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Cloud Authentication Based Face Recognition Technique

Anfal Thaer Hussein Alrahlawee

M. Sc. Thesis

Supervised by Assoc. Prof. Dr. OĞUZ BAYAT

Co-Supervisor: Asst. Prof. Dr.Adil Deniz Duru

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Cloud Authentication Based Face Recognition Technique

By

Anfal Thaer Hussein Alrahlawee

Department

Information Technology

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Asst. Prof. Dr.Adil Deniz DURD	Assoc. Prof. Dr. Ouğz BAYAT
Co-Supervisor	Supervisor

Examining Committee Members

Assoc. Prof. Dr. Ouğz BAYAT	Engineering, Altinbaș University	_____
Prof. Dr. Osman UÇAN	Engineering, Altinbaș University	_____
Asst. Prof. Dr.Adil Deniz DURU	Physical Education and sports, Marmara University	_____
Assoc. Prof. Dr. Ouğz ATA	Information technology , Altinbaș University	_____
Prof. Dr. Hasan Hüseyin BALIK	Air Force Academy, National Defence University	_____

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Asst. Prof. Dr. Ouğz ATA
Head of Department

Approval Date of Graduate School of Science and Engineering: ____/____/____

Assoc. Prof. Dr. Ouğz BAYAT
Director

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Anfal Thaer Hussein Alrahlawee

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ABSTRACT

Cloud Authentication Based Face Recognition Technique

ALRAHLAWEE Anfal Thaer

M.S. Information Technology, Altınbaş University,

Supervisor: Assoc. Prof. Dr. Oğuz Bayat

Co-Supervisor: Dr. Asst. Prof. Dr. Adil Deniz Duru

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It generally takes comparatively less processing time in the recognition of a single face. But it would be a lengthy procedure if implemented at a larger scale, where numerous faces are to be recognized. In this paper, the cloud computing service is used for providing scalability solution, where the required resources are increased by cloud computing in case of processing of larger data. The system developed in this study has been programmed and trained for the detection and recognition of faces with the help of cloud computing. The face detection has been done by the Viola and Jones algorithm, which used five kinds of Haar like features, cascaded classifiers, Adaboost learning method and integral image. Linear Discriminant Analysis (LDA) has been employed as an algorithm for face recognition, since it offers better performance in comparison to Principal Component Analysis (PCA) algorithm. The system performance has been tested on different images from the MUCT database.

Keywords: Face detection, Viola and Jones algorithm, LDA, Histogram equalization, Cloud computing

Bulut Doğrulama tarafından Yüz Tanıma teknik

ÖZET

Tek bir yüzün tanınmasında genellikle nispeten daha az işlem süresi gerekir. Ancak, çok sayıda yüzün tanınacağı daha geniş bir ölçekte uygulandığında daha uzun bir prosedür olacaktır. Bu yazıda, bulut bilişim hizmeti, daha büyük verilerin işlenmesi durumunda gerekli kaynakların bulut bilişim tarafından artırıldığında ölçeklenebilirlik çözümü sağlamak için kullanılmaktadır. Bu çalışmada geliştirilen sistem, bulut bilişim yardımıyla yüzlerin tespiti ve tanınması için programlanmış ve geliştirilmiştir. Kademeli sınıflandırıcılar, Adaboost öğrenme yöntemi ve integral görüntü gibi beş çeşit Haar benzeri özellikleri kullanan Viola ve Jones algoritması tarafından yüz algılama gerçekleştirilir. Lineer Diskriminant Analizi (LDA), yüz tanıma için bir algoritma olarak kullanılmıştır, çünkü Temel Bileşen Analizi (PCA) algoritmasına kıyasla daha iyi bir performans sunar. Sistem performansı MUCT veri tabanından farklı görüntüler üzerinde test edilmiştir.

Anahtar Kelimeler: Yüz tanıma, Viola ve Jones algoritması, LDA, Histogram eşitleme, Bulut bilişim.

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LIST OF ABBREVIATIONS

NIST	National institute of Standards and Technology
PAAS	Platform As A Service
SAAS	Software As A Service
IAAS	Infrastructure As A Service
APIs	An application program interface
IP	Internet Protocol
STAAS	Storage as a Service
DBAAS	Database as a service
VPN	Virtual Private Network
VMM	Virtual Machine Monitors
XML	EXtensible Markup Language
HTTP	Hypertext Transfer Protocol
ID	Identifier
ICA	Independent Component Analysis
SVM	support vector machines
RGB	Red Green Blue
LDA	Linear Discriminant Analysis
PCA	Principal Component Analysis
TCP/IP	Transmission Control Protocol/Internet Protocol

1. INTRODUCTION

1.1 OVERVIEW

In the present world, computers have turned out to be the most essential part of life. They are required just everywhere, for fun, work, investigations or in similar fields. The ever growing use of computers in day-to-day life has led to the increased requirements of computing resources [1]. For some major organizations like Google, Microsoft etc. it is not a big deal to utilize the supplies at any time as per their requirements [2].However, for smaller companies, cost has appeared to be a huge factor. In case of problems like machine failure, hard drive crash, bugs in software etc., cloud computing has offered a solution to massive infrastructures for overriding such issues [3].

Moreover, it is a quite challenging job to discover humans in images due to their variable shapes and broad range of positions depending upon the situation. In addition to this, the process of face detection and recognition needs numerous resources particularly when employed in huge databases [4]. The need for computing abilities has increased due to the typical challenges for resource allocations, which are considered necessary in big corporations. In view of the fact that cloud computing has been launched, it is now possible to combine the requirements of resources for face recognition and detection with that of cloud computing.

1.2 Face Detection

Face detection is presently a big topic of interest. A lot of attention has been directed towards face detection in the market of image processing [5]. An effective coding scheme is provided by face recognition and detection in teleconferencing and video calls.

Face detection is the process of identifying human faces in videos and images [6]. It is basically a special application of image segmentation. A digital video frame or image is partitioned into a number of segments (sets of pixels) under the process of image segmentation. Image segmentation is important for making things straightforward, expressing significant parts of digital

images and in this case study making face detection easier. All the face recognition or face analyzer systems always require the preprocessing step of face detection [7]. Figure 1.1 has illustrated the subsequent attempts for giving a complete idea of face detection.

Figure (1.1): Discovering Face [7] the figure clarify detection of individual at first time

The key idea behind image segmentation is the processing of image, in order to divide it into numerous elements [8]. The major objective at this point is the splitting up of an image into segments that are having a strong connection within objects. Segmentation plays a very vital part in applications related to image data analysis [9].

In a given image, it is quite difficult to detect the accurate place of human face [10]. An explanation regarding the process of face detection, its significance and challenges has been provided in the following sections:

1.2.1 Applications of Face Detection

Nowadays, several real world applications require detection and interpretation of faces in machine vision. Following are the few essential applications [11]:

- Identification of person at time of login
- Computer-human interaction, like tracking of eyes and mouth etc.

- Video calls during video conferences

1.2.2 Challenges in Face Detection

There are following factors that have made the task of face detection quite challenging [12]:

- Orientation or pose
- Scale
- Facial expressions
- Brightness resulting due to variation in illumination
- A video frame or image resolution
- Disguise mainly because of beards, spectacles etc.
- Background: complex/simple and dynamic/static

1.3 Face Recognition

The human ability of interacting with one another or with other objects is based on their ability of recognizing them [13]. Due to this capability, they can identify and recognize objects very easily. The modification or distortion of this ability has encouraged the researchers to work on how human brain processes the images for easy recognition. The human face recognition skill is very much reliable, although the facial expressions, viewing conditions, person face may change but it can be recognized even by seeing a fraction of face. Most of the people are capable of recognizing thousands of individuals whom they have met in their life in very less time [13].

It would be easy to develop an automated face identification system with the help of a machine, after understanding and knowing the mechanism of human brain with reference to its cognitive aspect [14]. Moreover, face recognition domain is still an active area of research as no complete approach or effective model has been presented till data that can entirely resolve this issue [15].

Nowadays, the field of automated face recognition has gained popularity. There are numerous applications of face detection; one among these is its employment in commercial and law enforcement applications. For instance, various valuable places like jewelry shops, banks etc.

that have been robbed, can review the security camera videos, and the criminal faces can be detected by matching them with police criminal records.

1.4 Cloud Computing

A lot of Greek myths have discussed about the creatures that have derived their power and life from planets like moon and sun. At present, somewhat same thing is happening in the world of computing. These days, the data and programs from laptops, desktops or even corporate rooms have been stored in cloud computing.

What does cloud computing exactly mean? It appears to be a computer model where functions and information is set up in huge data centers in cloud, which can be accessed by all the devices linked with the network [16]. Similar to other definitions related to this topic, cloud computing also needs an explanation of closely linked expression. Even though there is no precise scientific definition for this but it can be defined in a general way.

Whenever one thinks about what is needed by us always, the one thing that comes in mind is cloud computing. Therefore, it is necessary to increase the capacity of the computing method or add more abilities that can function in latest infrastructure, permit advanced software and new methods of personnel learning. The cloud computing involve paid or subscription-based services which helps in the expansion of already existing capabilities of Information and Communications Technology in real time.

The present world is considered to be the most important stage of cloud computing with a diverse group of providers. Multiple services are offered by big and small groups depending upon clouds, beginning with full blown applications to storage services and to spam filtering [17].

The “cloud computing” term is originated from “cloud”, which means development based on internet, while “computing” refers to the used computer technology [18]. It is a scalable computing style where virtualized resources dynamically provide a function based on internet. It is not required by the user to have control, knowledge or proficiency in the infrastructure of used cloud technology [19].

In recent times, cloud computing is one of the most hyped IT innovations [20]. The mechanism of cloud computing is a new standard that has given huge possibilities in numerous

areas. It is a combination of servers and devices that can be reached publically through internet [21]. Cloud computing facilitates users in using applications without installing them and reaching files from any device having internet access. Cloud computing offers a lot of essential internet dependent functions like data storage, infrastructure, hardware and programs etc. [22].

1.4.1 Advantages of Cloud Computing

1) Increased capacity: Cloud computing can do huge amount of work with fewer people in less time

2) Cost reduction: The normal computers, data and programs of customers are used in cloud computing, so there is no requirement of high cost devices

3) Accessibility: In cloud computing, users can access data anywhere from any device with access to internet

4) Requirement of less learning: Less number of individuals is required in cloud computing for the implementation of more jobs. Thus, minimum learning about difficulties in the hardware and software is required by the users.

National institute of Standards and Technology (NIST) has described five key characteristics of cloud computing which include: wide network access, on demand personal services, precise services, pooling of resources and flexibility, with service models like PAAS - Platform As A Service , SAAS - Software As A Service and IAAS - Infrastructure As A Service, plus deployment models like hybrid, society, public and private. The structure of cloud, illustrated by NIST is shown in Figure 1.2 [23].

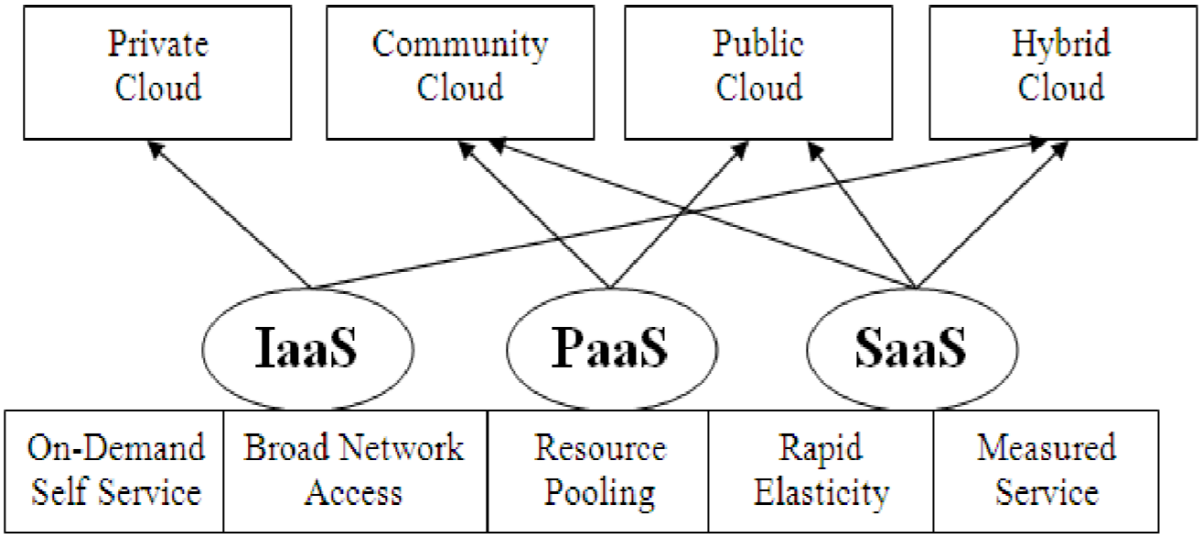


Figure (1.2): The structure of cloud, illustrated by (NIST) National "institute of Standards and Technology [23]

1.4.2 Characteristics

1) On-demand Self Service: All the required computing services are offered by cloud to its customers

2) Broad Network Access: It is possible for customers to reach the function of cloud using cell phones, laptop, personal computers etc. through internet

3) Pool of Resources: Provision of cloud scheduled funds to the users according to their needs

4) Rapid Elasticity: Cloud computing is capable of determining quickly and returns the determined functions as per requirements

5) Measured Services – The cloud provider controls the usage of resources [23]

1.4.3 Services

This section has described the model for various cloud services. At first, a hierarchical view of Cloud Computing has been presented that is followed by the explanation of the service model linked with each of the layer in this hierarchy:

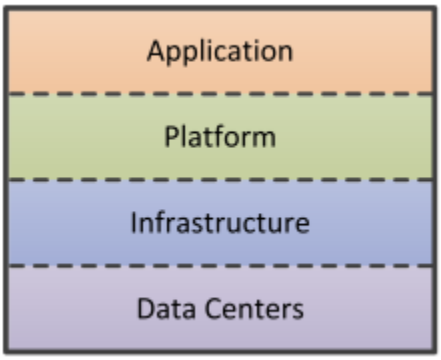


Figure (1.3) View of Layers of Cloud Hierarchy [23].

