Face recognition attendance system

A PROJECT REPORT

Submitted by

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LDRP INSTITUTE OF TECHNOLOGY AND RESEARCH GANDHINAGHAR

CERTIFICATE

This is to certify that the Project Work entitled **"Face recognition attendance system "** has been carried out by **Patel Manthan B. (19BEIT30041)** under my guidance in fulfilment of the degree of Bachelor of Engineering in information technology Semester-6 of Kadi Sarva Vishwavidyalaya University during the academic year 2021-22.

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Abstract

Face is the representation of one's identity. Hence, we have proposed an automated student attendance system based on face recognition. Face recognition system is very useful in life applications especially in security control systems. The airport protection system uses face recognition to identify suspects and FBI (Federal Bureau of Investigation) uses face recognition for criminal investigations. In our proposed approach, firstly, video framing is performed by activating the camera through a user-friendly interface. The face ROI is detected and segmented from the video frame by using Viola-Jones algorithm. In the pre-processing stage, scaling of the size of images is performed if necessary in order to prevent loss of information. The median filtering is applied to remove noise followed by conversion of colour images to grayscale images. After that, contrast-limited adaptive histogram equalization (CLAHE) is implemented on images to enhance the contrast of images. In face recognition stage, enhanced local binary pattern (LBP) and principal component analysis (PCA) is applied correspondingly in order to extract the features from facial images. In our proposed approach, the enhanced local binary pattern outperform the original LBP by reducing the illumination effect and increasing the recognition rate. Next, the features extracted from the test images are compared with the features extracted from the training images. The facial images are then classified and recognized based on the best result obtained from the combination of algorithm, enhanced LBP and PCA. Finally, the attendance of the recognized student will be marked and saved in the excel file. The student who is not registered will also be able to register on the spot and notification will be given if students sign in more than once. The average accuracy of recognition is 100 % for good quality images, 94.12 % of low-quality images and 95.76 % for Yale face database when two images per person are trained.

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1. Introduction

INTRODUCTION

The main objective of this project is to develop face recognition based automated student attendance system. In order to achieve better performance, the test images and training images of this proposed approach are limited to frontal and upright facial images that consist of a single face only. The test images and training images have to be captured by using the same device to ensure no quality difference. In addition, the students have to register in the database to be recognized. The enrolment can be done on the spot through the user-friendly interface

1.1 Scope

Face recognition is crucial in daily life in order to identify family, friends or someone we are familiar with. We might not perceive that several steps have actually taken in order to identify human faces. Human intelligence allows us to receive information and interpret the information in the recognition process. We receive information through the image projected into our eyes, by specifically retina in the form of light. Light is a form of electromagnetic waves which are radiated from a source onto an object and projected to human vision. Robinson-Riegler, G., & Robinson-Riegler, B. (2008) mentioned that after visual processing done by the human visual system, we actually classify shape, size, contour and the texture of the object in order to analyse the information. The analysed information will be compared to other representations of objects or face that exist in our memory to recognize. In fact, it is a hard challenge

to build an automated system to have the same capability as a human to recognize faces. However, we need large memory to recognize different faces, for example, in the Universities,

there are a lot of students with different race and gender, it is impossible to remember every face of the individual without making mistakes. In order to overcome human limitations, computers with almost limitless memory, high processing speed and power are used in face recognition systems.

The human face is a unique representation of individual identity. Thus, face recognition is defined as a biometric method in which identification of an individual is performed by comparing realtime capture image with stored images in the database of that person (Margaret Rouse, 2012).

Nowadays, face recognition system is prevalent due to its simplicity and awesome performance. For instance, airport protection systems and FBI use face recognition for criminal investigations by tracking suspects, missing children and drug activities (Robert Silk, 2017). Apart from that, Facebook which is a popular social networking website implement face recognition to allow the users to tag their friends in the photo for entertainment purposes (Sidney Fussell, 2018). Furthermore, Intel Company allows the users to use face recognition to get access to their online account (Reichert, C., 2017). Apple allows the users to unlock their mobile phone, iPhone X by using face recognition (deAgonia, M., 2017).

The work on face recognition began in 1960. Woody Bledsoe, Helen Chan Wolf and Charles Bisson had introduced a system which required the administrator to locate eyes, ears, nose and mouth from images. The distance and ratios between the located features and the common reference points are then calculated and compared. The studies are further enhanced by Goldstein, Harmon, and Lesk in 1970 by using other features such as hair colour and lip thickness to automate the recognition. In 1988, Kirby and Sirovich first suggested principle component analysis (PCA) to solve face recognition problem. Many studies on face recognition were then conducted continuously until today (Ashley DuVal, 2012).

1.2 Problem Definition

Traditional student attendance marking technique is often facing a lot of trouble. The face recognition student attendance system emphasizes its simplicity by eliminating classical student attendance marking technique such as calling student names or checking respective identification cards. There are not only disturbing the teaching process but also causes distraction for students during exam sessions. Apart from calling names, attendance sheet is passed around the classroom during the lecture sessions. The lecture class especially the class with a large number of students might find it difficult to have the attendance sheet being passed around the class. Thus, face recognition student attendance system is proposed in order to replace the manual signing of the presence of students which are burdensome and causes students get distracted in order to sign for their attendance. Furthermore, the face recognition

based automated student attendance system able to overcome the problem of fraudulent approach and lecturers does not have to count the number of students several times to ensure the presence of the students.

The paper proposed by Zhao, W et al. (2003) has listed the difficulties of facial identification. One of the difficulties of facial identification is the identification between known and unknown images. In addition, paper proposed by Pooja G.R et al. (2010) found out that the training process for face recognition student attendance system is slow and time-consuming. In addition, the paper proposed by Priyanka Wagh et al. (2015) mentioned that different lighting and head poses are often the problems that could degrade the performance of face recognition based student attendance system.

Hence, there is a need to develop a real time operating student attendance system which means the identification process must be done within defined time constraints to prevent omission. The extracted features from facial images which represent the identity of the students have to be consistent towards a change in background, illumination, pose and expression. High accuracy and fast computation time will be the evaluation points of the performance.

1.3 Project summary and purpose

The objective of this project is to develop face recognition based automated student attendance system. Expected achievements in order to fulfill the objectives are:

- To detect the face segment from the video frame.
- To extract the useful features from the face detected.
- To classify the features in order to recognize the face detected.
- To record the attendance of the identified student.

Figure 1.1 Block Diagram of the General Framework.

1.4 Overview of the project

Chapter 2 includes a brief review of the approaches and studies that have been done previously by other researchers whereas Chapter 3 describe proposed methods and approaches used to obtain the desired output. The results of the proposed approach would be presented and discussed in Chapter 4. The conclusion, as well as some recommendations would be included in Chapter 5.

2. Technology and Literature Review

2.1 Project background

In the face detection and recognition system, the process flow is initiated by being able to detect the facial features from a camera or a picture store in a memory. The algorithm processes the image captured and identifies the number of faces in the image by analyzing from the learned pattern and compare them to filter out the rest. This image processing uses multiple algorithm that takes facial features and compare them with known database.

The motivation behind this project is to simplify the means by which attendance is taken during lectures and how much time it takes. The use of ID cards or manually calling out attendance and writing it down on sheets is not productive and efficient. This system will detect the number of faces on the class and will also identify them from the store database. With the face detection and recognition system in place, it will be easy to tell if a student is actually present in the classroom or not.

3. System Requirements Study

3.1 Previous Work

The system will be presented an image either via camera or from memory and it must detect the number of faces on it automatically. After identifying faces, the system should crop the faces from the image and store them in memory for image recognition which will be done in the second step. The system should be able to automatically count the number of faces detected on the image.

The second step will be the recognition part where the system will be able to match faces from the stored dataset and compare it to the input data from the first step. A software will be used for this system which automatically sorts out the faces. The software will be interactive so to facilitate interaction between multiple tasks as required. Because the system has two steps, the second phase of the system will involve the training of images on a dataset that are to be used for recognition.

The system behavior has been explained in the following flowchart .

