faces when face recognizing operation is performing and give out the nearest identified image.

Recognition is accomplished by assigning the minimum Euclidean distances between feature vectors of face images. For recognition, the test image is classified depending on appropriate threshold values. Threshold value 0.0012 is used in this system to test the conditional similarity score. Recognition occurs when the similarity score of square minimum Euclidean distance is in the range of predefined threshold values. Then, the attendance information of the student will be displayed on the monitor screen. Finally it will be stored as the daily record in the storage device of the Raspberry Pi with the name, roll number, date and time and then producing an audio output whether successful or not.

V. SYSTEM RESULTS

This section describes the implementation results of the proposed system. After face detection and recognition are done by following the above steps, the attendance of the student will be marked with the roll number, name, date and time as an attendance report using the output of face recognition steps after the correct matching. With this proposed system, the recognition rate of the system is excellent. The following are the test and results of the proposed attendance management system for master degree of Electronic Engineering Department of Technological University (Mandalay), 2018.

The system may consider the incoming person is a known one with accompanying a sound as like "You are successfully enrolled!" if the similarity score is greater than threshold value.

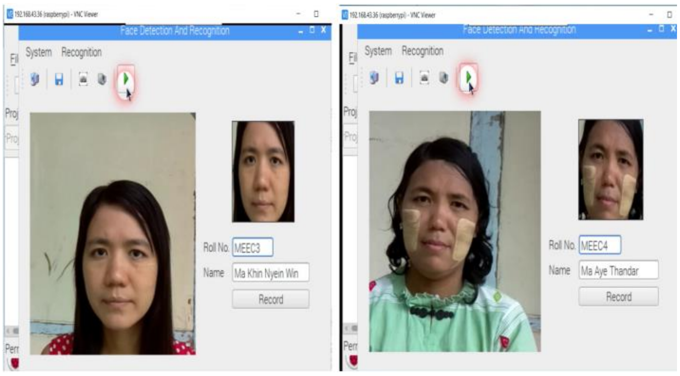

192.168.43.36 (raspberrypi) - VNC Viewer
Face Detection And Recognition
System
Recognition
Record

Roll No. MEEC1
Name g Kyaw Swar Thu Yein

Roll No. MEEC2
Name Ma Khin Swe Lin

Fig 8:- Test and Result for MEEC1 and MEEC2

Figure 8 shows test and result of the proposed system for students MEEC1 and MEEC2. The capturing image is identified with the face samples from the database and then shot out the result with the respective name and roll number. The output results are exactly generated for many times so it can be said that the recognition rate of the system is excellent.

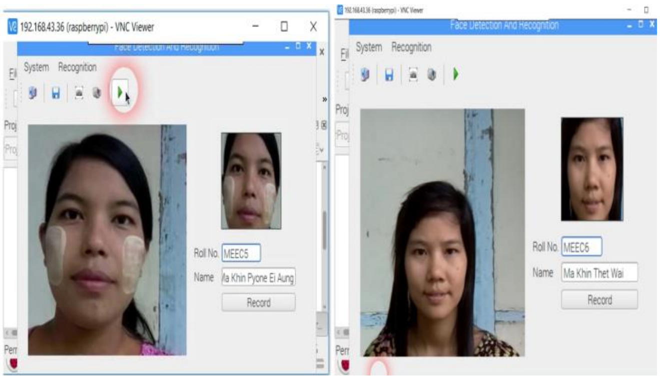

192.168.43.36 (raspberrypi) - VNC Viewer
Face Detection And Recognition
System
Recognition
Record

Roll No. MEEC3
Name Ma Khin Nyein Win

Roll No. MEEC4
Name Ma Aye Thandar

Fig 9:- Test and Result for MEEC3 and MEEC4

Figure 9 shows test and result of the proposed system for students MEEC3 and MEEC4. The output results are exactly generated for many times so it can be said that the recognition rate of the system is excellent.


