# Design and Implementation of Low Resolution Face Recognition System for Educational Purposes

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science in Information and Communication Technologies in Education.

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# ABSTRACT

In recent years, it has been observed that educational institutions, especially students, have started to use a number of special systems to facilitate the entrance of the exam and to ensure security. Automatic systems (automatic attendance systems) have become more popular as manual participation systems are ineffective and time-consuming. Nowadays, one of the automatic systems which have gained popularity especially in terms of educational institutions is the face recognition system. The most important reasons for this are that less direct face contact with cameras is required for detection and that development, installation, and application are less costly.

The main purpose of this research is to provide an alternative way to record in the class by using a facial recognition method and to automatically enroll students in examinations.

Some of the systems have some problems in the literature. In this study, some techniques and methods have been developed to reduce existing problems. In this context, according to the information obtained based on the literature, Viola-Jones Algorithm and Histogram Balancing are two important techniques called balancing and could eliminate the possible errors in the projection. As a result of the study, a system has been developed by making use of the literature in order to enable the students to take the exams and to get attendance in the classes automatically.

**Keywords**: Face Detection, Face Recognition, Viola-Jones Algorithm, Attendance Management Systems, Pre-Processing, Egin Face, Automatic Attendance System

# ÖZ

Son yıllarda eğitim kurumlarının, özellikle öğrencilerin sınava girişlerini kolaylaştırmak ve güvenliği sağlamak adına bir takım özel sistemleri kullanmaya başladığı görülmektedir. Manuel katılım sistemlerinin etkisiz ve zaman kaybına sebebiyet vermesi sebebi ile otomatik sistemler (otomatik katılım sistemleri) daha popüler hale gelmiştir. Günümüzde özellikle eğitim kurumları açısından popülerlik kazanan otomatik sistemlerden bir tanesi de biçimi Yüz Tanıma Sistemidir. Bunun en önemli nedenleri, algılama yapılabilmesi için kameralarla daha az doğrudan yüze temas gerekmesi, ayrıca geliştirme, montaj ve uygulamanın daha az maliyetli olmasıdır.

Bu araştırmanın temel amacı, bir yüz tanıma yöntemi kullanarak sınıf içi yoklama yapılmasını ve sınavlara öğrenci alınmasını otomatik olarak kayıt edecek alternatif bir yol sunmaktır.

Literatürde yer alan çalışmalarda bazı sistemlerin birtakım sorunları olduğu görülmektedir. Bu çalışmada mevcut sorunların azaltılması için bazı teknikler ve yöntemler geliştirilmiştir. Bu bağlamda literatüre dayalı olarak elde edilen bilgilere göre, Viola-Jones Algoritması ve Histogram Dengeleme adı verilen iki önemli tekniktir ve projeksiyondaki olası hataları ortadan kaldırabileceği belirlenmiştir. Çalışma sonucunda öğrencilerin sınavlara girişini ve sınıflarda yoklama alınmasını otomatik yapabilmek üzere, literatürden de faydalanılarak bir sistem geliştirilmiştir.

**Anahtar Kelimeler:** Yüz Algılama, Yüz Tanıma, Viola-Jones Algoritması, devam yönetim sistemleri, Öncesi İşleme ,Egin Yüz. Otomatik Devamlılık Sistemi

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# INTRODUCTION

## 1.1 Introduction

The broader field of education has seen rapid expansion in the culminating years of the 21st century and has ushered in unique educational centers such as Universities, Private and Public institutions to offer boundless education to the keen in the fields of Art, Music, Sports, Fashion, etc. To enhance the conveyance of valuable information to the students, dedicated instructors are recruited to assist with facilitation and also ensure students receive necessary material and up-to-date information that will expedite their readiness for the job market. As per every institution mandate, assessment of students is to be carried out on the regular by devoted instructors, to encourage student punctuality in doing school work and attending classes. This strict punctuality fosters quality employees of the future and responsible members of society. This brings about grand appreciation and astounding admiration of institutions of learning by the society at large because of its positive contribution. (Wagh, Priyanka, & Chaudhari, 2016).

Several institutions have conducted a study on students and other institutions of learning that revealed that, contrary to popular belief, higher student performance is determined by the quality of class attendance and full participation of the instructor conducting the class rather than the number of hours students undertake to study. This study was carried out by requesting instructors to record the total number of students who were in attendance in a week, and also requesting institutions to record and measure the consistency of instructors attending to the students in a week. The accumulation of results at the end of the week revealed that inaccurate measure of the student attendance by the instructors resulted in students becoming disengaged and disorientated in participating in class, and therefore caused an overall deterioration of academic performance when the outcome is extrapolated. The paramount notion suggested by this study is that some form of an accurate measurement of attendance enforces heightened student participation in the class. Amongst other reasons instructors do not adhere to consistent student attendance recording include the tediousness associated with the task and the great length of time consumed using papers and files to manually record the attendance of individual students.

The most common ways of recording student attendance are the usage of attendance lists, micro-management and the usage of biometric systems. To increase efficiency, automated systems could be implemented. The most common automated systems include fingerprint scanner, plastic cards, palms scanners, pins and eye detections for identification. The downsides of using these automated systems is that they are expensive to implement, time consuming and easier to manipulate. A suitable system that record student attendance should be efficient, cost-effective and impenetrable (Prabhavathi, 2017).

Using biometrics for keeping student attendance records is a viable solution, because biometrics are efficient, minimize errors and are also cost-effective. The most popular biometrics are fingerprint scanners, palms scanners, retina scanners and face recognition system. Face recognition systems proves to stand the test of time because it requires minimal bodily reaction for execution, it is cost-effective and it also offers minimal errors when executed. Face recognition system explained is a system that uses digital cameras to detect and extract a digital image of a face and then compares the extracted image with images in the database. (Prabhavathi, 2017).

The advent of technology has opened doors to the possibilities of carrying out menial tasks of the day online and this means coinciding rudimentary systems that will add efficiency and convenience should be developed. One of the many available systems is Face detection. Face detection primarily recognizes a face in any given random image. As easy as it sounds, the software that carries out the instruction of this task is very complex even for a computer. Therefore, execution drawbacks often emerge, caused by occlusions, illumination and face viewpoint. To mitigate these drawbacks, the Viola-Jones algorithm was developed. This algorithm processes images very quickly in the same equivalence with the high face detection rate (Cen, 2016).

In surveillance system, the captured images are too small and possess a low resolution and they should be matched with high-resolution images, so it will be cues of low face recognition. Majority effects of low face recognition in different resolution was evaluated and each effect will be calculated in the XU experiment. A new way forward was suggested based on these effects. An image with good quality is achieved through image-preprocessing that is used for illumination effects for a raw video image in a security camera. Face images are achieved by an image processor with a new resolution. This approach has shown to improve face recognition through experiments. Experiments also show that in addition to the camera type, image resolution is very effective on face recognition performance in security cameras. The Xu examples have proved that his approaches are significantly better when compared to the traditional approaches. However more effects should be calculated, including motion-blur, too much low resolution, and outdoor detection (Xu, Liu, & Li, 2014)

Varadharajan (2016) replaced automated attendance management system with manual methods. In one of the methods, the time is saved, and storage of information is more effective than manual methods. Many biometric processes are available for usage, but face recognition is the best biometric for implementation. For this technique, the camera will be fixed in a classroom and it will capture images, then the captured images will be compared with images in the database in order to recognize the students. If they are absent then a message will be sent to their parents to inform them about their absence. There are several methods for comparing student's faces. One of these methods is Eigen's face. With this method, we can replace all the oldest facial images. This system is easier to implement. For this method, attendance recording is easier and most effective without errors. However, difficulties to be encountered could include face recognition with glitches (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016).

Soniya (2017) recognized that across the world the automatic attendance plays a very important role in educational institutions and workplaces. This is because it is very reliable and it saves time. This system automatically recognizes the entrance of students in a class and periodically, marks attendance for them. The stored data can be useful for management decisions or student scores. Arduino is used automatically for the attendance of students. Therefore, this system will decrease the manual process of taking student attendance, and the time which is taken for making reports will be reduced. This attendance system is safe and reliable and it will assist the management to take student database from students and take attendance at the classes. This system can be upgraded in the near future and will possess capabilities that will easily calculate student marks and also upload students marks on their personal portals, or when students are absent, the system would inform the students' parents or guardian through message relaying (Soniya , Swetha Sri, Swetha Titty, Ramakrishnan, & Sivakumar, 2017).

## 1.2 Aim of the Study

The main purpose of this research is to present an alternative way that will automatically record student attendance in the exams using a face recognition technique.

## 1.3 Research Question

1- How to design and implement the FRT system for educational purposes?

2- How to apply FRT system in order to take and record student's attendance?

3- How to apply FRT system in order to take recorder and authenticate student's attendance for exam entrance?

## 1.4 Limitation

Viola-Jones algorithm by Haar feature, rgb2gray algorithm and the Eigenface Algorithm.

