

**Asia Pacific College**

**School of Computing and Information Technology**

**Magallanes, Makati City**

**STUDY ON DIFFERENT ALGORITHMS AND METHODS TO IMPLEMENT A CLASSROOM ATTENDANCE SYSTEM BASED ON FACE RECOGNITION**

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# Abstract

Your face is your identity. The methods to exploit this physical feature have seen a great change since the advent of image processing techniques. Attendance is taken in almost every school and is a prerequisite in completing a course. Traditional approach for attendance is professor calls student name and records attendance. It takes time to record attendance. Recording attendance takes 5-10 minutes of the entire class, for each lecture this is waste of time. To avoid these losses, we are about use an automatic process which is based on image processing. In this approach, we are using face detection & face recognition system. This face detection differentiates faces from non-faces and is therefore essential for accurate attendance. The other strategy involves face recognition for marking the student’s attendance. Principal component analysis is used for face detection & recognition. The student database is collected. The database includes name of the students, there images & student number. Thus with the help of this system, time will be saved. With the help of this system, it will be convenient to record attendance. We can take attendance accurately and effortlessly.

KEYWORDS:, Principal component analysis, Neural Networks, Euclidean Distance, back propagation, Histogram equalization.

# Introduction

## **Project Context**

Almost all schools use attendance systems to record when students enter class. Some schools also keep detailed records of attendance issues such as who calls in sick and who comes in late. An attendance system provides many benefits to schools. Technology had to play its role in this field just as well as it has done in other fields. The attendance monitoring system was created and it changed the way attendances were marked. The attendance monitoring system has made the lives of easier by making attendance marking procedure manageable.

When it comes to schools and universities, the attendance monitoring system is a great help for parents and teachers both. Parents are never uninformed of the dependability of their children in the class if the university is using an attendance monitoring system. With a monitoring system in place, the information can easily be printed or a soft copy can be sent directly to parents in their personal email accounts.

The system started with two basic processes - Manual processes and Automatic processes. Manual processes are eliminated as the staff needed to maintain them. It is often difficult to comply with regulation, but an automated attendance system is valuable for ensuring compliance with regulations regarding proof of attendance.

## **Purpose and Description**

The main purpose of this research is to monitor the attendance of the students in school and universities using face recognition attached in each class. Checking attendance would be easy and without hassle with the face recognition accurately recognize student faces and it won’t consume time unlike the traditional attendance system that would take 5-10 mins of class time.

## **Objectives**

Maintaining the attendance is very important in all the institutes for checking the performance of students. Every institute has its own method in this regard. Some are taking attendance manually using the old paper or file based approach and some have adopted methods of automatic attendance using some biometric techniques. But in these methods students have to wait for long time in making a queue at time they enter the classroom. Many biometric systems are available but the key authentication are same is all the techniques. Every biometric system consists of enrolment process in which unique features of a person is stored in the database and then there are processes of identification and verification. These two processes compare the biometric feature of a person with previously stored template captured at the time of enrollment. Biometric templates can be of many types like Fingerprints, Eye Iris, Face, Hand Geometry, Signature, Gait and voice. Our system uses the face recognition approach for the automatic attendance of students in the classroom environment without students’ intervention. Face recognition consists of two steps, in first step faces are detected in the image and then these detected faces are compared with the database for verification. A number of methods have been proposed for face detection i.e. AdaBoost algorithm, the FloatBoost algorithm, the S-AdaBoost algorithm, Support Vector Machines, and the Bayes classifier. The efficiency of face recognition algorithm can be increased with a fast face detection algorithm. Compared to the above methods we think the use of PCA with neural networks is a good solution in addressing our problem of face recognition. Our system utilized this algorithm for the detection of faces in the classroom image. Face recognition techniques can be divided into two types Appearance based which use texture features that is applied to whole face or some specific regions, other is Feature based which uses geometric features like mouth, nose, eyes, eye brows, cheeks and relation between them. Principal Component Analysis (PCA) and Neural Networks have been used for construction of face templates.