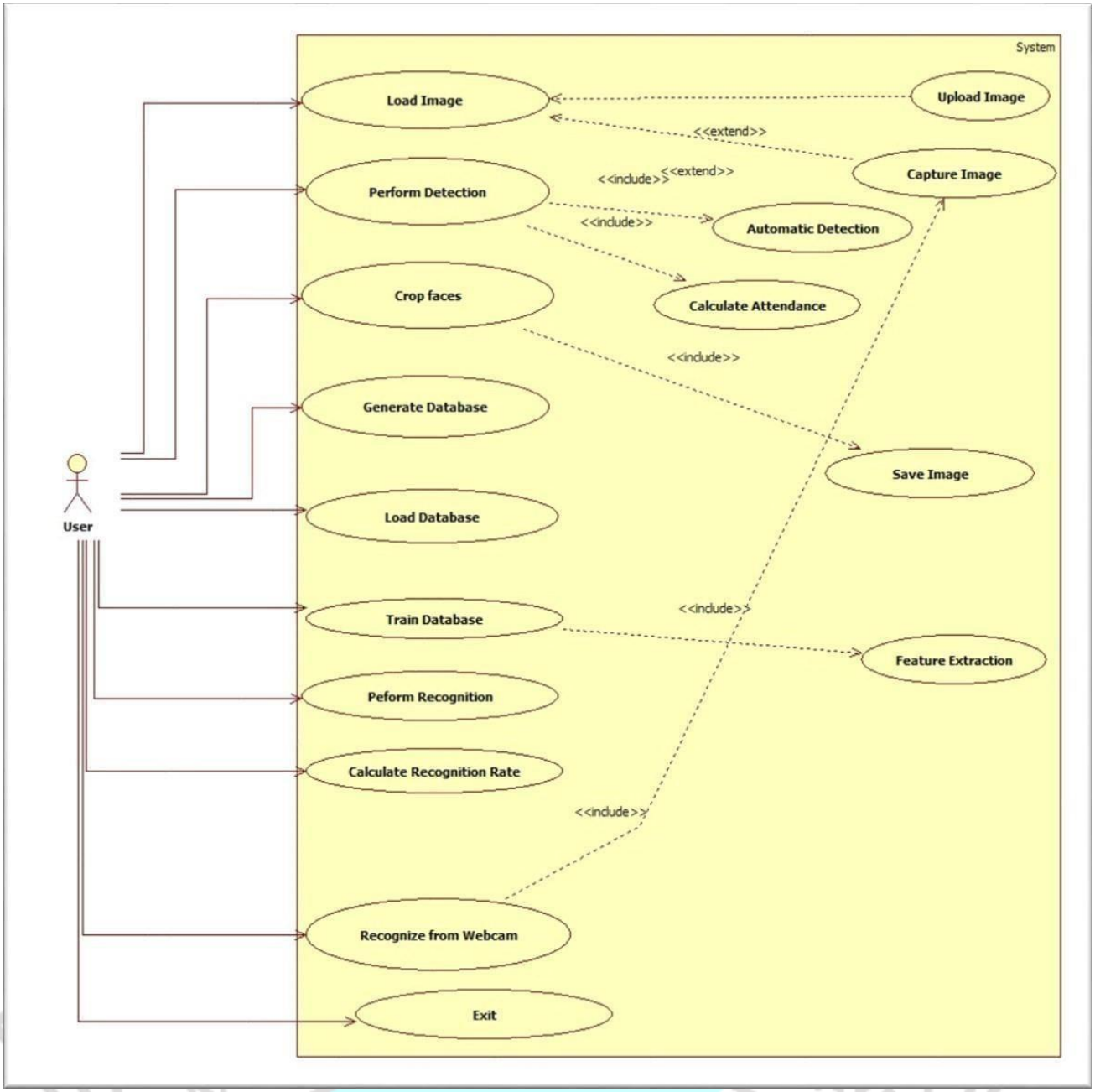

FIGURE 2.1: BLOCK DIAGRAM

Technology Used :

The key algorithms are haarcascade_frontalface_default for face detection and Hidden Markov Model with SVD.

- The implementation of The haarcascade_frontalface_default algorithm is available on softwares like MATLAB, OpenCV and Web Browsers (using adobe flash).
- The existing implementation of the Hidden Markov Model with SVD for face recognition are available on MATLAB, and OpenCV libraries.

The system will comprise of two modules. The first module a.k.a face detector is a mobile component, which is basically a camera that captures student faces and stores them in a file using computer vision face detection algorithms and face extraction techniques. The second module is a desktop application that does face recognition of the captured images (faces) in the file, marks the students register and then stores the results in a database for future analysis.

Following flowchart explains the process of the flow of information throughout the process.

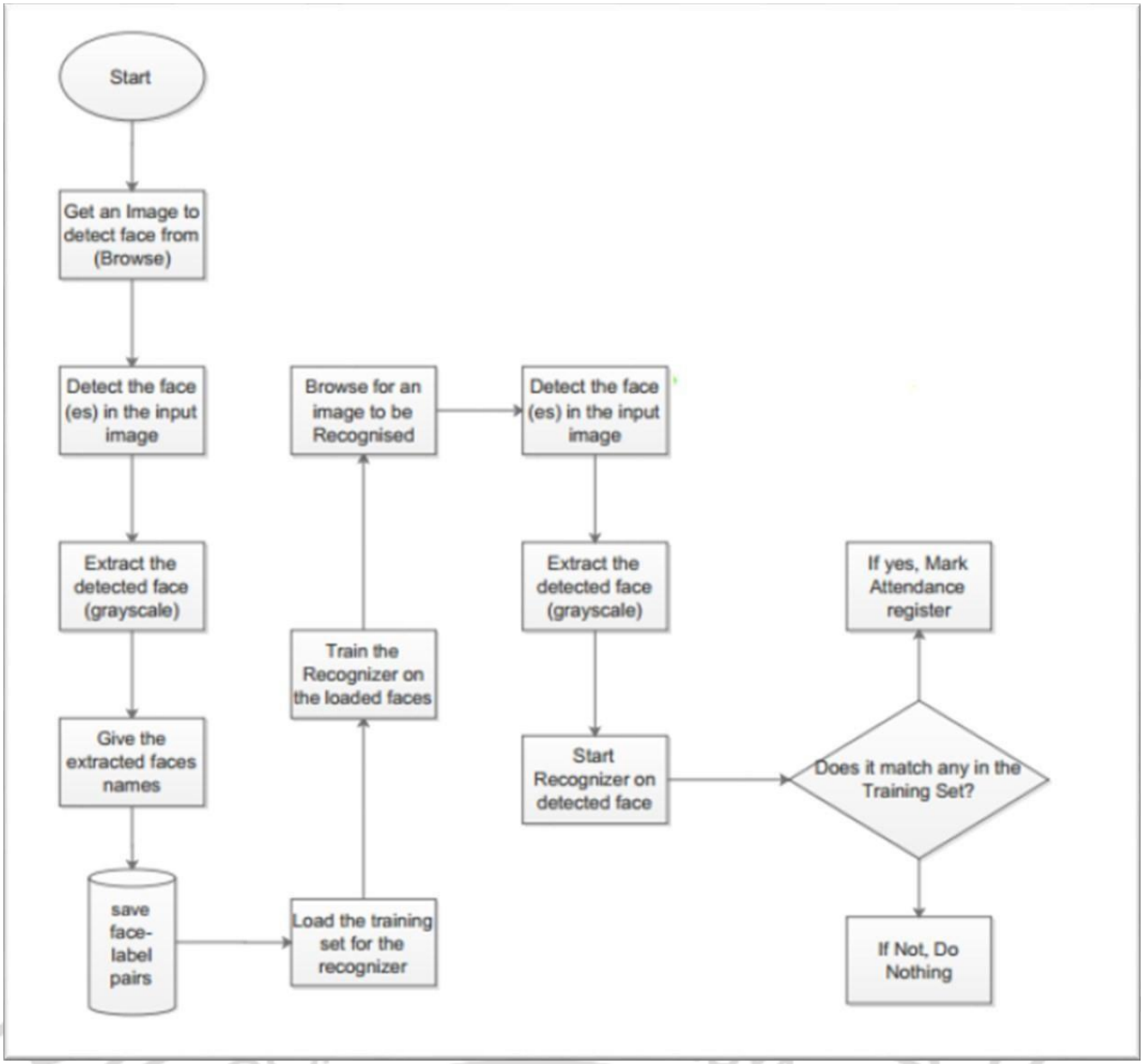

FIGURE 2.2: BLOCK DIAGRAM

Technology Used

The following tools will be used in the implementation of the designed system. They've been divided in to two categories; Mobile and Desktop tools

- **Mobile Tools**

The face detection module will use OpenCV library for implementation by use of the frontal Haar Cascade face detector in either Android studio

OpenCV for Android Library - (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision.

