A Project Report

On

FACE RECOGNITION BASED SMART ATTENDANCE SYSTEM

Submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF TECHNOLOGY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Under The Supervision of
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CANDIDATE'S DECLARATION

I/We hereby certify that the work which is being presented in the project, entitled **"FACE RECOGNITION BASED SMART ATTENDANCE SYSTEM"** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** submitted in the **School of Computing Science and Engineering** of **Galgotias University**, Greater Noida, is an original work carried out during the period of month, **August to December 2021**, under the supervision of **Mr. V. Arul** (Assistant Professor), Department of Computer Science and Engineering/Computer Application and Information and Science, of School of Computing Science and Engineering , Galgotias University, Greater Noida

The matter presented in the project has not been submitted by us for the award of any other degree of this or any other places.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Mr. V. Arul
Assistant Professor

<u>CERTIFICATE</u>

The Final Project Viva-Voce examination of Manasvi Jain(19SCSE1010530) & Ekansh Deep(19SCSE1010526) has been held on **<u>24-12-2021</u>** and their work is recommended for the Award of degree of Bachelor of Technology.

Signature of Examiner(s) **Signature of Supervisor(s)**

Signature of Project Coordinator **Signature of Dean**

Date: December, 2021

Place: Greater Noida

Acknowledgement

I would like to thank everyone who had contributed to the successful completion of this project. First, I would like to express my utmost gratitude to my research supervisor, Mr. V. Arul who in spite of being extraordinary busy with her duties, took time to give invaluable advice and guidance throughout the development of the research.

In addition, I would also like to express my deepest appreciation to my loving parents and family members for their constant support and encouragement.

Last but not the least; I am grateful for the unselfish cooperation and assistance that my friends had given me to complete this task.

Signature of Student

Abstract

Face Recognition is one of the most successful applications of image analysis because of availability of feasible technologies, including mobile. In the last decade, It has provided significant progress in this area. Systems have been developed for face detection but still it offers a great challenge to computer vision and pattern recognition researchers. As there are several reasons for recent increased interest in face recognition, including rising public concern for security, the need of identity verification in digital world, face analysis and modeling techniques in multimedia data management and computer entertainment.

The present implementation includes facial identification that is time saving and eradicates the possibilities of proxy attendance due to the facial authorization. This system can now be used in an area in which participation plays an important role. The system implemented uses LBPH face recognizer to identify the face of the person in real time. Eigen faces and Fisher faces are affected both by light and we cannot ensure perfect light conditions in real life. An improvement in the LBPH faces recognizer to overcome this problem. This system compares the image of the test and the training image and determines who is and is not present. The attendance data is stored in an excel sheet that is automatically updated in the system.

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CHAPTER-1
Introduction

1.1 Introduction

Attendance systems of old practices are not quite efficient now a day for keeping Track on student's attendance. Student enrollment in schools and colleges incrementing every year and taking each student attendance plays a very vital role. So, it is compulsory to discuss the efficacious system which records the attendance of a student automatically. Maintaining the attendance is very paramount in all the Schools/colleges for checking the performance of students. Every school/college has its own method in this regard. Some are taking attendance of students manually utilizing attendance registers or marking attendance sheets or file predicated approach and some have adopted the methods of automatic attendance utilizing some biometric techniques. But in these methods, students have to wait for a long time in making a queue at the time they enter inside the classroom.

Many biometric systems are available in the market but the key authentications are same in all of the techniques. Every biometric system consists of enrollment process in which the unique features of a person is stored in the database and after that, there are some processes of identification and verification of the person. These two processes compare the biometric feature of a person with interiorly stored template captured at the time of enrolment of a student. Biometric templates can be of many types like Dactyl grams, Ocular perceiver Iris, voice etc. Our system utilizes the face apperception approach for the automatic attendance of the students in the classroom environment without student intervention. The purport of developing the incipient attendance management system is to computerize the traditional methods of taking the attendance. Consequently, in order to drag the attention of students and make them interactive in visually examining technologies, we endeavor to move on to the latest upcoming trends on developing attendance systems. This is the reason for college/school attendance management system to come up with an approach that ascertains a vigorous contribution of students in classrooms.

1.2 Formulation of Problem

When there are so many students in a school/college, it becomes more and more difficult to mark attendance for each student and it is time consuming too. The Existing system of any institute is a manual entry for the students. This system faces the issue of wastage of time and also becomes

Complicated when the strength is more than the usual. Here, the attendance is being carried out in the hand written registers. It is very tedious job for us to maintain the record of the user.

Whenever we have to measure the performance of students, finding and calculating the average of the attendance of each enrolled student is also a very complicated task for us. The human effort is more here. The retrieval of the information is not a piece of cake as the records are maintained in the hand written registers. This existing system requires correct feed on input into the respective field. Therefore we are in a need of an automated system for marking and maintaining attendance of the students. Let us suppose that the wrong inputs are entered, the application resist to work. So, the user finds it difficult to use the existing system.

1.2.1 Tools & Technology Used

Image Capturing phase is one in which we capture the image of the students. This is the very basic phase from which we start initializing our system. We capture an image from our camera which predominantly checks for certain constraints like lightning, spacing, density, facial expressions etc. The captured image is resolute according to our requirements. Once it is resolute, we make sure it is either in .png or .jpeg format.

We take different frontal postures of an individual so that the accuracy can be attained to the maximum extent. This is the training database in which we classify every individual based on labels. For the captured image, from an every object we detect only frontal faces. This detects only face and removes every other part since we are exploring the features of faces only. These detected faces are stored somewhere in the database for further enquiry. Features are extracted in the extraction phase.

The detected bounding boxes are further queried to look for features extraction and the extracted features are stored in a matrix. For every detected phase, this feature extraction is done. Features that we look here are shape, edge, color, wavelet, auto-correlation and LBP. Face is recognized once we completed the extracting features. The feature which is already trained with every individual is compared with the detected faces features and if both features match, then it is recognized. Once it recognizes, it is going to update in the student attendance database. Once the process is completed, the testing images remains.

CHAPTER-2

Literature Survey

One of the most prosperous applications of image analysis and understanding, face apperception has recently received a paramount attention, especially during the past few years. In advisement to this, the quandary of machine apperception of human faces perpetuates to magnetize researchers from disciplines such as image processing, pattern apperception, neural networks, computer vision, computer graphics and psychology. The vigorous desideratum for utilize-cordial systems that can secure our assets and bulwark our privacy without losing our identity in a sea of numbers is conspicuous.

We as humans use faces to agonize and identify our friends and family. Computers can now withal identify people automatically utilizing stored information such as figure, iris or face to identify a particular person. Earlier many face apperception algorithms were habituated to achieve planarity automated face identification process. The first face apperception system was engendered in the 1960s. It was not plenarily automated and it required annual inputs of the location of the ocular perceivers, auditory perceivers, nasal discerner and mouth on the images then it calculates a distance to some prevalent point then it compares it to the stored data. They still image quandary has several innate advantages and disadvantages. For applications such as driver's license, due to the controlled nature of the image acquisition process, the segmentation quandary is rather facile. However, if only a static picture of an airport scene is available, automatic location and segmentation of a face could pose solemn challenges to any segmentation algorithm.

On the other hand, if a video sequence is available, segmentation of a moving person can be more facilely accomplished utilizing kinetics as a cue. But the diminutive size and low image quality of faces captured from video can significantly increase the arduousness in apperception. Face apperception and sometime is called face identifying is simply putting a label to kenned faces just like human as mentioned above, we learn the faces of our family and celebrities just by visually examining their faces. Since the 1970s there was many techniques and algorithms were developed for a machine to learn to agonize kenned faces. Most of the recent techniques involve at least three steps:

Face Detection

Face Preprocessing

Face recognition

Face Detection: Face detection is a process of locating a face inside an image frame, regardless of the identity of that face. Afore apperceiving a face, it is first essential to detect and extract the faces from the pristine pictures. Face Detection target on finding the faces (area and size) in an image and probably extract them to be utilized by the face apperception algorithm.