## 

## **Scope and Limitations**

The study focuses on getting the student attendance by the use of face recognition this will help school and universities to eliminate the old style of getting student attendance. Also, Principal component analysis, Neural Networks, Euclidean Distance, Back propagation, Histogram equalization.

# Related Literature

K.Senthamil Selvi et.al. [1] “Face recognition based Attendance marking system”. In this projected work, sort to find the attendance, positions and face descriptions in classroom lecture, we projected the presence administration system based on face detection in the classroom lecture. The system estimates the presence and the location of each student by continuous inspection and footage. The result of the beginning experiment shows continuous inspection improved the performance for estimation of the attendance.

Muhammad Fuzail et.al. [2] “Face Detection System for Attendance of Class’ Students”, An regular attendance supervision system is an essential tool for any LMS(Learning Management System). Most of the existing system are time consuming and necessitate for a semi instruction manual work from the instructor or students. This approach aim to explain the issues by integrates face detection in the procedure. Even though this method still lacks the capability to identify each student in attendance on class, there is still much more room for enhancement. Since we implement a modular approach we can get better different module until we reach an acceptable detection and identification rate. Another issue that has to be taken in consideration in the opportunity is a process to ensure users privacy. Whenever you like a representation is stored on servers, it must be impossible for a person to use that image.

Mathana Gopala et. al. [3] “Implementation of Automated Attendance System using Face Recognition”, automated presence System has been envision for the purpose of falling the errors that occur in the conventional (manual) attendance taking system. The aim is to computerize and make a system that is useful to the institute such as an organization. The efficient and exact method of attendance in the office atmosphere that can reinstate the old manual methods. This technique is secure enough, reliable and available for use. No need for dedicated hardware for installing the system in the office. It can be constructed using a camera and computer.

# Technical Background

**Theoretical Framework**

Enrollment phase: The image is taken using a web camera and stored in a database. Next, the face image is detected and trained. During training, the face image is pre-processed using geometric and photometric normalization. The features of the face image are extracted using several feature extraction techniques. The features data is then stored together with the user identity in a database.

Recognition/verification phase: A user's face is once again acquired and system uses this to either identify who the user is, or verify the claimed identity of the user. While identification involves comparing the acquired biometric information against templates corresponding to all users in the database, verification involves comparison with only those templates corresponding to claimed identity. The recognition/verification phase comprises of several modules which are image acquisition, face detection, and face recognition/verification.

Image acquisition/face detection module: Image acquisition module is to seek and then extracts a region which contains only the face. Face detection is used to detect face and to extract the information related to facial features. The image will then be resized and corrected geometrically and it will eliminate the background and scene which are unrelated to the face so that it is suitable for recognition/verification.

Face recognition/verification module: The face recognition module contains of preprocessing, feature extraction, and classification sub-modules. The input to the face recognition/verification module is the face image, which is derived from two sources from the camera or from the database. Each image is preprocessed to get the geometric and photometric normalized form of the face image. During feature extraction, the normalized image is represented as feature vectors. The result of the classification for the recognition purpose is determined by matching the client index with the client identity in the database.

Preprocessing: The purpose of the preprocessing module is to reduce or eliminate some of the variations in face due to illumination. It normalized and enhanced the face image to improve the recognition performance of the system. The preprocessing is crucial as the robustness of a face recognition system greatly depends on it. By using the normalization process, system robustness against scaling, posture, facial expression and illumination is increased. The photometric normalization techniques are used in histogram filtering.

Histogram equalization is the most common histogram normalization or gray level transform, which purpose is to produce an image with equally distributed brightness levels over the whole brightness scale. It is usually done on too dark or too bright images in order to enhance image quality and to improve face recognition performance. It modifies the dynamic range (contrast range) of the image and as a result, some important facial features become more apparent.

Feature Extraction: The purpose of the feature extraction is to extract the feature vectors or information which represents the face. The feature extraction algorithms used is Principal Component Analysis (PCA).