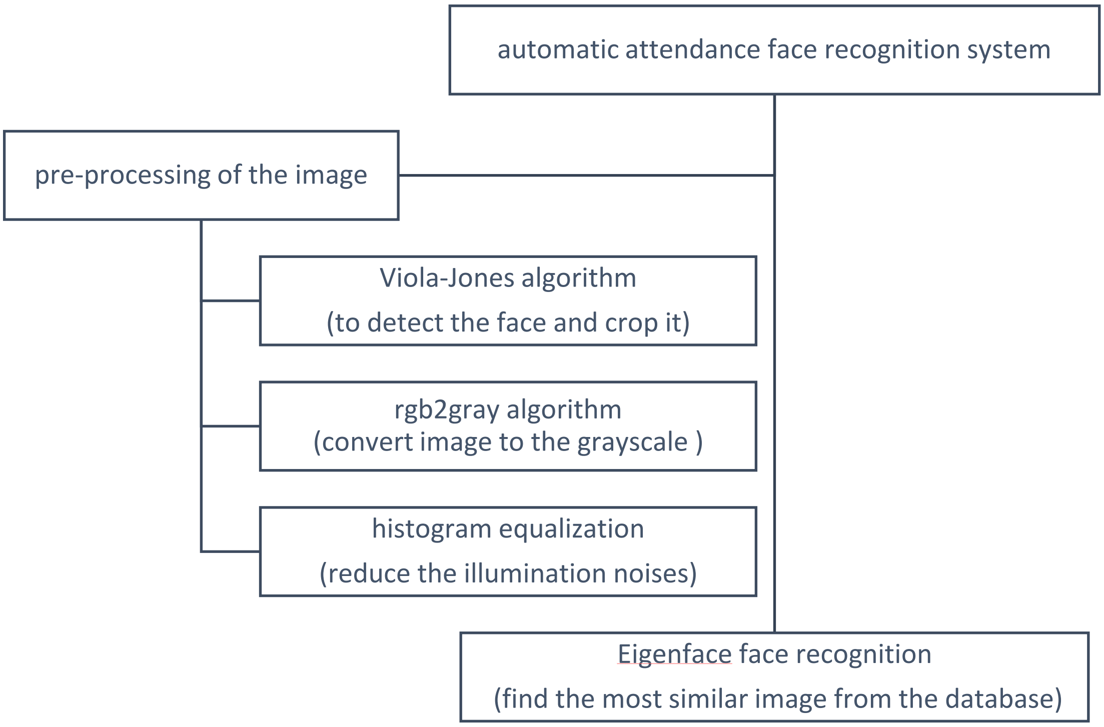


Figure 1: Automatic attendance face recognition system

## 1.5 The Significance of the Study

The traditional methods of recording student attendance are very flawed and involve jotting and passing paper log and this creates cheating opportunities for students, temporarily shifts student focus, students input wrong information, and the paper log could get damaged or lost.

Implementing the FRT system will eliminate all the downsides associated with traditional methods of taking student attendance and will increase the focus rate, eliminate cheating opportunities and automate the process of taking attendance by detecting and recognizing student faces.

The implementation of this system has various advantages. Errors in student attendance recording will be reduced and the system will prevent perpetrators from manipulating and obliterating data, and will also prevent data leakage. All student information will be stored inside the database. For implementation, this system will not require any special device or equipment. It is a computer-based system and will only be accessed through the usage of a software. It can easily connect with any kind of camera such as mobiles phone cameras or any other digital camera. The only input of this system is digital images of faces which could be captured with any kind of a camera and import them into the system. Biometrics such as fingerprint scanning and palm scanning can become a hassle to carry out but capturing face images is far easier and simplistic. Also, this system doesn't need any human intervention. The cameras can capture human pictures from a far distance and process it.

# Chapter 2

# LITERATURE REVIEW

## 2.1 Face Detection Algorithms

The technology of Face detection was born when two serial inventors, namely Wagh and Chaudhari (2015), wanted to develop a system that automatically detects, recognizes and authenticates student faces and also record their attendance. They named this system the Face Recognition System. The first step in the system's operation is to capture the face. The captured image is then imported into the system and it undergoes some pre-processing techniques that include converting the image into grayscale in order to enhance quality and also applying histogram equalization technique to the image (Baloch, HaroonYousaf, Ahmad, & Iran Baig, 2012). Subsequently following image enhancement, the process of detection commences. The process of detection requires specific algorithms for well-rounded functionality, including Support vector machines, Ada-Boost algorithm, Neural Networks, etc. (Wagh & Chaudnair, 2015). Wagh (2015) realized that only one detection algorithm, Ada-Boost algorithm, works best with the process of face detection. The application of cascade concepts and Haar feature works best with Ada-Boost algorithm (Heydarzadeh & ToroghiH, 2012)

Experts in Face detection technologies, Nilesh D. Veer and B. F. Momin, declared that to successfully automate the process of recording student attendance from a surveillance camera, face detection technology as well as its accompanying algorithm need to be implemented. According to these experts, the system needs to automatically register the students and also detect and recognize them (Veer & Momin, 2016). The process of registration should take place as follows: students simply need to stand right in front of the webcam and have their faces captured and saved inside the database (Veer & Momin, 2016). Viola-Jones Face detection algorithm will be applied to the images for enhancement (Viola, Paul, & Michael, 2014). This algorithm is better suited for the system of face detection because it enhances definition and quality of the image (Degtyarev, Nikolay, & Oleg Seredin, 2010).

Pioneers in detection technologies, Jayant and Borra (2016), have developed an automatic attendance system based on face recognition. Their face detection system uses the Viola-Jones algorithm because it has great image enhancement qualities and it is also accurate. (Viola, Paul, & Michael, 2014). Their ideal occasion of recording student attendance is to begin by fixing the camera in the direction that faces the door. The images captured will be converted into grayscale to denote the first step of pre-processing. The Viola-Jones algorithm will then be applied to the images for enhancement. To internally calculate facial features that categorize the images, Ada Boost algorithm will be applied. The algorithm will dissect the images and select the most important features amongst those which have been computed. Classifiers which are useful will be organized to form a cascade in order that will remove the background of the captured images (Kanchan & Borra, 2016). Three benefits of the Viola-Jones algorithm are fast feature calculation, choosing effective features and Instead of scaling the extracted images, preparing feature scaling subsequent face detection (Viola, Paul, & Michael, 2014).

Varadharajan (2016), detection technology developers, have given a concise definition for the algorithm that is based on face recognition because it consist of low limitation and high accuracy (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016). For face detection Varadharajan utilized a background subtraction technique. This technique is one of the most common techniques used in detection. Since the environment background is always static, it is subtracted once it is detected to exist within the set of images. To measure the accuracy of face detection, the subtraction in the background will be selected and examined within different conditions. (Egammal & mittal, 2006). The first step in the process is to convert the images into grayscale (Hsu, Mottale, & Jain, 2001) thereafter the subtraction in the background will take place (Hsu, Mottale, & Jain, 2001). The last step increases accuracy in the process of face detection (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016).

Detection and scanning technologists, argued that the process of face recognition should be divided into different categories, but with the main focus directed to detection and recognition. The first requirement should be a student's image of their face. The image will be captured by a camera which will be strategically placed in the classroom. The camera should be equipped with capabilities of recording a video. This capability should activate as soon as the camera senses movement, and the underlying recorded video should be sent to the main system for frame analysis. To detect the face of the student within the frames, the Viola-Jones Algorithm will have to be applied as well as the Ada Boost Algorithm and Haar feature classifiers. In a nutshell, Raghuwanshi attest that Viola-Jones algorithm is far much more imperative algorithm for this experiment (Raghuwanshi & Swami, 2017).

## 2.2 Face Recognition Algorithms

Over the years, pioneers in the industry refined and improved the technology of face recognition, to such an extent that it was integrated with mathematics. The mathematics integrated technology spawned a new name called Eigenface Technique. This technique uses mathematical transformation to recognize facial features. It is easier to implement and operates on the simplest algorithm. Furthermore add to the upside, the technique possesses the highest rate of processing time, boasts high storage capabilities and linear accuracy. In the downside, the technique has the highest correlation between training data and recognition data, and to achieve accuracy, it requires light intensity. Furthermore, it is easily changeable. An all rounded advantage for this technique is that it was developed to primarily enhance efficiency and also improve accuracy through orientation and image scaling, and therefore in that regard, it is an asset (Jaiswal, Sarita, & Rakesh, 2011).

The most important component in Wagh system design was the process of student face detection from an image. Different viable techniques for this approach, such as Eigen face, PCA and LDA hybrid algorithm could be explored. Wagh applied Eigen face technique along with its corresponding principal component analysis. The face of the students detected will be cropped from the image and their facial features will be extracted. With the aid of eigenfeatures, student face images will be easily recognized through the comparison of the face images and the database images of the students (Wagh & Chaudnair, 2015).

Success in using surveillance camera to track automated attendance is determined by implementing face detection and algorithm of face detection. Their system mainly involves registering students into the system and recognizing the students (Veer & Momin, 2016). To commence the process of recognizing students from the system, the duo extracted videos from the surveillance cameras. They converted the videos into individual frames. This is done to remove unwanted images. They then applied the Viola-Jones algorithm for enhancement because the algorithm uses an integral image display and Ada-boost for better performance in different lighting conditions (Veer & Momin, 2016). Recognition becomes possible subsequent detection. Facial features will then be extracted from the frames to be compared with the facial features from the database. This whole process is similar to the registration process of the students (Veer & Momin, 2016). PCA and LBP classifier could be considered for student recognition process (Faruqe & Hasan, 2009).