192.168.43.36 (raspberrypi) - VNC Viewer
Face Detection And Recognition
System
Recognition
Record

Roll No. MEEC5
Name la Khin Pyone Ei Aung

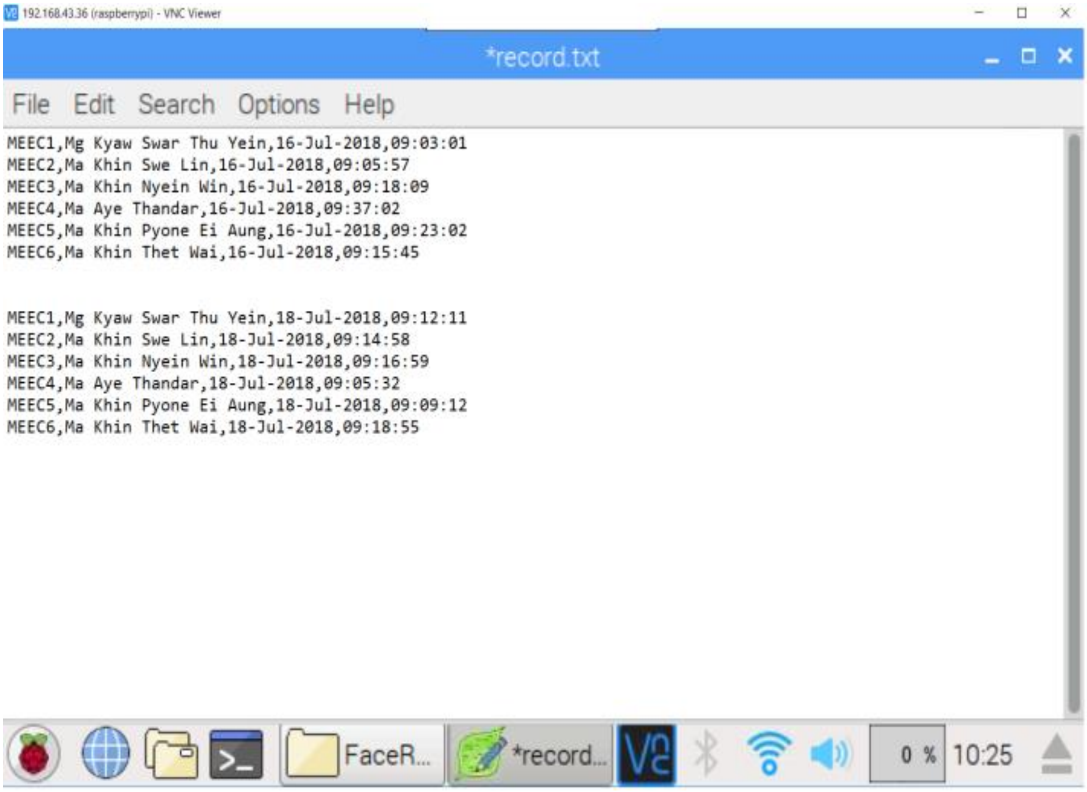
Roll No. MEEC6
Name Ma Khin Thet Wai

Fig 10:- Test and Result for MEEC5 and MEEC6

Figure 10 shows test and result of the proposed system for students MEEC5 and MEEC6. The output results are exactly generated so it can be said that the recognition rate of the system is excellent. The overall efficiency of the system was greatly dependent on the face detection rate.

So, the analysis revealed that the proposed system proves the excellent recognition rate.

After clicking the record icon on the display screen, attendance of the student will be directly stored as the daily record in the storage device of the Raspberry Pi with their name, roll number, date and time and is shown in Figure 11. It can be seen that everyone can know the exact enrolling time of the student whether late or not about the lecture time of each day.


192.168.43.36 (raspberrypi) - VNC Viewer
*record.txt
File Edit Search Options Help
FaceR...
*record...
0 %
10:25

```
MEEC1,Mg Kyaw Swar Thu Yein,16-Jul-2018,09:03:01
MEEC2,Ma Khin Swe Lin,16-Jul-2018,09:05:57
MEEC3,Ma Khin Nyein Win,16-Jul-2018,09:18:09
MEEC4,Ma Aye Thandar,16-Jul-2018,09:37:02
MEEC5,Ma Khin Pyone Ei Aung,16-Jul-2018,09:23:02
MEEC6,Ma Khin Thet Wai,16-Jul-2018,09:15:45


MEEC1,Mg Kyaw Swar Thu Yein,18-Jul-2018,09:12:11
MEEC2,Ma Khin Swe Lin,18-Jul-2018,09:14:58
MEEC3,Ma Khin Nyein Win,18-Jul-2018,09:16:59
MEEC4,Ma Aye Thandar,18-Jul-2018,09:05:32
MEEC5,Ma Khin Pyone Ei Aung,18-Jul-2018,09:09:12
MEEC6,Ma Khin Thet Wai,18-Jul-2018,09:18:55
```

