SELFIE FACE DETECTION AND RECOGNITION

A THESIS SUBMITTED TO THE INSTITUTE

GRADUATE STUDIES

OF

NEAR EAST UNIVERSITY

By

SAPAN NOORI AZEEZ

In Partial Fulfillment of the Requirements for

the Degree of Master of Science

in

Software Engineering

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SAPAN NOORI AZEEZ: SELFIE FACE DETECTION AND RECOGNITION

Approval of Director of Institute of Graduate Studies

Prof. Dr. K. Hüsnü Can Başer

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To this work.

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Signature:

Date: 28/06/2021

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Sincerely

Sapan Noori Azeez

ABSTRACT

Selfie face recognition plays a crucial role in a wide range of applications, for instance, video surveillance, criminal investigations, face image database management, and forensic applications. This is achieved by a special algorithm for face detection called “Viola Jones algorithm which is a robust, real time and mainly focuses on face detection.

The algorithms used in the face recognition are KPCA (kernel principal component analysis), SIFT (scale invariant feature extraction) and Edge& shaping. This is conducted through identifying an unidentified test image by contrasting it to recognized training images stored in the database of GBDT (gradient boosting decision tree), and provide information about the person recognized. These methods work well in a lot of circumstances such as complex backgrounds and different face conditions. As experimentally observed, these algorithms provide varying rates of accuracy under various conditions. The contribution of this project deals with face detection systems by recognition of face through Image processing. The software requirements for this project are MATLAB software.

Face detection algorithms were examined thoroughly, with a considerable amount of test images, conditions and variables varied. Most of the present work made use of real-time data. The overall detection rate was 95.4%. When evaluated on a more complicated dataset, FDDB, the proposed method overrides the existing and prior-art methods for face recognition. In order to achieve an appropriate way of adapting images, this study limits the number of extracting features of SIFT operators and key-point removal operators to a certain number, reducing computational complexity and increasing efficiency. SIFT features are often used to recognize the object and face. The main feature of this method is that it makes use of the benefits of a particular approach to choose the better key points.

Face recognition algorithms were carefully tested using a large number of test images under different conditions. In addition, for identifying faces, the method of GBDT has been proposed. The characteristics of the test samples were abstracted in a similar manner and equated to the qualified database. In 98.7 % of the occasions, the recognition rate was accurate and it reduces the time complexity for selecting the best feature in each round and thereby improving overall training efficiency. It has been observed that the proposed approach overrides these sophisticated methods over the proposed approach attaining an accuracy of 98.4 %. By using profundity information, the intended approach can acquire face pose information, which will be able to help with the landmark localization challenge. In the test, the running time for a face image is around 20ms.

ÖZET

Selfie yüz tanıma, çok çeşitli uygulamalarda çok önemli bir rol oynar. örneğin, video gözetimi, cezai soruşturmalar, yüz görüntüsü veri tabanı yönetimi ve adli tıp uygulamaları. Bu, sağlam, gerçek zamanlı ve esas olarak yüz tanımaya odaklanan “Viola Jones algoritması” adı verilen yüz algılama için özel bir algoritma ile elde edilir.

Yüz tanımada kullanılan algoritmalar KPCA (çekirdek temel bileşen analizi), SIFT (ölçek değişmez özellik çıkarma) ve Kenar ve şekillendirmedir. Bu, GBDT'nin (gradyan artırma karar ağacı) veri tabanında depolanan tanınmış eğitim görüntüleriyle karşılaştırılarak tanımlanamayan bir test görüntüsünün belirlenmesi ve tanınan kişi hakkında bilgi sağlanması yoluyla gerçekleştirilir. Bu yöntemler, karmaşık arka planlar ve farklı yüz koşulları gibi birçok durumda iyi çalışır. Deneysel olarak gözlemlendiği gibi, bu algoritmalar çeşitli koşullar altında değişen doğruluk oranları sağlar. Bu projenin katkısı, Görüntü işleme yoluyla yüzün tanınması yoluyla yüz algılama sistemleri ile ilgilidir. Bu proje için yazılım gereksinimleri MATLAB yazılımıdır.

Yüz algılama algoritmaları, önemli miktarda test görüntüsü, koşulları ve değişkenleri ile kapsamlı bir şekilde incelendi. Mevcut çalışmaların çoğu gerçek zamanlı verilerden yararlandı. Genel tespit oranı %95, 4 idi. Daha karmaşık bir veri kümesi olan FDDB üzerinde değerlendirildiğinde, önerilen yöntem, yüz tanıma için mevcut ve önceki tekniğe ait yöntemleri geçersiz kılar. Görüntüleri uyarlamanın uygun bir yolunu elde etmek için bu çalışma, SIFT operatörlerinin ve anahtar nokta kaldırma operatörlerinin öznitelik çıkarma sayısını belirli bir sayı ile sınırlandırarak, hesaplama karmaşıklığını azaltmakta ve verimliliği artırmaktadır. SIFT özellikleri genellikle nesneyi ve yüzü tanımak için kullanılır. Bu yöntemin temel özelliği, daha iyi kilit noktaları seçmek için belirli bir yaklaşımın faydalarından yararlanmasıdır.