Android Studio/ Eclipse IDE - Android Studio is the official IDE for Android application development, based on IntelliJ IDEA.

- **Desktop Tools**

EmguCV Library - EmguCV is a cross platform .Net wrapper to the OpenCV image processing library. OpenCV/EmguCV uses a type of face detector called a Haar Cascade. The Haar Cascade is a classifier (detector) trained on thousands of human faces.

Visual Studio - Visual Studio is able to build and run the solution examples after a proper configuration of EmguCV. The desktop software will implement the two sub-systems (Training set manager and Face recognizer) together with face detector in windows form.

The approach performs face recognition-based student attendance system. This method is also similar to others and begins with the input of an image either loaded from memory or from camera. Then it pre-processes the facial features and extracts it followed by subjective selecting

and then the recognition of the facial images from known database. Both LBP and PCA feature extraction methods are studied in detail and computed in this approach in order

to make comparisons. LBP is enhanced in this approach to reduce the illumination effect. An algorithm to combine enhanced LBP and PCA is also designed for subjective selection in order to increase the accuracy.

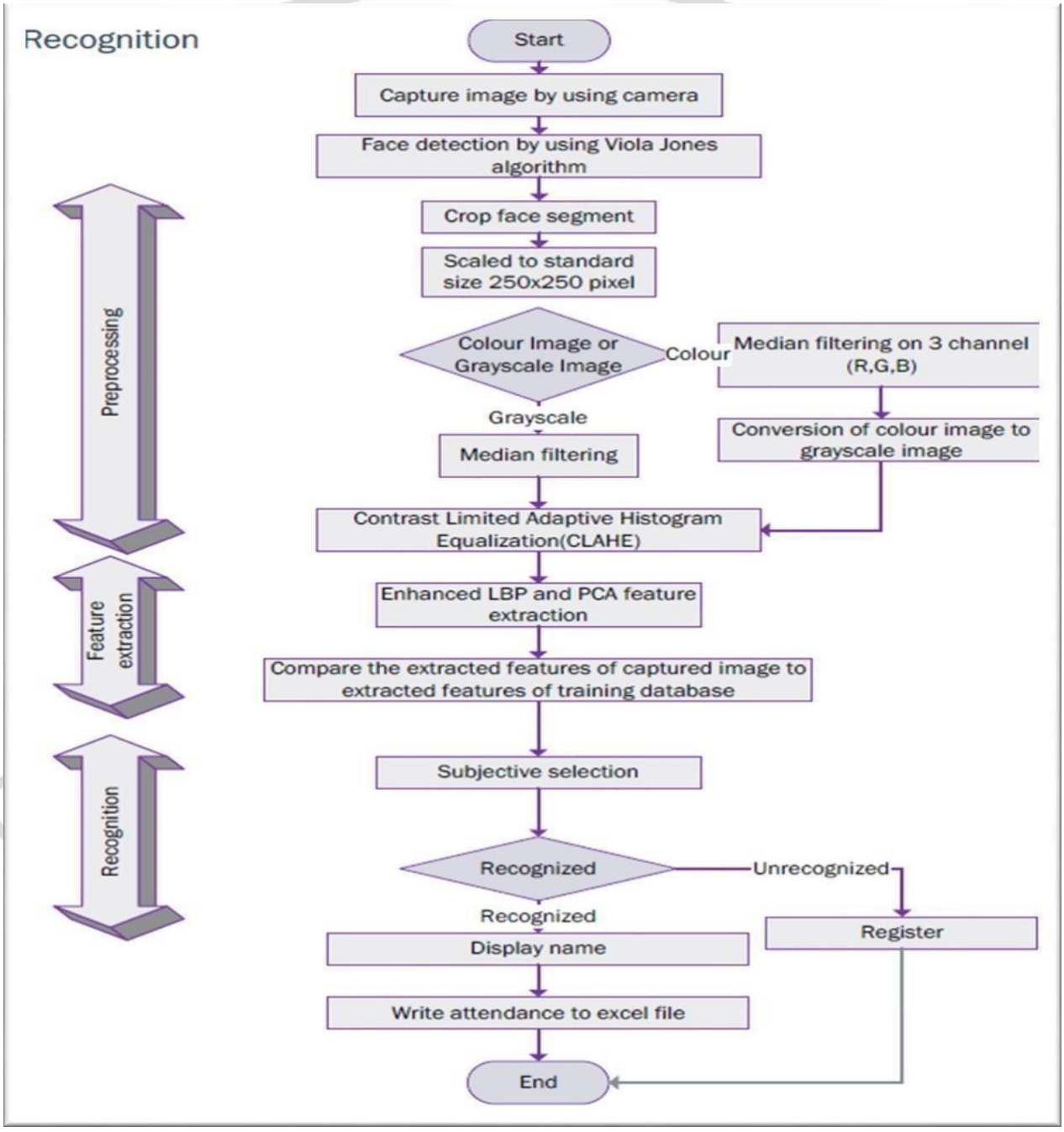

FIGURE 2.3: BLOCK DIAGRAM The project is completely built in MATLAB with OpenCV libraries implemented in it.

4. System Analysis

4.1 Input Images

Although our own database should be used to design real time face recognition student attendance system, the databases that are provided by the previous researchers are also used to design the system more effectively, efficiently and for evaluation purposes.

Yale face database is used as both training set and testing set to evaluate the performance. Yale face database contains one hundred and sixty-five grayscale images of fifteen individuals. There are eleven images per individual; each image of the individual is in different condition. The conditions included centre-light, with glasses, happy, left-light, without glasses, normal, right-light, sad, sleepy, surprised and wink. These different variations provided by the database is able to ensure the system to be operated consistently in variety of situations and conditions.

Figure 4.1 Sample Images in Face Database

For our own database, the images of students are captured by using laptop built in camera and mobile phone camera. Each student provided four images, two for training set and two for testing set. The images captured by using laptop built in camera are categorized as low quality images, whereas mobile phone camera captured images are categorized as high quality images. The high quality images consists of seventeen students while low quality images consists of twenty-six students. The recognition rate of low quality images and high quality images

will be compared in Chapter 4 to draw a conclusion in term of performance between image sets of different quality.

Figure 3.4 Sample of High Quality Images

Figure 3.5 Sample of Low Quality Images

4.1.1 Limitations of the Images

The input image for the proposed approach has to be frontal, upright and only a single face. Although the system is designed to be able to recognize the student with glasses and without glasses, student should provide both facial images with and without glasses to be trained to increase the accuracy to be recognized without glasses. The training image and testing image should be captured by using the same device to avoid quality difference. The students have to register in order to be recognized. The enrolment can be done on the spot through the user-friendly interface.

These conditions have to be satisfied to ensure that the proposed approach can perform well.

4.2.1 Pre-Processing

Testing set and training set images are captured using a camera. There are unwanted noise and uneven lighting exists in the images. Therefore, several pre-processing steps are necessary before proceeding to feature extraction.

Pre-processing steps that would be carried out include scaling of image, median filtering, conversion of colour images to grayscale images and adaptive histogram equalization. The details of these steps would be discussed in the later sections.

4.2.1.2 Scaling of Image

Scaling of images is one of the frequent tasks in image processing. The size of the images has to be carefully manipulated to prevent loss of spatial information. (Gonzalez, R. C., & Woods, 2008), In order to perform face recognition, the size of the image has to be equalized. This has become crucial, especially in the feature extraction process, the test images and training images have to be in the same size and dimension to ensure the precise outcome. Thus, in this proposed approach test images and train images are standardize at size 250 × 250 pixels.