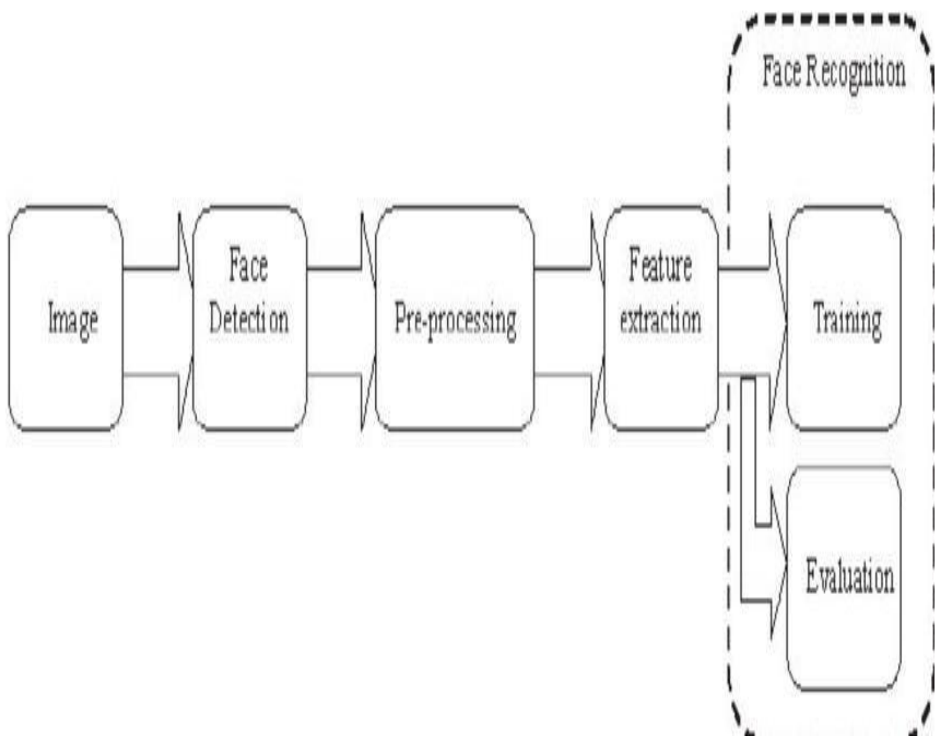
In face detection methods, those who are depending on training sets to capture the sizably voluminous unevenness in facial features have enticed much attention and given the best results. Generally these methods scan the input picture at all potential area and scales then as the sub windows either as non-face or face. Viola and Jones presented an efficacious detection technique utilizing Haar-like features and AdaBoost as an expeditious training algorithm. For apperceiving a face, the algorithms compare only faces. Any other element in the picture that is not a component of a face deteriorates the apperception.

Face Preprocessing: Any of the antecedent methods can be utilized for extracting faces from input pictures. The next step is to pre-process these faces in order to make the training phase more facile and amend the probability to apperceive a person opportunely. The training data will be standardized. Not all the pictures have the same zoom on the face and have maybe not all the same size. Most of the algorithms for facial apperception require the same size for the entire training set. Pre-processing includes different modifications. First of all, the faces need to be centered in the picture in the same way. The location of the two ocular perceivers and the nasal perceiver is often utilized as a landmark for centering faces. The aim is to have the ocular perceivers at the same level and the nasal perceiver at the same position for all images. To apply these modifications, the coordinates of the landmark ware needed. For that, it is possible to utilize a Haar-cascade classifier for detecting nasal perceiver and ocular perceivers.

After detecting a face in the frame, we can now process the face inside the green Rectangle. Face apperception is susceptible to vicissitudes in lighting conditions, face orientation, and face expression, so it is paramount to diminish these differences as much as possible. There are numerous techniques to eliminate those issues.

Face Recognition: We will discuss current developments in face recognition in upcoming various sections. In Section 1, we briefly review issues that are relevant from a psychophysical point of

View. Section 2 will provide a detailed review of recent developments in face recognition techniques using still images. In Section 3, face recognition techniques based on video are reviewed. Data collection and performance evaluation of face recognition algorithms are addressed in Section 4 with descriptions of representative protocols. In Section 5, we discuss two important problems in face recognition that can be mathematically studied, lack of robustness to illumination and pose variations, and we review proposed methods of overcoming these limitations.



Face detection and cropping block: This is the first stage of any face apperception system and the key distinction between a semi-automatic and a plenarily automatic face recognizer. In order to make the apperception system plenarily automatic, the detection and extraction of faces from an image should withal be automatic. Face detection additionally represents a very paramount step before face apperception, because the precision of the apperception process is a direct function of the precision of the detection process.

Pre-processing block: The face image can be treated with a series of pre-processing techniques to minimize the effect of factors that can adversely influence the face apperception algorithm. The most critical of these are facial pose and illumination. A discussion on these factors and their paramount.

Feature extraction block: In this step the features utilized in the apperception phase are computed. These features vary depending on the automatic face apperception system utilized. For example, the first and most simplistic features utilized in face apperception were the geometrical cognations and distances

between paramount points in a face, and the apperception ’algorithm’ matched these distances, the most widely used features in face apperception are KL or eigenfaces, and the standard apperception ’algorithm’ uses either the Euclidian distance to match features.

Face apperception block: This consists of 2 separate stages: a training process, where the algorithm is victual samples of the subjects to be learned and a distinct model for each subject is tenacious; and an evaluation process where a model of an incipiently acquired test subject is compared against all existing models in the database and the most proximately corresponding model is resolute. If these are adequately close an apperception event is triggered.

2.2 Face Detection

Difference between face detection and face recognition are often misunderstood. Face detection is to determine only the face segment or face region from image, whereas face recognition is to identify the owner of the facial image. S.Aanjanadevi et al. (2017) and Wei-Lun Chao (2007) presented a few factors which cause face detection and face recognition to encounter difficulties. These factors consist of background, illumination, pose, expression, occlusion, rotation, scaling and translation.

Background	Variation of background and environment around people in the image which affect the efficiency of face recognition.
Illumination	Illumination is the variation caused by various lighting environments which degrade the facial feature detection
Pose	Pose variation means different angle of the acquired the facial image which cause distortion to recognition process, especially for Eigen face

	and Fisher face recognition method.
Expression	Different facial expressions are used to express feelings and emotions. The expression variation causes spatial relation change and the facial-feature shape change
Occlusion	Occlusion means part of the human face is unobserved. This will diminish the performance of face recognition algorithms due to deficiency information.
Rotation, Scaling and Translation	Transformation of images which might cause distortion of the original information about the images.

There are a few face detection methods that the previous researchers have worked on. However, most of them used frontal upright facial images which consist of only one face. The face region is fully exposed without obstacles and free from the spectacles.

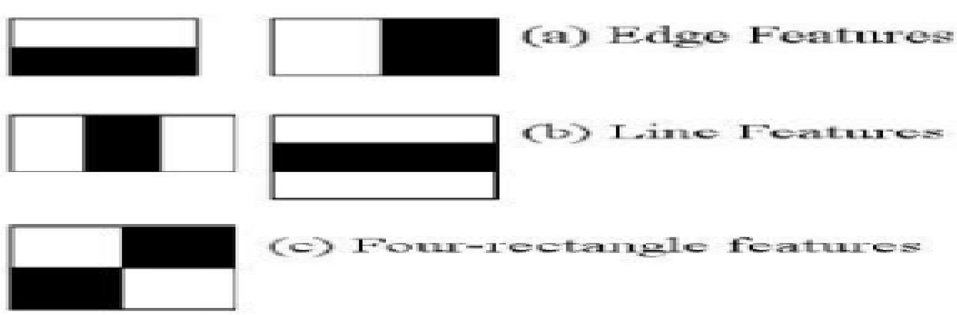
Akshara Jadhav et al. (2017) and by P. Arun Mozhi Devan et al. (2017) suggested Viola-Jones algorithm for face detection for student attendance system. They concluded that out of methods such as face geometry- based methods, Feature Invariant methods and Machine learning based methods, Viola-Jones algorithm is not 8 only fast and robust, but gives high detection rate and performs better in different lighting condition. Rahul V. Patil and S. B. Bangar (2017) also agreed that Viola-Jones algorithm gives better performance in different lighting condition. In addition, in the paper by Mrunmayee Shirodkar et al. (2015), they mentioned that Viola-Jones algorithm is able to eliminate the issues of illumination as well as scaling and rotation.