Yüz tanıma algoritmaları, farklı koşullar altında çok sayıda test görüntüsü kullanılarak dikkatlice test edildi. Ek olarak, yüzleri tanımlamak için GBDT yöntemi önerilmiştir. Test örneklerinin özellikleri benzer şekilde özetlendi ve nitelikli veri tabanına eşitlendi. Vakaların %98.7'sinde, tanıma oranı doğruydu ve her turda en iyi özelliği seçmek için zaman karmaşıklığını azalttı ve böylece genel eğitim verimliliğini artırdı. Önerilen yaklaşımın bu karmaşık yöntemleri, önerilen yaklaşıma göre %98, 4 doğrulukla geçersiz kıldığı gözlemlenmiştir. Amaçlanan yaklaşım, derinlik bilgilerini kullanarak, dönüm noktası yerelleştirme zorluğuna yardımcı olabilecek yüz pozu bilgilerini elde edebilir. Testte, bir yüz görüntüsünün çalışma süresi yaklaşık 20 ms'dir.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW OF BIOMETRICS

Biometrics is the science of identifying an entity based on the characteristic of physical(fingerprints, iris, face, hand geometry, and palm print) or behavioral traits (gait, voice, and signature) accompanying with the individual. Behavioral authentication methods such as iris, speech, fingerprint, palmprint, and face are now playing an essential part in the field of biological and human-computer interaction in the form of vision, and attracting very challenging interests for many researchers. Among them, Face Recognition allows users to quickly complete their identification without interrupting their activities.

Over the past few decades, the need for biometric security control in all fields of society is increasingly growing, requiring user identification and authentication. For detection and recognition, passwords and IDs are very familiar. While PINS or passwords may be used to determine identity, these clues are easily lost, stolen, and passed on. As a consequence, using secret code/PIN to check the identity of an individual is dangerous. The ability of the biometric systems to distinguish between an authorized individual and an impostor who corruptly obtains secure access from an authorized person is one of the main reasons for development.

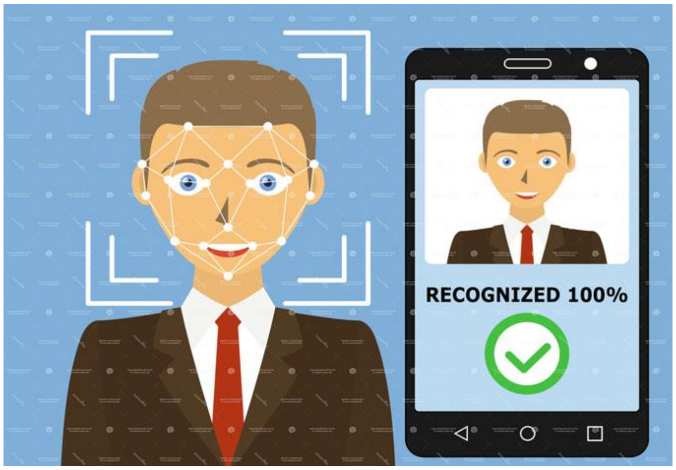


Figure 1.1 Selfie face based mobile device authentication [61]

Biometric systems are commonly embedded into mobile devices, such as smart phones, to retain mobile financial services such as banking. In this case, the area of "selfie biometrics" has expected a huge deal of interest from both academic and commercial experts. By definition, a "selfie" is a self-portrait image produced with a Smartphone in hand or supported by a digital camera [1]. As a result, "selfie biometrics" is an endorsement system in which a user uses Smartphone cameras to detect images using their own biometric features (such as face, fingerprint, or retina).Figure 1.1 depicts a Selfie face-based mobile device authentication scenario. As a result, there is no need for external hardware to collect biometric samples for mobile device authentication.

1.2 SELFIE FACIAL RECOGNITION

Selfie facial analysis is such a frequent non-intrusive biometric technology and is becoming increasingly widespread. Face recognition has developed over the last two decades in accordance with fundamental developments in modern technology and may make a difference in the coming decades. Since almost every portable device, such as a phone, tablet, or laptop, comes with a digital camera, it will become the most convenient method of granting special access. In social interactions, the face is our predominant object of attention, and it plays a crucial role in expressing personality and emotional characteristics.

The proposed method identifies a variety of aspects of faces through human lives and can recognize faces at a moment, after decades apart. Due to significant changes in external stimulation due to the evolving conditions, age, and disturbances such as beards, glasses, or hairstyle changes, this ability is very resilient.

It is quite exciting to know how something as trivial as taking selfie scan speak about a person’s much. At present, we almighty have seen people taking selfie in places like the palace, church, Public Park, academy, museum, gallery, festivals, and popular places like Girne castle, Galata tower and Taj Mahal etc. Typically, Selfie with a Smartphone/webcam, is a picture that you take of yourself. Many smart phones of the current generation are fitted with a high-resolution camera, which we consider to be a selfie camera. Smartphone’s have invaded our lives so much that we can't survive without them. Selfie's appeal comes from the ease with which the photographer makes and shares and the control it offers. The Oxford English Dictionary officially named the word "Selfie" in 2003.