4.3 Feature Extraction

Different facial images mean there are changes in textural or geometric information. In order to perform face recognition, these features have to be extracted from the facial images and classified appropriately. In this project, enhanced LBP and PCA are used for face recognition.

The idea comes from nature of human visual perception which performs face recognition depending on the local statistic and global statistic features. Enhanced LBP extracts the local grayscale features by performing feature extraction on a small region throughout the entire image. On the other hand, PCA extracts the global grayscale features which means feature extraction is performed on the whole image.

4.3.1 Working Principle of Original LBP

LBP is basically a texture based descriptor which it encoded local primitive into binary string. (Timo Ojala et al., 2002). The original LBP operator works on a 3×3 mask size. 3×3 mask size contains 9 pixels. The center pixel will be used as a threshold to convert the neighboring pixels (the other 8 pixels) into binary digit. If the neighboring pixel value is larger than the center pixel value, then it is assigned to 1, otherwise it is assigned to 0. After that, the neighborhoods pixel bits are concatenated to a binary code to form a byte value representing the center pixel. Figure 3.6 shows an example of LBP conversion.

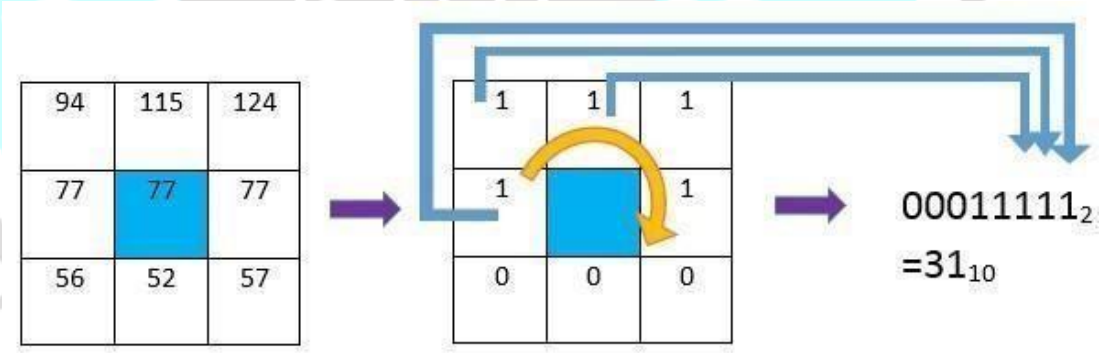

Figure 3.10 Example of LBP Conversion

(3.1)

$$LBP = \sum_{0}^{7} f(Pn - Pc).2^n$$

where Pc indicates centre pixel and Pn (n = 0,…, 7) are 8 of its neighbouring pixels respectively.

The starting point of the encoding process can be any of neighbouring pixels as long as the formation of binary string is following the order either in clockwise or anticlockwise rotation. The thresholding function f(y) can be written as follows

(3.2)

$$f(y) = \begin{cases} 0 & y < 0; \\ 1 & y \geq 0; \end{cases}$$

4.3.2 Working Principle of Proposed LBP

The original LBP operator is composed of 3 × 3 filter size with 9 pixels. Instead of the circular pattern, it looks more rectangular in shape. The 9 pixels adjacent to each other means every detail will be taken as sampling points even the non-essential details. It is more affected by uneven lighting condition because the small filter size emphasizes small scale detail (Lee and Li, 2007), even the shadow created by non-uniform lighting condition. In our proposed approach, a larger radius size, R is implemented in LBP operator. In the paper of Md. Abdur Rahim et.al (2013), the equation of modifying the radius size has been introduced. However, the paper did not mention the effect of changing the radius size. In the proposed approach, analysis is done on different radius sizes in order to enhance the system and reduce the illumination effect. By increasing the radius size, the filter size will be increased. R indicates radius from the centre pixel,θ indicates the angle of the sampling point with respect to the center pixel and P indicates number of sampling points on the edge of the circle taken to compare with the centre pixel. Given the neighbouring's notation (P, R,θ) is implemented, the coordinates of the centre pixel (Xc, Yc) and the coordinates of the P neighbours (Xp, Yp) on the edge of the circle with radius R can be computed with the sines and cosines shown in the equation (Md. Abdur Rahim et.al,2013):

$$Xp = Xc + Rcos(\theta/P)$$

$$Yp = Yc + Rsin(\theta/P)$$

(3.3)

Although the radius has been increased, total 8 sampling points are taken which is similar to the original LBP operator. In the approach, CLAHE is performed on the grayscale input facial images to improve the contrast. The contrast improved images remain as grayscale images. The proposed LBP operator extracts the grayscale features from the contrast improved grayscale images which requires only 8 bit computation. After that, the pixels at the sampling points will be encoded as 8 bit binary string in the same way as original LBP operator encoding process. Enhanced LBP with radius size two, perform better compared to original LBP and has more consistent recognition rate compared to other radius size. Hence, enhanced LBP with radius size two will be used as proposed approach. The proposed LBP operator will be further explained in Chapter 4 (result and discussion).

5.System Design

5.1 Design Constraints

The constraints which were considered while designing on project are following.

5.1.1 Design Constraint: Engineering Standards

The samples for database should be increase, as to increase the efficiency of detection. Also, the more the expensive the camera, the easier its algorithm is likely detecting the person.

5.1.2 Design Constraint: Environmental

The camera should capture all the students present in the class. Each student present should be seated such that it is visible to camera, so that his/her attendance gets marked easily.

5.1.3 Design Constraint: Ethical

The second limitation which is faced include the person appearance by face, which a person changes his/her look and looks different from the picture in the database of the attendance system, then it may be difficult for his/her attendance to be marked.

5.2 Design Methodology

As we mentioned before in (Figure 1.1). The project process is:

- A camera will take continuous stream.
- In LABVIEW, IMAQ library for vision will be used.
- Convert the RGB image to grayscale image.

- Then perform Machine Vision Algorithm and match with patterns stored in our database.
- If pattern matches based on the score of how successful, decide to mark attendance or not.
- Update the marked attendance in a measurement file.

5.3 Product Subsystems and Components

5.3.1 Product Subsystem1: Vision Acquisition

This subsystem is used to acquire continuous stream of video from attached camera. It starts a camera session from desired camera and transmits its image feed to further processing. The feed captured is inline processed and then the next feed is captured as shown in (Figure 3.1).

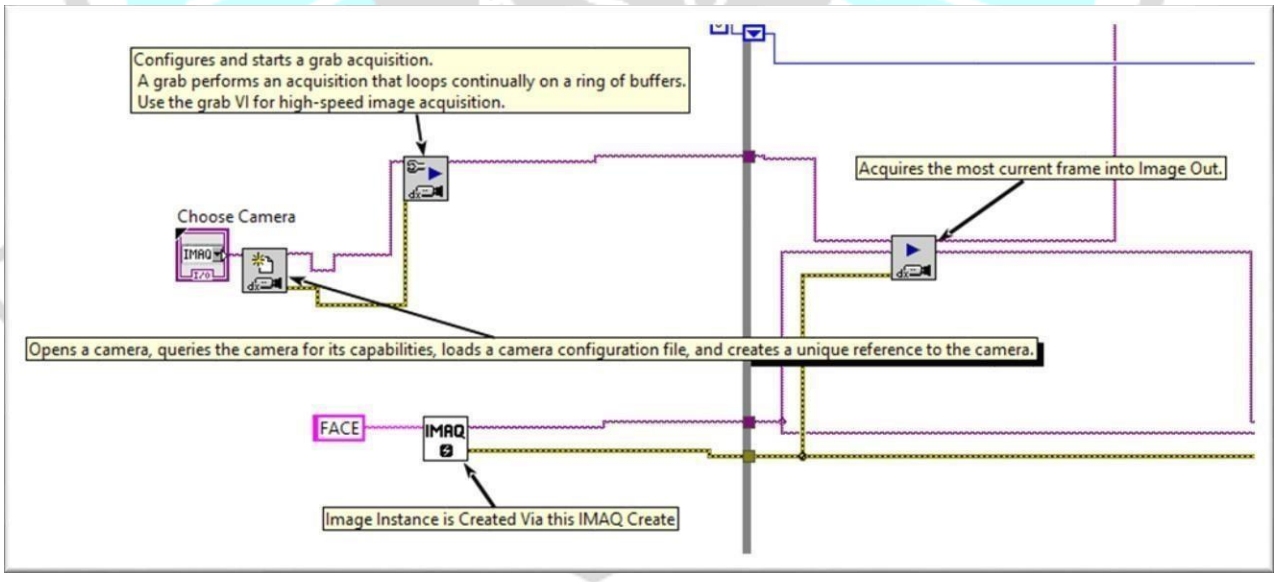

FIGURE 3.1: VISION ACQUISITION PROGRAMING ICONS

3.3.2 Product Subsystem2: Grayscale Conversion

This module converts an RGB (32bit) image to Grayscale (Unsigned 8 bit) image. This is requirement of Vision Assistant Processing whose image input must be 8 bits as shown in (Figure3.2).