The face recognition automated attendance system designed by Jayant and Borra (2016) has to be configured by alignment-free partial recognition algorithm for the normal functionality of the process of recognition. The upside of using this algorithm is that it does not require face pre-alignment, students need not to be attentive to the camera to have their faces captured and it can fully function under any type of distortion including pose variation, occlusion and illumination (Kanchan & Borra, 2016). For this algorithm, important features and their descriptions will be extracted using Multi-Key Point Descriptor. The partial's face descriptors will not be altered because of MKD's sturdiness. Sparse Representation Classification (SRC) will be used for face recognition (Jain & Liao, 2012).

Varadharajan took advantage of the fact that there are many systems of face recognition available to be explored. The trio decided to implement the Eigen Value Method (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016). They alleged the suitability of this system because of its speed (NirmalayaKar, 2012). The major advantageous constituents of the system include speed, ease and learning ability, all these makes it befitting for face recognition (Zhao, Chellapa, Phillips, & Rosenfld, 2003). Face images will be broken down to face features of small characteristic sets that make up the main components of the captured facial images of the primary training set. Through the linear composition of Eigen faces, each face will be introduced. Therefore each face will be approximated using Eigen faces (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016).

Cropped face images that were detected were systemically processed by a correlating algorithm. The detection required the element of Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA). Based on the precision of recognition both algorithms will be put into comparison. Within the predisposition of PCA, Eigenfaces algorithm will be applied. The facial features extracted that include image related information make up the Eigenfaces. Comparison will take place between the extracted face images and images in the database for recognition to take place. Student attendance will be recorded once validation is confirmed (Raghuwanshi & Swami, 2017).

## 2.3 Used Algorithms

Face detection is the first in face recognition. The process of face detection is also one of the most studied subjects in computer studies. The main objective in intensive studies of face detection is to study all the processes involved in capturing human face images for face detection through a computer. And also explore in detail whether the computer could return exact locations of the captured face in the image. There are currently many algorithms available to coincide together with the process of face detection. The most efficient and effective algorithm is Viola-Jones algorithm because it possesses the ability to process images very quickly and it is also accurate.

Yang et al categorized the approaches of face detection into four major categories namely knowledge-based, feature invariant, temple matching and appearance based approaches (Zhang & Zhang, 2010). Knowledge-based approaches are dependent on a specific set of rules that detect faces based on human knowledge. For instance, a face consists of two eyes, a nose and a mouth, all relatively positioned next to each other. Approaches of feature invariant extract structural features of the face, and consequently locate the face (Kender & Kjeldsen, 1996) (Leung, Burl, & Perona, 1998). To distinguish facial and non-facial regions, a statistical classifier is trained and then used for this process. Matching approaches of the template predefine and parameterize templates of the face to detect and locate faces, by calculating values of correlation between templates and image of input (Craw, Tock, & Bennett, 1992). Approaches of appearance are dependent on a set of delegate training face images to discover face models (Rowley, Baluja, & Kanade, 1998). Appearance based methods are generally much superior in performance when compared to any other method. For the past decade, Viola-Jones face detector has been the most impactful in face detection research. The process is mostly used in industry applications such as digital cameras and digital photo managing software.

The three main ideas providing real-time face detection in Viola-Jones algorithm are image integral, classifier learning with AdaBoost, and attentional cascade structure (Cen, 2016).

Face detection experts Mittal mentioned the disadvantages of Viola-Jones algorithm being light sensitivity, detecting random objects as the face and requiring certain human posture to detect the face. They also mentioned the advantages of using Viola-Jones algorithm being quick computation of the facial features, effective selection of facial features and high rate of detection (Mittal & Shivnani, 2016).

The first object detection framework to provide competitive object detection rates in real time is Viola-Jones object detection framework, and it was proposed in 2001 by Paul Viola and Michael Jones (Viola & Jones, 2001). The limiting constraint of the Viola–Jones algorithm is its requirement for full view frontal upright faces. Therefore, the occurrence of any detection is tied to the face that should always be facing towards direction of the camera. As much as this constraint sounds diminishing and of dire consequence, the limiting insinuation is always fully acknowledged by the photographer and the model (Viola & Jones, 2001).

Since facial images that are extracted can change in illuminations, viewpoint, etc, it is imperative to have an idea about features which could be useful in representing a human face to exclusively deal with changes. In order to reduce the noises, few pre-processing methods should be applied (Haiyang & Zhang, 2011). The outcome of face recognition and its rate is influenced by the process of pre-processing. This is the reason extracted images should become grayscale subsequent detection. The color of the light source also has an influence on the image RGB color and this could reflect on the facial features. The reflection will negatively affect face recognition and ultimately reduce its rate of detection (Gadiparthi, Abebe, & Sreenivas, 2015). RGB2GRAY methodology was successfully used to convert the extracted images into grayscale by reducing the underlying effects.

Illumination effects are the next challenge for facial images. Histogram equalization method was used to remove illumination noises. To reduce and improve face illumination and avail the facial features for extracting, histogram equalization method will be used. Data amount will be reduced by this method but loss of information will not be avoided (Ramirez-Gutierrez, Cruz-Perez, Olivares-Mercado, Nakano-Miyatake, & Perez-Meana, 2011).

For authentication, the facial image will be compared to the facial images in the database subsequent pre-processing. Principal Component Analysis (PCA) will be used for this approach. PCA is a statistical calculation method that used in face recognition to decrease the number of variables. Every facial image in the training set of the PCA method will be characterized as a linear combination of weighted eigenvectors collectively called Eigenfaces (Chandra & Sumam, 2012).

In computer vision, Eigenfaces are regarded as Eigenvectors which are used for the problem of facial recognition. They refer to the approach of base appearance in recognizing the face which could capture the variation in face image collection. To encode and compare individual faces in a general approach, this information will be used (Kirby & Sirovich, 1987). Eigenfaces have mostly been used to extract specific information on human faces including eyes, lips or nose and engage in the reduction of complexity and calculation by the indication of face image (Vijaya, Bharadwaj, Ram Mohan Rao, Govardhan, & Reddy, 2009).

Vectors of human faces are used in the main formation of Eigenfaces. The one important concept in Electrical Engineering Eigenfaces relate to is Fourier Analysis. Fourier Analysis denotes a sum of weighted sinusoids that differ in frequency could recompose a perfect signal. This technique allows a sum of weighted Eigenfaces to reconstruct a particular human face.

## 2.4 Related Research

The most useful biometric system to identify people is the technique of Face Recognition (Patil & Shukla, 2104). This technique is beneficial in recording student attendance in educational systems. The educational system is constantly growing rapidly and it is amassing thousands of students each and every year. This means it is becoming increasingly difficult to record each and every single student attending in over a dozen departments spread on almost every school campus. An automated face recognition system that will track students will go a long way in solving the most complex task of recognizing a crowd of students attending in a dozen departments at any given time (Wagh & Chaudnair, 2015).

Wagh discovered that their designed automated system of attendance for tracking students will prohibit students from cheating altogether. Their system is very simplistic and direct. They only require a computer consisting of the database of images of student faces and a camera (Wagh & Chaudnair, 2015).

Success of using a surveillance camera to record student attendance is directly connected with implementing the algorithm of face recognition and face detection. This is because limitations exist for distinctive algorithms and techniques. Using a recorded video to identify human faces is very intricate because of the pre-existing noises such as background alteration, face shifting and illumination problems. Commonly used algorithms focus more on the frontal view of human faces and remove backgrounds like buildings and trees in the image. The expert duo is pitching for an attendance system that will erase those limitations. Their system will recognize and register students (Veer & Momin, 2016).

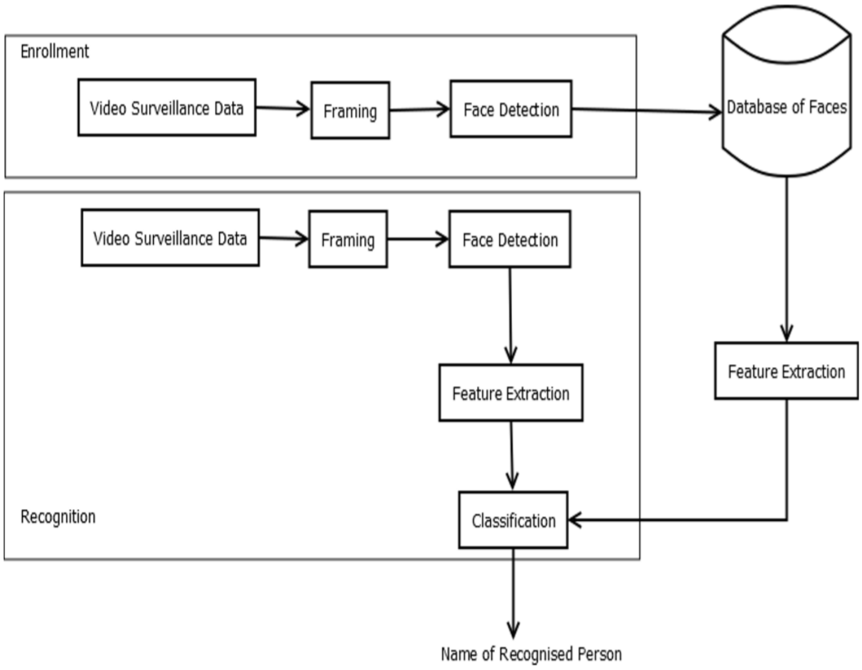



Figure 2: Veer and Momin presented their system that will remove the limitations of face recognition

Nilesh discovered that their system delivers 100% of the rate of face detection in a frame that could contain 40 students. They also discovered that when the number of students increase per frame, the rate of face detection decreases. This entails that the system will function perfectly if it were to record student attendance individually (Veer & Momin, 2016).