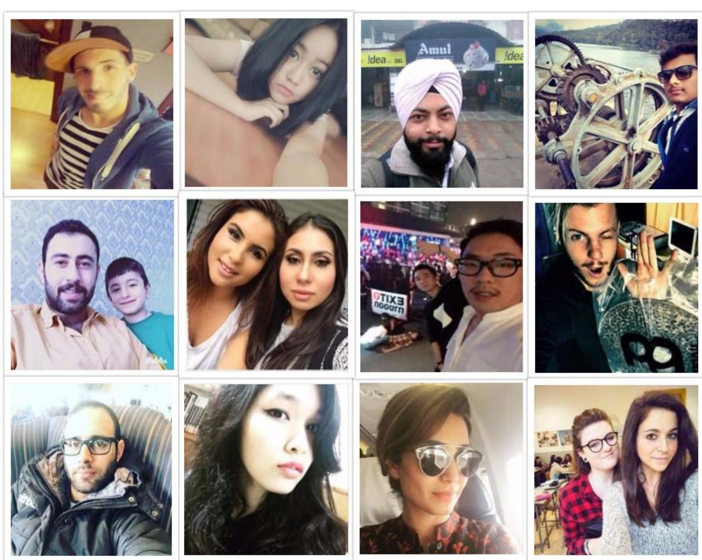


Figure 1.2 Sample Selfie Images[1]

Taking a ‘selfie' with a mobile appliance has suit a usual activity in daily life, as seen in figure 1.2.Positioning the camera, changing the pose, selecting the correct environment, and trying to find the best illumination conditions are all aspects of this basic action that are identical to face authentication on a Smartphone [2].Most formal procedures and methodologies for image quality in the field of face authentication are largely focused on passport photos, but only suddenly research focus has shifted to mobile devices.

As the world moves towards a digital world, technology is rising at a very rapid pace. It is one of the most rapidly expanding areas of the biometric industry. Selfie face recognition is becoming increasingly important in a variety of applications, including video monitoring, criminal investigation, and so on. If you want to open a bank account or travel from one location to another, authentication of identity plays a very important role. Identification is the process by which a large number of identity classes classify the input image, while verification is the process by which a pair of images is classified as belonging or not to the same identity [3]. Over many years, facial recognition has attracted a huge deal of notice to the value of both pattern recognition study and realistic applications, and the concert of facial recognition algorithms has considerably increased. The ability to recognize faces in images or videos is predicted. We categorize the device in two ways during the selfie face recognition process.

- Authentication/identifications the process of deciding the identity of an individual. It provides an answer to the question of who this person is. And in which the confirmation of a person's identity is accomplished by recognition/detection.

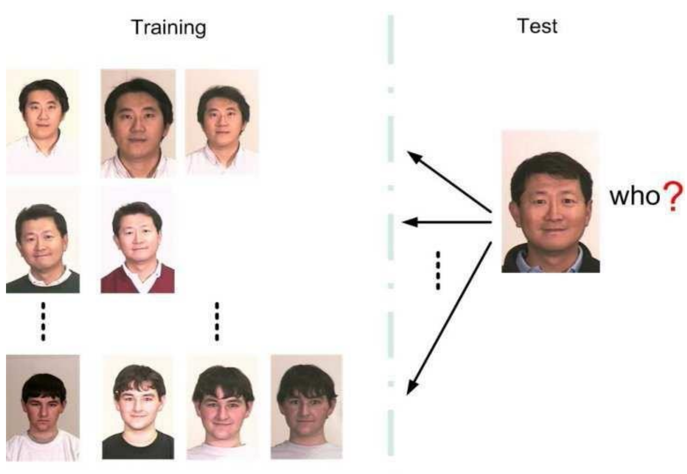


Figure 1.3 Face from the sample database

➢ In figure 1.3, a selfie face recognition device is a computer-based program that instantly recognizes an individual from a digital photo. This is accomplished by matching extracted facial features in a live image to those in a face database. This machine should be able to recognize faces in both pictures and videos.

1.3 BASIC PROCESS OF SELFIE FACE RECOGNITION SYSTEM

The input and output of a selfie facial recognition device are shown in Figure 1.4. The input is a captured by the camera source, and the output is the identifying or confirmation of the subject present in the image or video source.

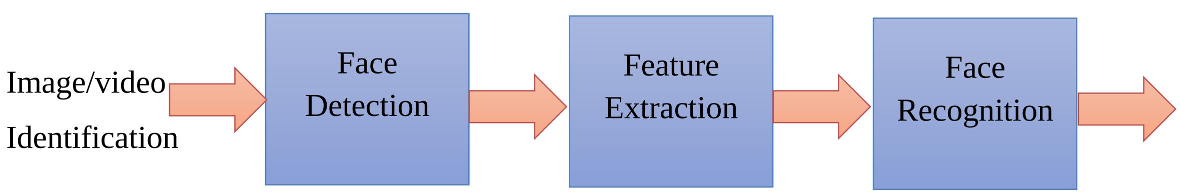


Figure 1.4Process of Selfie facial recognition system

In a selfie face recognition system, Face detection is the primary step in the identification scheme of the selfie face prior to recognition. As shown in Figure 1.5, is the method of recognizing all the related faces in the input images at various locations and sizes. Face recognition is a model that needs a lot of variations and has many computer vision implementations. In certain systems, face detection and characterization are done simultaneously, while in others, face detection is done first, followed by face localization if the results are positive [4]. Face detection is thus a two-class issue in which a determination must be taken as to whether the image contains a face or not.

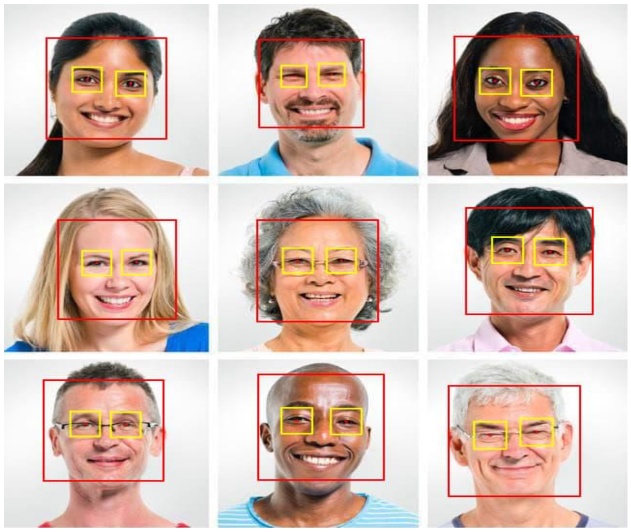


Figure 1.5Detected Selfie face images[62]

Is input a selfie face or not?