Data centers: In the infrastructure of cloud computing technologies, the data centers provide hardware resources for network, storage and raw computation. Generally, the data centers are created in less populated regions with low cost rates of energy and less probability of natural disasters. These are made up of a huge number of inter-connected servers [23].

1) SAAS Model: In this model, the cloud provider offers software application like Turbo C, Microsoft office etc. as a utility to cloud user. Finally, the software is presented to the customers through the application layer as an on-demand service, mostly in the browser. This service is embraced by almost all the companies doing e-business. This is an alternate to applications running locally with some obvious pluses over them. Primarily, the users are not asked to install and regularly update those applications that are hosted in the cloud on their personal computers. This saves their time and disk space as well, thus increasing user-friendliness and accessibility. This is also helpful for software providers as there is automatic distribution of updates to the users, requiring changing of only some instances that have been running on cloud infrastructure. Moreover, the applications can be targeted by software developers for working in controlled and known environment, which leads to improved quality and more secure products [23].

2) PAAS Model: In this model, cloud providers give a computing platform such as web server, operating system, database etc. to the users of cloud. An additional level of abstraction has been added by the 2nd layer known as the Platform layer, to the services that are being offered by the Infrastructure Layer. This aggregates them effectively and offers an entire software platform for designing applications, control, deployment, evaluation and advancements. Specifically, this layer provides APIs and programming models for cloud applications, for instance, Map Reduction.

Moreover, issues like sizing of resources required in the execution of services are shown clearly to developers.

3) IAAS Model: It is the main target of every company to reduce cost and time duration of operations. The IaaS model is implemented for achieving these primary targets. This layer is focused on controlling the underlying resources of data centers and provisions them as services to users through the virtualization of communications, computational power, storage capacity and other basic computational resources required for running software. Such companies that offer this type of services are generally known as Infrastructure Providers (IPs). Although, the physical infrastructure is not controlled directly by the users but they can scale it.

The virtualized input can decrease and increase dynamically as per their requirements. This is in accordance with the perspective of utility, where users make use of services and do payments for only what is consumed by them. In addition to this, the virtualization of resources is having huge significance for IPs, as its focus is on the maximization of infrastructure efficiency, and thus makes it more advantageous. One such example of profitable solution in this field is the Amazon elastic computing cloud.

Within the domain of IaaS, a few sub-categories can be defined as well, though; the IT community is not very much agreed to it. The persons form marketing businesses generally do the naming, in order to differentiate among the characteristics of their products. It is noted that the term "storage" in not very explicit in defining the exact type of service offered by it. Thus, Storage as a Service (StaaS) and Database as a service (DBaaS) have emerged from this perspective. DBaaS is aimed at offering fine-grained data access by supporting multi-tenancy, providing service of database functionality, automatic management of resources and other traits of conventional database service systems [23].

1.4.4 Models for Cloud Deployment

The cloud infrastructure can also be classified according to its mode of deployment. At present, the IT community has acknowledged three major models of deployment i.e. hybrid, private and public clouds. Even though, a few other types of models are also considered like virtual private clouds and community.

Public Clouds: Under this model, the cloud infrastructure is owned by organizations selling cloud services. These organizations offer resources to the big industry groups (like Microsoft, Google, and Amazon) or to common public. The service users are offered multiple advantages by the public clouds, as no major investment has been done on its setup and the interrelated natural risks are transferred to the infrastructure providers. Nevertheless, a few limitations are also there, like the absence of well-grained control of data, security and network settings that hinder the activity in some business scenarios [23].

Private Clouds: Although the cloud network has been developed around wide-ranging clouds, companies are showing interest in open source cloud computing tools that facilitate them in creating private clouds with the help of leased or owned infrastructures. Therefore, the main target of particular cloud deployments is to offer users from organizations a smart and elastic unique infrastructure instead of offering services on internet, and for driving service workloads within the administrative domains. This model provides the highest degree control over the privacy, accuracy and behavior of resources. Furthermore, it enhances efficiency and reuse of resources, but it loses the benefits of public cloud as the organizations have to do maintenance by themselves and to entail up-front expenses if they don't own the infrastructure. To some extent, the delayed adoption of the principles of Grid Computing by corporate IT is represented by it [23].

Hybrid Clouds: There are still some limitations in both the private and public cloud approaches, i.e. the public clouds lack in security and control while private ones face difficulty in contraction and expansion of on-demand resources. The hybrid deployment model is a common solution to this, where there is merging of unique clouds bounded by technology for enabling the interoperability among these. In this way the best features are being taken from each of the deployment model. In case of hybrid cloud, a private cloud is built by an organization over its personal infrastructure, which maintains the benefit of controlling security and performance related aspects with the option of utilizing the extra resource from public cloud as per the requirements. For instance, when there is a peak demand on an online retailer's infrastructure, especially in holiday season. Considering the negative aspect, the development of a hybrid cloud requires a cautious decision on separating the particular and general elements of cloud and the implementation cost of interoperability between these two models of deployment [23].

Community Clouds: To some extent, the community clouds lie in the middle of private and public clouds. They are neither wholly open as commercial services to general public nor owned by one organization as in the case of private clouds. The cloud infrastructure is typically trained for use by a specific and restricted community of organizations having common interests.

Virtual Private Clouds: Virtual private cloud is another approach of catering the specific and common limitations of clouds. In this model, a platform has been built over a public cloud infrastructure for emulating a private cloud, which controls the Virtual Private Network (VPN) technology. This strategy allows users to make their private structures and security settings with higher control level compared to which is provided by public clouds, and at the same retain the scalability of resources. This cloud is fundamentally more of a holistic design as it is not only simulated and implemented server but also the underlying communication network that facilitates the job of transferring services to the cloud from proprietary infrastructures [23].

1.4.5 Enabling Technologies

The cloud infrastructure is set up by a set of well-known technologies. In the absence of technologies like the programming models, distributed systems of storage, web services, virtualization etc, it would not be possible to attain most of the features of cloud paradigm. These technologies are as under:

Virtualization Technology: The components of virtualization technology have made the cloud computing services of the models possible. Every architecture layer can be offered according to demands as a service of virtualized resources, which not only provides users the environmental access control and isolated performance, but facilitate the infrastructure providers in attaining scalability and flexibility of the hardware resources. In addition to this, the virtual machines serve as a sandbox environment, which enforces a high level of security and segregation between the instances.

Under the perspective of Cloud Computing, virtualization is attained via special-purpose applications known as hypervisors or Virtual Machine Monitors (VMM), which create a hardware environment for the deployment of guest operating systems, whilst every aspect about interactions

and resources is controlled. The most commonly used Virtual Machine Monitors include VMware ESX, KVM and Xen Hypervisor [23].

Web Services: A website service is a software based system that is created for offering interoperable interactions within machines on a network. Other systems are interfaced with the web service in a manner set by its representation using SOAP messages, typically conveyed using XML and HTTP series, along with other web standards. The cloud computing standard has earned significant recognition and development due to the universal acceptance of Web services in the business of ecommerce, specifically in the service providing industry. The cloud services are typically exposed as web services, which can be accessed easily from any part of the world and control the standard mechanisms that are provided for interaction with different kind of clients. Amazon Web Services is one such example of this technology [23].

Distributed Storage System: Another vital technology in the domain of cloud computing is the underlying distributed storage system. It provides the base for building numerous layers of cloud. Being designed over the huge distributed data centers, this offers flexibility and scalability to the cloud platforms, thus permitting emigration, combination and transparent supervision of data format. Amazon S3 and Google File System is an example of this technology. A model for cloud storage should not just focus about the process of storing and manipulating data amount but also about accessing it in a semantic manner. The main target of a distributed storage system is to summarize the real physical data location. The access should be provided by logical name instead of physical name. For instance, a key is assigned to every object in Amazon S3, which is accessed via a pure Identifier (ID), not identifying any physical location.

Programming Model: With the purpose of complying with the ease of use requirements from the vision of utility computing, a few cloud programming models should be proposed for customers in order to get more easily adjusted for the model, given that they are neither too innovative nor too complex. “Map Reduce” is considered to be one of the most recognized programming models, which facilitates in the generation and processing of huge data sets across big data centers [23].

1.5 Types OF Authentication

The most basic type of authentication is password authentication. Under this type of authentication, the users are asked to create certain key, which is known to them only. But there

are certain disadvantages that are associated with this authentication mode, such as weak strength. It is not just difficult to handle passwords but it is also very insecure due to their vulnerability of being cracked or guessed easily by the hackers. With the evolution of technology, the tools used by the hackers for cracking people's credentials have also evolved. Besides only guessing the password, hackers commonly use a technique termed brute-force attack. In this technique, a computer program is used by hackers for running through every combination of password, until a match is found. Thus, to minimize the chances of hacking, the passwords must be unique, complex and lengthy. However, it is quite hard to remember the complex passwords, which means that this approach is not user-friendly or effective [24].

Another type of authentication is via smart card, in which a pin code present at the back of the card is used. This can be very crucial in case of loss of card, since it will be very susceptible to attack.

Biometric authentication is the third type of authentication, which commonly uses scan of finger print for verifying the images and matching with the database information. In recent years, fingerprint scanning has turned out to be a known replacement for passwords. The major plus of this type is that the users benefit from an easy and quick process, and they do not have to cope with the inconvenience of making and remembering complicated passwords. Moreover, biometric authentication is more secured compared to password authentication, since it is not easy to duplicate or crack the unique biological traits. But, there are few types of errors in this type of authentication, such as false acceptance error when a passive person is being verified as a known person. Another big drawback with fingerprints scanning is that it is possible to trick these systems through a mold or image. Furthermore, the creation of copy of users' fingerprints is not the only option of hacking a system by an unauthorized user. A latest research has revealed that a master fingerprint, made up from numerous characteristics of common fingerprints, can be employed for fooling the systems of fingerprint. Although, there are several advantages of fingerprint scanning, but the weakness issues in its accessibility and security may be a serious concern for a lot of companies. That is why; there is a need of some other alternative approach for the authentication process [25].

The face recognition method is the last type where the face recognition output is a predicted ID. It is a must to match this ID with the one present in record for authorized person. The provision of

security through face recognition solutions is considered to be a future wave. The facial data points and the liveness detection of next-generation have been utilized by the facial recognition software for accurate authentication of users [26].

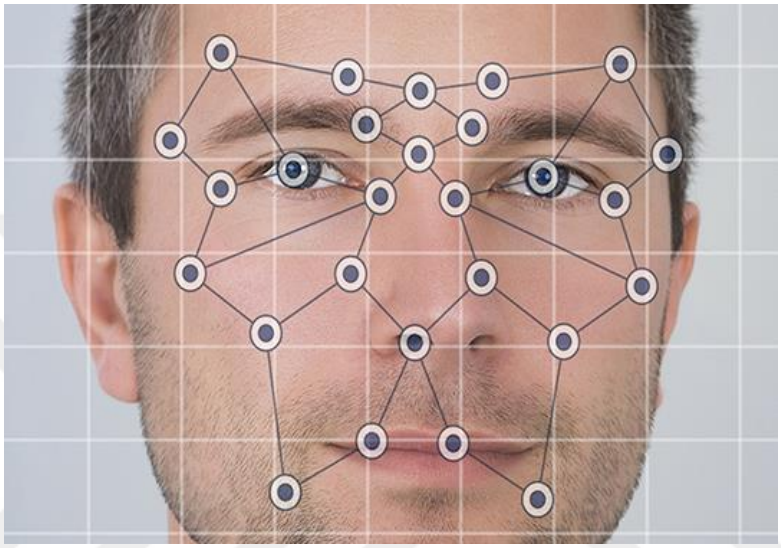


Figure (1.4): Facial Data Points for Face Recognition [26]

1.6 Objective

The main aim of this research work is to create and apply a software project where the programming language and training methods would be applied for the detection and recognition of faces with the help of cloud computing. The methodology adopted for this thesis will be explained in depth in chapter three. It is expected to be an excellent mechanism of facial recognition and has shown promising results for achieving high accuracy rate. This research work includes information to investigate and apply front view personal face detection and recognition systems on the basis of cloud computing.