Every educational system possesses its own unique system of attendance. Some use traditional methods whilst others use other forms of biometric systems. Organizations consisting of large student attendance will find it difficult to record each and every single student and also calculate their average attendance percentage value. Implementing a Radio Frequency Identification technique (RFID) will be very beneficial for these organizations. (Lim, 2009). The only flaw of an RFID is that it is highly cheatable, students will easily bypass it and cheat. Kanchan Jayant firmly believe that installing a biometric system would mitigate the problem. Would achieve the solution. This system consist of scanners ranging from voice, palm hand, eye, etc and each has its own pros and cons (Kanchan & Borra, 2016).

Using biometric techniques to record student attendance is more reliable than using traditional methods in that biometric techniques offer superior security. However, they are not without flaw. Most of these techniques are uncommon or unheard of and so this diminishes the reliability of the system. Only one system offers the peace of mind reliability and security, and this system is Face Recognition (Kanchan & Borra, 2016).

Kanchan Jayant and Borra (2016) developed an algorithm database that will collect images of students in their college registration period along with student names and seat number. For every 20 minutes in class, a frame will be captured. The focus of face detection system will be dependent on the student orientation angle. Student posture will also be of considerable importance during class hours. A face detection will be automatically saved as a training set in the database for that particular student.

Since student appearance may differ all the time, student's face will be flawlessly detected in every case. The system will then crop the face and face recognition system will be applied on the cropped face. The duo's algorithm managed to recognize about 41% - 71% correctly. The algorithm has room for improvement if database images could be used for verification (Kanchan & Borra, 2016).

Preserving student attendance is very complicated for institutions (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016). Every institution has its dedicated methodology of administering student attendance. Some institutions use attendance sheets whilst others use biometric techniques. Most of these methodologies are unnecessarily time consuming. Student attendance is usually recorded by faculty instructors and by every means waste valuable staff time. Another downside of this is there's always room for errors. Student will not back down from cheating if granted an opportunity.

Calculating attendance average will also prove very challenging when done manually and chances are there will be many mistakes and errors within the calculations. Calculation sheets could also go missing or get torn. The only solution for such a debacle would be an automated Face Recognition System (Shoewn, 2012).

The availability of many biometric techniques bring about a common problem in that all of them share almost a similar concept and similar disadvantages. (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016). All the biometric techniques could simply be overshadowed by an automated attendance management system. This will prove to stand the test of time and will store data until unnecessary (Khan Balcoh, HaroonYousaf, Ahma, & IranBaig, 2012).

Varadharajan (2016) have described a methodology based on face recognition since it is resembling low limitation and high accuracy. The block diagram is described as the following figure (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016).

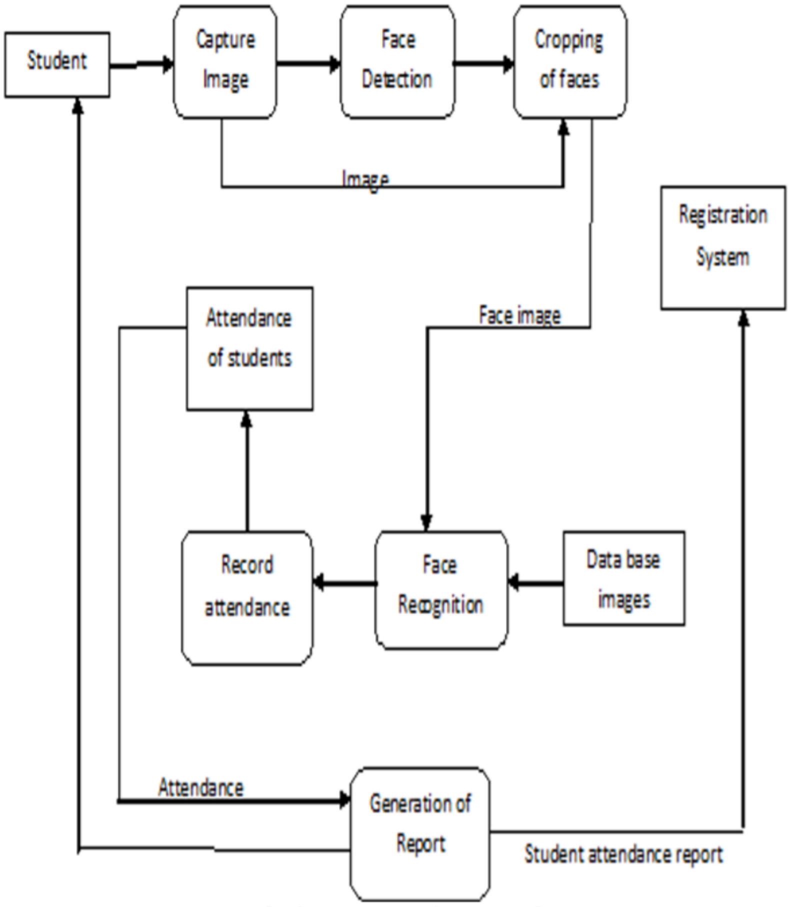


Figure 3: the designed method of Varadharajan, Dharani, Jeevitha, Kavinmathi, and Hemalatha base on face recognition

Old methodologies could replace this methodology. Although this methodology is efficient and useful it will require simpler and cheaper equipment. This means now that attendance management is simpler and has higher accuracy (Varadharajan, Dharani, Jeevitha, Kavinmathi, & Hemalatha, 2016).

Raghuwanshi and Dr. Preeti (2017) discovered that video-based facial recognition has caught on so much attention recently when they've invested so much time and work to raise public awareness about the system previously. Many people use many available biometric techniques for detection without giving the accurate face detection system a try. It is slowly moving towards becoming the default method for detection (Shukla, 2014). Face Recognition system could be easily implemented in the educational system in order to accurately record student attendance. In many organizations, it is always compulsory for student and employees to register their attendance. This is time consuming if done manually and present many disadvantages. The sheet for recording attendance could easily be manipulated or destroyed. The solution for this could be the instigation of biometric techniques such as fingerprint, palm hand, iris recognition, etc.

The downside of using these biometric techniques is that they require good care and personal attention. To avoid human interference, researchers have developed a video-based face recognition system. This is because the process of face detection offers an extensive potential product development such as security or organizational surveillance system (Raghuwanshi & Swami, 2017).

Raghuwanshi and Dr. Preeti (2017) designated the importance of using the technique of face detection in educational institutes to achieve an attendance management system that is effective, record student attendance and also automatically calculate the total percentage of students attending. The process of face detection will be divided into unique steps, with the most important once being face detection and recognition.

The best result could be achieved by both the PCA and LDA algorithm through the placement of a suitable camera in a suitable distance, in a suitable area of the classroom and a static pose, all these could go a long way in aiding to achieve the best result. Since both of these algorithms function on pixel calculation, high resolution for the images will be required. They share similar characteristics. For time factor allocation, the first preference is the PCA because it takes less time than the LDA. For rate of recognition, the first preference is the LDA because it has higher recognition rate (Raghuwanshi & Swami, 2017).

# Chapter 3

# DESIGN AND IMPLEMENTATION OF THE SYSTEM

The Face recognition technique (FRT) is a technical functionality that detects and recognizes facial images and it is web based designed. It was specifically designed to record student attendance in examination periods. The two main parts contained within the system database consist of the processes which store student images and student information, and the functionality which is necessary in authenticating student.

## 3.1 Gathering Images Database

The first approach in the FRT system is to create and put together images of the model database. From all model members, images should be captured. From every face positioning of each member equal images need to be captured. The total number of images captured from each member should be equal to the result of the FRT system. Every member should have the exact number of images. Members need to look straight into the camera.

Figure 4: The raw picture which are captured from one member of the model with the phone camera.

Ten photos of each member were considered for the FRT system database. The member needs to make sure they look at the lens although their face positioning could change from time to time, such as turning to look to the right or left or raise up or down the face or look straight into the lens as depicted in Fig. 4. Ten different positions of the members face positionings will be captured because the FRT system needs to store all member's facial features in the database including apparent scars or shape of the face, nose, eyes or other features. A normal classroom with normal light will be used to capture photos. A phone camera was used by the FRT system to capture the pictures above. No light filtering was added to the pictures during the photography session. The following images are examples of photos which were captured from a model.

## 3.2 Pre-Processing of Database Images

After the images have been captured they need to undergo the procedure of pre-processing as an FRT standard in order to be enhanced.

Figure 5: The steps of image pre-processing

The raw pictures will have to change into the standard format of the FRT system in the pre-processing step. Issues which might have arose during the photography will be resolved at the beginning of this step. The following chart, shows the steps of pre-processing.