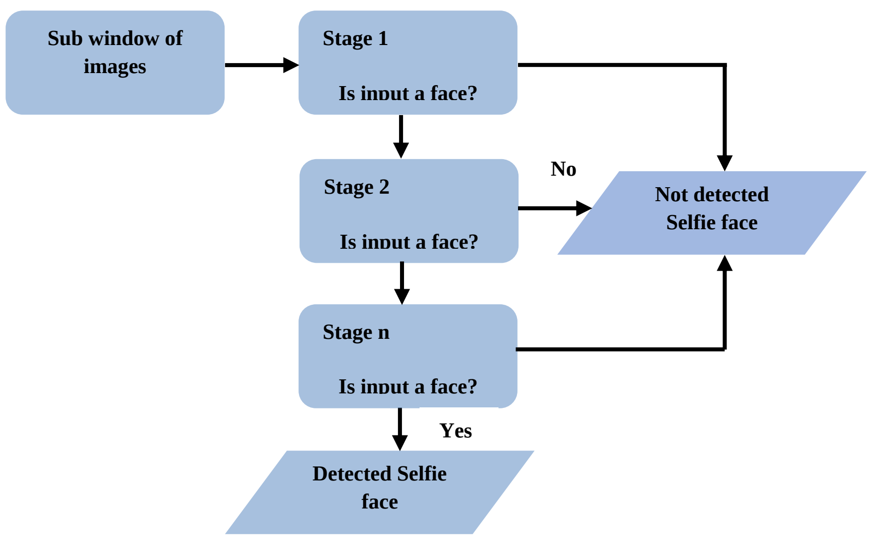


Figure 1.6 Flowchart of selfie face detection[12]

A selfie face image will be detected by this system to determine whether a sub window is certainly not a feature or a feature. It emphasize that no selfie face is identified in the image if one of the steps is not taken. It will pass through all the steps shown in the figure 1.6if the sub window is a feature.

The next step is the extraction of a feature, which involves extracting individual facial features from the data after the face, has been identified. This step is useful to recognize emotions or to monitor facial characteristics. Facial areas, changes, positions and measurements are examples of features [5].The number of data required to classify a huge amount of information is reduced through the extraction of features. Having a larger set of variables can cause problems when dealing with huge information. It may also require a classification algorithm with poor generalization to new samples. The method of extraction of features in an image is shown in Figure 1.7.

Figure 1.7Feature extractions in an image[63]

Finally, the method moves on to the third stage of recognition, which involves detection or verification. In figure 1.8, the system will record an identity from a database as part of a classification stage. When figure of an unknown individual is provided, the person's identity may be assessed by examining it to a database of identified individual images. When an image of an unknown person is presented with an assertion of identification, the authentication task is to decide if the person matches the identities in the system.

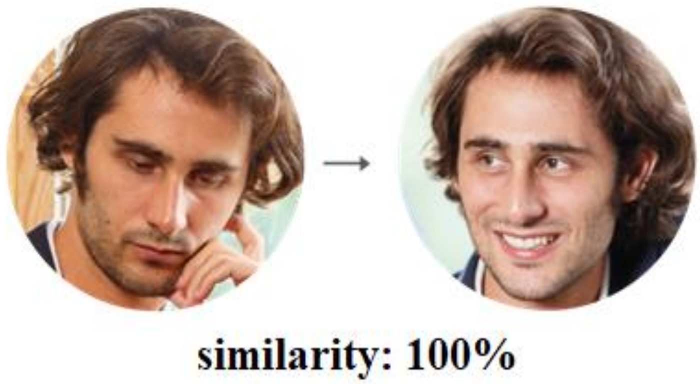


Figure 1.8 Recognized selfie images

1.4 KEY ISSUES IN SELFIE FACE RECOGNITION

The problem is to classify the given face image in relation to the other images collected in the face database. This includes deciding the validity of the query face image by comparing it to the face dataset and ensuring that the identity is one of the images in the database. The job of recognizing selfie faces in still photographs is more complicated and demanding. The aim of our project is to create a face recognition algorithm that identifies faces in images and extracts them. Then, the extracted face should be recognized [6].Many factors lead to inconsistencies in the selfie image of a single face, contributing to the challenge of accurately recognizing faces. These considerations must be discussed in order to properly identify the target selfie images:

- **Physical changes:** Changes in facial expressions, poses, ageing, appearance (with or without glasses), and presence/absence of structuring elements/occlusions are all factors to consider.
- **Illumination condition:** Current face recognition algorithms are capable of managing pure lighting changes on the face. On the other side, fail in low-light conditions where large parts of the face are blurred. It's much more difficult when lighting is associated with the variation of the pose.