Face Detection Methods	Advantages	Disadvantages
Viola Jonas algorithm	1. High detection speed 2. High accuracy.	1. Long training time. 2. Limited head pose. 3. Not able to detect dark faces.
Local Binary pattern	1. Simple computation. 2. High tolerance against the monotonic illumination changes.	1. Only used for binary and grey images. 2. Overall performance is inaccurate compared to Viola-

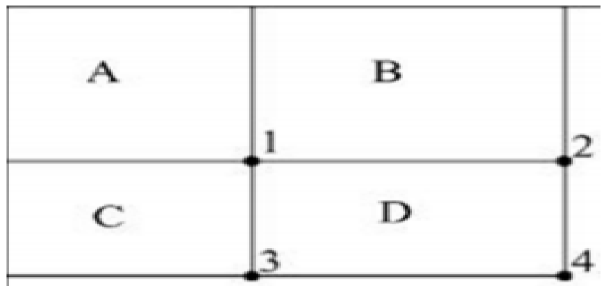
		Jones algorithm.
AdaBoost algorithm (part of Viola Jonas algorithm)	Need not to have any prior knowledge about face structure.	The result highly depends on the training data and affected by weak classifiers
SMQT Features and SNOW Classifier Method	1. Capable to deal with lighting problem in object detection. 2. Efficient in computation.	The region contain very similar to grey value regions will be misidentified as face.
Neural-Network	High accuracy only if large size of image were trained.	1. Detection process is slow and computation is complex. 2. Overall performance is weaker than Viola-Jones algorithm.

2.2.1 Voila – Jonas Algorithm

Viola-Jones algorithm which was introduced by P. Viola, M. J. Jones (2001) is the most popular algorithm to localize the face segment from static images or video frame. Basically the concept of Viola-Jones algorithm consists of four parts. The first part is known as Haar feature, second part is where integral image is created, followed by implementation of Adaboost on the third part and lastly cascading process.



Viola-Jones algorithm analyses a given image using Haar features consisting of multiple rectangles (Mekha Joseph et al., 2016). Figure shows several types of Haar features. The features perform as window function mapping onto the image. A single value result, which representing each feature can be computed by subtracting the sum of the white rectangle(s) from the sum of the black rectangle(s).



The value of integrating image in a specific location is the sum of pixels on the left and the top of the respective location. In order to illustrate clearly, the value of the integral image at location 1 is the sum of the pixels in rectangle A. The values of integral image at the rest of the locations are cumulative. For instance, the value at location 2 is summation of A and B, (A + B), at location 3 is summation of A and C, (A + C), and at location 4 is summation of all the regions, (A + B + C + D) (Srushti Girhe et al., 2015). Therefore, the sum within the D region can be computed with only addition and subtraction of diagonal at location 4 + 1 − (2 + 3) to eliminate rectangles A, B and C.

2.3 Pre-Processing

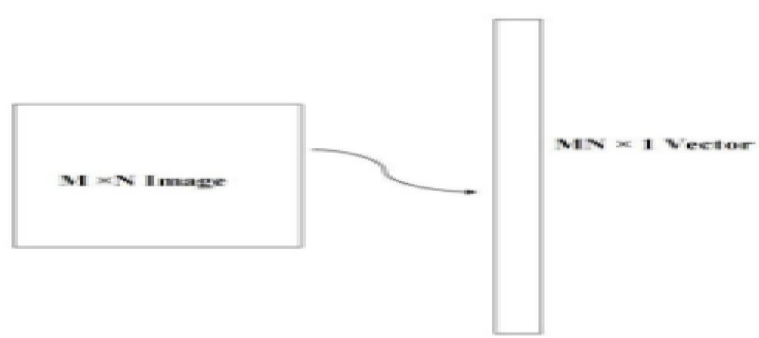
Pre-processing enhances the performance of the system. It plays an essential role to improve the accuracy of face recognition. Scaling is one of the important preprocessing steps to manipulate the size of the image. Scaling down of an image increases the processing speed by reducing the system computations since the number of pixels are reduced. The size and pixels of the image carry spatial information. Gonzalez, R. C. and Woods (2008) mentioned spatial information is a measure of the smallest discernible detail in an image. Hence, spatial information has to be manipulated carefully to avoid distortion of images to prevent checkerboard effect. The size should be same for all the images for normalization and standardization purposes. Proposed PCA (Principal Component Analysis) to extract features from facial images, same length and width of image is preferred, thus images were scaled to 120 × 120 pixels.

Besides scaling of images, color image is usually converted to grayscale image for pre-processing. Grayscale images are believed to be less sensitive to illumination condition and take less computational time. Grayscale image is 8 bit image which the pixel range from 0 to 255 whereas color image is 24 bit image which pixel can have 16 77 7216 values. Hence, color image requires more storage space and more computational power compared to grayscale images. (Kanan and Cottrell, 2012). If color image is not necessary in computation, then it is considered as noise. In addition, pre-processing is important to enhance the contrast of images. In the paper of Pratiksha M. Patel (2016), he mentioned that Histogram equalization is one of the methods of pre-processing in order to improve the contrast of the image. It provides uniform distribution of intensities over the intensity level axis, which is able to reduce uneven illumination effect at the same time.

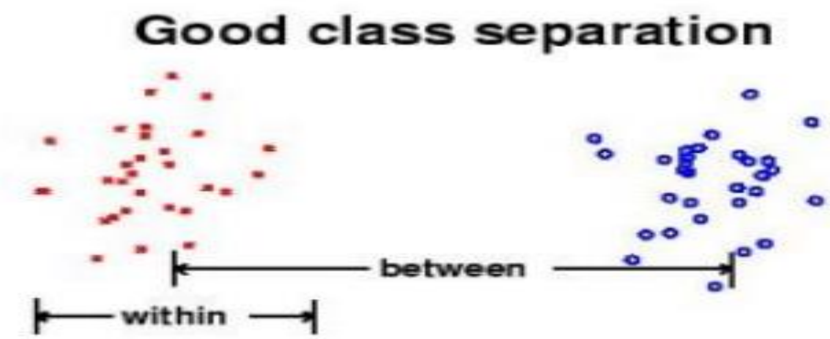
2.4 Feature Extraction

The feature is a set of data that represents the information in an image. Extraction of facial feature is most essential for face recognition. However, selection of features could be an arduous task. Feature extraction algorithm has to be consistent and stable over a variety of changes in order to give high accuracy result.

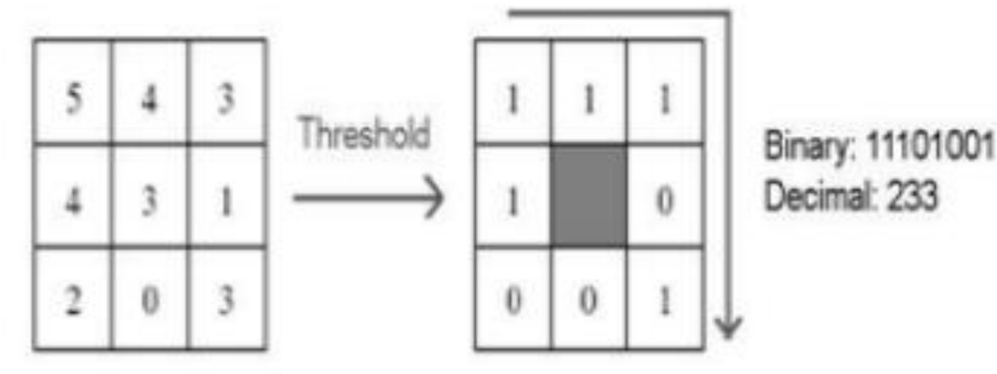
PCA is famous with its robust and high speed computation. Basically, PCA retains data variation and remove unnecessary existing correlations among the original features. PCA is basically a dimension reduction algorithm. It compresses each facial image which is represented by the matrix into single column vector. Furthermore, PCA removes average value from image to centralize the image data. The Principle Component of distribution of facial images is known as Eigen faces. Every single facial image from training set contributes to Eigen faces. As a result, Eigen face encodes best variation among known facial images. Training images and test images are then projected onto Eigen face space to obtain projected training images and projected test image respectively. Euclidean distance is computed by comparing the distance between projected training images and projected test image to perform the recognition. PCA feature extraction process includes all trained facial images. Hence, the extracted feature contains correlation between facial images in the training set and the result of recognition of PCA highly depends on training set image.



LDA (Linear discriminant analysis) also known as Fisher face is another popular algorithm for face recognition. In the paper by Suman Kumar Bhattacharyya and Kumar Rahul (2013), LDA was proposed for face recognition. LDA extract features by grouping images of the same class and separate images of different classes. LDA is able to perform well even with different facial expressions, illumination and pose due to its class separation characteristic. Same class is defined by facial images of the same individual, but with different facial expressions, varying lighting or pose, whereas facial images of person with different identity are categorized as different classes. Same class images yield within-class scatter matrix meanwhile different class images yield between-class scatter matrix. LDA manage to maximize the ratio of the determinant of the between-class scatter matrix over the determinant of the within class scatter matrix. LDA is believed to have lower error rates compared to PCA only if more samples per class are trained and small size of different class.