2. RELATED WORK

2.1 Introduction

In recent years, the domain of face detection and recognition has been researched keenly. An abundant accumulation of data and information has led to the critical security requirements. Face recognition has been a tricky problem in the field of computer vision. That is why this filed has earned a huge consideration in research communities and medical fields, along with pattern recognition and biometric spheres. This section provides an up-to-date assessment of major research studies done in the area of face recognition. It highlights some of the techniques that have been employed in past for human face recognition and evaluates their outcomes.

In the literature of computer vision, one of the most researched topics is face detection, not just due to its challenging nature but also because of the various applications offered by it. Zafeiriou.S carried out a comprehensive survey in 2015, regarding the efforts done in this area and their resulting outputs. It has been highlighted in this paper that this development is achieved due to the efforts of community and the advancements of robust algorithm of computer vision. The recent developments in the domain of face detection are considered in this survey, starting with Seminal Viola–Jones methodology for face detection. All the surveyed techniques are divided into two categories i.e. rigid templates and deformable models. The paper also reviewed the major databases that have been used for evaluating face detection algorithms [27].

This chapter provides a general idea about the main techniques for human face recognition, which are mostly applied to front faces.

2.2 Related Work

In 2015, Jie Z. implemented Haar-like features, which is considered to be one of the most effective and quicker methods in this field for face detection, and training of those features using AdaBoost algorithm. The most significant advantage of Haar-like feature is its calculation speed [20].

In 2016, Hazim N. with his team proposed an automatic face recognition system on the basis of appearance-based features, where the focus is not just on local facial features but on the

whole face image. Face detection, the first step of entire process, is done using Viola-Jones method. This method earned maximum worth in 2000's and was termed as the first framework for object detection in real time. Face detection is followed by extraction of features. Linear Discriminant Analysis (LDA) has been employed in this paper for face recognition, to overcome the limitations of Principal Component Analysis. Since in pattern recognition, a major issue is the distance within two images, thus Square Euclidean Distance (SED) has been used in this paper. The presented approach is tested on 3 databases including Grimace, Face94 and MUCT. The system evaluation has shown that the recognition rate is increased with increase in number of training images [28].

In 2016, a solution has been presented for distinguishing between non-objects and objects in an image under computational constraints. A cascade detector is employed, which is made up of a set of node classifiers having incrementing discriminative power. However, out of several thousand image patches being produced from input image, the searched object existed in very few. Training on such unbalanced data sets result in poor performance of node classifiers. Therefore, a learning strategy is proposed in this work with the aim of increasing the ranking capacity of node classifiers instead of their accuracy. The analysis done on greatly unbalanced practical issues show that this approach is effective and efficient in comparison to other training methods [29].

Cloud computing is a promising area of computation that facilitates low-cost, flexible, scalable and on-demand services to its users. There are two major issues in cloud computing, i.e. security and access control. In 2016, Namasudra S. and Roy P. have presented a new scheme for authentication in their paper. Chebyshev chaotic maps are being employed in this scheme. Various security factors like login scalability, freedom of changing password, forward security, 2-factor security and mutual authentication are satisfied with this model. The secrecy of user's session key is assured by forward security, in case of loss of server private key. Moreover, the proposed system has allowed users to remain anonymous and untraceable. It is shown that different attacks on the security of cloud computing can be resisted by the proposed system, thus making it superior to the current schemes [30].

Nafchi H. proposed a new decolorization method, referred as CorrC2G, in 2017 for converting colored images into grayscale. The three universal parameters of linear weighting are estimated by this method for color conversion using correlation. The direct estimation of these

parameters is done from the correlations between contrast image and each RGB image channel. This method is employed well with RGB channels directly with no need of using any training, optimization or edge information. The experimental results have shown the high efficiency of presented decolorization method, which can be compared with the recent high-tech decolorization systems [31].

In 2017, Rupali S. believed that a 3D image can be used for the purpose of approval, since it offers more accuracy. In this research study, three stages of approval are used; first one is text based password where user has entered a text, which will be considered as on time password. Second stage is the hand gesture recognition wherein the consumer is required to place his hand in the camera direction followed by the selection of unique point out of the twenty-two points on hand. The final stage is face recognition, where the customer is asked to face the camera, so that the face can be recognized by the camera. Subsequently, the seventy eight landmark points are chosen which are then stored in the users database [22].

In 2017, Anshun R. presented and compared the methods for automatic appearance system applied on video-dependent face recognition. Hence, video is the system input while an excel sheet having students present in that video is the output. Automatic attendance can be done with the help of varied biometric mechanisms. Face recognition is among those mechanisms which do involve human intervention. In this study, the presence of student in the class is marked from the class video by primarily implementing face detection, which separate out non-faces from faces, and then implementing face recognition which determines the faces matched from the database of faces. The database includes pictures and names of students. If the match is valid, then attendance is recorded in excel sheet. Face recognition is done and compared on the basis of detection accuracy using algorithms of Linear Discriminant Analysis and Principle Component Analysis [32].

In 2017, Silvia et. al. Proved in their paper that it is possible to successfully use the a contrario methodology to improve the performance of the classical Viola {Jones face-detector. they have justified that a Gaussian distribution can be used as a background model against which to test the existence of faces in an image, and then they have proposed a method to adapt the detection threshold of a single strong classifier to control the number of false positives. The method has been tested with three different representative datasets (IMM, BioID, FDDB) [33].

In 2017, Andreas et. al. Investigated-a method to stretch the Viola–Jones method to mingle information about near positives, as well a to include tracking capabilities. The Viola–Jones framework is not perfectly suited for the enforcement of our insinuate likelihood map, as some extra amount of misapprehension was necessary to build up an initial map from the detection outcome. This-work as it is the most well known for Viola–Jones, was chosen and widely used tactic to static face detection today, and it is able to work in real time. However, this is speedily changing as deep learning oncoming are unremitting improving on performance, with hardware dedicated to them being sophisticated jointly (embedded GPUs). Although Viola Jones works very well with near anterior faces, its execution safely suffers with faces having degradations and tyrannical poses or other. It could be expected that precision of MTCNN, VGG or other accessions for unconstrained face-detection would be amended in the same way that Viola–Jones has been amended here [34].

In 2018, Gu-Min et. al. proposed a method to reconstruct a data sample, some values of which are lost due to sensor instability in the electronic nose system. The proposed method is composed of a part for obtaining a feature vector for representing data in a low dimensional space and a part for updating the feature values appropriately for data restoration. By using L1-norm maximization-based PCA (L1-PCA). In order to confirm the effect of the proposed data reconstruction method, they experimented with face images that are high dimensional data such as electronic nose data, from the AR database [35].

3. METHODOLOGY

3.1 Introduction

Face recognition is a function usually performed by human beings every day in an effortless manner. Easy access, low cost desktops and embedded computing systems have helped in drawing attention towards the involvement of dynamic digital image processing in numerous applications, including biometric authentication, computer-human interaction and multimedia management. It is followed naturally by the study and improvement in dynamic face recognition approaches. Face recognition is having many advantages over other biometric modalities such as iris and finger prints. Moreover, it is also nonintrusive and normal.

The most significant advantage of face is that it can be captured in any space and in an undetectable manner. Among the biometric attributes defined by Hietmeyer [36], the facial features witness the maximum conformity in a Machine Readable Travel Documents system [37], depending upon some evaluation factors, such as common perception, machine requirements, regeneration, and registration, as shown in Figure 3.1. Face recognition, as an essential biometric mechanism, has earned a significant spot due to the fast developments in image capturing devices (cell phone cameras, surveillance cameras), presence of huge number of facial images on internet and increasing needs for improved security.

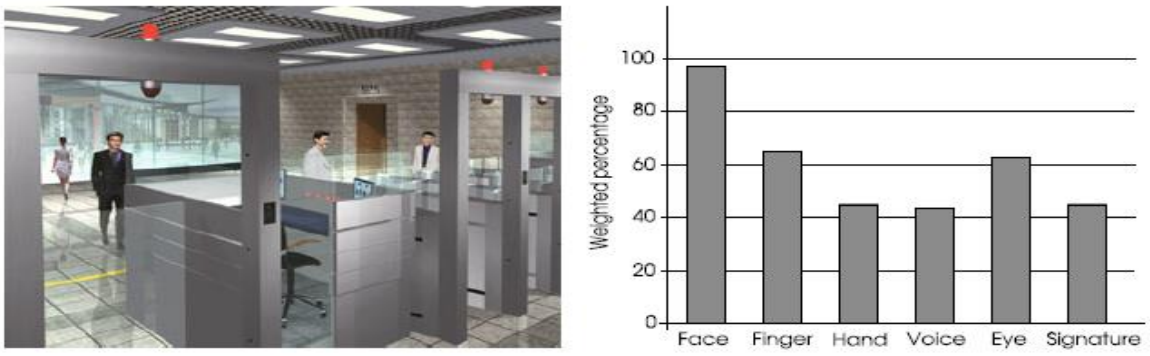


Figure (3.1): Scenario of Biometric MRTD [25]

In 1973, Takeo Kanade designed the primary dynamic system for facial recognition during his PhD research thesis [38]. There were no noticeable developments in the domain of automated face recognition until the work done by Kirby and Sirovich on a small depiction of facial dimension, with the help of Principal Component Analysis or Karhunen–Loeve convert. The

research done by Pentland and Turk on Eigen faces [39] activated research on facial recognition. Other most highlighted developments in the domain of face recognition include the Fisher face method [40, 41], which included Linear Discriminant Analysis.

3.2 Proposed methodology

The facial identification system is initiated typically with a picture or video stream. The outcome is the identification or discovery of some objects or something present in input. The following stages are involved in the proposed system, as represented in the figure 3.2.

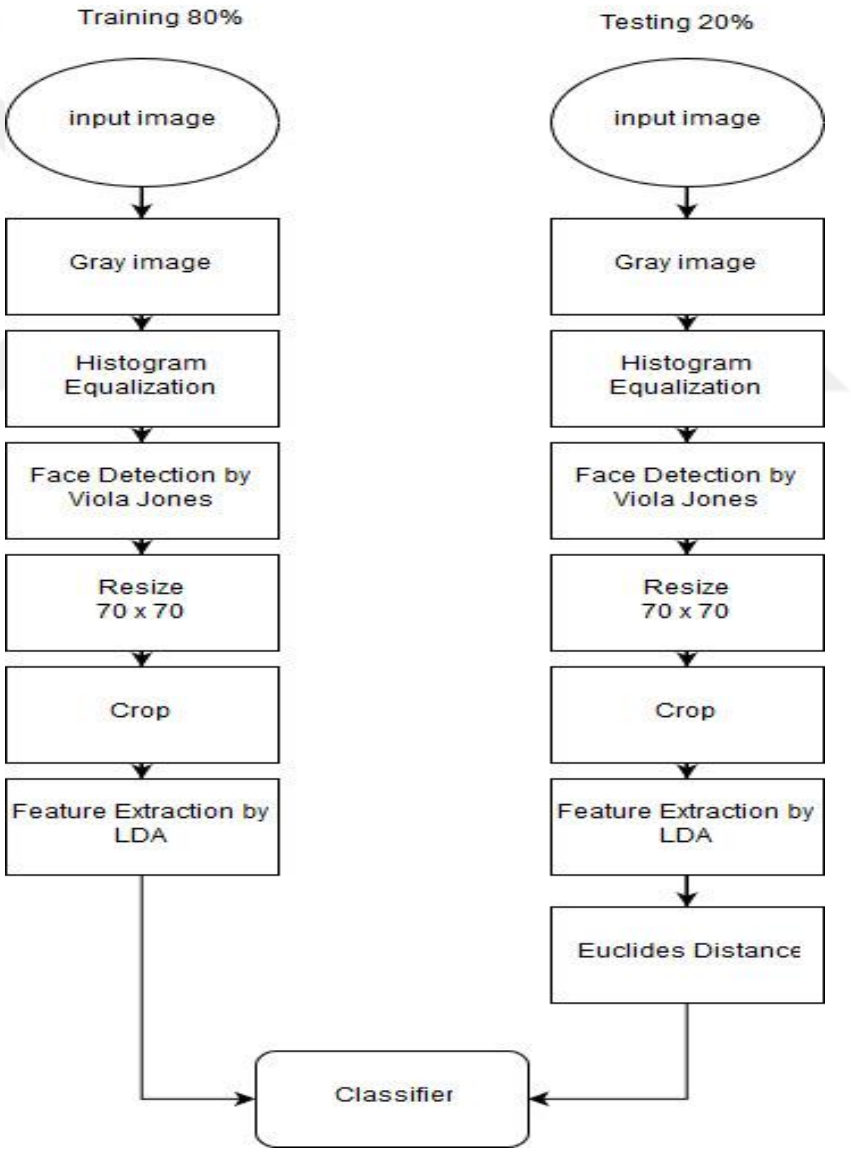


Figure (3.2): The Proposed System

3.3 Image Preprocessing

Image processing has become an essential area of investigation and exploitation of images is increased in a range of applications. In this domain, scientists are achieving new targets like restoration, compression, and segmentation etc. of images, for boosting the available image processing mechanisms and finding novel methods of solving issues in this domain. The latest applications of this field include processing of satellite images, clinical and molecular image processing with the help of various methods of image processing [42].