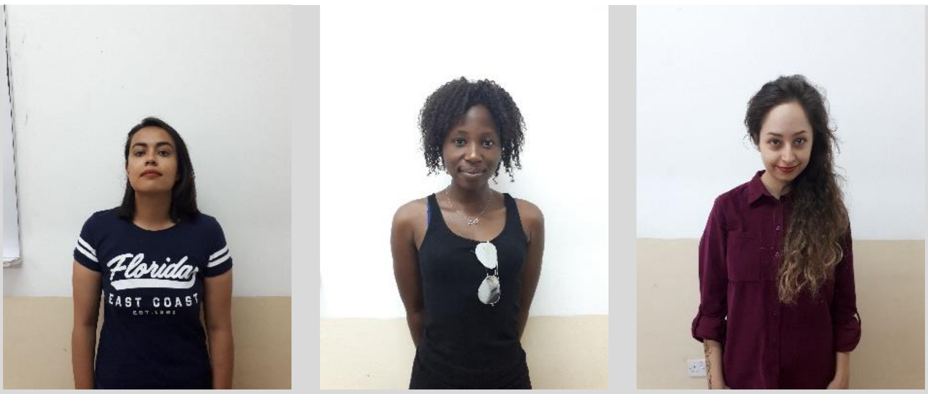
### 3.2.1 Cropping

Cropping is the first step of the FRT system pre-processing. The FRT system sometimes malfunctions when recognizing a picture simply because the photography had been taking place in an uncontrollable environment and the pictures therein contain unrecognizable background. This is why removing picture backgrounds and other unwanted stains is a necessity. The face will be cropped by the system and it will be saved in the database. Recognizing a face in the pictures has several different solutions such as searching for eyes or nose. With this technique, the system can decide which part of the image contains face and needs to be extracted.

Viola-Jones object detection framework has been used in the FRT system. This framework is the first object detection framework which was presented in 2001 by Paul Viola and Michael Jones based on proposed detection rates in real-time. Viola–Jones requires full view frontal upright faces (Mittal & Shivnani, 2016).


Tilted to the left side | Tilted to the left side | Tilted to the right side

Figure 6: Example of the entire image which tilted to either sides.




Correct Position | Correct Position | Correct Position

Figure 7: Examples of the Images which are in the correct position

Fig. 6 and Fig.7 show the correct positioning of the face for full detection. It is important that the face is not tilted in any other direction but held up towards the camera. As much as it sounds like the restrictions imposed could limit the algorithm’s performance since usually after detection follows recognition, it is completely acceptable and acknowledged by the model and the photographer.

Features of Viola-Jones object detection framework possess a rectangular looking like filter called Haar feature.

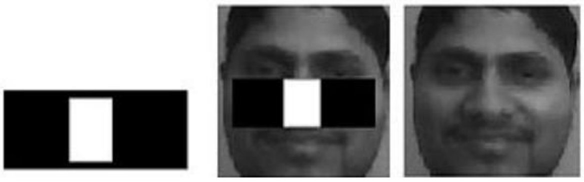


Figure 8: Haar Feature that looks similar to the bridge of the nose is applied onto the face

Figure 9: Haar Feature that looks similar to the eye region which is darker than the upper cheeks is applied onto a face.

Haar features originates from functions of Haar basis (wavelets-based transformation of images). The are several common contrasting features on the human face including the eye (A dark pupil in the white background) etc. and such features are utilized by the algorithm.

Through the framework of Viola-Jones object detection in the image, the FRT system will try to locate the face of the model. Then the system will use the algorithm to locate the eyes to ensure the area selected is suitable. When everything checks out, cropping and extraction will take place.

Using the code below, the FRT system will check the availability of the folder subsequent the introduction of the folder of images to the system.

```
clc;

close all;
myFolder = './Images';
if ~isdir(myFolder)
```

```
    errorMessage = sprintf('Error: The following folder does not exist:\n%s',
myFolder);
    uiwait(warndlg(errorMessage));
    return;
end
```

The images will be loaded and stored in the FRT system in a variable called “a”.

```
filePattern = fullfile(myFolder, '*.jpg');
jpegFiles = dir(filePattern);
for k = 1:length(jpegFiles)
    baseFileName = jpegFiles(k).name;
    fullFileName = fullfile(myFolder, baseFileName);
    fprintf(1, 'Now reading %s\n', fullFileName);
    a=imread(fullFileName);
    disp(size(a));
```

The size of image will be changed to the standard size of the system image which is (900*600) and will be stored in a variable called “A”. This change is due to the different resolutions found in different cameras. The system will not limit the cameras. This permits every mobile phone to capture different images with different resolutions and different sizes. This process is conducive for the system because photos will be converted into the standard size of the FRT system prior any system processing.

```
   A=imresize(a,[900 600]);
```

The Viola-Jones face detector is introduced to the FRT system. For this step, the images should be sent to the Viola-Jones face detector module and prompt this module to look for the face in the imported images and return its results to the FRT system.

```
FaceDetector = vision.CascadeObjectDetector();
BBOX = step(FaceDetector,A);
B=insertObjectAnnotation(A,'rectangle',BBOX,'Face');
imshow(B) , title('detected Faces');
n=size(BBOX,1);
str_n=num2str(n);
str=strcat('no of detected faces = ',str_n);
disp(str);
```

If the returned value of the Viola-Jones module is detected as a face, this part of the image will be cropped as a human face detected and will be stored in the memory of the FRT system for next process. The cropped part of the image will be stored in a variable called "faceImage ".

```
faceImage = imcrop(A,BBOX(i,:));
```

For further reassurance, the FRT system will be prompted by the Viola-Jones module to detect the face area selected. This module will query for human eyes and will return the result to the FRT system.

```
FaceDetector1 = vision.CascadeObjectDetector('EyePairBig');
BBOX1 = step(FaceDetector1,faceImage);
B1=insertObjectAnnotation(faceImage,'rectangle',BBOX1,'Face');
figure,imshow(B1), title('detected eyes');
n1=size(BBOX1,1);
str_n1=num2str(n1);
str1=strcat('no of detected eyes are= ',str_n1);
disp(str1);
```

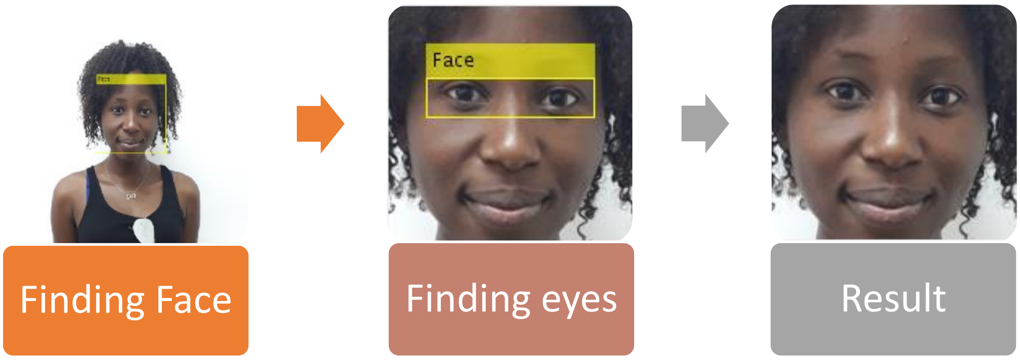


Figure 10: Example of face detection by Viola-Jones method

As depicted in Fig.10, the FRT system detects the face image imported into the system by the method of Viola-Jones algorithm. The selected area will then be cropped by the system.

### 3.2.2 Resizing and Change to Grayscale

Subsequent face recognition and cropping, the system will change the extracted face image size to 112*92 and thereafter convert the picture into grayscale.

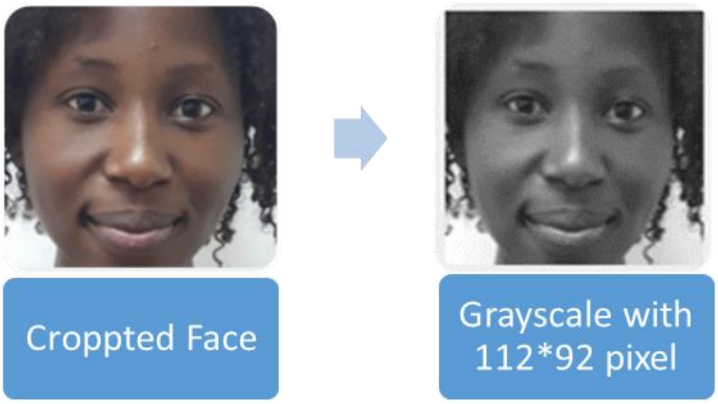


Figure 11: Example of resizing and change to grayscale

The FRT system will use the RGB2GRAY algorithm to convert the image into grayscale. All the images should have an equal size of 112*92 in grayscale. All the images should have the same standard detail for the FRT system images.

The code below will resize the face image detected and save it into a variable called "J"

```
J = imresize(faceImage,[112 92]);
```

Then the image will be converted to into grayscale and will be saved in the database.

```
l=rgb2gray(J);
figure, imshow(l), title('grayscale');
close all;
imageLowResulutionSave = fullfile('./Faces', baseFileName);
basepath =imageLowResulutionSave;
imwrite(l,basepath);
```

### 3.2.3 Removing Noises

Since the pictures will not be captured in a controlled environment, they may contain illumination effects such as shadows or too much light and these effects could potentially be destructive to the final outcome. Therefore, the introdution of FRT into the system will impact it positively by eliminating all the existing effects. The FRT system should however be applied cautiously so that it does not erase any facial features together with the pre-existing effects since the system will have to recognize and archive the results of facial features. Therefore the FRT system will use the process of histogram equalization to enhance contrast.