The original LBP (Local Binary Patterns) operator was introduced by the paper of Timo Ojala et al. (2002). In the paper by Md. Abdur Rahim et al. (2013), they proposed LBP to extract both texture details and contour to represent facial images. LBP divides each facial image into smaller regions and histogram of each region is extracted. The histograms of every region are concatenated into a single feature vector. This feature vector is the representation of the facial image and Chi square statistic is used to measure similarities between facial images. The smallest window size of each region is 3 by 3. It is computed by thresholding each pixel in a window where middle pixel is the threshold value. The neighborhood larger than threshold value is assigned to 1 whereas the neighborhood lower than threshold value is assigned to 0. Then the resulting binary pixels will form a byte value representing center pixel.



LBP has a few advantages which make it popular to be implemented. It has high tolerance against the monotonic illumination changes and it is able to deal with variety of facial expressions, image rotation and aging of persons. These overwhelming characteristics cause LBP to be prevalent in real-time applications.

Neural network is initially used only in face detection. It is then further studied to be implemented in face recognition. In the paper by Manisha M. Kasar et al. (2016), Artificial Neural Network (ANN) was studied for face recognition. ANN consists of the network of artificial neurons known as "nodes". The nodes act as human brain in order to make recognition and classification. These nodes are interconnected and values are assigned to determine the strength of their connections. High value indicates strong connection. Neurons were categorized into three types of nodes or layers which are input nodes, hidden nodes, and output nodes. Input nodes are given weight based on its impact. Hidden nodes consist of some mathematical function and thresholding function to perform prediction or probabilities that determine and block unnecessary inputs and result is yield in output nodes. Hidden nodes can be more than one layer. Multiple inputs generate one output at the output node.

2.4.1 Types of Feature Extraction

Holistic-based methods are also known as appearance-based methods, which mean entire information about a face patch is involved and used to perform some transformation to obtain a complex representation for recognition. Example of Holistic-based methods are PCA(Principal Component Analysis) and LDA(Linear dependent Analysis).On the other hand, feature-based methods directly extract detail from specific points especially facial features such as eyes, noses, and lips whereas other information which is considered as redundant will be discarded. Example of feature-based method is LBP (Local Binary Pattern). These methods mentioned are usually combined to exist as Hybrid method, for example Holistic-based method combine with Feature-based in order to increase efficiency.

2.5 Feature Classification and Face Recognition

Classification involves the process of identification of face. Distance classifier finds the distance between the test image and train image based on the extracted features. The smaller the distance between the input feature points and the trained feature points, the higher the similarity of the test image and training image. In other words, the facial images with the smallest/minimum distance will be classified as the same person. Deepesh Raj (2011) mentioned several types of distance classifiers such as Euclidean Distance, City Block Distance and Mahalanobis distance for face recognition. Md. Abdur Rahim et al. (2013) implemented Chi-Square statistic as distance classifier for LBP operator. The equation of each classification method is defined below.

Chi square distance is defined as:

$$\chi^2 = \sum \frac{\text{oberved frequency} - \text{expected frequency}}{\text{expected frequency}}. \tag{2.1}$$

Chi-square statistic is usually used to compare between two bins of histogram. The City Block Distance or Manhattan Distance is known as L1-norm which is defined in

$$d(x,y) = |x-y| \tag{2.2}$$

The Euclidean distance is known as L2-norm which is defined in

(2.3)

$$d(x,y) = |x - y|^2$$

where, X is the input feature points and Y is the trained featured points.

The Mahalanobis distance is defined in

(2.4)

$$d(x,y) = \frac{(y - m_x)}{S_x}(y - m_x)^T$$

where m_x is mean of x and S_x is covariance matrix of x.

Proposed Euclidean distance to compute the distance between two images after PCA feature extraction was performed. Threshold can be set for the distance calculated from the classifier. A face is classified as belonging to a class only if its distance is below the chosen threshold, otherwise the face is classified as unknown.

2.6 Evaluation

Different databases are used in order to evaluate the system performance. The database provided by previous researchers with different variable conditions, for example, lighting and expression will be used to justify the system and for study purpose. Furthermore, our own database will be used to analyze the system for real time application. From the literature review of the previous researchers, the common method to justify the performance of the system is by finding the accuracy of recognition.

The formula for accuracy or recognition rate is defined below:

(2.5)

$$accuracy = \frac{total\ matched\ images}{total\ tested\ images} x100$$

Method	Advantages	Disadvantages	Accuracy
Eigen face/ Kernel PCA (Principal component Analysis)	High speed in training and recognition.	Face recognition is depending on training database.	77.97 %
Fisher face/ LDA (Linear Discriminant Analysis)	Images of individual with different illumination, facial expressions able to be recognized if more samples are trained.	1. Bigger database is required because images of different expression of the individual have to be trained in same class. 2. It depend more on database compared to PCA.	82.45 %
LBP(Local Binary Pattern)	It is able to overcome variety of facial expressions, varying illumination, image rotation and aging of person.	Training time is longer than PCA and LDA.	90.93 %
Neural network	High accuracy only if large database is trained.	1. Required long time to train. 2. Database is extremely large to have high accuracy.	N.A

CHAPTER – 3
Functionality/Working of Project

3.1 Methodology flow

The approach performs face recognition based student attendance system. The methodology flow begins with the capture of image by using simple and handy interface, followed by pre-processing of the captured facial images, then feature extraction from the facial images, subjective selection and lastly classification of the facial images to be recognized. Both LBP and PCA feature extraction methods are studied in detail and computed in this proposed 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. The details of each stage will be discussed in the following sections.

The flow chart for the proposed system is categorized into two parts, first training of images followed by testing images (recognize the unknown input image) shown in Figure 3.1 and Figure Respectively.

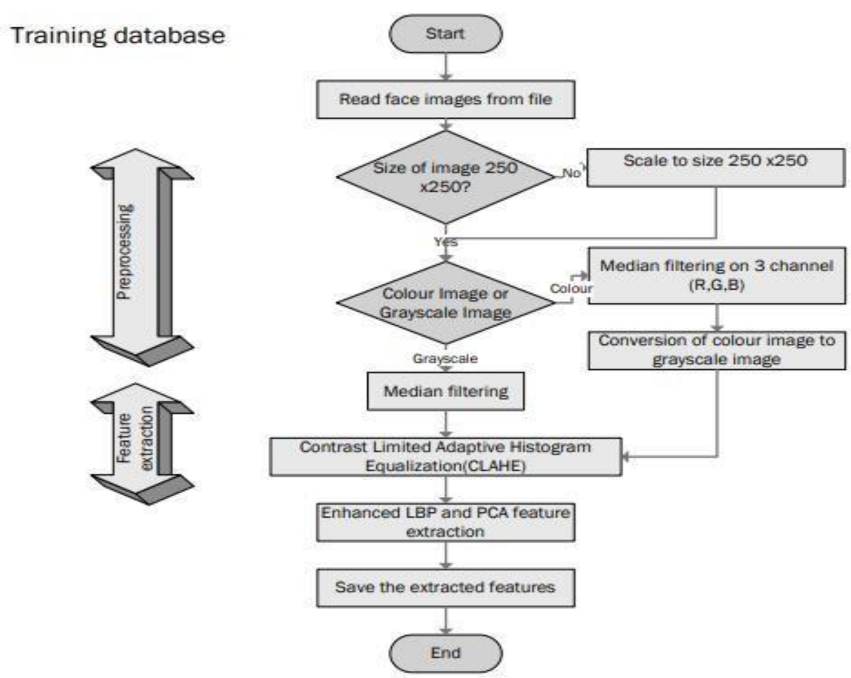


Figure 3.1 Flow of the Proposed Approach (Training Part)