In processing of an image, the key steps include scanning of image, followed by memorizing it and then translating it after boosting. Figure 3.3 shows the schematic diagram of image scanner digitizer. Images can be processed in two ways, i.e. by digital processing or analog one [43].

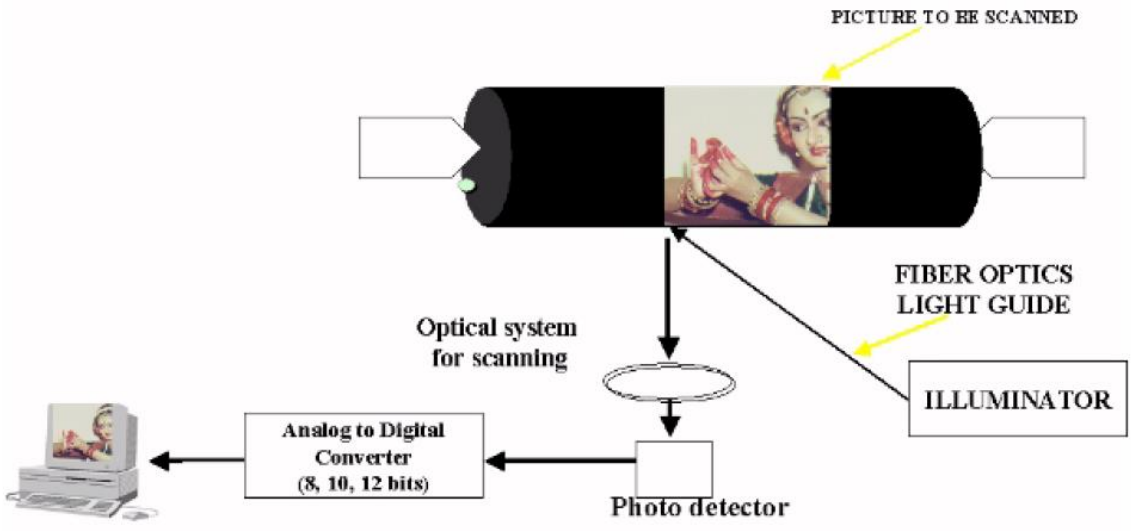


Figure (3.3): Scanned Image [43]

The image is altered through electrical methods in analog image processing. The most general example is the image of a television. The television signal is basically a voltage signal, whose value is altered for indicating brightness through the image.

The shape of an image is altered by changing the level via electricity. The contrast and lighting commands on a television offers service for the modification of reference and value of

video signal; thus having an impact on the darkening, illuminating and changing of the range of illumination [43]. In digital image processing, the picture is processed by applying digital PCs. A scanner digitizer transforms the picture into digital shape and after that processes it. Its verification is done as numerical representation of subjecting objects to a series of processes for achieving a set goal. This starts with one image and then adjustment of same version is presented. Digital image processing is referred as a 2D image processing approach using digital computer [44].

3.4 Gray image

The translation of colored image to grayscale version is a major application of effective implementation of image processing in different fields. In a colored picture, a pixel is made up of three colors i.e. Blue, Green and Red. The numbers of Blue, Green and Red color are applied in 3 axis i.e. XYZ, briefed by the hue, purring, and lightness attributes. The number of bits in lightness attributes could provide the color quality of an image on the basis of indication of colors [42]. 8 bits are used for the indication of basic color image whereas the high-quality color image is indicated using 16 bits. 24 bit is enough for indicating actual color picture; however, the dusky color picture is indicated by 32 bit.

The maximum amount of different color numbers provided by the digital instrument are determined by the bits number. If 8 bit is taken by each RGB then integrating Blue, Green and Red will take 24-bit and offer about 16,777,216 range of colors. The 24-bit basically points toward the pixel color in colored image. The light intensity of grayscale image is indicated by 8 bit value. In grayscale images, the light intensity of pixel amplitude lies in the range 0-255. The colored picture transformation into a grayscale one is basically the transformation of Blue, Green, and Red (24 bit) to a grayscale value of 8 bit [42]. The same major 3-step procedure is used by all the grays-scale methods, i.e. obtaining the RGB pixel values, implementing mathematics for converting these values to single gray value, using next equation for substituting new grey values in place of original RGB values.

$$\text{Gray} = 0.1140 * \text{Blue} + 0.5870 * \text{Green} + 0.2989 * \text{Red} \qquad (3.1)$$

Algorithm : RGB to grayscale
Input: RGB Image
Output: Grayscale Image

Begin
Step1: Read RGB Image
Step 2: for all image of RGB. pixel Do
BEGIN
Blue = pixel. Blue
Green = Pixel. Green
Red = Pixel. Red
Image of grayscale. Pixel = 0.1140 * Blue+ 0.5870 * Green + 0.2989 * Red
END
END

3.5 Equalization of Histogram

This is a common approach for the enhancement of bad look of an image. It is quite similar to that of histogram stretching but typically offers more visually placate results through a broaden extent of images [45]. The histogram outcomes with a mount assembled closely with one another for opening out or smoothing histogram formulates the deeper illustration of deep pixels and the lighter display of light pixels. The main thing is appearance, in an image the deep pixels cannot get further deeper, but, they will appear deeper due to such pixels which are somewhat lighter.

In case of digital images, there are four main stages of the histogram equalization process [45]:

1. Determination of histogram values
2. Normalization of values obtained at stage one will be done by dividing them with total number of pixels
3. Values from the 2nd step will be multiplied by gray level value and rounded off
4. The outcome of stage three is mapped to the gray level by one to one correspondence

The following equations illustrate the accumulative distribution function:

$$\text{C.D.F. (y)} = \sum_{j=1}^{y} H(j) \quad (3.2)$$

Where:

y: grey value

H: histogram of images

Following is the formula for calculation of histogram equalization:

$$H.E\ (i) = round\ \left(\frac{C.D.F - vwf_{min}}{A*B - vwf_{min}}\right) * (G - 1)) \quad (3.3)$$

Here:

vwf_{min}: Minimum accumulative distribution function value

A * B: number of rows and columns in images

G: applied grey levels =256

Algorithm : equalization of histogram
Input: image; number of gray level in 0-255 range
Output: Enhanced image
Begin **Step1:** Size of grey image Size of Image: A x B, gray level range: 0 - 255, Creation of a matrix G of 256 dimension and initiating with 0 **Step 2:** Creation of histogram image by swabbing every image pixel an incrementing the corresponding matrix parameter G [gray - value (pix)] = G [gray - value (pix)]+1 **Step 3 :** Using accumulative distribution function C.D.F by applying equation 3.2 **Step 4:** Determining new value using rule of standard histogram equalization by equation 3.3

Step 5: Building new image by using new gray values in place of the native ones

Modern Image [A][B] = T [Previous Image [A][B]]

END

3.6 Face Detection

Face detection is required by the recent facial verification applications. The face image that has been recorded in the database is occasionally previously normalized. The main focus of face detection is identifying the presence of any face in the image, and if there is a face present then verify that and find it within the image. The analysis under various changes shows that the main issues in the face detection process are skin color, ethnicity, expression, and turning. Furthermore, external factors like image quality, complicated backgrounds and incompatibility with illumination conditions can particularly play a part in the detection procedure [46]. There are two ways that are mainly adopted for face detection:

1. **Knowledge-based Approach**

   This technique may also be referred as rule-based approach. Under this, the human knowledge regarding the faces is gathered and converted into a set of rules. There are some very simple and straightforward rules, such as, there are generally 2 eyes on a face which are place symmetrically, and the area of eyes is typically deeper compared to the cheek area [46].

2. **Feature Invariant Approach**

   This approach is focused on determining face properties like eye brows, mouth, nose, hair and tries to collect them for shaping nominees and then identifying the face by taking help of geometrics relation. This methodology is more brilliant compared to knowledge based methods, since it can identify face in images having different facial expressions and poses. However, this approach does not perform well under certain conditions (e.g. stopping, noise and lighting), resulting in the alteration of images structure to such an extent that it cannot be discovered. Moreover, it also causes the repression of some characteristics in the

side shadows of dominant edges under too thick illumination, thus making this algorithm not suitable for wide use [47].

3. **Template Matching Approach**

Under this approach, the images that are entered with the recorded facial characteristic or schemes are compared. This method attempts to verify a face in the form of a function; the verification of different characteristics can be done in a separate manner. For instance, a face might be divided into nose, mouth, contour of eye and eyes etc. [47].

4. **Appearance Based Approach**

It is basically a template matching method where the training of scheme database is carried out using a group of training images. In appearance based approach, the training of prototypes is done from the image having examples. In general, this method is based on approaches that are used for statistical analysis and machine learning in order to find out the benefits of facial images properties. These methods are also appropriate in case of proper data extraction for facial verification [47].

3.6.1 Viola Jones

The object detection mechanism is considered to be the pioneer method that has supported discovery of objects in a speedy way [48]. This method was proposed in 2001 by Michael Jones and Paul Viola. It is the method of rapid and accurate discovery of objects with the help of Adaboost machine learning.

The Viola Jones method for object detection is termed as the primary object detection mechanism, which has given competitive object discovery rate in real time. It can learn different object classes for detecting varied objects by establishing Haar-like feature. It has been suggest mainly for the issues in facial detection [48]. Some objects being identified by Viola and Jones are shown in Figure 3.4

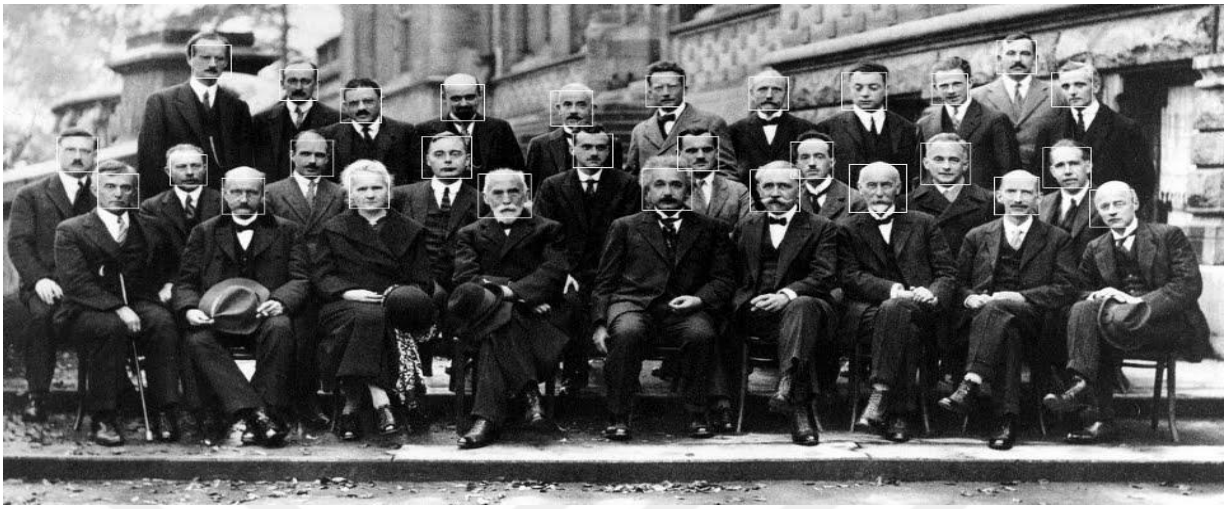


Figure (3.4): Object finding by Viola[48]

The key characteristics of Viola and Jones functions are illustrated as follows:

1. The image integration was primarily applied by Papageorgioun [49]. This helps in the indication of Haar-like features t rapid rectangular calculation of face detector. The integral image at the place *u, w* involves the pixel addition on top and in the left of *u, w* [42]:

$$\mathrm{jj}(\mathrm{u},\mathrm{w}) = \sum_{\acute{u}\leq \mathrm{u},\acute{w}\leq \mathrm{w}} \mathrm{j}(\acute{u},\acute{w}), \qquad (3.4)$$

Here the primary image is indicated as *j* (*ú*,*ẃ*) while the integral image is denoted by *jj* (*u, w*), thus developing the subsequent recurrences, as indicated in the Figure 3.5.

The integral image might have been calculated in one override over the initial picture.