Principal component analysis : PCA for face recognition is based on the information theory approach. It extracted the relevant information in a face image and encoded as efficiently as possible. It identifies the subspace of the image space spanned by the training face image data and de-correlates the pixel values. The classical representation of a face image is obtained by projecting it to the coordinate system defined by the principal components. The projection of face images into the principal component subspace achieves information compression, de-correlation and dimensionality reduction to facilitate decision making. In mathematical terms, the principal components of the distribution of faces or the eigenvectors of the covariance matrix of the set of face images, is sought by treating an image as a vector in a very high dimensional face space[7][8][9].We apply PCA on this database and get the unique feature vectors using the following method. Suppose there are P patterns and each pattern has t training images of m x n configuration.

• The database is rearranged in the form of a matrix where each column represents an image.

• With the help of Eigen values and Eigen vectors covariance matrix is computed.

• Feature vector for each image is then computed. This feature vector represents the signature of the image. Signature matrix for whole database is then computed.

• Euclidian distance of the image is computed with all the signatures in the database.

• Image is identified as the one which gives least distance with the signature of the image to recognize.

Classification: The purpose of the classification sub-module is to map the feature space of a test data to a discrete set of label data that serves as template. The classification techniques used are Neural Network, Normalized correlation, Euclidean Distance.

Neural Network: Neural Network is a machine learning algorithm that has been used for various pattern classification problems such as gender classification, face recognition, and classification of facial expression. Neural Network classifier has advantages for classification such as incredible generalization and good learning ability.

A Neural Network is made up of neurons residing in various layers of network. These neurons of different layers are connected with each other via links and those links have some values called weights. These weights store the information. Basically the neural network is composed of 3 types of layers: first is Input layer, which is responsible for inserting the information to the network. Second is Hidden layer. It may consist of one or more layers as needed but it has been observed that one or two hidden layers are sufficient to solve difficult problems. The hidden layer is responsible for processing the data and training of the network. Last layer is the output layer which is used to give the network’s output to a comparator which compares the output with predefined target value neural networks requires training. We give some input patterns for training and some target values and the weights of neural networks get adjusted A Neural network is said to be good and efficient if it requires less training patterns, takes less time for Training and is able to recognize more unseen patterns. Face neural network consists of 448 input nodes, 12 hidden nodes and 1 output node, and it can be used to train face images. The training images for face neural network can be categorized into three groups - authorized face images, non-face images and other unauthorized face images. The neural network: is trained to produce an output of either 1 for authorized or 0 for non-face images and other unauthorized face images.

In back propagation method, if we use 20 to 40hidden neurons, we get 100% recognition accuracy in very less time. When we increase hidden neurons from 40 to 60 the recognition accuracy remains 100% but training time increases.

Euclidean distance is the solution in finding the distance between histograms of the original image and enrolled images. By the minimum distance between the histograms, it will find the most matching image of the original one. One of the most common metric used is he Euclidean distance measure because it measures the similarity of pattern samples in the geometric pattern space. The Euclidean metric is widely used mainly because it is simple to calculate.

Another method that may be used for this system would be a two-step mechanism. First comes to be face detection then followed by face recognition. For face detection we will be using Viola Jones face detection algorithm while for face recognition we will use hybrid algorithm from PCA and LDA.

1) Viola-Jones algorithm

There are three major blocks in Viola-Jones algorithm; Integral Images, Ada-Boost Algorithm and Attentional cascade. The integral image computes a value at each pixel for example (x,y) that is the sum of the pixel values above to the left of (x,y). This is quickly computed in one pass through the image. Viola jones algorithm uses Haar like features. This is nothing but scalar product between the image & some haar like structures. Feature is selected through adaboost. Ada-Boost provides an effective learning algorithm and strong bounds on generalization performance. The overall form of the detection process is that of a degenerate decision tree, what we call a “cascade”. A positive result from the first classifier triggers the evaluation of a second classifier which has also been adjusted to achieve very high detection rates. A positive result from the second classifier triggers a third classifier, and so on. A negative outcome at any point leads to the immediate rejection of the sub-window. The cascade training process involves two types of tradeoffs. In most cases classifiers with more features will achieve higher detection rates and lower false positive rates. At the same time classifiers with more features require more time to compute. In principle one can use following stages.