- **Occlusion:** Under occlusion, the efficiency of face recognition algorithms is generally poor. Other objects in the scene, as well as sunglasses and other items, can obscure the face. Occlusion may be accidental or deliberate. Subjects can be encouraged to make identification attempts by covering parts of their faces in such circumstances.
- **Expression:** The algorithms are generally resistant to facial speech, excluding acute expressions such as screaming. Algorithms have problems with mouth deformation and eye occlusion due to eye widening and eye closure. Under the impact of facial expressions, the face is significantly deformed [7]. People could easily cope with this variability, but systems are struggling with expression databases. Face recognition under intense facial expression is still a problem that has not been resolved, and relevant data would bring a lot of information to face recognition under expression.
- **Image orientation:** The rotation of the camera's optical axis has a direct effect on the face images. The angle of the face is influenced by image orientation.
- **Background changes:** It prevents the complete backdrop image or location of a picture from being delivered.
- **Pose:** Face recognition is also affected by posing variation. As a consequence, the question raised is a significant obstacle to the widespread use of facial recognition systems. In other words, the difference between these people in different attitudes is superior to the dissimilarity between diverse people in the similar attitude.
- **Scale variation:** The face can come in a variety of shapes and sizes.
- **Image condition:** In the phase of face detection, variables such as strength, resolution, camera illumination, environment, image capturing system characteristics, and distance between device and individual play a significant role.
- Facial surgery, makeup, and retouching can alter the look of the facial image.
- The physical state of selfie photographs and the printing accuracy of document photos differ greatly.
- Selfie images from early adolescence and late adolescence, the appearance of the face may have undergone significant natural changes.

In order to overcome these challenges, the method of Selfie faces recognition need to be proposed. However, due to the limited variation in the data set, the proposed work overcomes all the problems in the face recognition system.

1.5 OBJECTIVES OF THE THESIS

Current research in selfie face recognition is focused on improving the face recognition algorithm based on recognized selfie faces, and has achieved satisfactory recognition rates under certain conditions and regulated circumstances. The objectives of the research work are to progress the recognition rate and accuracy of the following method sis discussed below:

- The Haar Cascade Classifier is used to perform face detection using the viola jones algorithm.
- To perform preprocessing such as contrast adjustment and noise reduction using face detail preprocessing techniques.
- Design, develop and improve feature extraction algorithms for face identification regardless of various poses, shape, size, illumination conditions, facial expression, and occlusion face.
- To extract features using the KPCA, Edge, and SIFT algorithms.
- To perform face recognition using gradient boosting decision tree (GBDT) algorithm.
- Using standard face databases and a self-created image database to evaluate and validate the aforementioned algorithms.

1.6 MOTIVATION

Due to the widespread use of digital imagery, the principle of biometric authentication within the scope of selfie face recognition is relatively new. Many researchers have already contributed to this technology and others are working on it. The majority of the research papers discussed selfie face recognition methodology, device efficiency enhancements, criteria for efficient feature extraction, liveliness detection methodology, and so on. Selfie Face recognition is most extensively used methods for identifying individuals and foreign objects in authentication and identification [8]. It has recently attracted a lot of attention and concern from both scientists and the public in general. The general public's concern originates partly from recent terrorist acts throughout the world, which have increased demand for practical security solutions.

Owing to an extensive variety of real-world applications, selfie facial recognition has become increasingly relevant. This is also a difficult task in the area of analysis. Most people live in villages where they work in the field, and their faces become partly visible, if not completely invisible, as an effect of their work. As a result, in the academic context, developing face recognition techniques under partial visibility conditions is critical. To build these various applications, accurate and robust computerized facial recognition techniques and procedures are required. Though, these tools and techniques are unavailable or only accessible in extremely complex, highly priced setups. Developing an algorithm to diminish the complication and advance the accuracy rate of classifying people is a suggestion for future work.

1.7 RESEARCH OVERVIEW AND CONTRIBUTIONS

To underscore the research contributions in the thesis, following are the list of ideas presented in different chapters of this thesis:

- This intended methodology, is categorized into two foremost stages: initial part refers to the training set intent primarily on enhancing the facial recognition system while the other section centered on the testing set based on the documented selfie faces.
- In the training set, to take a selfie face images of people arriving at workplace or a construction, using viola jones algorithm, the Haar Cascade Classifier will be employed to the acquired selfie images to spot out particular faces, which will be utilized as an inlet to the Face Recognition System.
- In certain progressive image detail preprocessing procedures in particular contrast enhancement, noise diminution is employed to the detected images to enhance their attribute.
- To enhance the performance levels in recognition, KPCA, SIFT, Edge& shaping is going to use for face recognition under feature extraction process.
- We have proposed some novel mathematical algorithm of gradient boosting decision tree is a machine learning method for regression and classification troubles.
- The evaluation of accuracy and recognition rate of various classifiers and feature level algorithms is discussed.

1.8 APPLICATIONS

- **Law Enforcement**

  Suspects can be identified quickly, which aids in the prosecution of crimes.
- **Machine/Robot vision**

  Aside from the many problems that a robot faces today; increasing the robot's vision remains one of the mainly significant concerns.
- **In standard biometric laboratory**

  Image processing is used to classify objects in images, and then machine learning is used to train the system to recognize changes in pattern.
- **General identity verification**

Electoral registration, banking, electronic commerce, recognizing newborns, national identification cards, passports, and employee identification cards are only a few examples.

- Face recognition technologies are no longer restricted to activities such as identity authentication and surveillance [9]
- For example, the military's importance can be found in retail, a senior protection or child care facility's surveillance, and command and control interfaces or an industrial device.

1.9 ORGANIZATION OF THE THESIS

This research work intended to design and integrate the new methodologies for ensuring and improving the recital of face recognition system. It deals with the designing of selfie face recognition systems with respect to different algorithms and also evaluates the performance of recognition by calculating the performance such as recognition rate, accuracy and so on.