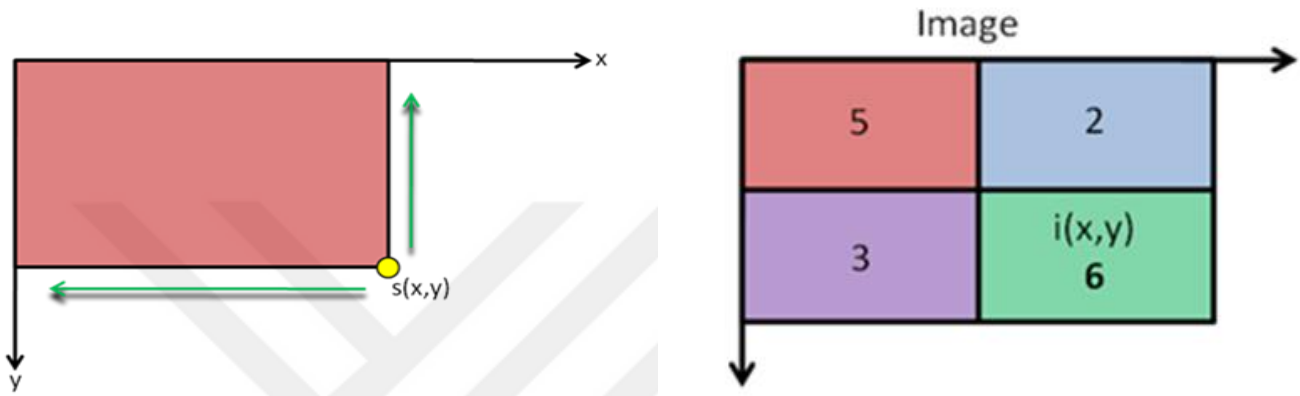


Figure (3.5): Image of integral value [50]

For this reason, each Haar-like rectangular summation might be done with precision in only 4 reference arrays, whereas the evaluation of various factors within rectangular summations of Haar-like features may be done in 6 references [50].

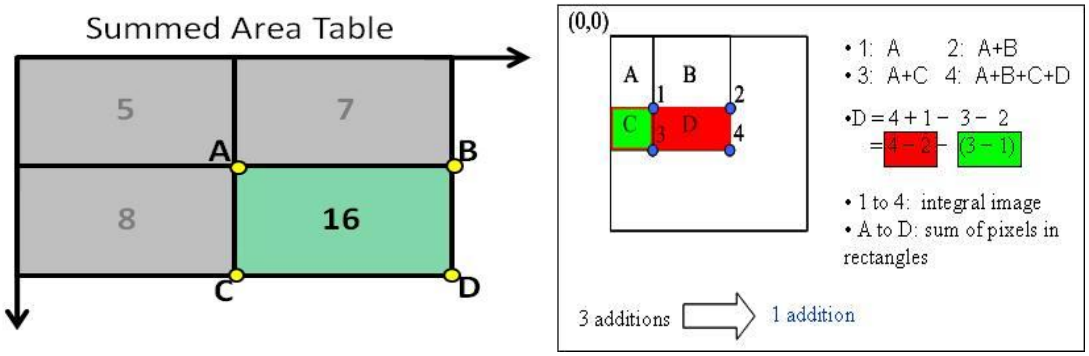


Figure (3.6): Calculation of integral image[50]

In the example illustrated in Figure 3.6, the pixels sum in region D can be calculated using 4 metric references. The image integration amplitudes at point 1, 2 and 3 identifies the pixels of addition region i.e. (A+B), (A+C) and A. The location of four sums has been shown in the above figure.

Algorithm : Image integral
Input: E (image X*Y).
Output: EE (integral image X*Y).

BEGIN
STEP1: for v =1 to X **DO**
STEP 2: for w =1 to Y **DO**
STEP 3 :EE (v, w) = E (v, w) + EE (v, w-1) + EE (v-1,w) – EE(v-1, w-1)
END FOR
END FOR
END

2. The filter process of Haar-like features is dependent upon the categorization of pictures by Viola and Jones' system. In Viola and Jones method, the pixels are not applied straight, whereas a selection is made for the implementation of characteristics, with the help of which a conversion can be made towards code knowledge of applied properties and ad-hoc field, instead of this the system may be incremented fast by pixels. Furthermore, Haar-like features are broadly effective in face detection process. After the identification of integral image, there will be a simultaneous identification of every Haar-like property at every scale or place. The number of Haar-like features is displayed in Figure 3.8. [39]. For a two-rectangle feature, the value is the difference between pixels sum.

The two-rectangle feature value is the difference between the pixels sum inside the two rectangular regions as portrayed in below figure 3.7:

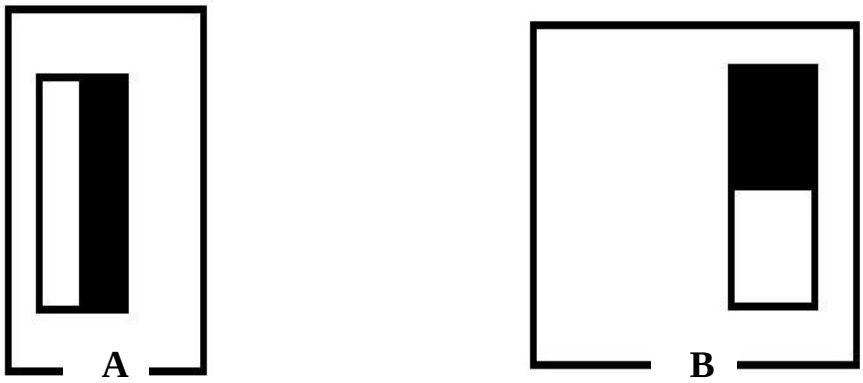


Figure (3.7): Calculation of Haar like features (the pixels sum lying inside the white rectangle are subtracted from pixels sum in the grey rectangle)[39]

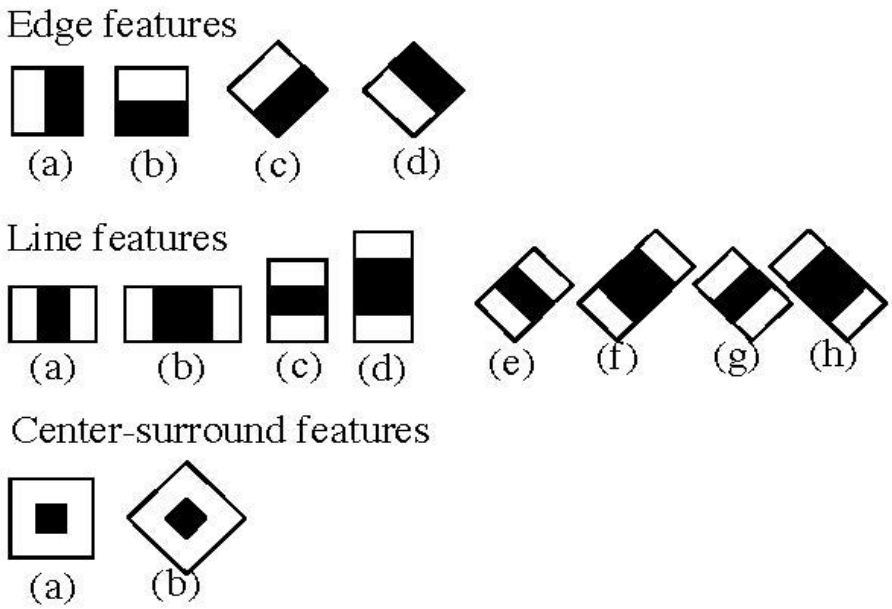


Figure (3.8) Examples of Haar-like features[39]

3. AdaBoost training is machine learning method, where a little is selected in place of the delicate classifiers, each of which is specified accurately with one Haar- like feature, which is then combined for forming a powerful classifier [50].

Algorithm : Learning of AdaBoost
Input: image (a_1, b_1) // b_i = 1 for not positive or 0 for positive image. Assumed weight $w_{c,j}$ = 1/2m , 1/2a where m , a is the indication of negative and positive images
Output: A strong learner classifier

BEGIN

STEP1: for C = 1 to N where N: hypothesis

STEP 2: normalization of the weight, $w_{c,j} = w_{c,j} / \sum_{i=1}^{n} w_{c,i}$

STEP3 : Selection of delicate classifier, E_c = min $f,p,\theta \sum_i$ wi | h(xi, f, $p\theta$) - yi |

STEP 4 : Up gradation of weight, $w_{c+1,j} = w_{c,j}\ \beta c^{1-ej}$

where

ei = 0 in case of correct classification of example xi

ei =1 in case of incorrect classification and $\beta c = E_c$ /1 - E_c

STEP 5 : Powerful classifier is

$$\mathbf{C(x)} = \begin{cases} \mathbf{1} & \sum_{c=1}^{N} \alpha c\ hc(x) \geq \frac{1}{2} \sum_{c=1}^{N} \alpha c \ where\ \alpha c = \log 1/\beta c \\ \mathbf{0} & \boldsymbol{otherwise} \end{cases}$$

END

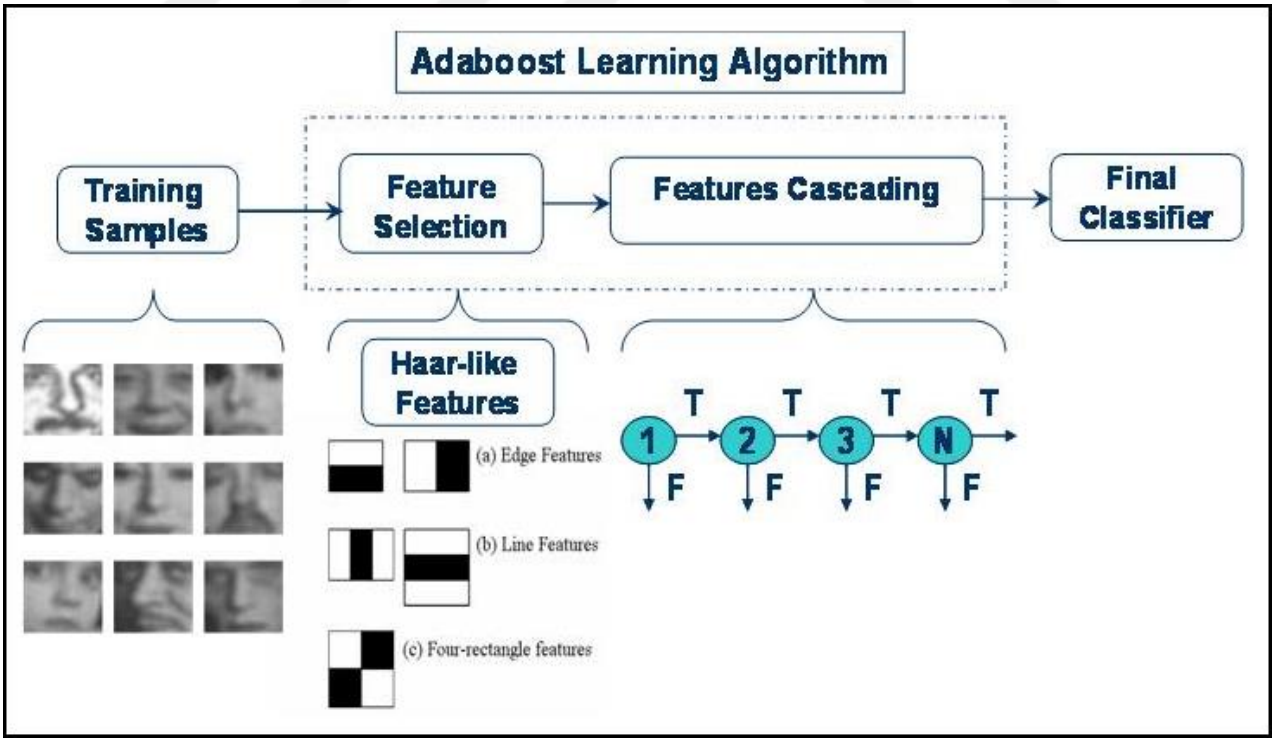


Figure (3.9): AdaBoost Learning Algorithm [49]

$M_i(u)$, a weak classifier, which is a multipart of a feature $N_i(u)$, might be specified as:

$$M(u) = \begin{cases} 1 \; if \; P_i N_i(u) < P_i \varphi_i \\ 0 \qquad otherwise \end{cases} \tag{3.7}$$

Where p_i stand for equality and φ_i refer to the ideal threshold, which establishes the unequal sign direction, therefore, the unclassified amount of examples is minimized. A subnet window of 24x24 image pixel is indicated by Parameter u.

In each round, only one weak classifier is collected by the algorithm that can split the examples of negative cases and positive ones from the learning set in the most effective way. In the subsequent rounds, a weight having bigger value will be provided by the negative address examples, whereas the right examples will give a weight with smaller value [49].

The linear integration of delicate classifiers used the following final strong classifier$M(u)$:

$$M(u) = \begin{cases} 1 \quad if \sum_{t=1}^{T} \alpha_t h_t(x) \geq \gamma \sum_{t=1}^{T} \alpha_t \\ 0 \; otherwise \end{cases} \tag{3.8}$$

Where

α_t = weight of delicate classifier

λ= the strong threshold classifier

(t=1……T) = rounds of series period

In the examples, the error rate of initial rounds is in the range of 0.3 to 0.4, whereas the error rates of final rounds is more than 0.4, thus clarifying the fact that the job is becoming more and more difficult [49].