Fig 11:- Attendance Results for all Students Storing in Storage Device

If the similarity score is less than predefined threshold value, the system may consider the incoming person is unknown person. The system will not show any text result but a sound will produce as like "Failed! Please try again." A result example for an unknown person is shown in Figure 12. In this figure, no information is displayed but a sound file will be generated for failure case.

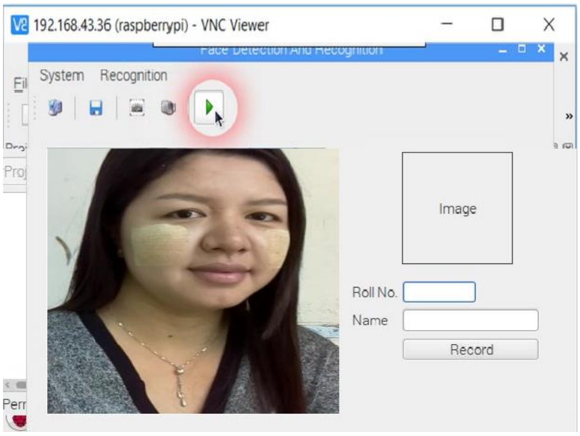

192.168.43.36 (raspberrypi) - VNC Viewer
Face Detection And Recognition
System
Recognition
Image
Roll No.
Name
Record

Fig 12:- Test and Result for Unknown Person

In this system, there are sixty images in the data base for all students with different positions and expressions. To know the system condition, the recognition rate of the system can be calculated as follows:

$$\text{Recognition rate} = \frac{\text{no.of correctly identified images}}{\text{total no.of images}} \text{x100}$$

Under good lighting condition in real-time, the following Table 1 shows the recognition rate of the system.

Roll no.	Tested times	Correct times	Incorrect times	Recognition rate
MEEC1	30	30	-	100%
MEEC2	20	19	1	95%
MEEC3	20	18	2	90%
MEEC4	20	20	-	100%
MEEC5	20	20	-	100%
MEEC6	20	19	1	95%

Table 1:- Recognition Rate of the System under Good Lighting Condition

Therefore, real-time test results of total number of tested images are 130 and total numbers of correctly identified images are 126. The overall recognition rate of the system under good lighting condition is 97%.

If the light is poor, the system cannot know the exact pixel values of the face and so it will shoot out incorrect result. The following Table 2 shows the recognition rate of the system under poor lighting condition in real-time. Real-time test results of total number of tested images are 130 and total numbers of correctly identified images are 110. The overall recognition rate of the system under poor lighting condition is 85%.

Roll no.	Tested times	Correct times	Incorrect times	Recognition rate
MEEC1	30	26	4	86%
MEEC2	20	16	4	80%
MEEC3	20	16	4	80%
MEEC4	20	19	1	95%
MEEC5	20	17	3	85%
MEEC6	20	16	4	80%

Table 2:- Recognition Rate of the System under Poor Lighting Condition Styles

The following Table 3 shows recognition rate of the system under normal lighting condition for testing nine people. Total numbers of tested images are 190 and total numbers of correctly identified images are 177. The overall recognition rate of the system under normal lighting condition is 93%. So there is a little change in recognition rate of the system as long as increasing in the number of people.

It can be known that the Eigen-face algorithm is greatly dependent on the lighting condition and on the other hand this algorithm can give the best result under fulfilled lighting condition.