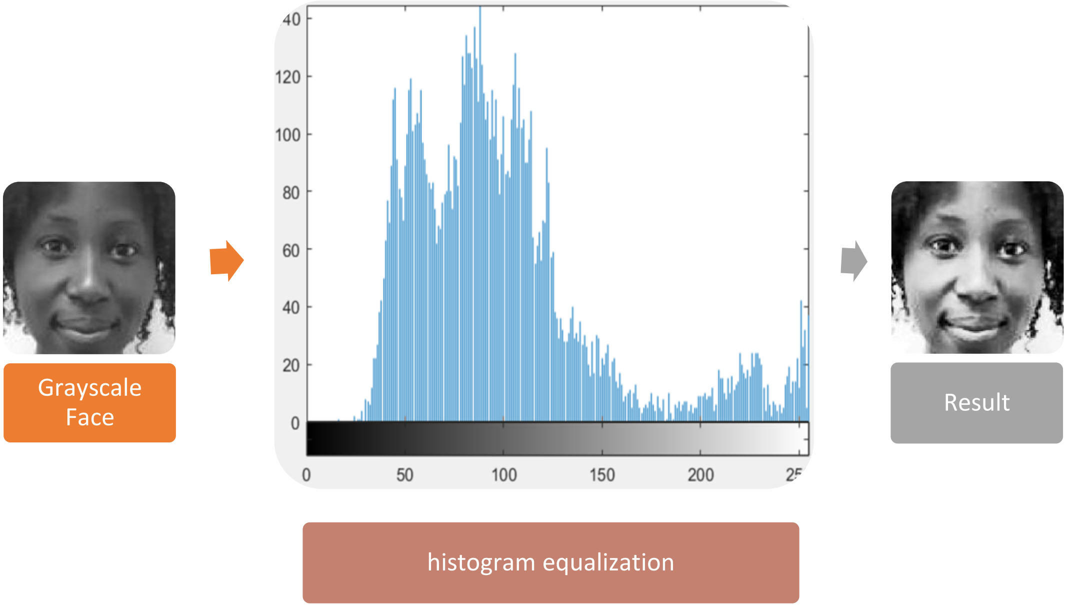



Figure 12: Example of removing image illuminations using histogram equalization

To enhance the image contrast, the FRT system will transform the values in an intensity image, or the colormmap values of an indexed image so that the specified histogram approximately matches the output of the image.

The cropped face image folder will be introduced into the system and FRT system will check the folder availability.

```
myFolder = './Faces';
if ~isdir(myFolder)
    errorMessage = sprintf('Error: The following folder does not exist:\n%s',
myFolder);
    uiwait(warndlg(errorMessage));
    return;
end
```

Then the images will be individually loaded into the FRT system, and stored into the system with a variable “I “

```
filePattern = fullfile(myFolder, '*.jpg');
jpegFiles = dir(filePattern);
for k = 1:length(jpegFiles)
    baseFileName = jpegFiles(k).name;
    fullFileName = fullfile(myFolder, baseFileName);
    fprintf(1, 'Now reading %s\n', fullFileName);


    I = imread(fullFileName);
```

Then the histogram equalization of all images will be calculated and stored into system with variable "I2"

```
    I2 = histeq(I);
```

After the application of histogram equalization process, the image result will be saved in the system as database

```
    imagewithoutNoisPathSave = fullfile('./removeNoises', baseFileName);
    imwrite (I2, imagewithoutNoisPathSave);
```

The last step is to remove noises in the FRT system and this will enable the source images to prepare to create database within the system.   A comparison will initiate between the source image and the image captured by the system for authentication of the student to take place.

### 3.3 Make Ready the Image for Authentication

The FRT system has to create the process of pre-processing for comparison, similar to the database image on it, such as face recogniton, cropping selected face, converting it to grayscale, then to standard size and then remove illumination noises and compare the two. The images will then be saved in zero matrix such as images in the database. Details of the image should be similar to the images in the database.

The code below depicts the process in which the image will be introduced to the system and the availability of the image is checked by the FRT system.

```
myFolder = './FaceImage';
if ~isdir(myFolder)
    errorMessage = sprintf('Error: The following folder does not exist:\n%s',
myFolder);
    uiwait(warndlg(errorMessage));
    return;
end
filePattern = fullfile(myFolder, '*.jpg');
jpegFiles = dir(filePattern);

baseFileName = jpegFiles.name;
fullFileName = fullfile(myFolder, baseFileName);
fprintf(1, 'Now reading %s\n', fullFileName);
```

the image will be stored in a variable called"a".

```
a=imread(fullFileName);
```

The image size will be changed to the system standard size of (900*600) and will be stored in variable "A". This is done to accommodate different resolutions of different camera types. There's no limitation for cameras in this system. So every mobile phone connected to the system will capture images in different size and resolution. This is ideal for the system because before any processing arranges the photo it will be converted to the standard image size of FRT.

```
A=imresize(a,[900 600]);
```

The Viola-Jones face detector is introduced to the FRT system. In this part, the image should be sent to the Viola-Jones face detector module and ask this module to look for the face in the imported images and return its results to the FRT system.

```
FaceDetector = vision.CascadeObjectDetector();
BBOX = step(FaceDetector,A);
B=insertObjectAnnotation(A,'rectangle',BBOX,'Face');
imshow(B) , title('detected Faces');
n=size(BBOX,1);
str_n=num2str(n);
str=strcat('no of detected faces = ',str_n);
```

If the returned value of the Viola-Jones module is detected as a face, the correlating part of the image will be cropped immediately when the human face is detected and will be stored within the memory of the FRT system for next process. The cropped part will be stored in a variable "faceImage ".

```
faceImage = imcrop(A,BBOX(1,:));
```

To validate the decision of the FRT system, it will be prompted again by Viola-Jones module to detect the eyes in the face area selected. This module will be searching for human eyes and will return the results to the FRT system.

```
FaceDetector1 = vision.CascadeObjectDetector('EyePairBig');
BBOX1 = step(FaceDetector1,faceImage);
B1=insertObjectAnnotation(faceImage,'rectangle',BBOX1,'eyes');
figure,imshow(B1), title('detected eyes');
n1=size(BBOX1,1);
str_n1=num2str(n1);
str1=strcat('no of detected eyes are= ',str_n1);
```

Once the system recognizes the face, it will crop it and then change the extracted image size to 112*92, thereafter it will convert the image into grayscale. To convert the image to RGB2GRAY algorithm the image has to possess similar resolution size as the extracted image resolution size of 112*92 and should be converted to grayscale. The image detail is the standard detail for all the FRT system images.

The code below checks for returned value. If the detected face is correct, then the cropped image will be resized and stored into variable "J".

```
if n1>0
    J = imresize(faceImage,[112 92]);
```

Then the image will be saved in the system and converted into grayscale to run another pre-processing on the image.

```
    PersonFace=rgb2gray(J);
    figure, imshow(PersonFace), title('grayscale');
    close all;
    ImageFaceReadyForSave = fullfile('./FaceImage/Face', 'PersonFace.jpg');
    basepath =ImageFaceReadyForSave;
    imwrite(PersonFace,basepath);
```

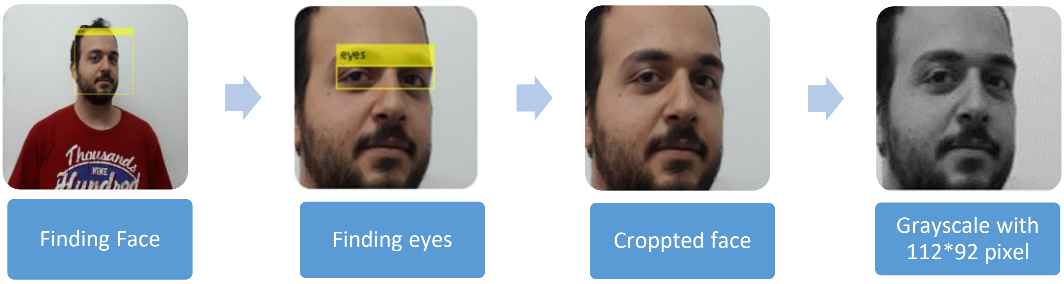


Figure 13: Example of the process to make ready the image for authentication

The cropped facial image below will be initiated into the system and FRT system will check whether the image is available or not.

```
myFolder = './FaceImage/Face';
if ~isdir(myFolder)
    errorMessage = sprintf('Error: The following folder does not exist:\n%s',
myFolder);
    uiwait(warndlg(errorMessage));
    return;
end
filePattern = fullfile(myFolder, 'PersonFace.jpg');
jpegFiles = dir(filePattern);
baseFileName = jpegFiles.name;
fullFileName = fullfile(myFolder, baseFileName);
fprintf(1, 'Now reading %s\n', fullFileName);
```

the image will be stored in variable ”I”.

```
I = imread(fullFileName);
```

The image of the histogram equalization will be computed and stored in variable “I2”.

```
I2 = histeq(I);
```

Subsequent the histogram equalization process, the resulting image has to be saved in the system in order to compare it with the database images.

```
ImageFaceWithoutNoises =f ullfile('./FaceImage/FaceWithoutNoises',
'FaceWithoutNoises.jpg');
imwrite (I2, ImageFaceWithoutNoises);
```