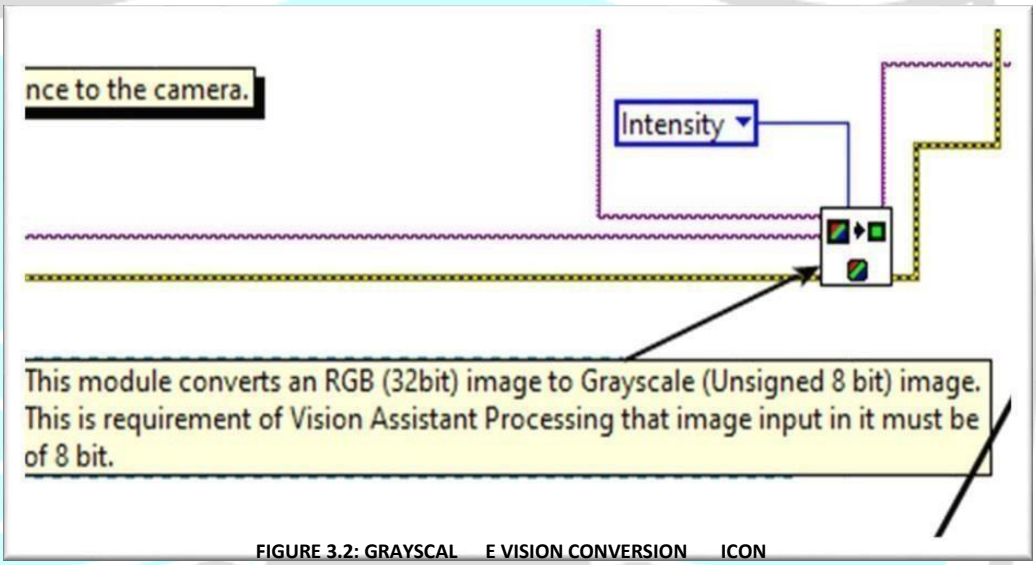

FIGURE 3.2: GRAYSCAL E VISION CONVERSION ICON

3.3.3 Product Subsystem3: Vision Assistant

In (Figure 3.3) Vision Assistant helps us to perform Machine Vision Algorithm Pattern Matching on our image. This allows us to detect faces of student in a group of class. First one must add student fatemplate in this program to create a database of images using reference images. The result is outputed which includes the information of score 0-1000 to tell how successful a match was, position of match occurred in image, angle of match occurred in image. This information together with number of matches for each user will be used to mark attendance of user in future progresses.

6.System Testing

6.1 Result

In this proposed approach, face recognition student attendance system with userfriendly interface is designed by using MATLAB GUI(Graphic User Interface). A few buttons are designed in the interface, each provides specific function, for example, start button is to initialize the camera and to perform face recognition automatically according to the face detected, register button allows enrolment or registrations of students and update button is to train the latest images that have been registered in the database. Lastly, browse button and recognize button is to browse facial images from selected database and recognized the selected image to test the functionality of the system respectively.

In this part, enhanced LBP with radius two is chosen and used as proposed algorithm. The analysis of choosing the radius size will be further explained in the discussion.

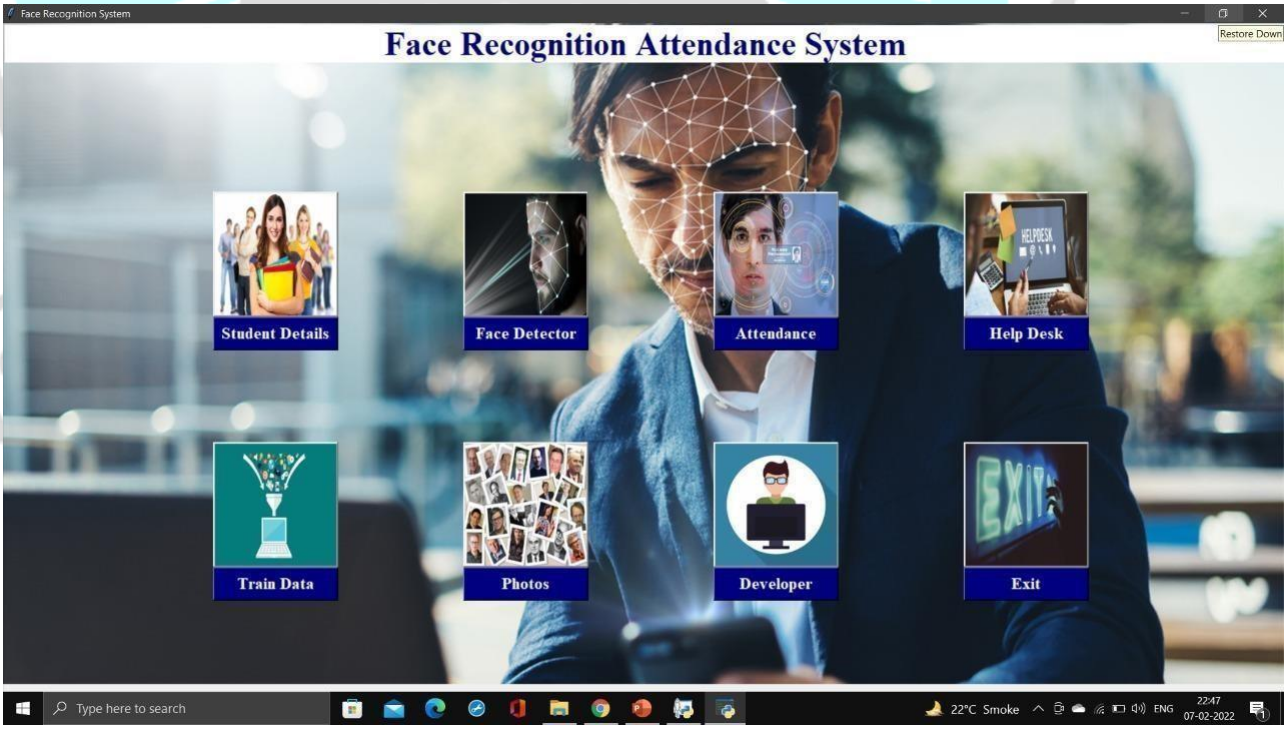

Figure 4.1 User's Interface (Matlab GUI)