4. Cascaded Classifiers

Viola and Jones created a cascaded configuration of classifiers that involve a series of strong classifiers, with the purpose of rejecting the unpromising picture areas in a speedy manner. The strong classifiers are arranged in cascade form in ascending order of complexity. By doing this, the primary classifiers dispatch numerous area that are unlikely for compound faces with less effort, since a lot of calculations are then done next on the contender's areas i.e. more advanced classifiers. The detection performance is effectively incremented by this approach and from bigger aspect the calculation time is also minimized. AdaBoost depending upon Viola detector is accurate and fast. It offers high efficiency and can be applied easily. On the other hand, the major limitations are the more time required for training and the avid search carried by it through feature space [50].

3.7 Crop

It is important to carry out the pre-processing of image for making the process of feature extraction easy, since it is hard to extract features from crowded and unfocused images [51]. Face cropping is therefore an essential step for achieving high recognition rate. In the cropping section, the unwanted parts of a picture are removed using a smart graphic tool. A rectangular area of interest is extracted through cropping of the original image. This helps in paying attention on a particular region of image, and discarding those portions of image that have less significant information as shown in following figures.

Figure (3.10): Original Image MUCT dataset

Figure (3.11): Cropped Image

Depending upon the application of a system, a particular set of pre-processing steps is selected. In face recognition system, the manual alignment of all the database facial images is done by adjusting the eyes location. Thus, initially, all facial images are rotated for setting the eyes centers on specific pixels. The region of image where there is a possibility of face is cropped, which is then used in the process of face recognition. The face cropping is done manually from the entire image based on the position of mouth, right and left eyes [52].

3.8 Resize

Resizing is an important image pre-processing step for face recognition system. The image interpolation method is used for resizing the image resulting from different face detection methods with particular output size [51]. Image interpolation is the process of resizing or distorting the image from one to another pixel grid. Image resizing is required for increasing or decreasing the total number of pixels. The impact of resizing images in different scales is observed in the recognition process. Since different information has been carried by different sized images, so, it

is critical to examine the best size of image in depth. Images are resized with the intention of producing lower size of data that speeds up the processing time. They are typically resized at a 0.1-0.9 valued scale [52]. Here, the “Resize” step is implemented for normalizing the image dimensions (70 X 70) after the detection of face by Viola Jones algorithm, in order to allow the use of LDA. An example of image resized in “70x70” dimension is shown below:

Figure (3.12): Original Image (243 x 207) MUCT dataset

Figure (3.13): RESIZED IMAGE (70 x 70)

3.9 Linear Discriminant Analysis (LDA)

LDA is an approach that has been implemented in machine learning, pattern recognition and statistics for computing linear features integration, which illustrates or divides two or more events or objects classes.

The resulting collection may act as a linear classifier or, in general, for reducing the dimension before the correspondence of LDA last classification to the principle component analysis, as both of these are dependent on linear conversions and matrix multiplication [53]. In the case of principle component analysis, the conversion relies upon the reduction of mean square error between initial data vectors and its evaluation from the minimized data vector dimensions. Moreover, no class variation is considered by the principal component analysis. However, in case of linear discriminant analysis, the conversion is based upon improving the "within class variance" rate with respect to "between class variance" rate; with focus on reduce data changes in the same class and incrementing the division among classes [54]. An LDA example is shown in following Figure 3.14:

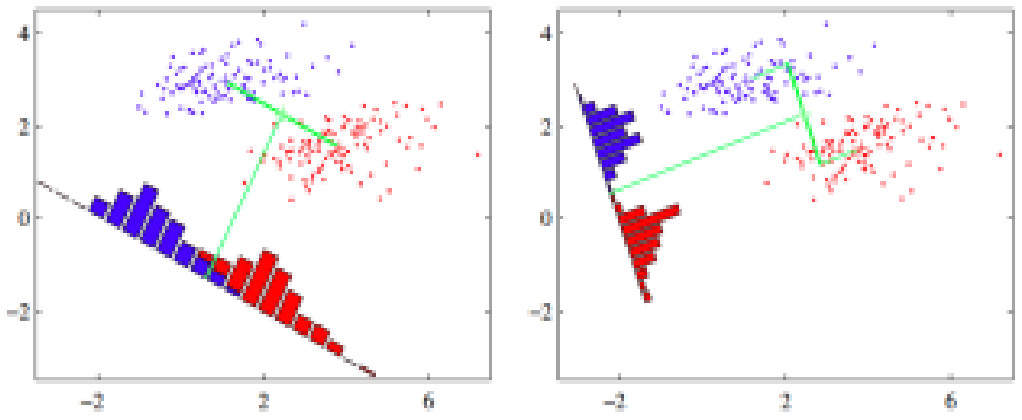


Figure (3.14): LDA Example[45]

Two different class samples are indicated by the left figure, which are indicted in blue and red color, along with the histogram resulting due to dropping of the line that connects the class means. A huge class overlap is noted in the dropped space. The right side figure shows that the similar drops are dependent upon the Fisher linear discriminant; which exhibits the substantial

developed class division [45]. The process of LDA starts with the calculation all stepsc by following algorithm :

Algorithm : Linear discriminate analysis
Input: Image
Output: Fisher vectors
Begin **Step 1:**Input transform face images **Step 2:** Add the transmit face picture in matrix to memory **Step 3:** Compute the d-dimensional mean of vectors **Step 4:** Calculate the scatter matrices **a.** Calculate class sector matrix **b.** Calculate the covariance of class **c.** Calculate between matrix of class sector **Step 5:** Find Eigen value problem **Step 6:** Select LDA for sub space. **a)** Arrange the Eigen vectors by reducing Eigen values **b)** Choose k-Eigen vectors with the largest Eigen values **Step 7:** Form new sub space by converting the samples **Step 8:** Sent feature vectors **End**

3.10 Classifier

After carrying out the step of feature extraction with the help of LDA algorithm, it will be stored by the system in the form of a file, known as classifier. It is then compared with the test image for finding the Euclidean distance. The Euclidean distance / Euclidean metric is the standard

direct line distance measured within both points in Euclidean space. In the Euclidean plane, the space is depicted by equation 3.14 given that p1 = (P_{x1}, P_{y1}) and p2 = (Px_2, P_{y2}):

$$d(p1, p2) = \sqrt{(P_{x2} - P_{x1})^2 + \left(P_{y2} - P_{y1}\right)^2}$$

3.11 Summary

This chapter discussed the research methodology being proposed for implementing this project and attaining required outcomes. All the major stages involved in the face detection process were considered and elaborated. Furthermore, the key steps of an image processing system were also highlighted. This chapter pointed out the different techniques for image processing in general and the one used in this research study in particular. It focused on the ways that have been adopted for detecting faces in this project. Furthermore, the key characteristics of Viola and Jones algorithm and Linear Discriminant Analysis were discussed, equations were provided for mathematical calculations and different important variables were explored for precise analysis and accurate implementation. In last, this chapter talked about the significance of cropping and resizing of images and use of classifiers in face detection process.

4. RESULTS AND DISSCUSION

4.1 Introduction

This chapter is aimed at building a face recognition system on the basis of cloud computing for authenticating users. Viola and Jones algorithm has been used by the system for detecting faces, by using five kinds of Haar like features, cascaded classifiers, Adaboost learning method and integral image. Linear discriminate analysis (LDA) is employed as an algorithm for face recognition. The LDA algorithm is used since it offers improved performance in comparison to PCA. Moreover, excellent results are provided by it due to its low sensitivity for lighting, speedy processing and lower numbers of features. Before moving into the stage of face detection, it is a must to convert the image from RGB to grayscale for increasing the system speed and afterward move across the stage of histogram equalization. In image processing, histogram equalization is a process of adjusting contrast using the histogram of image. This approach generally raises the overall contrast of several images, particularly when the functional image data is characterized by close contrast values. It is possible to have a better distribution of intensities on the histogram with the help of this adjustment. This facilitates the lower local contrast areas to attain better contrast. The cropping is done for determining the edges of an image, after which resizing is done for unifying the dimensions of used image. The database cloud has been implemented for performing the verification of face present in the image.

4.2 Dataset

There are 3755 faces in the MUCT database with about seventy-six manual landmarks, as depicted in Figure (4.1).

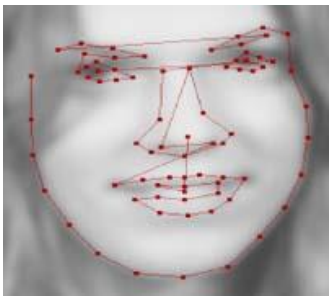


Figure (4.1): The 76 MUCT Landmark describe landmarks face

This MUCT database was formed for providing more diversity of ethnicity, age and lighting compared to existing landmarked databases of 2D faces. Some examples of database images (in low-resolution) are shown in Figure (4.2).

Figure (4.2): Examples of MUCT Database Images

Five webcams were used for capturing images of every subject. There were a total of ten different setups for lighting, and for every subject about two or three of these setups were used. A specific scheme was chosen for naming the image files in order to make selection of subsets easier.

4.3 Software requirement

In this system, the languages used are Oracle 10G, java 8 under net beans 8 and VC++ under visual studio 2013. The protocol used for sending information is the transmission control protocol (TCP/IP) protocol.

4.4 Proposed method

The basic layout for the proposed system is shown in Figure 4.3. It is based upon two interfaces, client interface and cloud interface, which have been developed using java

programming language. After the program compilation, the two interfaces will get displayed as depicted in Figure 4.4 and Figure 4.5:

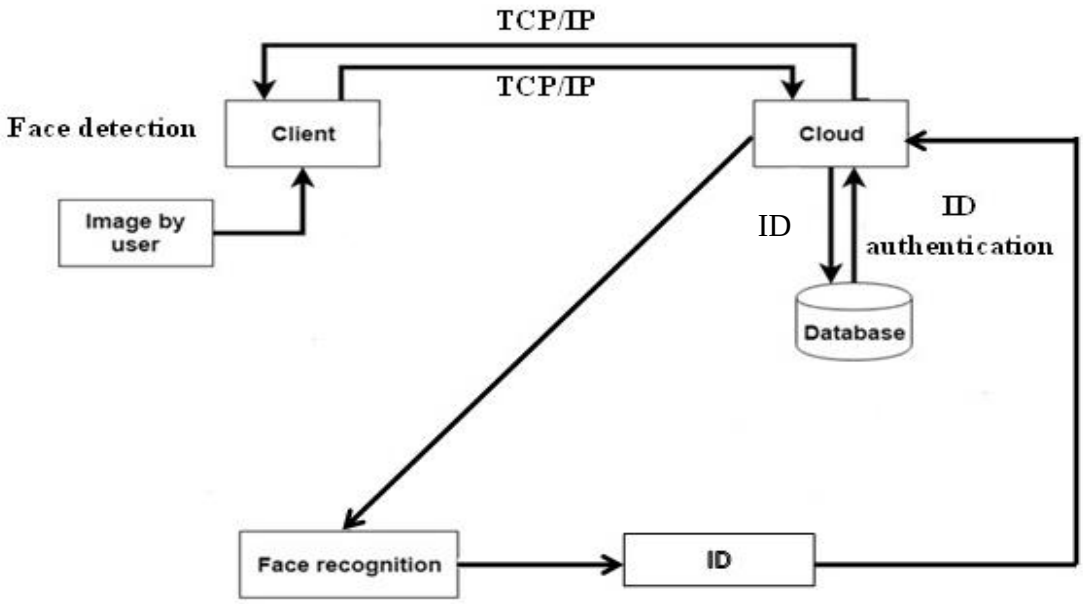


Figure (4.3): General Model of the System

Figure 4.4 and 4.5 shows the screen for client interface and cloud one respectively.