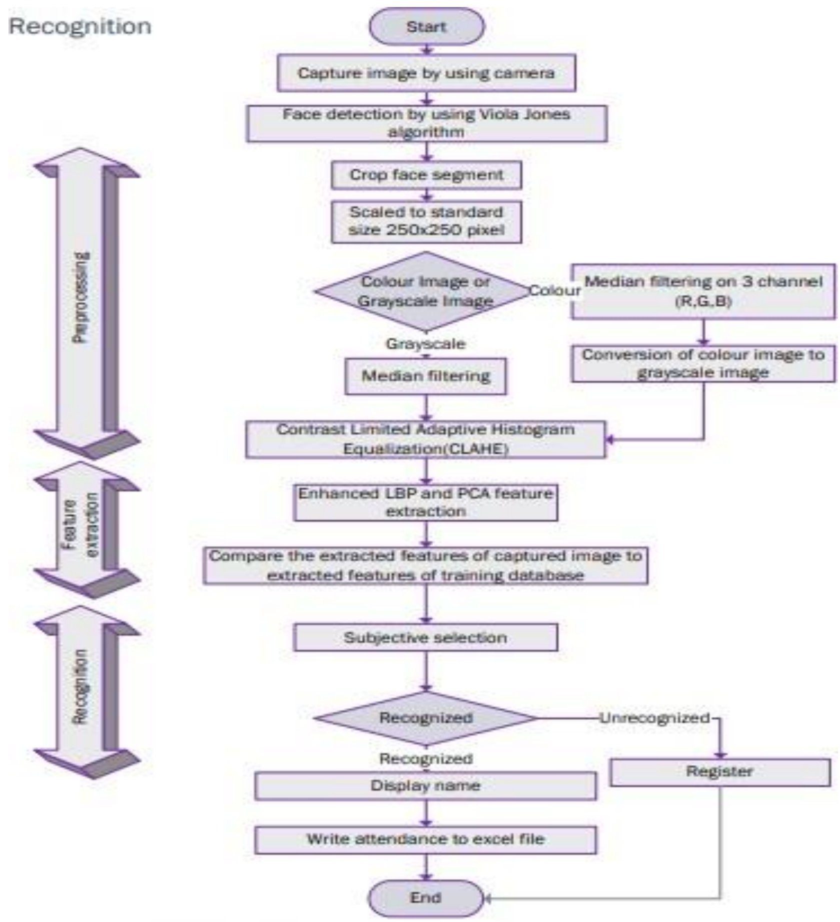


Figure 3.2 Flow of the Proposed Approach (Recognition Part)

3.2 Face Detection

Viola-Jones object detection framework will be used to detect the face from the video camera recording frame. The working principle of Viola-Jones algorithm is mentioned in Chapter 2. The limitation of the Viola-Jones framework is that the facial image has to be a frontal upright image; the face of the individual must point towards the camera in a video frame.

3.2.1 Pre-Processing

Testing set and training set images are captured using a camera. There is 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 color images to grayscale images and adaptive histogram equalization. The details of these steps would be discussed in the later sections.

3.2.1.1 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.

3.2.1.2 Median Filtering

Median filtering is a robust noise reduction method. It is widely used in various applications due to its capability to remove unwanted noise as well as retaining useful detail in images. Since the color images captured by using a camera are RGB images, median filtering is done on three different channels of the image. If the input image is a grayscale image, then the median filtering can be performed directly without separating the channels.

Figure 3.6 Median Filtering Done on Three Channels

Figure 3.7 Median Filtering Done on a Single Channel

3.2.1.3 Conversion to Grayscale Image

Camera captures color images; however the proposed contrast improvement method CLAHE can only be performed on grayscale images. After improving the contrast, the illumination effect of the images able to be reduced. LBP extracts the grayscale features from the contrast improved images as 8 bit texture descriptor (Ojala, T. et al., 2002).Therefore, color images have to be converted to grayscale images before proceeding to the later steps. By converting color images to grayscale images, the complexity of the computation can be reduced resulting in higher speed of computation (Kanan and Cottrell, 2012).

Figure 3.8 Conversion of Image to Grayscale Image

3.3 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.

3.3.1 Working Principle of Original LBP

LBP is basically a texture based descriptor which it encoded local primitive into binary string. 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.

$$LBP = \sum_{0}^{7} f(Pn - Pc).2^{n} \quad (3.1)$$

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 neighboring 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:

$$f(y) = \begin{cases} 0 & y < 0; \\ 1 & y \geq 0; \end{cases} \quad (3.2)$$

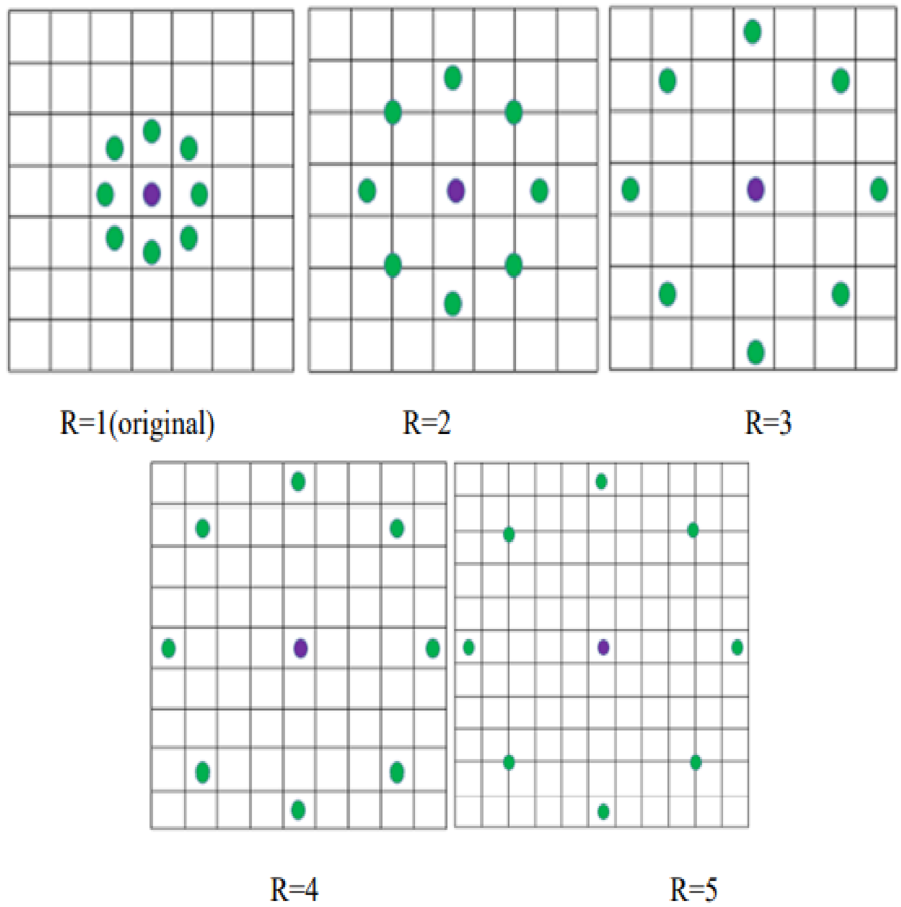
3.3.2 Working Principle of Proposed LBP

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, 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 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:

$$Xp = Xc + R\cos(\theta/P)$$
$$Yp = Yc + R\sin(\theta/P) \quad (3.3)$$

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.



Basically, the increasing in the size of the radius means extending the circular pattern of LBP externally. The green spots within the blocks indicate the sampling pixels to be encoded into binary string. For the sampling pixel located in between the R=1(original) R=2 R=3 R=4 R=5 Figure 3.11 LBP with Different Radius Sizes 36 blocks, it indicates the average pixel value is computed from the adjacent pixels (diagonal).

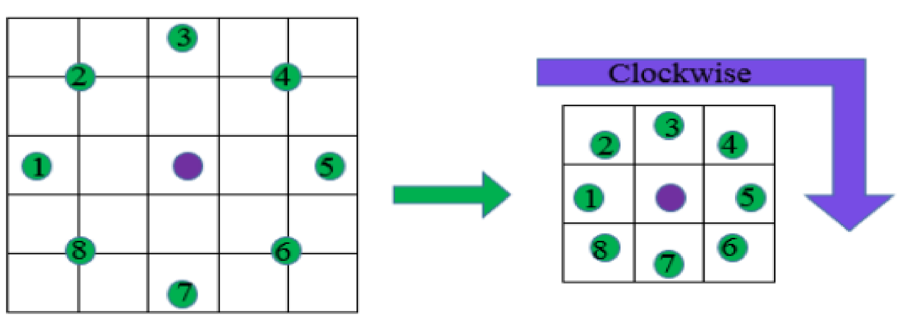


Figure 3.12 Proposed LBP Operator with Radius 2 and Its Encoding Pattern.

The feature vector of the image is constructed after the Local Binary Pattern of every pixel is calculated. The histogram of the feature vector image is computed in order to be classified by distance classifier. However, it loss spatial information because histogram representation does not include spatial information but only discrete information. (Gonzalez, R. C., & Woods, 2008). In order to overcome this problem, the feature vector image is then divided into blocks. A histogram is constructed in each region respectively. Every bin in a histogram represents a pattern and contains the frequency of its appearance in the region. The feature vector of entire image is then constructed by concatenating the regional histograms in the sequence to one histogram. (Md. Abdur Rahim et al., 2013). This histogram remains its regional spatial information and represents the identity of single image which is then classified to perform the recognition.