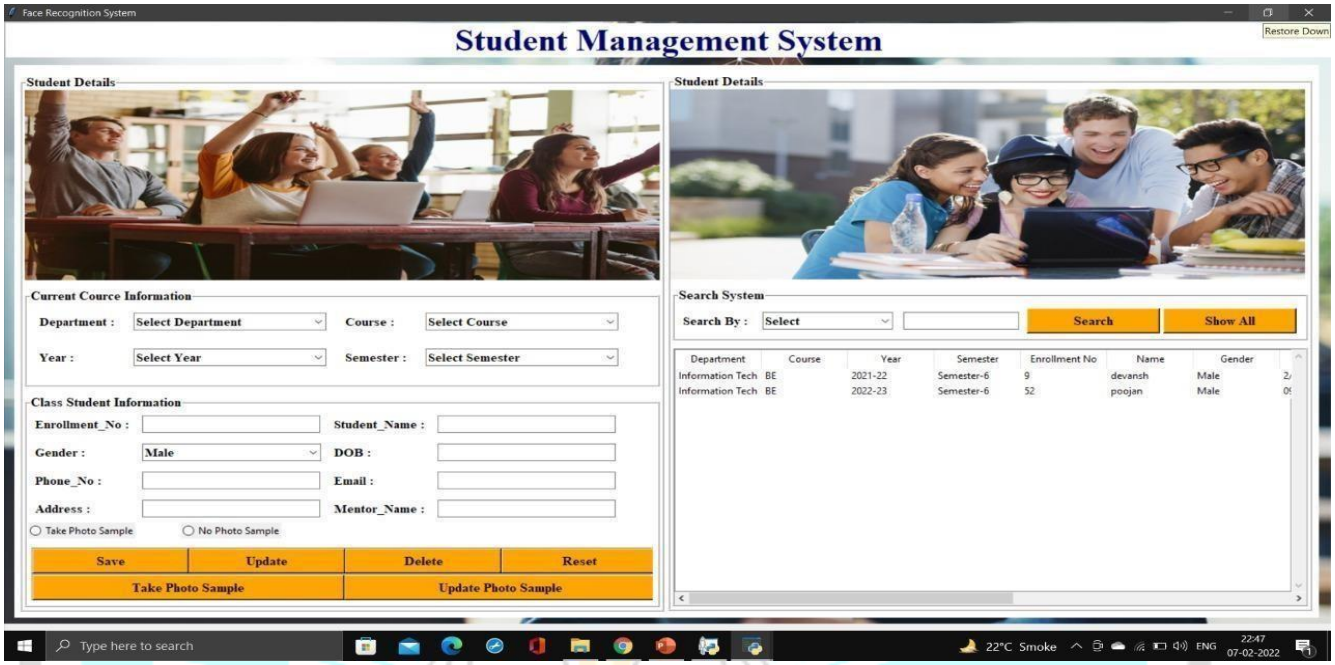

Figure 4.2 Student data information

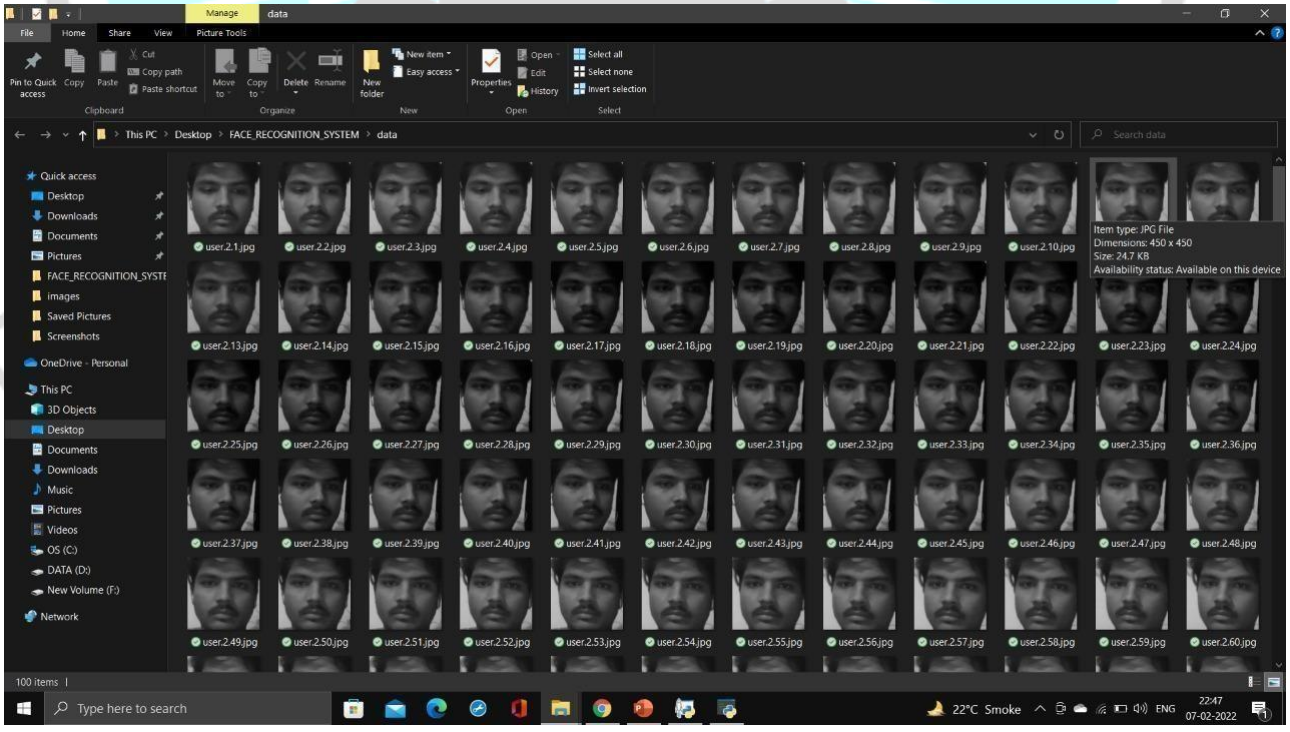

Figure 4.3 Real Time Face Recognition (Automated)

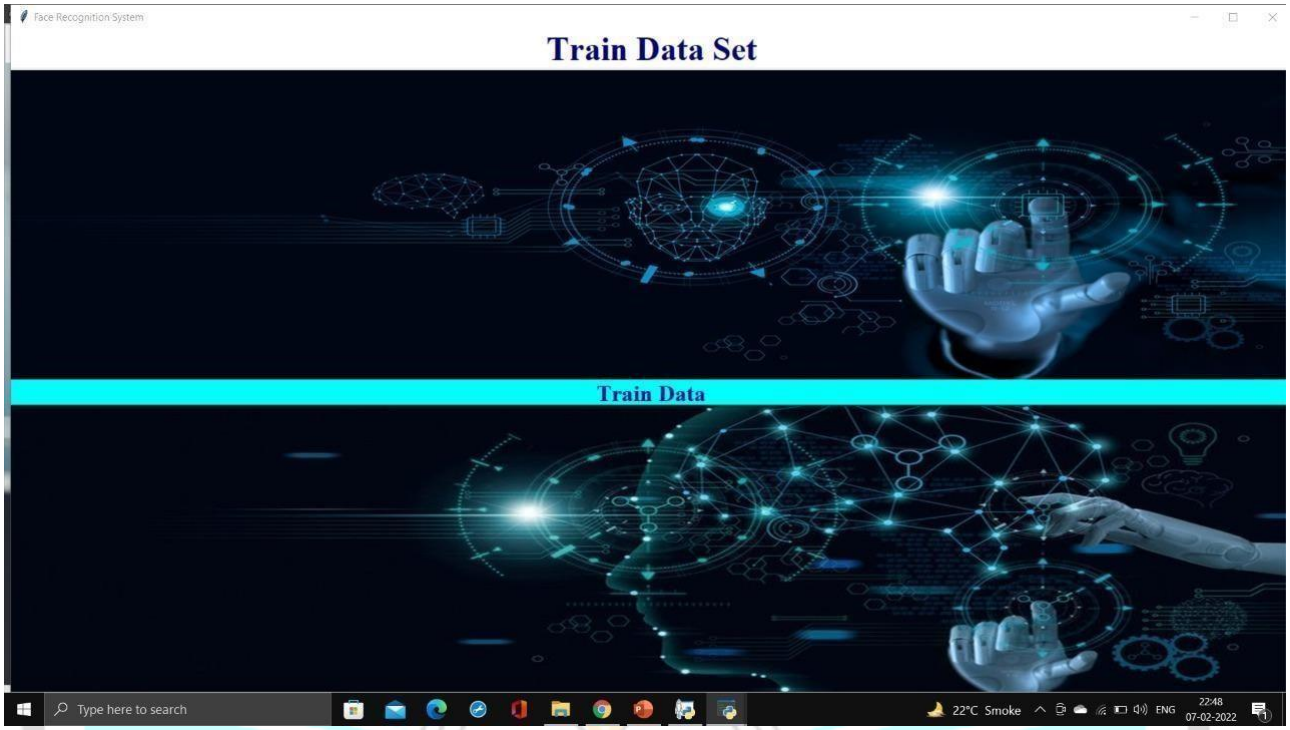

Figure 4.4 Train Data For Face Recognition (Automated)