Cascade classifier

i) the number of classifier stages, ii) the number of features in each stage, and iii) the threshold of each stage, are traded off in order to minimize the expected number of evaluated features. Unfortunately finding this optimum is a tremendously difficult problem. In practice a very simple framework is used to produce an effective classifier which is highly efficient. Each stage in the cascade reduces the false positive rate and decreases the detection rate. A target is selected for the minimum reduction in false positives and the maximum decrease in detection. Each stage is trained by adding features until the target detection and false positives rates are met these rates are determined by testing the detector on a validation set. Stages are added until the overall target for false positive and detection rate is met.

2) Histogram Normalization

Captured image sometimes have brightness or darkness in it which should be removed for good results. First the RGB image is converted to the gray scale image for enhancement. Histogram normalization is good technique for contrast enhancement in the spatial domain.

2.1) Noise Filtering

Many sources of noise may exist in the input image when captured from the camera. There are many techniques for noise removal. Low pass filtering in the frequency domain may be a good choice but this also removes some important information in the image. In our system median filtering in is used for the purpose of noise removal in the histogram normalized image.

2.2) Skin classification

This is used to increase the efficiency of the face detection algorithm. Voila and Jones algorithm is used for detection. The images of faces and then applied on the class room image for detection of multiple faces in the image.

2.3) Face Detection:

Haar classifiers have been used for detection. Initially face detection algorithm was tested on variety of images with different face positions and lighting conditions and then algorithm was applied to detect faces in real time video. Algorithm is trained for the images of faces and then applied on the class room image for detection of multiple faces in the image.

2.4) Face Recognition and Attendance

After the face detection step the next is face recognition. This can be achieved by cropping the first detected face from the image and compare it with the database. This is called the selection of region of interest. In this way faces of students are verified one by one with the face database using the Eigen Face method and attendance is marked on the server.

The system consists of a camera that captures the images of the classroom and sends it to the image enhancement module. After enhancement the image comes in the Face Detection and Recognition modules and then the attendance is marked on the database server. At the time of enrollment templates of face images of individual students are stored in the Face database. Here all the faces are detected from the input image and the algorithm compares them one by one with the face database. If any face is recognized the attendance is marked on the server from where anyone can access and use it for different purposes. This system uses a protocol for attendance. A time table module is also attached with the system which automatically gets the subject, class, date and time. Teachers come in the class and just press a button to start the attendance process and the system automatically gets the attendance without even the intensions of students and teacher. In this way a lot of time is saved and this is highly securing process no one can mark the attendance of other. Attendance is maintained on the server so anyone can access it for it purposes like administration, parents and students themselves. Camera takes the images continuously to detect and recognize all the students in the classroom. In order to avoid the false detection we are using the skin classification technique. Using this technique enhance the efficiency and accuracy of the detection process. In this process first the skin is classified and then only skin pixels remains and all other pixels in the image are set to black, this greatly enhance the accuracy of face detection process.