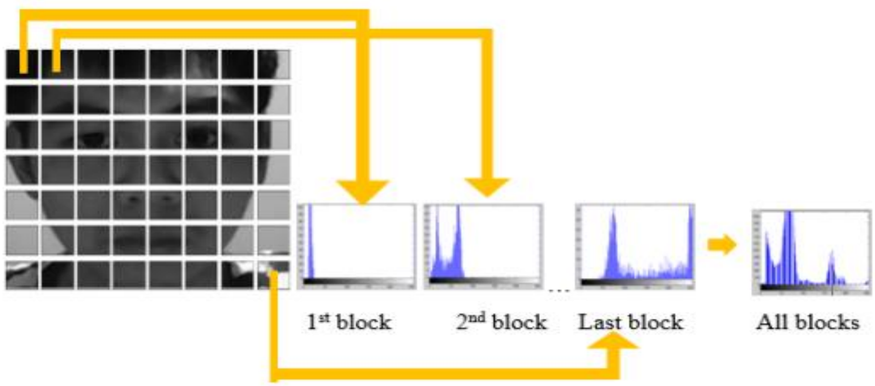


Figure 3.13 Histogram of Image Blocks

3.3.3 Working Principle of PCA

In this proposed approach, PCA face recognition is studied, as it is one of the popular face recognition methods that was suggested and used by the previous researchers. The accuracy of PCA is computed in order to compare with the enhanced LBP.

PCA includes a few steps which will briefly be described in the following paragraphs. For PCA, the image scale, length (M) and height (M) is not so important. This is because PCA is mostly dealing with number of total images, N instead of M. However, same size of test image and training image is a must for PCA computation. Same length and height of the image is assumed in the following equation for illustration. Given a training set of N images with size $M \times M$, the first step of PCA is to convert two dimensional vectors to one dimensional vector. The one dimensional vector can be either column vector or row vector. In this approach, the column vector conversion is done. For each facial image with matrix notation $M \times M$ will be converted to column vector Γi, with dimension $M2 \times 1$.There are N facial images, each face is represented by column vector Γ1, Γ2, Γ3, .., ΓN. Feature vector of each face is stored in this column vector. The dimension reduced face matrix is constructed by concatenating every single column vector.

PCA is briefly explained by using the equation in the following steps.

Step1: Prepare the data,

$$\overset{\Gamma 1}{\begin{bmatrix} a11 \\ a12 \\ a13 \\ \vdots \\ aM^2 \end{bmatrix}} \overset{\Gamma 2}{\begin{bmatrix} a11 \\ a12 \\ a13 \\ \vdots \\ aM^2 \end{bmatrix}} \overset{\Gamma 3}{\begin{bmatrix} a11 \\ a12 \\ a13 \\ \vdots \\ aM^2 \end{bmatrix}} \ldots \overset{\Gamma N}{\begin{bmatrix} a11 \\ a12 \\ a13 \\ \vdots \\ aM^2 \end{bmatrix}} = \overset{\text{Dimension reduced matrix}}{\begin{bmatrix} a11 & a12 & \ldots & a1N \\ a21 & a22 & \ldots & a2N \\ a31 & a32 & \ldots & a3N \\ \vdots & \vdots & \vdots & \vdots \\ aM^21 & aM^22 & \ldots & aM^2N \end{bmatrix}} \tag{3.4}$$

Step 2: Obtain the mean/average face vector Next, the average face vector which is also known as mean face is calculated. The mean is computed row by row between the column vectors. The equation of mean face is shown below.

$$\varphi = \frac{1}{N}\sum_{i=1}^{N} \Gamma_i \tag{3.5}$$

$$\text{Mean face, } \varphi = \begin{bmatrix} \frac{a11 + a12 + \cdots + a1N}{N} \\ \frac{a21 + a22 + \cdots + a2N}{N} \\ \vdots \end{bmatrix} \tag{3.6}$$

Step 3: Subtract the mean/average face vector In order to ensure the image data is centered at the origin; the mean face is subtracted from each column vector.

$$\Phi_i = \Gamma_i - \varphi \qquad i = 1,2,\ldots,N \tag{3.7}$$

Dimension reduced matrix — Mean face, φ (3.8)

$$\begin{bmatrix} a11 & a12 & \ldots & a1N \\ a21 & a22 & \ldots & a2N \\ a31 & a23 & \ldots & a3N \\ \vdots & \vdots & \vdots & \vdots \\ aM^21 & aM^22 & \ldots & aM^2N \end{bmatrix} - \begin{bmatrix} \frac{a11 + a12 + \cdots + a1N}{N} \\ \frac{a21 + a22 + \cdots + a2N}{N} \\ \vdots \end{bmatrix}$$

matrix A , Φ

$$= \begin{bmatrix} b11 & b12 & \ldots & b1N \\ b21 & b22 & \ldots & b2N \\ b31 & b23 & \ldots & b3N \\ \vdots & \vdots & \vdots & \vdots \\ bM^21 & bM^22 & \ldots & bM^2N \end{bmatrix}$$

Step 4: Calculate the covariance matrix

$$C = \frac{1}{N}\sum_{i=1}^{N} \Phi_i \Phi_i^T = AA^T \;, (M^2 x M^2) \tag{3.9}$$

$$A = [\Phi_1\, \Phi_2 \cdots \Phi_N] \;, (M^2 x N)$$

where A is the matrix constructed from the concatenation of the column vectors after remove the mean face.

The purpose of covariance matrix to be constructed is to compute the eigenvectors and eigenvalues. However, $AA\ T$ have dimension $M2 \times M2$ which is extremely large to be calculated. , and $A\ TA$ have the same eigenvalues, λ and their eigenvectors can be related as $ui = Avi$ .Hence A TA which have dimension $N\ 2xN\ 2$ is calculated instead of $AA\ T$ because $N\ 2 \ll M2$, less computational time is required.

Step 5: Calculate the eigenvectors and eigenvalues from the covariance matrix.

$$u_i = Av_i \qquad i=1,2,\ldots,N\text{-}1 \tag{3.10}$$

ui is the eigenvector of $AA\ T$ whereas vi is eigenvector of $A\ TA$.Eigenvalues of $A\ TA$, are calculated and sorted. Eigenvalues less than 1 are eliminated so the number of non-zero eigenvectors may be less than (N-1). (Kalyan Sourav Dash, 2014).The eigenvectors of , = [ui … uN−1] is also known as Eigen face. Eigen face is the principle component distribution of facial image.

Step 6: Projection of facial image to Eigen face.

$$\Omega_i = U^T(\Gamma_i - \varphi) \qquad i=1,2,\ldots,N\text{-}1 \tag{3.11}$$

The facial image is projected on the Eigen face by using the equation to obtain the projected image Ω. $\Gamma i - \varphi$ is the centered vector, which the mean face is removed.

Steps 1 to 6 are used to train the training image set. For test image only step 1,2, 3 and 6 is required. Step 4 and 5 are not required for test image as the Eigen face is needed only to compute once while training. The Euclidean distance is then used as distance classifier to calculate the shortest distance between the projected image and projected test image for recognition.

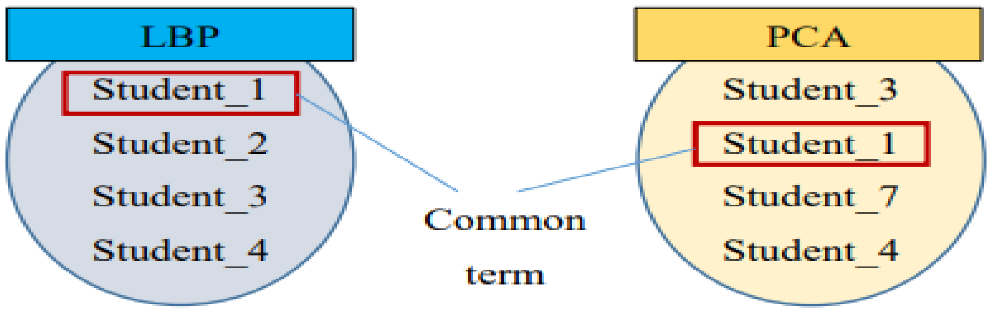
3.3.4 Feature Classification

Chi-square statistic is used as a dissimilarity measure for LBP to determine the shortest distance between training image and the testing image. On the other hand, Euclidean distance is used to compute the shortest distance between trained and test image after PCA feature extraction. Classifiers, Chi-square statistic and Euclidean distance determine the closest or nearest possible training image to the testing image for face recognition. However, the nearest result might not be always true. Therefore, an algorithm to combine enhanced LBP and PCA is applied in order to increase the accuracy of the system.