CHAPTER 1: INTRODUCTION

In this chapter the fundamentals of Biometric, especially the selfie face recognition is explained. The background of research was also provided.

CHAPTER 2: RELATED WORKS

This chapter addresses the usefulness of the system in detecting and recognizing selfie faces in illumination variations settings, with better results in varying illuminations of face angles, as well as earlier research on selfie Face Recognition. The research has been examined, and the current study project has been meticulously organized to fill in the gaps.

CHAPTER 3: FACE DETECTION ON SELFIE IMAGES

This chapter covers face detection, which is the initial stage of a face recognition system that uses the Viola Jones method. The Haar Cascade Classifier is used to identify individual faces in the documented selfie photographs, which will be used as the source for the Face Recognition System.

CHAPTER 4: FEATURE EXTRACTION AND SELFIE FACE RECOGNITION

This chapter presents the different algorithms of KPCA, SIFT, Edge& shaping is going to use for face recognition under feature extraction processand gradient tree boosting is a machine learning method for regression and classification troubles and the results are compared with certain existing method.

CHAPTER 5: CONCLUSION

It outlines the work's findings and makes some recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Current research in selfie face recognition is focused on improving the face recognition algorithm based on recognized selfie faces, and has achieved satisfactory recognition rates under certain conditions and regulated circumstances. However, the majority of the suggested methods have certain disadvantages. Many variables, such as facial expression, lighting, and different poses, restrict the accuracy level of classification of a selfie face recognition device. Because of these constraints, automatic recognition of selfie faces is an important research subject. Furthermore, the literature shows that some of the evolved techniques have a high recognition rate, while others have a low rate, resulting in a satisfactory recognition rate [10]. This chapter is dedicated to this problem, and the established technique has demonstrated high rates for all recognized selfie faces. From this review, this paper endeavors to give a brief review about the Selfie Face Recognition techniques, with results from previous research and their assessment.

2.2 DOCUMENT FACE TO SELFIE FACE MATCHING

In 2020 Subedha, D.,*et al*, [11] has compared the user's live face (selfie face)to the verified document image based on face recognition. A method for updating classifier weights, called Dynamic Weight Imprinting (DWI) which enables faster convergence and more generalizable representations. In real world implementations, the large visual differences of selfie faces are the significant challenges for these tasks. Correlations with static weight engraving strategies confirm that DWI is prepared to capture the worldwide sharing of embeddings precisely. Additionally, the Blockchain approach ensures the record data and is the quickest and fastest strategy to date. The framework increases the efficacy of operations at each level by using the features of the Blockchain methodology. The structure saves on paper, reduces management costs, avoids forgery of records, and offers accurate and reliable digital certificate information and compares the live face of the user with the checked document face in figure 2.1.

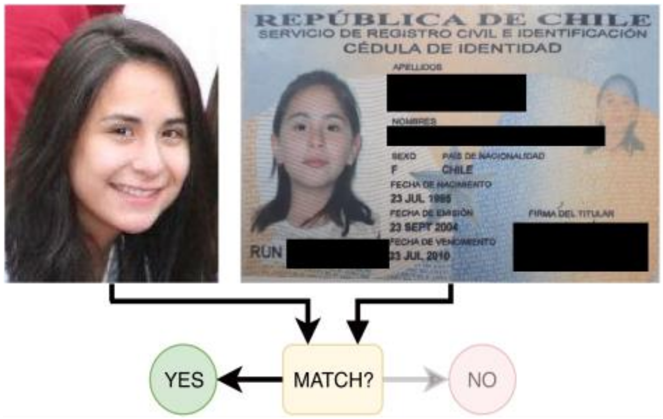


Fig 2.1 Matching Selfie face with verified document image[11]

The image of an ID document that they consider an additional difficulty in this work from pre-adolescence to post-adolescence stage by inciting it to the direct image, so that the appearance of the face may have undergone significant natural changes. The LPB features in the LFW database were first extracted by splitting the face image into x10×10 non-aligned sub-windows, then computing, and finally merging all histograms for feature representation. The purpose of this automatic filtering is to remove the external faces for each sign automatically. The method of Face Comparison is performed faster and leads to better results of generalization and also prevents over fitting. The database is divided equally for research and used for further training in the view of AM-assessment SoftMax. In the LFW standard verification protocol, our base model achieves 99.67 % accuracy and 99.60 % verification rate (VR) for the BLUFR protocol at 0.1 % for the False Acceptance Rate (FAR).

2.3 HAAR CASCADE CLASSIFIER FEATURES

In 2019 Priadana, A., *et al*, [12] a technique called web data abstraction and human face identification with the Haar Cascade method has been proposed. The goal of this research is to use the Haar Cascade technique to strain selfie face images on seek out come contingent on Instagram hashtags by merging these techniques. We use this technique because it is simple and effective. The Haar cascade classifier approach is an extensive detection method in terms of dependability and hastens for face detection from an image and is possible to be utilized infused in real time application**.** Paula Voila and Michael Jones[19] originally provided for this approach. Characteristics of the Haar are the key component of the Haar Cascade Classifier for detection of faces. In figure 2.2, Haar features are used to identify the occurrence of the characteristics of the known image. By deducting the spatial resolution under the white rectangle and the black rectangle, each function produces a single value.