**Conceptual Framework**

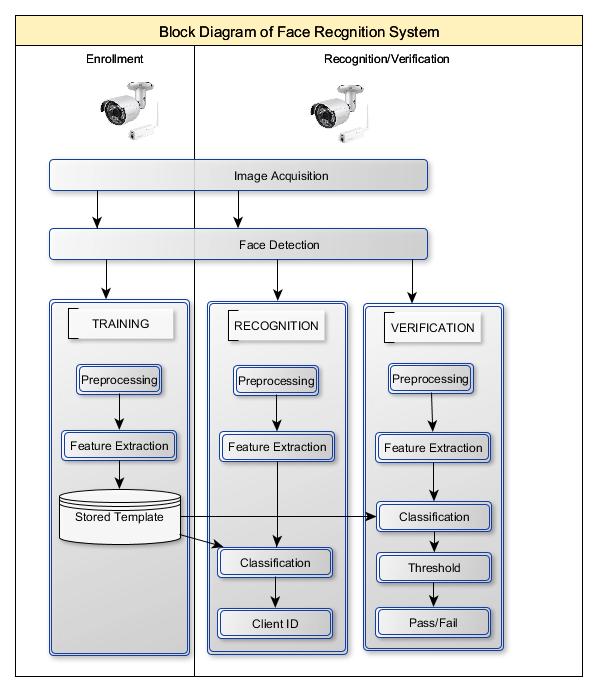


Fig. 1 Conceptual Framework

The system consists of a camera that captures the images of the classroom and sends it to the image enhancement module. After enhancement, the image comes in the Face Detection and Recognition modules and then the attendance is marked on the database server. At the time of enrollment templates of face images of individual students are stored in the Face database. If any face is recognized the attendance is marked on the server from where anyone can access and use it for different purposes. This system uses a protocol for attendance. A time table module is also attached with the system which automatically gets the subject, class, date and time. Teachers come in the class and just press a button to start the attendance process and the system automatically gets the attendance without even the intensions of students and teacher. In this way, a lot of time is saved and this is highly secure process no one can mark the attendance of other. Attendance is maintained on the server so anyone can access it for it purposes like administration, parents and students themselves.

# Design and Methodology

This paper proposes a face recognition method using PCA with neural network back error propagation learning algorithm. In this paper a feature is extracted using principal component analysis and then classification by creation of back propagation neural network. We run our algorithm for face recognition application using principal component analysis, neural network and also calculate its performance by using the photometric normalization technique: Histogram Equalization and comparing with Euclidean Distance, and Normalized correlation classifiers. The system produces promising results for face verification and face recognition. The proposed face recognition system consists of two phases which are the enrolment and recognition/verification phases. It consists of several modules which are Image Acquisition, Face Detection, Training, Recognition and Verification. In image processing session, the image acquisition, feature extraction and data normalization are performed.

**Nature of the Study**

The researchers propose a face recognition method using PCA with neural network back error propagation learning algorithm. In this paper a feature is extracted using **principal component analysis** and then classification by creation of back propagation neural network. We run our algorithm for face recognition application using principal component analysis, neural network and also calculate its performance by using the photometric normalization technique: Histogram Equalization and comparing with Euclidean Distance, and Normalized correlation classifiers. The system produces promising results for face verification and face recognition.

**Population and Sample**

The population of interest for this study are Asia Pacific College students.

**Research Instruments**

The researchers used literature related to the study with topics about Face recognition, neural network, Back Propagation, Principle Component Analysis, Histogram Equalization, and Euclidean Distance.

To further support the statements of this research, other materials will be used such as EBSCO Host and Google Scholar for factual references.

**Data Analysis**

The proposed face recognition system consists of two phases which are the enrolment and recognition/verification phases. It consists of several modules which are Image Acquisition, Face Detection, Training, Recognition and Verification. In image processing session, the image acquisition, feature extraction and data normalization are performed.

The steps to perform histogram equalization are as

follows:

1. For an N x M image of G gray-levels, create two

arrays H and T of length G initialized with 0 values.

2. Form the image histogram: scan every pixel and

increment the relevant member of H-- if pixel X has

intensity p, perform

H[p] = H[p] +1 (1)

3. Form the cumulative image histogram Hc; use the

same array H to store the result.

H[O] = H[O]

H[p] = H [p -1] + H[p]

For p = 1,..., G-1.

4. Set

G -1I

T[p] H[p] (2)

MN7

Rescan the image and write an output image with

gray-levels q, setting q = T[p].

# Conclusions

The paper has presented a face recognition system using PCA with neural networks in the context of face verification and face recognition using photometric normalization for comparison. The researchers will need to conduct experiments to show the Neural Network Euclidean distance rules using PCA for overall performance for verification. For recognition, Euclidean distance classifier must be studied in order the show the accuracy using the original face image. Also, the results of applying histogram equalization techniques on the face image must be studied to show its impact to the performance of the system in a controlled environment.

# Appendices

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