3.3.5 Subjective Selection Algorithm and Face Recognition

The feature classification that has been performed in previous part gives the closest result but not absolute. In order to increase the accuracy and suppress the false 41 recognition rate, an algorithm to combine enhanced LBP and PCA is designed in this proposed approach.

In this proposed approach, best five results are obtained from enhanced LBP and PCA. This means that five individuals which have closest distance with respect to input image will be identified. LBP and PCA are two different algorithms which have a different working principle. Hence, LBP and PCA will not have exactly the same five individuals identified. In order to ensure the system capability to suppress the false recognition, one is only classified as recognized if and only if he or she is the first common individual that is identified by both LBP and PCA. From chapter 2, LBP shows higher accuracy compared to PCA. Thus, LBP is designed to have higher priority compared to PCA. This is shown in the Figure 3.14; Student_1 is recognized instead of Student_3 because LBP is prioritized. As a result, the first common individual is selected from PCA with respect to LBP and classified as recognized. If there is no common term between LBP and PCA then the system will not recognize any subject. This subjective selection algorithm is designed to be automated in the system.



The input image will be recognized as Student_1.

Figure 3.14 Subjective Selection Algorithm

CHAPTER – 4

Result & Discussion

4.1 Result

In this proposed approach, face recognition student attendance system with user friendly 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 Real Time Face Recognition (Automated)

Figure 4.2 show once the start button is pressed, the process is automated. The face image is captured from the video recording frame and the face recognition is performed.

Figure 4.3 Image Browsing and Face Recognition

Figure 4.3 shows browsing of the image and the performing of the face recognition.

Figure 4.4 False Recognition Is Supressed

Figure 4.4 shows subjective selection algorithm is designed to prevent false recognition if the camera light is not yet ready.

4.2 Discussion

This proposed approach provides a method to perform face recognition for student attendance system, which is based on the texture based features of facial images. Face recognition is the identification of an individual by comparing his/her real-time captured image with stored images in database of that person. Thus, training set has to be chosen based on the latest appearance of an individual other than taking important factor for instance illumination into consideration.

The proposed approach is being trained and tested on different datasets. Yale face database which consists of one hundred and sixty-five images of fifteen individuals with multiple conditions is implemented. However, this database consists of only grayscale images. Hence, our own database with color images which is further categorized into high quality set and the low quality set, as images are different in their quality: some images are blurred while some are clearer. The statistics of each data set have been discussed in the earlier chapter.

Viola-Jones object detection framework is applied in this approach to detect and localize the face given a facial image or provided a video frame. From the detected face, an algorithm that can extract the important features to perform face recognition is designed.

Some pre-processing steps are performed on the input facial image before the features are extracted. Median filtering is used because it is able to preserve the edges of the image while removing the image noises. The facial image will be scaled to a suitable size for standardizing purpose and converted to grayscale image if it is not a grayscale image because CLAHE and LBP operator work on a grayscale image.

One of the factors that are usually a stumbling stone for face recognition performance is uneven lighting condition. Hence, many alternatives have been conducted in this proposed approach in order to reduce the non-uniform lighting condition. Before feature extraction takes place, pre-processing is performed on the cropped face image (ROI) to reduce the illumination problem.

In the previous chapters, Contrast Limited Adaptive Histogram Equalization (CLAHE) is proposed in pre-processing in order to improve the image contrast and reduce the illumination effect. Most of the previous researchers have implemented histogram equalization in their approach. In order to study the difference between the CLAHE and histogram equalization, comparison is made and tabulated in Table 4.2.

For the comparison, our own database and Yale face database are used. From the result tabulated, CLAHE appears to perform better compared to histogram equalization. From the image of our own database, the left hand side of the original image appears to be darker compared to right hand side. However, histogram equalization does not improve the contrast effectively, which causes the image remains darker at left hand side. Unlike histogram equalization, CLAHE appears to improve the contrast more evenly throughout the entire facial image. This could help to reduce uneven illumination. In Yale face database, CLAHE prevents some region appears to be washed out as well as reduce over enhancement of noise. Besides, CLAHE shows a clear edge and contour compared to histogram equalization. In addition, by referring to the histograms, the pixel is widely span over the intensity scale axis 0 to 255 for CLAHE whereas for histogram equalization the pixel span from 0 to only about 200 over the intensity scale axis. Hence, it can be said that the contrast of the image is more evenly improved throughout the image by CLAHE compared to histogram equalization based on the result obtained.

After pre-processing, useful feature is extracted by using enhanced LBP (local Binary pattern).Unlike the original LBP operator, enhanced LBP operator consists of different radius size is proposed as mentioned in previous chapters. This different radius size enhanced LBP operator is less affected by uneven lighting compared to original LBP operator. The extracted feature for different radius is shown and tabulated in Table 4.3.The results show when the radius increased, the images are smoothen.

For evaluation purpose, Yale face database with different condition is used for comparison. The normal facial image of each individual in Yale face database is trained and the facial images with varying condition are input as the test image. The recognition rate with the different radius size of LBP operator is computed and tabulated in Table 4.4.

From the Table 4.4, when the radius size increase, only facial images with conditions right light, left light and center light are affected whereas for the other conditions the recognition rate remains constant. This shows that by increasing the radius, uneven lighting effect can be reduced without distorting the detail of the image. From Figure 4.6, the line graph shows that the accuracy of different light conditions increase when radius increases. In addition, it shows that among the different lighting conditions, the system work the best in left light condition followed by center light condition and the last is right light condition.

The recognition rate of LBP operator with different radius is then computed by using our own database. However, LBP operator with different radius does not give significant results because there is no critical illumination problem exists in the images of our own database. Hence, the pixels of good quality images of our own database are modified to generate the illumination effects in order to determine the impact of different size LBP operator. Figure 4.7 shows condition I, II, III and IV which illustrate different illumination effects.

By increasing the radius size, the detail information is simplified and the contour or shape of the face is emphasized. This illustrates that some of the useless or redundant information is removed and more emphasis is on the critical details for recognition.

As it is proven any increasing radius LBP performs better compared to original by reducing illumination effect, consistency of the system is also emphasized other than accuracy of the system. From the Table 4.5, although radius three and radius four have higher average accuracy compared to radius two, radius two is more consistent toward different conditions. As the conditions I, II, III and IV is self-simulated conditions, in real time face recognition, the illumination condition is unpredictable. Hence, radius two gives consistent result which is (94.12 %) in condition I, condition III and condition IV is chosen and used as proposed algorithm.

The fact that, the radius might not be the larger the better because larger radius with respect to larger filter size emphasizes complementary information to small scale 49 detail but at the same time it loss discriminative information. The discriminative information is important, for instance to recognize students with glasses free condition.

However, it does prove that the enhanced LBP operator with increased radius performs better compared to original LBP in case of illumination effect reduction. Hence, the radius size of the LBP operator has to be wisely selected in order to reduce the illumination effect without sacrificing much of the recognition rate.

From the result, the condition II appears to have lower accuracy compared to others. This is due to the lighting effect of the training image. The training images have its left side relatively darker compared to its right side which is directly opposite of the test image (condition II).

From the result of proposed LBP in Table 4.6, database with good quality color images, achieves the highest accuracy (100 %) either one image or two images per individual is trained whereas database with poor quality color images have average accuracy of (86.54 %) when only one image per individual is trained and average accuracy of (88.46 %) when two images per individual are trained. It can be said that the approach works best with good quality images, poor quality images could degrade Figure 4.6 Images of Students with or Without Wearing Glasses Training Image Test Image (Condition II) Figure 4.7 Training Image VS Testing Image 50 the performance of the algorithm. Poor quality images were captured by using Laptop camera. The poor quality images might include the relatively darker images; blur images or having too much unwanted noise. In blurred images, the face is blurred out. Unwanted noise can be reduced by applying median filtering, but for those blurred images there are no suitable ways to get rid of it.

4.3 Comparison of LBP and PCA

In this proposed approach, PCA face recognition is performed in order to identify the differences with respect to LBP by using the same database. From the result obtained in Table 4.7, supposedly PCA should have worked better with high quality images which are similar to enhanced LBP. However, it gives slightly lower accuracy in recognition in high quality images compared to low quality images. This is due to different size of the database are used in the proposed approach. For high quality images there are only seventeen students in the database, whereas low quality images involve twenty-six students, which are almost ten students more than high quality images. It is the PCA's nature to be more affected by the size of the database compared to LBP. Hence, the larger the size of the database which means the more students includes in the database, the lower the recognition rate of PCA.