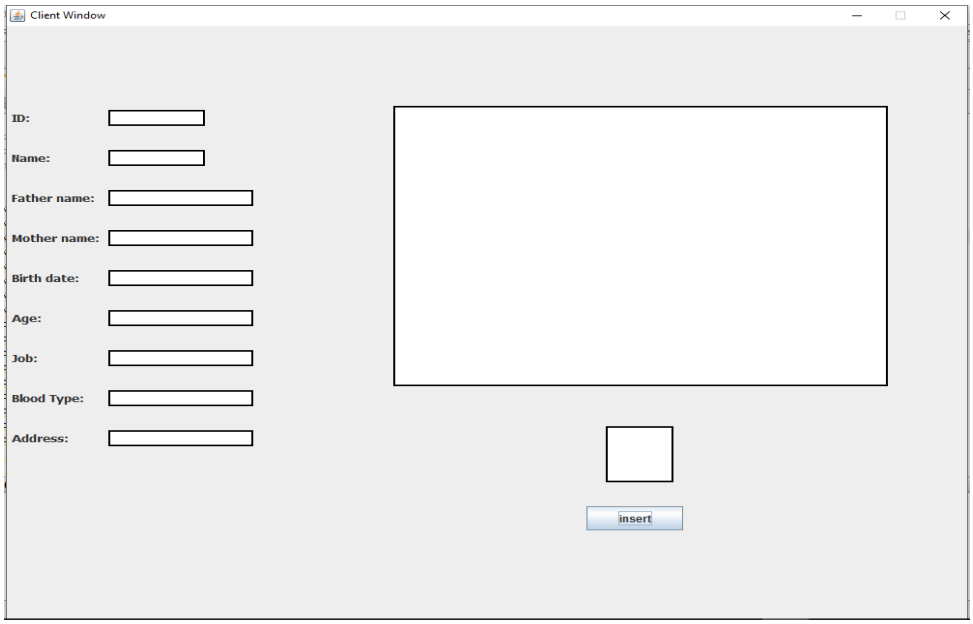


Figure (4.4): Client interface

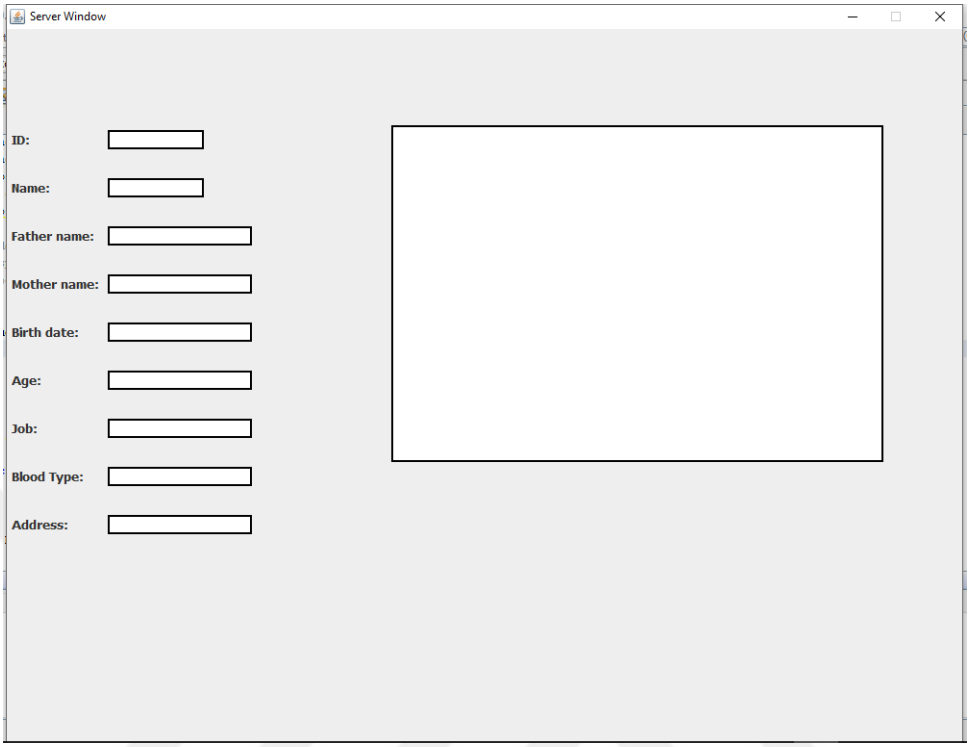


Figure (4.5): Cloud Interface

4.4.1 Uploading of Image

Under this step, the image of the person that has to be detected and validated is uploaded after selecting the browse option. Afterward, the preprocessing of image is done; in addition to that the process of face detection is also initiated for detecting the face and subsequently getting the image, which is small in size and can be sent quickly.

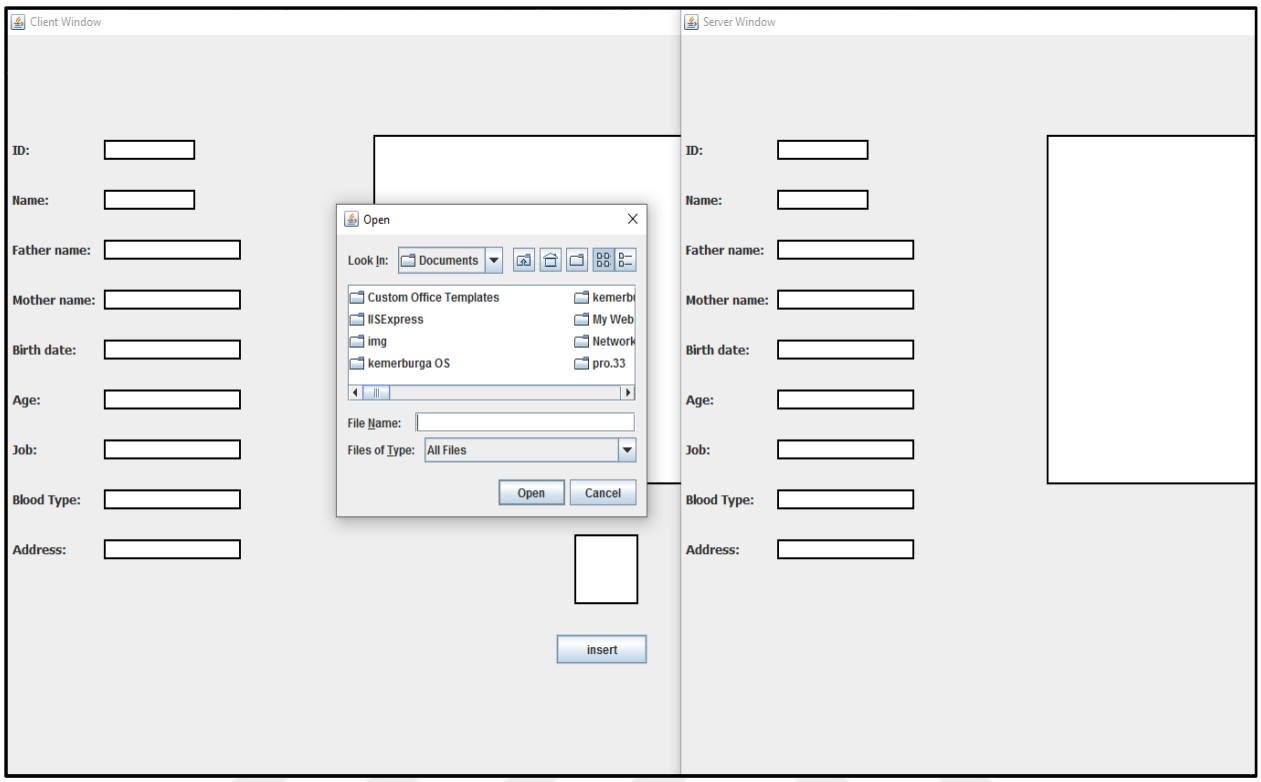


Figure (4.6): Interface for Browsing

4.4.2 Image Transfer

The person's facial image is transferred to the 2nd interface i.e. cloud by using TCP/IP protocol as illustrated in the following figure.

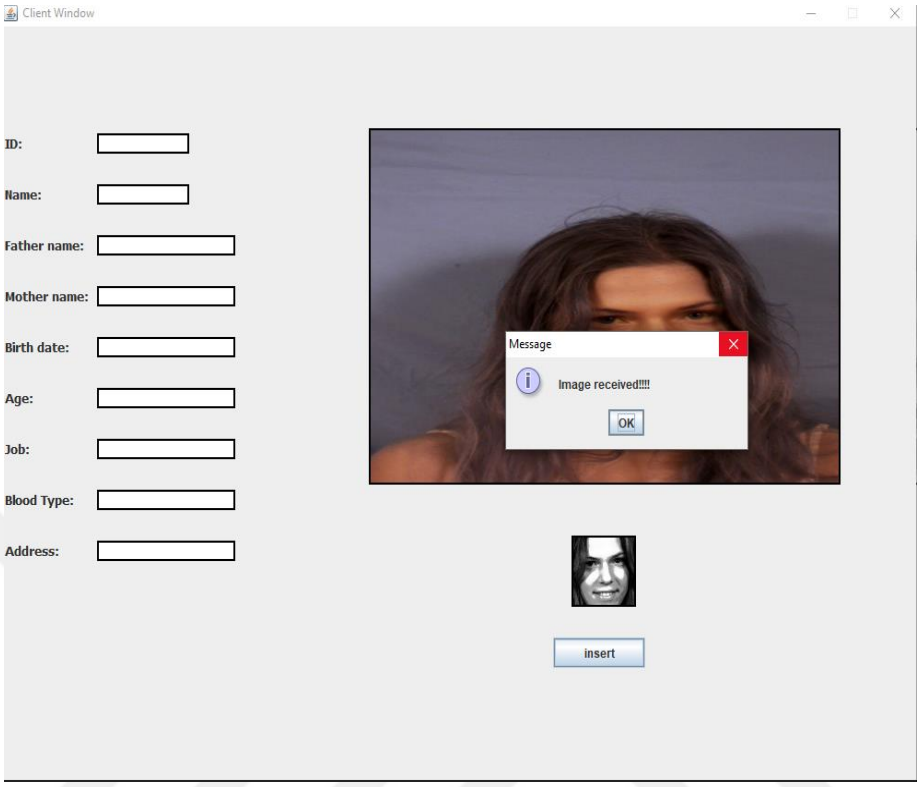


Figure (4.7): Transfer of Image

4.4.3 Image Processing

This is one of the most important stages where the process of detection takes place. As indicated in Figure 4.3, the image is transferred from the cloud interface to the point where face detection is done. From here, the other operations are carried out using combination of Euclidean distance and LDA algorithm for extracting features and then identifying the individual by matching it with the previous manual, which has been used in the process of training.

4.4.4 Image Recognition

Image recognition is the last step when the transmission of all of the information and data has been completed towards the client interface, which has been displayed as a page including all the required information regarding the person identification, as depicted in the above figure. In this program, the TCP has been implemented that plays it part by taking conformity of the other pair at each step of sending and receiving, particularly while sending video clips, messages or text. The reason behind the implementation of this protocol is to assure that all the information and data is reached without any deletion.

4.4.5 Determination of Database and ID

In this particular stage, the retrieval of ID is done from the recognition phase at the cloud interface, which is then transferred to the database from the cloud interface. The database contains information tables regarding each ID such as name, mother name, father name, blood group, workplace details etc. If any ID is brought to Oracle, the information is matched with the recorded data for determining the person present in the picture.

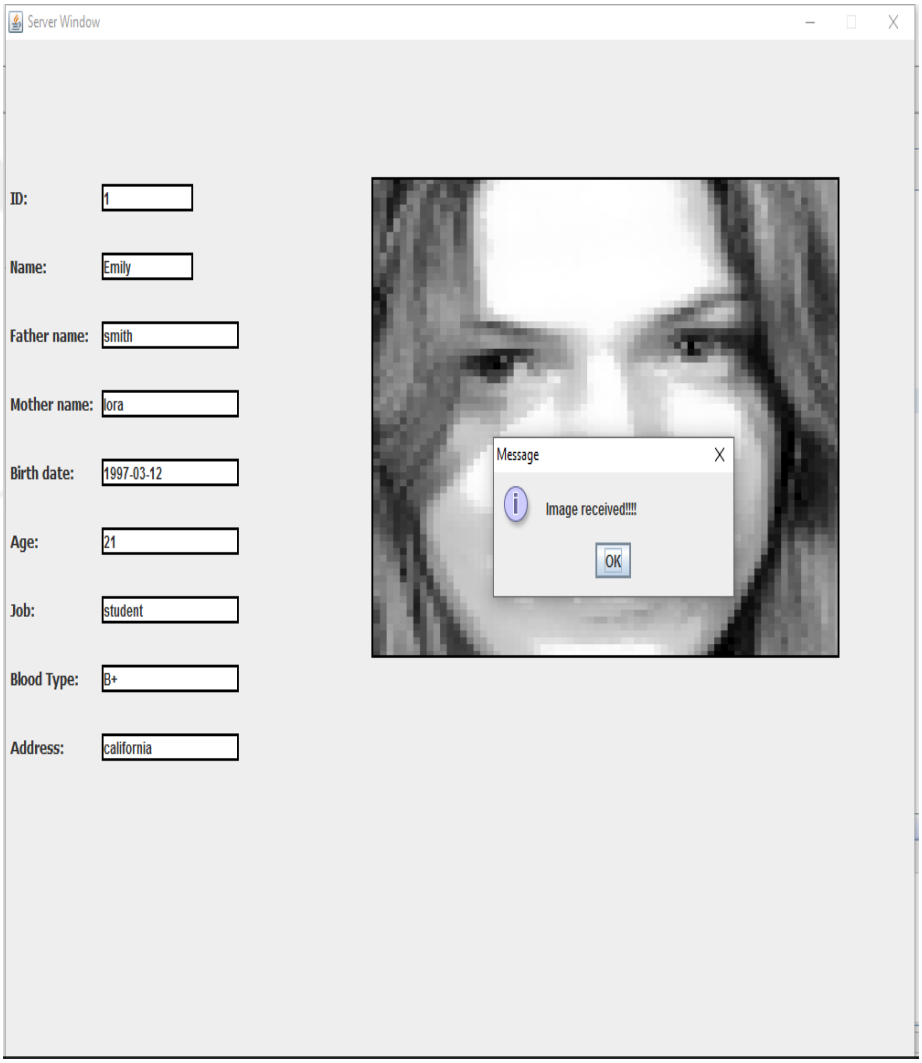


Figure (4.8): Image Received by the Cloud

4.4.6 Information Retrieval by the Client

The following figure represents the information, which has been sent back from the cloud towards the client, containing data about the person's ID that is obtained after the verification process been carried out by the trained system.