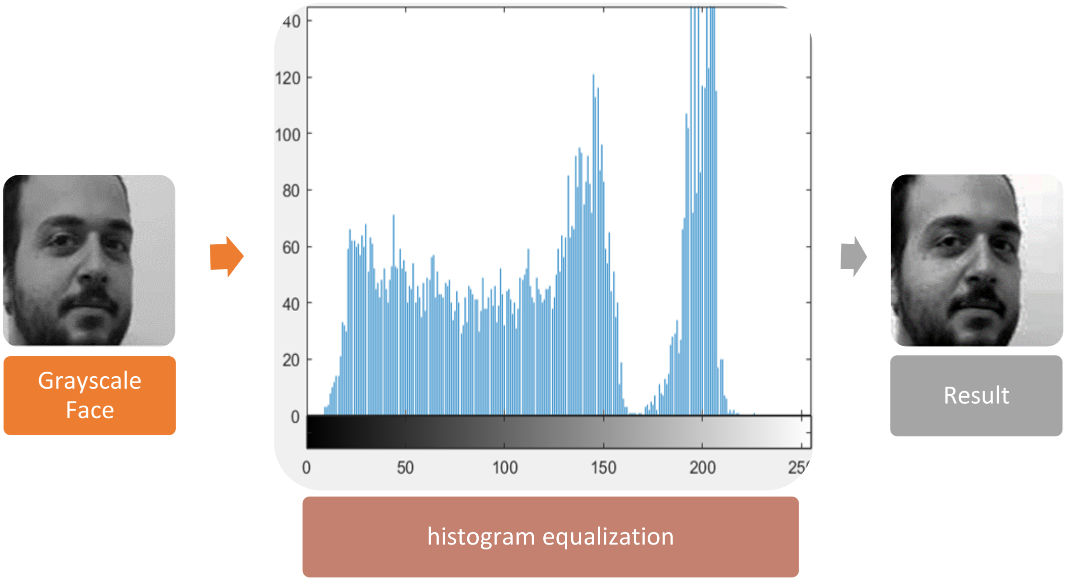



Figure 14: Example of removing image illuminations using histogram equalization for inputted image

Removing noise is the last step of pre-processing in the FRT system and therefore the image is ready for comparing.

## 3.4 Recognize the Face and Human Authenticate

Subsequent pre-processing of the image, the FRT system is ready to recognize the face and authenticate it. The system uses eigenface for face recognition.

The eigenface recognition system can be divided into two main segments: the creation of the eigenface and recognition, or detection, of a new face.

The eigenface technique is a powerful yet simplistic resolution to the face recognition problems. It is for a fact the most productive way of classifying faces. Old techniques of classifying faces focused on distinctive facial features, but the eigenface technique extract information by subdividing human faces according to face patterns. These patterns are not limited to facial features that are special and patterns are incorporated. The compilation of information from different aspects of the face makes Eigenface analysis more effective than other face recognition methods which function based on facial features.

Eigenfaces are directly based on vectors of human faces. This is related directly to the main concepts in electrical engineering called Fourier analysis. Fourier analysis illustrates that a sum of weighted sinusoids at differing frequencies could recompose a signal perfectly well. With this technique, a total sum of weighted eigenfaces could reconstruct an exact human face.

### 3.4.1 Making Ready the Database of the Facial Images

The FRT system initially has to prepare its database before finding eigenfaces. All face images have to be equal to the same size of (112*92), and they must undergo the process of greyscale with values that range from 0 to 255. Each face image should be converted vector of Tn of length N (N=imagewidth*imageheight). The most important face sets should contain as many images per person. This spikes accuracy because of all the information available about every individual.  Therefore, this collection is then called "face space" and is equal to dimension N.

The FRT system initially creates a matrix of zeroes through image sizes and then images will be saved within them and this will be saved as database in a bigger matrix by specific index.

Function has been used to make FRT database.  This function will be loaded loaded images in the database

```
function out=load_database();
```

The code below shows how the folder of images will be initiated into the system and FRT system will check the availability of the folder.

```
myFolder = './removeNoises';
if ~isdir(myFolder)
    errorMessage = sprintf('Error: The following folder does not exist:\n%s',
myFolder);
    uiwait(warndlg(errorMessage));
    return;
end
filePattern = fullfile(myFolder, '*.jpg');
jpegFiles = dir(filePattern);
```

A zero matrix instance will be initiated. The size of this matrix is dependent on the size and image number. The standard size of images in the FRT system is 112*92.

This means that for every image 10304 sectors are needed to store the images in the database. The instruction "length(jpegFiles)" will represent the image number in which FRT system prepares for the database. This matrix is called "V" in the FRT system.

```
v=zeros(10304,length(jpegFiles));
```

In the following code, the FRT system needs to put all the images in this matrix. For this approach, the shape of the image should be changed and fit together with database matrix.

```
for j=1:length(jpegFiles)
        baseFileName = jpegFiles(j).name;
        fullFileName = fullfile(myFolder, baseFileName);
        a=imread(fullFileName);
        v(:,j)=reshape(a,size(a,1)*size(a,2),1);

    end
```

Finally, the matrix will be converted to unsigned 8-bit numbers to conserve memory. The converted matrix will be located in a new variable called "W".

```
    w=uint8(v);
```

the "W" variable will be sent to FRT system as its database.

```
out=w;
```

### 3.4.2 Making Ready the Image for Comparing

In order to compare the input image with the images in the database and authentication, after pre-processing which is mentioned before, the image should be stored in a zero matrix such as images in the database.

For this approach, the image will be introduced to the system and FRT system will check the availability of the image.

```
myFolder = './FaceImage/FaceWithoutNoises';
if ~isdir(myFolder)
    errorMessage = sprintf('Error: The following folder does not exist:\n%s',
myFolder);
    uiwait(warndlg(errorMessage));
    return;
end
filePattern = fullfile(myFolder, 'FaceWithoutNoises.jpg');
jpegFiles = dir(filePattern);
```

An instance of the zero matrices will be initiated. The size of this matrix depends on the size of the image. in FRT system the standard size of images is 112*92. so it means that for this image we need 10304 sectors. this matrix called " faseSample " in the FRT system.

```
faseSample=zeros(10304,1);
```

In the following, the FRT system needs to put the image in this matrix. For this approach, the shape of the images should be changed and be fit with this matrix.

```
baseFileName = jpegFiles.name;
fullFileName = fullfile(myFolder, baseFileName);
a=imread(fullFileName);
faseSample(:,1)=reshape(a,size(a,1)*size(a,2),1);
```

Finally, the matrix will be converted to unsigned 8-bit numbers to save memory. The newly converted matrix will be located in a new variable which is called “sample".

```
sample = uint8(faseSample);
```

### 3.4.3 Authenticate the Image

The next task of the FRT system will be to calculate the facial average in the space of face. The difference for each facial average will then be computed. FRT system uses these differences to compute a covariance matrix (C) for its dataset. The covariance between two sets of data reveals how much the sets correlate.

The eigenvectors of C consist of eigenfaces which are being searched by the FRT system although C is the number of image pixels in the FRT system. The bottom-line solution will be complex. If the FRT system continued with the process, the Eigenface technique would be unsuccessful in face recognition. This implies that this step would be rendered erroneous.

The FRT system could decrease the eigenvectors number of the covariance matrix. The FRT system is based on a statistical technique which is called Principal Component Analysis (PCA), and could lower the mentioned covariance matrix from N which is the pixels numbers in its image to M which is the images numbers in the database. However, since it will become larger, the PCA analysis could be used to reduce a huge dimensional space with smaller vectors sets. This technique is one of the most favorable techniques which could be used to locate the patterns in the high dimensional data.  It is normally used in two approaches namely face recognition and image compression. The PCA analysis is usable for face recognition because normally human facial images look the same and exhibit similar structures and common patterns against the non-facial images.

M-k eigenfaces seemingly look similar and are verily useful in generating a full base for the space of the face. Where the K introduced as numbers of unique humans in the set of faces which are known.

Finally, a suitable image reconstruction could be achieved by a few eigenfaces called M', which normally range anywhere from .1M to .2M. These are related to the highest eigenvalues vectors and shown the most variance inside the face space.

The coefficient correlation is a number representing the similarity between 2 images in relation with their respective pixel intensity.

A and B are the images which the FRT system are compare, whilst the subscript indices M and N point to the pixel location in the image. In short Matlab computes every pixel location in both images, starting from the difference between the intensity value at that pixel and the mean intensity of the whole image signified as a letter with a straight line over it. With the returned value number of the result, the FRT system can decide on the recognition accuracy.