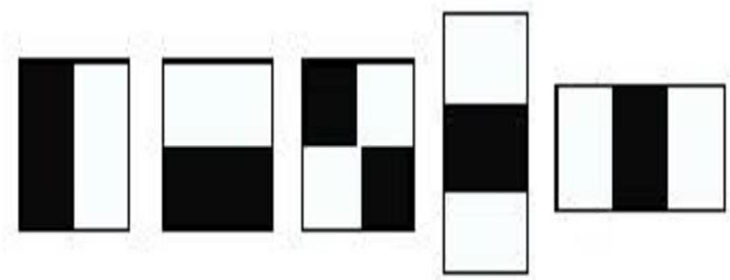


Fig. 2.2 Haar features [12]

It can be shown that there is an accuracy value of 71.48 % in the detection system used to detect a human face. The statistical findings indicate that the FP value is 33.82 %, which has a major effect on machine precision outcomes. As a result, selfie face images can be filtered via the Haar Cascade scheme to show that the selfie face detection method has an affirmative analytical value of 64.65 %. Arithmetical findings indicate that the FP value is 35.35%, which also has a significant effect on the accuracy of the device results.

2.4 PCA AND KPCA ALGORITHM

In 2016Sherly, E.,*et al,* [13] has compared a method of PCA with Kernel PCA for extracting features and recognizing of faces. The human face has a main role, consisting of a complex combination of characteristics that enables us to interact, articulate our state of mind and passions. Kernel PCA estimation is a nonlinear sort of PCA that works better in bewildered spatial development of high-dimensional part which means KPCA with less error have been found and it gives the better performance for the face recognition system.

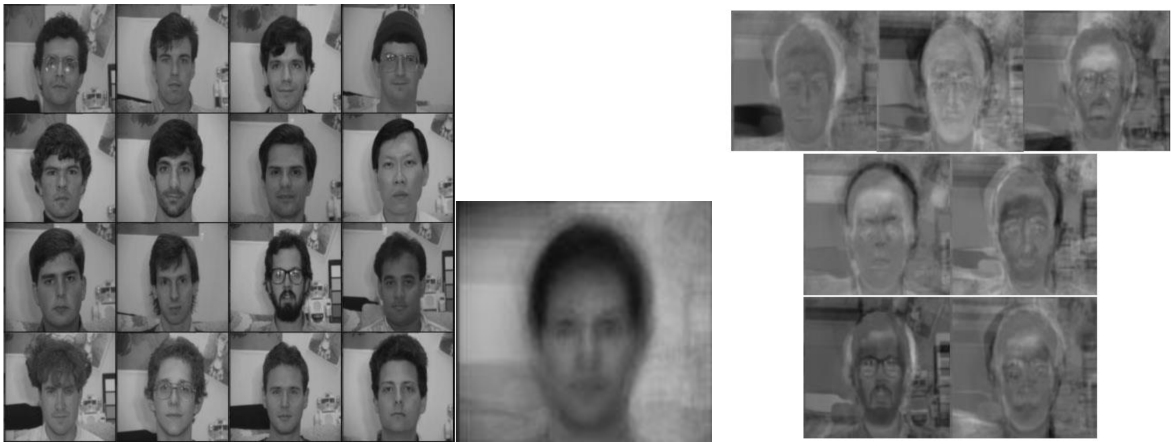
By extracting the "right" features or rather the main structure of the dataset, PCA aims to decrease the dimensionality of the facts space in order to reduce time complexity. The basic components are sufficient to describe most of the structure in the dataset as the basis of our new coordinate. However, PCA sometimes ignores some of the key vectors used to describe the dataset and therefore fails to extract high-level information from the image. To assess the error rate of training and testing data between the PCA and KPCA are shown in table2.1.

Table2.1 Error rate between PCA and KPCA

Error rate	Training data	Testing data
PCA	9.35%	25.32%
KPCA	7.90%	13.56%

Using the Yela database, the rate of error in the training set and test data showed that KPCA had better results with less error. For each algorithm, the accuracy of recognition, facial expression variation, changes in illumination, computation time are compared to the Yela data set showing a KPCA for face recognition has improved performance.

jafri, R. And Arabnia, H.R., [22] analyzed that any exacting face can be effectively depicted along the organize space of the eigen images, and that any face can be reconstructed roughly by using only a limited set of eigen images and that the resulting projection could be used to identify faces as classification features.The eigenfaces describe a space of features that dramatically limits theproportion of the novel space, and in this reduced space, face recognition is carried out. The standard face and the peak seven eigen faces extracted from the trained images are shown in figure 2.3.



(a) (b) (c)

Fig 2.3 (a) Model of training set (b) Average face (c) Training set of seven eigenfaces

When anindividual image of every person is accessible, howeverin case of multiple images for each person exhibits, PCA seems to work well. PCA preserves unnecessary differences owing to illumination and expression of faces by selecting the projection that maximizes the overall scatter.Owing to clarification and lighting way, the differences between the images of the same face are nearlygreater than image differences by virtue of a shift in face characteristics in figure 2.4.