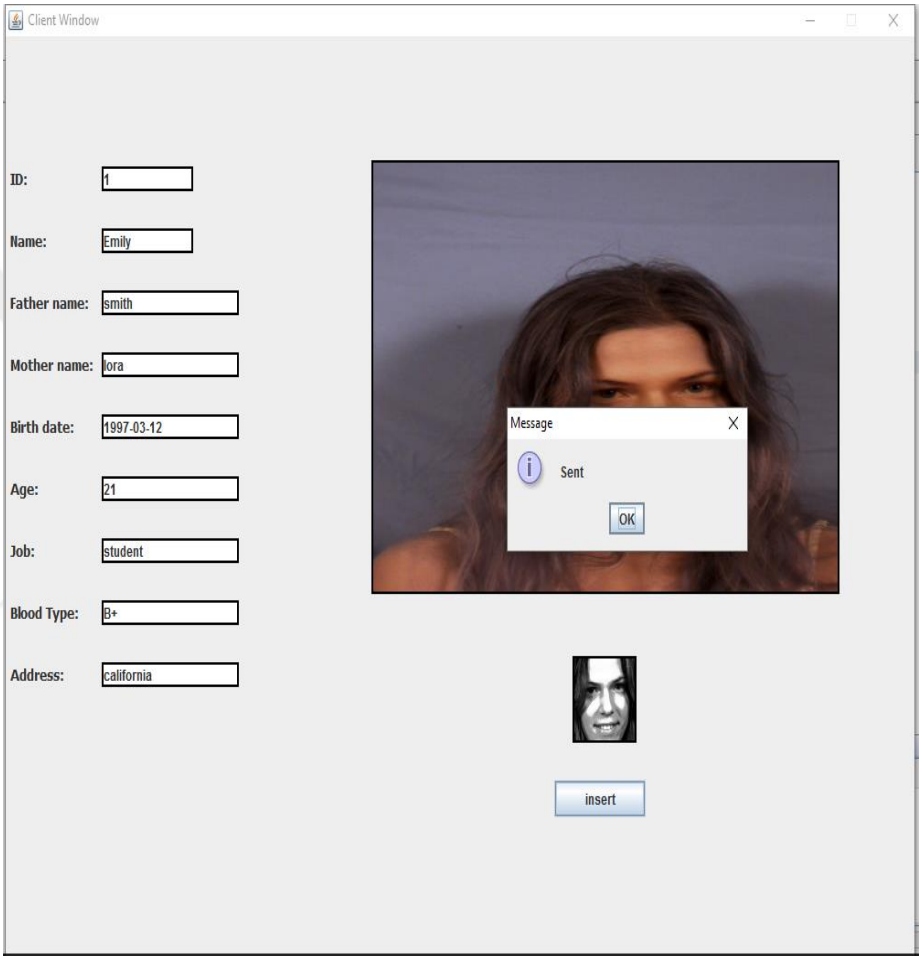
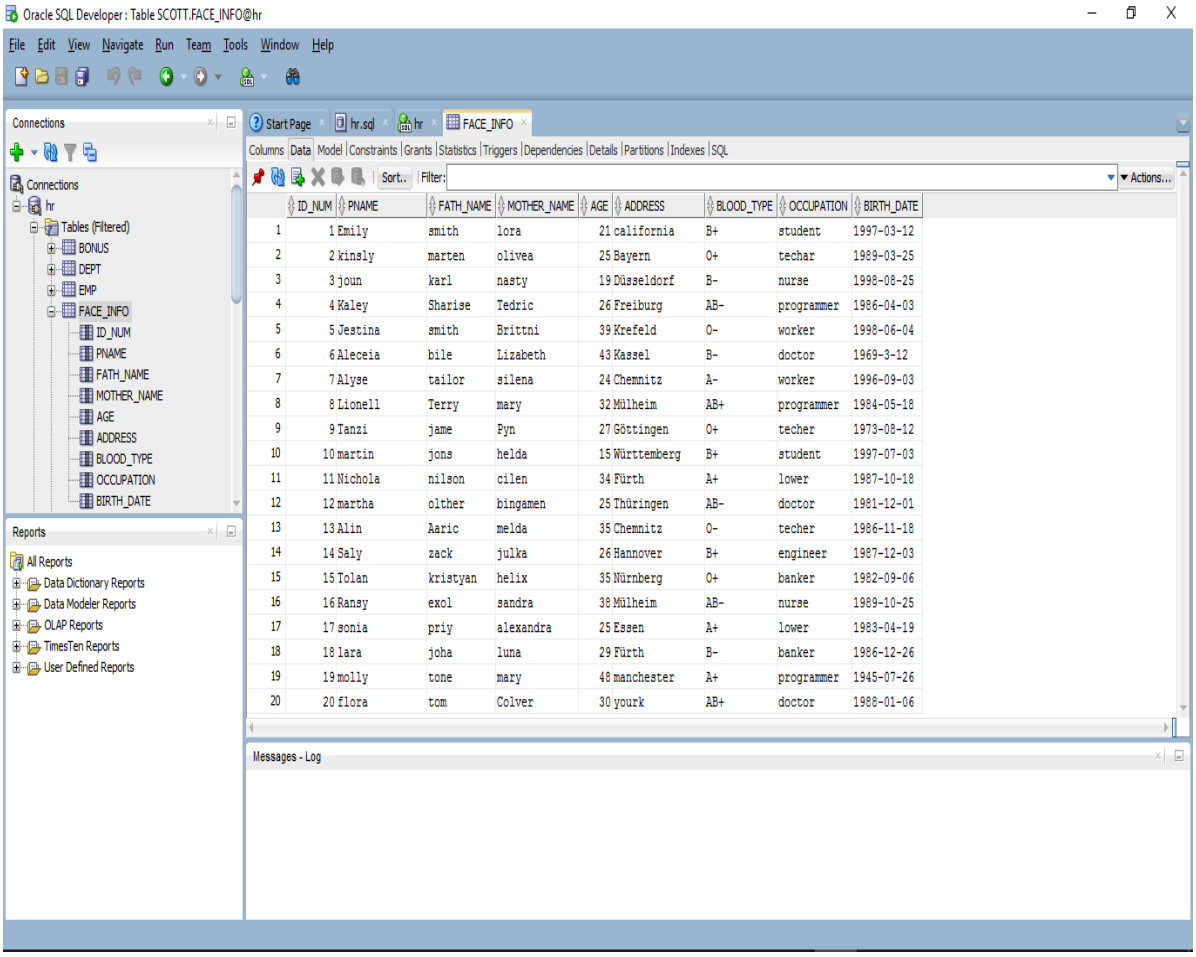


Figure (4.9): Retrieval of Client's Information

4.4.7 Database Image

The display of database is shown in the following figure having SQL developer for Oracle, which is used by the system for storing information about the individuals. This information includes father name, mother name, date of birth, blood type, workplace details. The information is about several people for which the system has been trained. The training has been given for doing the comparison of images being transferred by the cloud interface and to perform the authentication process in a correct way.



	ID_NUM	PNAME	FATH_NAME	MOTHER_NAME	AGE	ADDRESS	BLOOD_TYPE	OCCUPATION	BIRTH_DATE
1	1	Emily	smith	lora	21	california	B+	student	1997-03-12
2	2	kinsly	marten	olivea	25	Bayern	O+	techar	1989-03-25
3	3	joun	karl	nasty	19	Düsseldorf	B-	nurse	1998-08-25
4	4	Kaley	Sharise	Tedric	26	Freiburg	AB-	programmer	1986-04-03
5	5	Jestina	smith	Brittni	39	Krefeld	O-	worker	1998-06-04
6	6	Aleceia	bile	Lizabeth	43	Kassel	B-	doctor	1969-3-12
7	7	Alyse	tailor	silena	24	Chemnitz	A-	worker	1996-09-03
8	8	Lionell	Terry	mary	32	Mülheim	AB+	programmer	1984-05-18
9	9	Tanzi	jame	Pyn	27	Göttingen	O+	techer	1973-08-12
10	10	martin	jons	helda	15	Württemberg	B+	student	1997-07-03
11	11	Nichola	nilson	cilen	34	Fürth	A+	lower	1987-10-18
12	12	martha	olther	bingamen	25	Thüringen	AB-	doctor	1981-12-01
13	13	Alin	Aaric	melda	35	Chemnitz	O-	techer	1986-11-18
14	14	Saly	zack	julka	26	Hannover	B+	engineer	1987-12-03
15	15	Tolan	kristyan	helix	35	Nürnberg	O+	banker	1982-09-06
16	16	Ransy	exol	sandra	38	Mülheim	AB-	nurse	1989-10-25
17	17	sonia	priy	alexandra	25	Essen	A+	lower	1983-04-19
18	18	lara	joha	luna	29	Fürth	B-	banker	1986-12-26
19	19	molly	tone	mary	48	manchester	A+	programmer	1945-07-26
20	20	flora	tom	Colver	30	yourk	AB+	doctor	1988-01-06

Figure (4.10): Database Display

4.5 Cloud Structure

The cloud structure is made up of database server, face recognition server, client and in addition to that TCP/IP protocol, which is used for the transmission of information within these stages. The face detection process has been implemented in the manner discussed previously, after that the detected face has been sent to the face recognition server for obtaining the ID. Then obtained ID will be forwarded to the database server for completing the process of matching, which will be then sent again to the client along with all the information about that person, taken from the cloud.

4.6 Discussion

A dataset of 20 persons having different faces, different skin tones i.e. black/white, as well as coming from different origins has been used for getting a system with strong detection capabilities in diverse scenarios with excellent performance. Total image in my dataset it 240 images Each person have 12 image in system 8 for tanning and 4 for test, total images training in my project it 160 images and total images in the test it 80 images and, the number of hit divided number of test this present of Precision 98.75 . The obtained results are compiled in the table below:

Table (4.1): System Results

Total trains	Total tests	Total hit	Total miss	Precision
160	80	79	1	98.75%

In 2017, Laxmi Soni and his team proposed and approach to detect human faces with high accuracy. In this paper they have used the viola and jones approach to detect human faces and recognize it. Furthermore, they have concluded that the viola and jones algorithm accompanied by specific threshold values, gave a promising results in detecting and recognizing human faces [55]. Below a comparison between the results of our proposed work and their work shown in Table (4.2).

Table (4.2): Results comparison

	In Laxmi Son Son and his team	In my project
Number of Faces in test	482	80
Number of correct detections	457	79
Total missing	25	1
Precision	94.81%	98.75%

It obvious that according to Table (4.2), our proposed methodology gave better results than the previously mentioned related work. Now we explain the num. in comparison below:

- The number of faces (482) is refer for test the faces in In Laxmi Son Son and his team.
- Number of test the face appeared for Laxmi son and his team by using viola jones algorithm and PCA algorithm (457) with totally missing (25) faces.
- The number of faces (80) is refer test the faces in my project
- The faces detection in my project it (79) it by using LDA algorithm and algorithm viola jones with missing only one face.
- The percent of accuracy in Laxmi son and his team it (94.81%).
- The percent accuracy of my project it (98.75%).

4.7 Summary

This chapter provided a comprehensive approach for building a face recognition system with the key purpose of authenticating users, on the basis of cloud computing. It discussed the algorithms used for the detection and recognition of faces. A number of factors were considered that provided adjustable contrasts and improved results. The chapter illustrated the importance of histogram equalization and the cropping and resizing processes, which helped in obtaining enhanced performance and precise detection of faces in an image. It talked about the datasets and software used for analysis. The procedures for uploading, transferring, processing and recognizing an image were explained. A brief overview of cloud structure and different interfaces was also covered. Finally, a table of results was included in this chapter, which mentioned the total number of tests being performed and the results and accuracy being obtained.

4. CONCLUSION AND FUTURE WORK

5.1 Introduction

This chapter is focused on providing the conclusions that have been drawn from the studies and investigations being done for this research project. Considering the achieved outcomes, the future aspects of this work and any improvements that can be made in this regard are also discussed here in this chapter.

5.2 Conclusion

The dataset used in this work will result in a highly accurate system , There will be strong security since only the client will have the knowledge about the port ,There will be high authenticity as the server has been trained with previously verified images; therefore, it is not possible for any unknown image to replace the original one. The integration of system with TCP/IP protocol will help in getting acknowledgments after sending The use of Viola & Jones algorithm has increased the capability of the face detection system Almost 98% accurate results are attained by the system.

5.3 Future work

There are few ideas that can be of huge significance from the future aspect of this work:

- To carry out an extensive study regarding the computation of cloud security and its significance in the present scenario
- Implementation of an LDA based neural network for achieving improved outcomes
- To conduct a comprehensive comparison between the two major algorithms of this domain i.e. PCA and LDA algorithms
- To study and implement a fuzzy recognition system that is based on Linear Discriminant Analysis

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