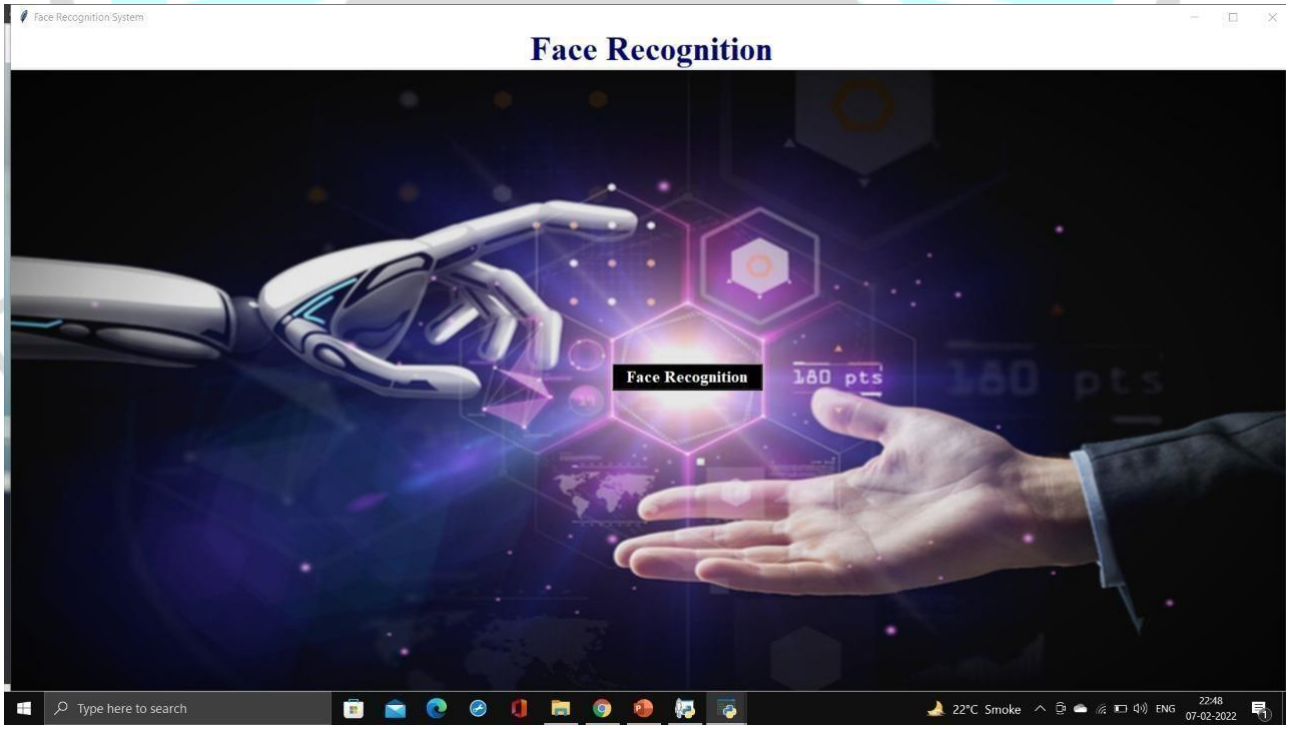

Figure 4.5 Image Browsing and Face Recognition

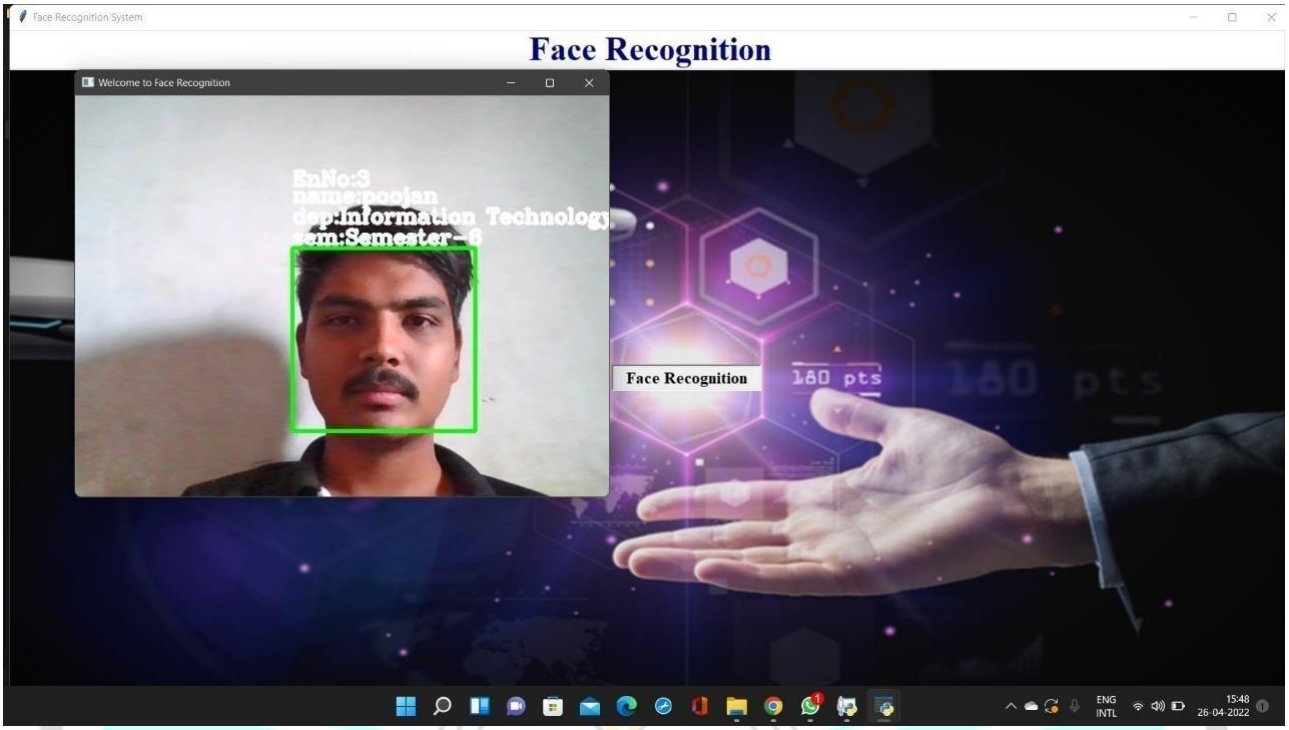

Figure 4.6 True Recognition Is Supressed

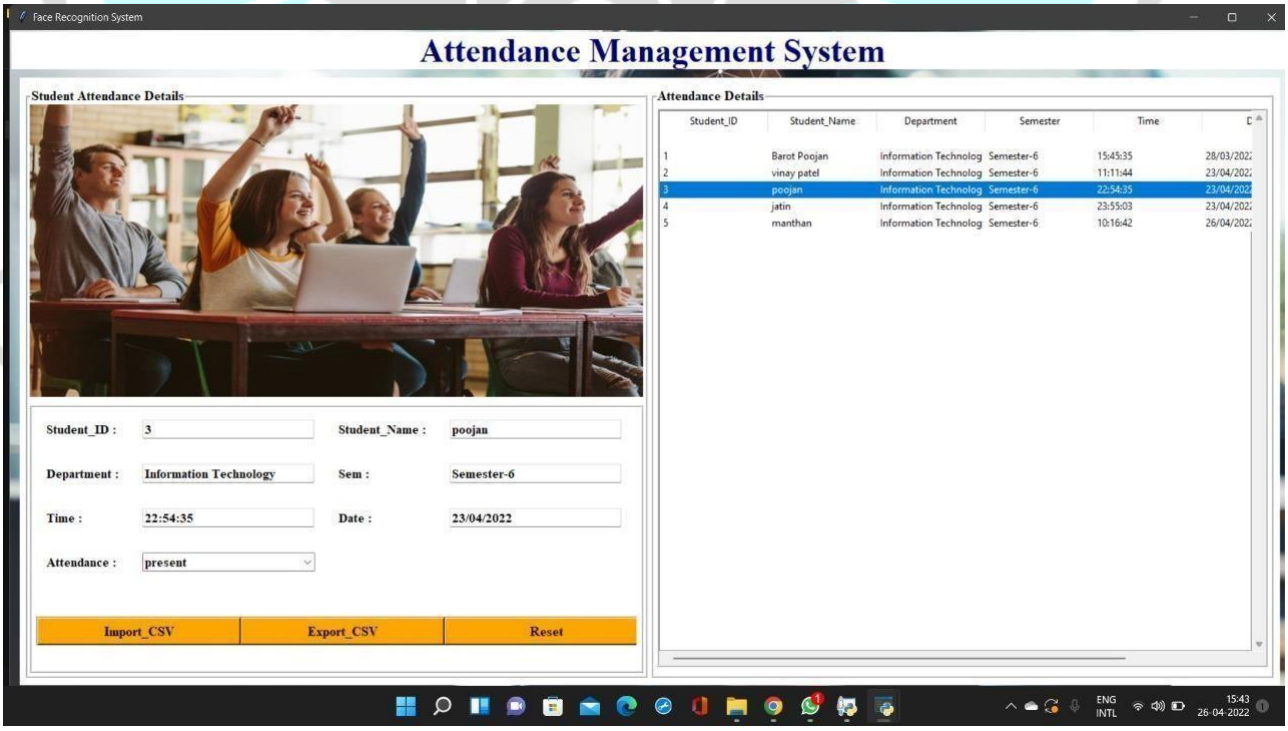

Figure 4.7 Attendance based on Excel(DataBase)

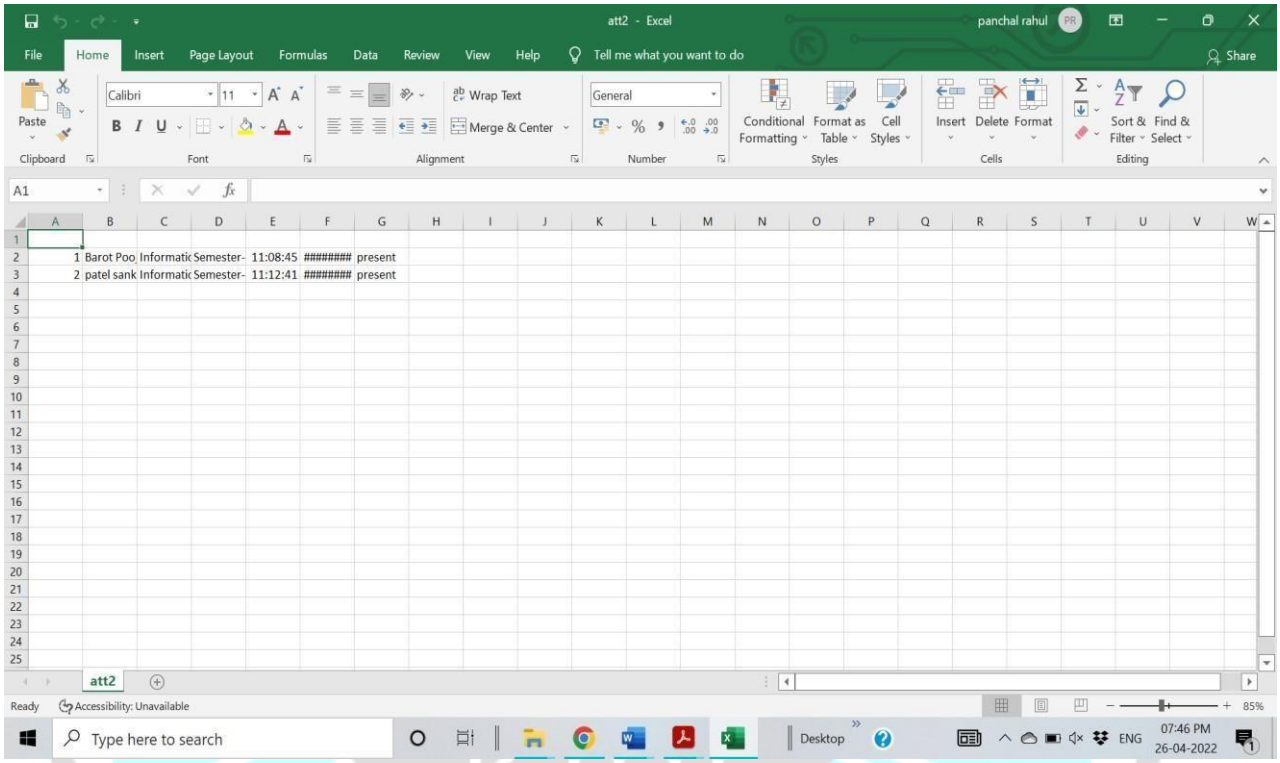

Figure 4.5 Attendance in Excel File

7.Conclusion

7.1 Conclusion

In this approach, a face recognition based automated student attendance system is thoroughly described. The proposed approach provides a method to identify the individuals by comparing their input image obtained from recording video frame with respect to train image. This proposed approach able to detect and localize face from an input facial image, which is obtained from the recording video frame. Besides, it provides a method in pre-processing stage to enhance the image contrast and reduce the illumination effect. Extraction of features from the facial image is performed by applying both LBP and PCA. The algorithm designed to combine LBP and PCA able to stabilize the system by giving consistent results. The accuracy of this proposed approach is 100 % for high-quality images, 92.31 % for low-quality images and 95.76 % of Yale face database when two images per person are trained.

As a conclusion for analysis, the extraction of facial feature could be challenging especially in different lighting. In pre-processing stage, Contrast Limited Adaptive Histogram Equalization (CLAHE) able to reduce the illumination effect.

CLAHE perform better compared to histogram equalization in terms of contrast improvement. Enhanced LBP with larger radius size specifically, radius size two, perform better compared to original LBP operator, with less affected by illumination and more consistent compared to other radius sizes.

7.2 Recommendation