For face recognition, this algorithm uses the eigenface system (based on principal component analysis - PCA) to recognize faces. First the database will be loaded into the program.

```
w=load_database();
```

FRT system will store information of the entered image from its matrix to a new variable called "r".

```
r=sample(:,1);
```

The information of loaded database will be stored in a new variable called "v".

```
v=w;
```

The variable which is called "N" incorporate signature numbers which are used for each image.

```
N=10;
```

In the following calculation, the mean is subtracted from v and will be calculated. Variable "m" is the mean of all images and variable "vzm" is "v" with the mean removed.

```
O=uint8(ones(1,size(v,2)));

m=uint8(mean(v,2));
vzm=v-uint8(single(m)*single(O));
```

In the following calculation, calculating eigenvectors of the corresponding matrix will take place. The FRT system will be pick the eigenvector corresponding to the N largest eigenvalues.

```
L=single(vzm)'*single(vzm);

[V,D]=eig(L);

V=single(vzm)*V;

V=V(:,end:-1:end-(N-1));
```

The code below shows the calculation of the signature for each image. Variable "cv" is a zero matrix and each row in "cv" is the signature for one image.

```
cv=zeros(size(v,2),N);

for i=1:size(v,2)
    cv(i,:)=single(vzm(:,i))'*V;
end
```

The imported face image will be displayed and needs to be authenticated.

```
subplot(121);

imshow(reshape(r,112,92));title('Looking for
...','FontWeight','bold','Fontsize',16,'color','red');

subplot(122);
```

“P” will subtract the mean of the entered image using the mean of all images.

```
p=r-m;
```

"S" is a multiplication of single-precision of “P” and “V”. Which "V" is the the 10 largest eigenvalue

```
s=single(p)'*V;
z=[];
for i=1:size(v,2)
    z=[z,norm(cv(i,:)-s,2)];
    if(rem(i,20)==0),imshow(reshape(v(:,i),112,92)),end
    drawnow;
end

[a,i]=min(z);
R = corr2(v(:,i),r);
if R>=0.8
    subplot(122);

imshow(reshape(v(:,i),112,92));title('Found!','FontWeight','bold','Fontsize'
,16,'color','red');
end
if R<0.8
subplot(122);
imshow(reshape(v(:,i),112,92));title('Error!','FontWeight','bold','Fontsize'
,16,'color','red');
    text( 20,50 ,'Error!','FontWeight','bold','Fontsize',30,'color','red');
```

```
end
```

In order to test the correctness of the student's recognition and authentication, the FRT system should be passing two different types of tests.

1. First, authenticate a human contained in the selected model,
2. second, reject the identity of a person who does not exist in the model

One model has been chosen for the first test who is registered in the system. The image of the model was captured in another environment. Also, the images have been captured with another mobile phone. The captured images were uploaded to the FRT system.

Figure 15: Example of correct person result

It looks like the pre-processing of the FRT system is successful in the detection of the human face from a different image resolution. Also, the illumination noises were removed successfully. Hence the system successfully authenticated the student.

In the second test, a model which is not registered in the system was chosen. The model image was captured in the same environment as the previous test.

Figure 16: Example of wrong person result

After uploading the images to the FRT system, the system successfully rejected it.

# Chapter 4

# EVALATION OF THE SYSTEM

## 4.1 Applying FRT System in Order to Take and Record Student's Attendance

The FRT system will be web-based designed. When students register, their images should be captured and uploaded into the FRT system. Images should individually be captured from students. Preferably 10 images should be captured for every student. Along with the student information, images should be uploaded. To avoid any misunderstanding or confusion, for every image uploaded to the system, the corresponding student should undergo face detection and everything has to be displayed to the operator. For every erroneous image, there must be a re-capturing to provide a secure environment for the FRT system.


Figure 17: Sample of detected face which has been shown to the operator

Sometime system detection might become faulty, influenced by external effects such as shadows, illumination noises or crowds background. Therefore, photography should always take place in a controlled environment.


Figure 18: Sample of incorrect detection because of illumination noises

There is no camera with any limitation. Using any camera for photography is of no dire consequence. However, the photography pose is very important. The photographer must have a solid assurance that the student is looking directly into the lens of the camera. The photographer should capture at least 10 different images of each student.

Figure 19: samples of different head pose and the face emotions

Different images mean the photographer needs to capture a head pose and the facial emotions of the students. Accuracy and precision of the photographer would increase the FRT system accuracy.

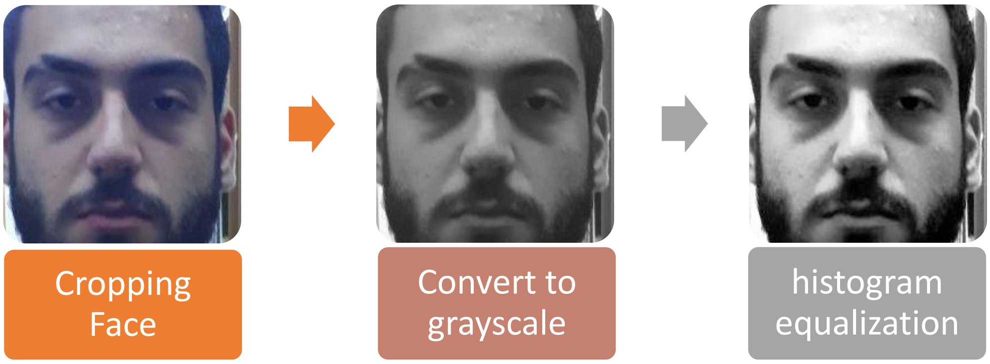



Figure 20: The pre-processing steps

Subsequent image validation by the operator, the FRT system should pre-process the images individually and save them in the database along with student identity information.

## 4.2 Apply FRT System in Order to Take Recorder and Authenticate Student's

Authentication of student exams is the main approach of this system. Usually the exams are held in an uncontrolled environment. The most outstanding advantage of the FRT system is that it doesn't need any special equipment. The exam invigilator could be connected to the internet and still use this system.

Since the FRT system does not have any camera limitation, the invigilator can always use any camera type which is easily accessible and capture student images individually and upload the images into the system. Capturing individual images with students sitting in vertical rows could become a hassle and very tedious. The solution to this problem is to request students to line up horizontally for easier image capturing. Through this method the rate of uncontrolled environmental weaknesses will be reduced.

Figure 21: Example of crowded background which is cause of confusing the system

For a more trustworthy approach, the invigilator could control the sequential flow of things by requesting images of the detected face and deciding on the fate of the images. One image is needed by the FRT system from every student for authentication.  From the invigilators' approval the system will pre-process the input images and compare them with database images and return information for every student.

Figure 22: Sample of detected face which has been shown to the invigilator

The most important quality of this system is its ability to comprehend and learn. Since the human face will differ from time to time, these changes may frustrate the system and reduce its rate of recognition. To reduce these issues the FRT system needs to learn the faces of the students. After every successful authentication, the system will store the students' input images into the database. This technique assists the system in making changes in the student's facial features and archiving those changes. These archives increase the system's trustworthiness and the rate of reliable authentication will increase.

Finally, the FRT system will store the information of the attendance in the database. This information could be very imperative for all the institutions. These institutions will use this information in many different approaches and in different ways. Depending on an institution's aim and usage of attendance information, the system is able to change and archive a different result.

## 4.3 Testing and Result

The FRT system was tested on a class model which contained 6 students. 10 images from each student were captured. Different head pose and face emotions were considered for every student's images. All the captured images were uploaded to the system together with the student's information. The information was saved in the FRT database after it had undergone pre-processing and acceptance. The FRT system uses two tests to assess the accuracy of the student's recognition and authentication, the first is to authenticate a human contained in the model selected and, second, reject the identity of a person and second reject the identity of the person who does not exist in the model.

### 4.3.1 Authenticate a Human Contained in the Selected Model

Two different types of model have been chosen for this test, namely male and female with unique hairstyle. A total of 10 images were capture from a different environment. Changes in illuminations was applied and the images were captured with a different mobile phone. The captured images were uploaded into the FRT system.

Seemingly, the FRT system was successful in detecting the human faces in an image resolution that is different. The illumination noise was also successfully removed and therefore the system successfully authenticated the student.

### 4.3.2 Rejection of the Identity of a Person Who Does Not Exist in the Model

Two people who were initially not registered in the system were chosen for this test. The two selected models were male and female. Just like the previous test, the model images were captured in the same environment. The FRT system rejected the model images after they were uploaded.

# Chapter 5

# CONCLUSION

Currently there is a rapid rise in established educational institutions such as universities, private and public schools. A rapid rise in educational institutions mean a rise in the demand of education by students and this makes it very frustrating to record student attendance in totality using traditional method of paper log and pen. To mitigate this apparent problem, many schools have resorted to the usage of biometric systems such as the RFID card, but the drawbacks of these systems are far more magnified, because they are time consuming, costs too much money, they are security flawed, they require an ongoing human attendance for maximum functionality, and they have archiving incapability. The use of an ideal automated system to track student attendance should solve the security flaw problem, should be time efficient, cost effective and be manipulation proof.

The only system that checks all the boxes is the Face Recognition system. This is an automated system and it is time efficient, it allows for an easy pairing of a computer and a camera, it is manipulation proof, requires less human interaction and it easily archives information.

The traditional methods of recording student attendance are very flawed and involve jotting and passing paper log and this creates cheating opportunities for students, temporarily shifts student focus, students input wrong information, and the paper log could get damaged or lost.

Implementing the FRT system will eliminate all the downsides associated with traditional methods of taking student attendance and will increase the focus rate, eliminate cheating opportunities and automate the process of taking attendance by detecting and recognizing student faces.

Since many institutions conduct their exams in rooms without any form of surveillance or cameras, the FRT system could simply be linked with any mobile phone camera.

This system could be configured and designed based on multiple-detection in the future. This will assist the system in potentially reducing inclinations of wasting time and carry out the process of face detection from a single digital image which will be captured from individual students and will be uploaded to the system.

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# APPENDIX

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