Furthermore, the enhanced LBP is compared with the PCA face recognition, by using the same pre-processing procedure and same image enhancement technique. From the Table 4.6 and Table 4.7, the average accuracy of PCA is lower compared to the LBP in all the databases, our own database with high and low quality images and also Yale face database is used respectively. Hence, it can be said that enhanced LBP works better compared to the PCA face recognition given the same dataset is used for training and testing.

An automated subjective selection algorithm involves both enhanced LBP and PCA is designed for face recognition. The best results from enhanced LBP and PCA correspondingly are compared to obtain a common result. This common result will be classified as recognized individual. By doing so, the system becomes more 51 reliable, stable and consistent not only in different expression but also in different lighting condition. This is because two algorithms are used for generalization, one act as a reference to another one. Especially in the camera initializing stage, if the camera is started faster than the lighting source, a darker image will be captured. However the dark image is meaningless to be recognized. The combination of enhanced LBP and PCA able to block the meaningless image from being recognized. Overall accuracy with and without combination of LBP and PCA are tabulated in Table 4.8. It shows that with high quality images make no difference with or without the algorithm.

However, for low quality images, it shows significant improvement in the accuracy with the algorithm.

4.4 Comparison with previous Researches

Paper/difference	Automated Class Attendance System based on face recognition using PCA Algorithm	Proposed algorithm	Automated Attendance Management System Based On Face Recognition Algorithms
Noise removal	None	Median filtering	None
Image enhancement	None	Contrast Limited Adaptive Histogram Equalization	Histogram equalization
Featured based	PCA	Enhanced LBP and PCA	PCA/LDA/LBPH
Database	Own database	Own database and Yale face database	NITW-database
Attendance	Write attendance to Excel file	Subjective selection by enhanced LBP and PCA,and write attendance to Excel file	Write attendance to Excel file

From the Table 4.10, proposed algorithm is compared with face recognition student attendance system proposed by previous researchers. The techniques used by the previous researchers to process the images are compared in this proposed approach.

In terms of image enhancement, the paper published in 2013 used histogram equalization to improve the image contrast, while another paper did not apply any technique to improve the image contrast. In this proposed algorithm, CLAHE is used to improve the image contrast. Histogram equalization, which is often used in x-ray applications, gives bone structure a clearer view. However, histogram equalization will tend to cause over enhancement to some of the regions and cause it to be washed out while other regions are not enhanced properly. Hence, CLAHE is implemented instead of histogram equalization to prevent over enhancement and improve the contrast more evenly throughout the image. The difference between CLAHE and histogram equalization is tabulated in result of the previous part.

The research, published in the year 2015 used PCA for feature extraction. While the paper published in the year 2013 used multiple feature extraction algorithms. These feature extraction algorithms are PCA, LDA and LBPH. In this proposed approach, other than enhanced LBP algorithm, PCA is also computed in order to make comparison and to understand their property and performance respectively. In the paper of year 2013, either one of the feature extraction methods PCA, LDA and LBPH 53 is used each time. In this proposed approach, enhanced LBP and PCA are both used as combination to ensure consistent results.

The previous researcher who published the paper in 2015 used their own databases of images in study. The paper published in year 2013 used an image database of 80 individuals (NITW-database) with 20 images of each person, while the paper in year 2015 did not mention the size of image database used. The proposed algorithm uses multiple image databases, which include Yale face database with different lighting and expression for training and testing. In fact, Yale face database allows the study of performance of the proposed algorithm in uneven lighting and variety of expression condition. However, Yale face database consists of only grayscale images without background, thus our own database with color images is also used in real time application to perform face recognition.

Face recognition is the process of identification of an individual by choosing the closest distance between test image and train image. Hence, quality of images plays an important role in performance of face recognition. Blurred images caused by movement tend to create the after image which can degrade the performance. Furthermore, the test images captured in extremely bright or dark condition can degrade the performance as well because its show a large variation with the train image provided train image is captured in moderate lighting. All these factors have to be taken into consideration when selecting images for testing and training purpose. It is always better to use more images for training, so that the result obtained provides a better generalization and in consequence provide better performance.

In addition, both papers did not apply technique for removal of image noise. In proposed algorithm, Median filtering is used to filter out noises in the image. If the noises on the images are not removed, the algorithm might recognize the noises as part of the crucial features. These will probably affect the overall performance of the algorithm. Lastly, both papers write student attendance to Excel file as post-processing. In the proposed approach, a subjective selection algorithm is designed to obtain a common result from enhanced LBP and PCA. This common result from enhanced LBP 54 and PCA is classified as recognized individual and written to Excel file. This algorithm able to reduce false recognition, especially in camera initializing stage, when the camera light is not ready to function. Hence, the proposed algorithm makes the system to be more reliable by giving the consistent result.

4.5 Weakness of the Algorithm

The proposed algorithm can only work with a single face. Multiple faces appear in the same image causes each of them to be small. Small face region gives inaccurate features; this will decrease the performance of the system. Hence, whenever more than a face is detected, the system will not perform the recognition.

The LBP algorithm is highly sensitive to image quality and highly affected by the blurred image. LBP is the texture based descriptor which extracts the local grayscale features by performing feature extraction on a small region throughout the entire image. Hence, test image and train image have to be the same quality and captured by the same device in order to have high accuracy. The laptop built in webcam is the default device in this proposed approach to capture image. The webcam and lighting source of the laptop have low performance which cause the captured images appear to be darker and blurred. This cause the system only function the best if the test image and train image are both captured at the same place under approximately same illumination.

Besides, false recognition occurs when the facial image is blurred. The blurred image caused by the after image created by movement will degrade the performance. The face feature extracted from the blurred image would be totally different compared to train image resulting in false recognition. In addition, if an individual wears make up in the image for face recognition, the important features will be covered. Similarly, face region should not be covered by hair, beard or any accessories to ensure better performance. For instance, a girl provides a facial image with her face covered by hair; it causes false recognition to occur if the girl ties her hair. This is because anything covering the face region will be assumed as face feature. This causes a relatively large difference between test image and train image.

Different level of brightness or lighting could be a challenging problem for face recognition. Hence, limitation of the proposed algorithm is studied and analysis is conducted by modifying the pixels of high quality images in order to manipulate the brightness of the facial images. The recognition rate of facial images under different level of brightness is computed and tabulated. Figure

4.12 shows images with different intensity by adding different constants to pixel. The performance of the proposed algorithm is tabulated in the Table 4.9. From the Table 4.9, the proposed algorithm function the best when the intensity increase by a constant at the range of 25 and 50.Further increasing or decreasing the intensity level out of this range will cause the recognition rate to drop to (94.12 %) .Hence, it can be said that the system work better in a relatively brighter image then a darker image.

4.6 Problem faced and Solution Taken

One of the problems in real-time face recognition is the difficulty to obtain sufficient and suitable images for training and testing purpose. It is hard to obtain in real-time databases with a variety of variables, and it is hard to obtain publicly available databases. Yale face database is one of the databases that could be downloaded by the public. Hence, Yale face database is adopted and used in this proposed approach. However, Yale face database consists of only grayscale images without any background. Hence, our own database consists of color images which are categorized to high- quality images and low quality-images are also used.

Besides, it is very difficult to obtain an open source or the free face recognition software in order to make comparisons. In this proposed approach, Luxand Face SDK window demo version software is downloaded and implemented in the laptop. By using laptop built in webcam to recognize faces, the proposed algorithm and Luxand Face SDK demo able to be compared.

From the Luxand face recognition website (Luxand.com, 2018), they explained that the Face SDK is a high performance, multi-platform face recognition, identification and facial feature detection solution. For Luxand Face Recognition software, the self-learning Al enables video-based identification and the enrolment can be done at any time as simple as putting a name tag in a video, the system will identify that subject in all past, present and future videos. As video-based identification software, it is believed to work better than key-frame based identification. Nevertheless, the detailed information of its working principle is unable to be obtained from their sites.

Viola-Jones algorithm can cause false face detection. This can be solved by increasing the detection threshold (Mathworks.com, 2018). The threshold indicates the number of detections needed to declare a final detection around an object. By using MATLAB built in function, Merge Threshold, the detection threshold can be adjusted to reduce the false face detection.

CHAPTER – 5
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.

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