In this proposed approach,there are a few limitations. First,the input image has to be frontal and a upright single facial image. Second,the accuracy might drop under extreme illumination problem. Third,false recognition might occur if the captured image is blurred. Besides, LBP is textural based descriptor which extracts local features. Hence, test image and train image have to be the same quality which is captured by using the same device in order to have high

accuracy. Lastly, if an individual wears make up in the image for face recognition, the important features will be covered.

In fact, a better camera with a better lighting source able to reduce the illumination problem and also able to avoid the captured of blurred images. In this proposed approach, laptop built in camera is a default device. However the lighting source of the laptop camera is very dim, this cause the system to be unstable. For future work, a better camera and a better lighting source can be used in order to obtain better result. This can reduce the dependency on the brightness of environment, especially the places to capture test and train images. Furthermore, a face recognition system which has more faces other than a single facial image can be designed. This can increase the efficiency of the system. The test image and train image in this approach is highly related to each other and highly dependent on the image captured device. The capture device has to be the same for this approach to perform better. Thus, other algorithms can be used instead of LBP, for example A.I (artificial intelligence) algorithm which can be implemented to perform the face recognition. CNN (Convolution Neural Network) which is a hot topic recently, is a machine deep learning algorithm which is able to perform recognition with less dependency on a particular train image given a large database. However, CNN requires an extremely large database to increase its accuracy or having relatively small class size to have high performance.

In pre-processing stage, an algorithm, for instance affine transform can be applied to align the facial image based on coordinates in the middle of the eyes. This might help, especially in PCA algorithm, which it maps test image to train image to perform face recognition.