Roll no.	Tested times	Correct times	Incorrect times	Recognition rate
MEEC1	30	29	1	97%
MEEC2	20	18	2	90%
MEEC3	20	18	2	90%
MEEC4	20	19	1	95%
MEEC5	20	19	1	95%
MEEC6	20	18	2	90%
P1	20	19	1	95%
P2	20	19	1	95%
P3	20	18	2	90%

Table 3:- Recognition Rate of the System under Normal Lighting Condition

To improve system recognition rate

- ➢ use high resolution camera
- ➢ capture in good lighting condition
- ➢ create the database with different expressions, different poses and also different position degree
- ➢ store photos in database that is taken in the place where the process will actually be done
- ➢ should not be complex background and students' head may be rotated no more than 15 degree
- ➢ standing distance may not far three feet away from camera
- ➢ should be the same capturing camera and standing distance for both acquiring of photos in real-time testing and storing in database
- ➢ System may not be accurate result if
- ➢ variations in lighting
- ➢ variations in facial expressions
- ➢ angle between face and camera
- ➢ wearing glasses
- ➢ putting too much Myanmar traditional Thanakha on face
- ➢ changing facial hair and hairstyles

VI. CONCLUSIONS

In this paper, the attendance of the students is tracked by using the language Python and OpenCV. PCA is matched with k-Nearest Neighbor classifier to give the best and desired result. Face Recognition is great fascinating on Python accompanying with OpenCV has made it greatly straightforward and easy for users to code it. It just takes a few lines of code to have a fully working face recognition application. This system is convenient to users, easy to use and gives better security. It saves time duration and effort, especially for a lecture with large number of students. This proposed system reduces the possibilities of proxy attendance of the students, who were not present in the class and gives out the actual attendance report. However, the performance of the proposed system depends on the position of the students before the camera to capture the image. Therefore it is needed to stay on the right position to acquire the image.

By further extensions, this proposed system can be improved by using other algorithms, methods, programming language, different manipulating processor, web camera with great resolutions and applying for a large number of students. Moreover, it can be extended that the group photo or multi-faces at the same time can be taken as an input image without taking one by one. Then, it can be improved for poor lighting conditions and longer distance to capture the image. The more the input images trained in database, the more the performance of face recognition for tracking students' attendances. However, face recognition is weak to identify identical twins.

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REFERENCES

[1]. Ajinkya Patil and Mrudang Shukla, “Implementation of Classroom Attendance System Based on Face Recognition in Class”, Symbiosis Institute of Technology, Pune, Maharashtra, India, International Journal of Advances in Engineering & Technology, July, 2014.

[2]. Sarath Chandu Gaddam, N. V. K. Ramesh and Hemadhanekula, “Face Recognition Based Attendance Management System with Raspberry Pi 2 using Eigen Faces Algorithm”, Embedded Systems, Electronics and Computers Engineering, K L University, Andhra Pradesh, India.

[3]. Jan Erik Solem, “Programming Computer Vision with Python”, 2012.

[4]. Anshuman Prakash and Manoj Kumar Tewari, “Study of Different Algorithms for Face Recognition”, Department of Electronics & Communication Engineering, National Institute of Technology Rourkela.

[5]. Dr. Saed Sayad, “K Nearest Neighbors”, University of Toronto, 2010.

[6]. Ramiz Raja, “Face Recognition using Open CV and Python: A Beginner’s Guide”, 2017.

[7]. G.Lakshmi Priya, M.Pandimadevi and G.Ramu Priya, “Implementation of Attendance Management System using SMART-FR”, Department of ECE, Sethu Institute of Technology, Virudhunagar, India.

[8]. Lalitha.E, “Linux Based Face Recognization System using Raspberry Pi in Attendance System”, Department of Electronics and Communication Engineering, Sri Manakular Vinayagar Engineering College.

[9]. Shrutika V. Deshmukh, “Face Detection and Face Recognition Using Raspberry Pi”, Electronics and Telecommunication Department, HVPM’s College of Engineering and Technology Amravati, India.

[10]. Ch.S.R.Gowri, “Automated Intelligence System for Attendance Monitoring With Open CV Based on Internet of Things (IOT)”, Department of ECE, Aditya college of Engineering, Surampalem, Andhra Pradesh.