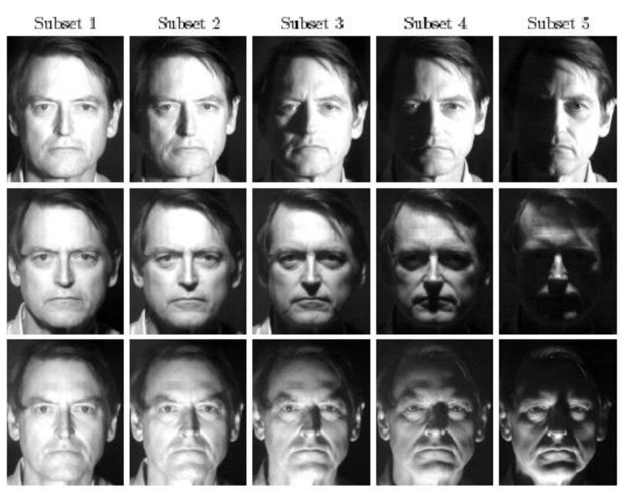


Fig 2.4 Under varying lightconditions

Using a database of 2,500 photographs of 16 individuals, the approach was checked for all variations of three head orientations, head sizes or balance, illuminationcircumstances and different resolutions. For lighting, direction and scale difference, recognition rates of 96%, 85% and 64% were recorded.

2.5 GABOR WAVELET FEATURES

In 2019 Wang, J.S.,*et al*, [14] has proposed an Improved Gabor Wavelet Transform (GWT) Algorithm based on face recognition system.To initiate the Gabor Wavelet (GW)and pertain it to the extraction of the image function, this manuscriptinitiallyestablishes the one-dimensional Gabor wavelet analysis deduction in order to initiate the 2-DGW. Then the Gabor wavelettransform and the discrete cosine transform (DCT) arecombined to form the improved GWT,which is used to realize the image feature extraction anddimension reduction of 93% accuracy. To compress the initial image, the use of 2D DCT is assumed so that recognition rate and recognition time are better than using Gabor wavelet transformation directly. This decreases the time and boosts the effective rate of recognition.

Table 2.2 Recognition accuracy rates of trained and test samples

Tested timing	No. of trainedimages	No. of tested images	Accuracy rate of recognized trained images	Accuracy rate of recognized tested images
1	160	240	0.965	0.922
2	160	240	0.975	0.935
3	160	240	0.952	0.922
4	160	240	0.961	0.920

Processing the 2D DCT image, intercepting a small portion of the top left spot, effectively compressing the picture, and then extracting the Gabor wavelet function is the concept of improving the Gabor wavelet filter.Recognition time will also be significantly reduced and the rate of recognition will be increased to some extent. In table 2.2, the findings indicate that the accuracy rate of recognized face imagesis above 0.93. The accuracy of the recognition is comparatively better.

2.6 LINEAR DISCRIMINANT ANALYSIS (LDA)

In 2017 Zainuddin, Z., *et al*, [15] implementedanonline validation of an LDA algorithm based on face recognition system. LDA is also an algorithm that attempts to diminishproportions. In order to project input data into area withslighterproportions where all model can be optimized individually, LDA considers the ideal projection. When modeling the differences between classes, it is commonly used to find linear combinations of features, and recently multi-class LDA algorithms are more used that can handle more than two classes. By using this algorithm, the device is able to recognize about 93 % of authorized persons and reject 100 % of unauthorized persons.

The LDA algorithm is used to train images that were processed in the database after the previous step. In this step, the LDA algorithm is the final determinant of whether or not the face is recognizable. The results of the evaluation of class data training for learners enrolled in the distance learning system are seen in the table 2.3.

Table 2.3 Evaluation of class statistics training for learners enroll in the distance learning scheme

No.	No. of individuals	No. of tests	Knownindividual	Not Recognized	Accuracy %	Error %
1	User 1	10	9	1	90%	10%
2	User 2	10	10	0	100%	0%
3	User 3	10	10	0	100%	0%
4	User 4	10	8	2	80%	20%
5	User 5	10	9	1	90%	10%
6	User 6	10	9	1	90%	10%
7	User 7	10	10	0	100%	0%

8	User 8	10	10	0	100%	0%
9	User 9	10	9	1	90%	10%
10	User 10	10	9	1	90%	10%
				Average	93%	7%

This reflects the findings of the research participant who have previously registered with the process. The findings indicate that the device will function well if the face is unregistered [16]. The standardentitlement indicates a rank of accuracy of up to 93%. In some of the login checks, the error system indicates a percentage of 7%.However, it should be noted that in figure 2.5, some recent work demonstrates that PCA can outperform LDA when the trainedstatistics set is limited and also that PCA is less perceptive to various trained sets.

(a)

(b)

Figure 2.5 Samples of (a) eigenfaces and (b) Fisherfaces

The normal eigenfaces and the method of Fisherfaces presume that there is afinestprediction that aims the face images in the reduced subspace to separate non-overlapping regions where each one of these areasmatches to a specific focus. In fact, however, that theory may not always be valid as descriptions of diversenatives may often atlas in the face space to the same region and, thus, regions according to diverse individuals may not always be disjointed.

One of the key drawbacks of the PCA and LDA approach is that if the face descriptionslies on a non-linear sub manifold in the image space, these systemsnecessarily see only the Euclidean structure and fall short to determine the primaryconfiguration [17]. PCA's own vectors are exclusively determined by the pair interactionamid pixels in the image database. Conversely, there are supplementary methods for recognizing simple vectors that relies on high-order correlation between pixels, and it appear fair to assume that using such approaches will result in even better recognition of the data.

2.7 RelatedWorks

In 2016 Sadeghipour, E., *et al*, [18] has proposed an algorithmcalled improved SIFTbased on face recognition system. Most of the algorithms proposed are designed to better classify face images and assign them to an individual in the database.The outcomes attained from dissimilar tests exposed that the planned algorithm was furtherefficient and accurate than other algorithms, with accuracy of 98.75% and run time of 4.3 second, but the run time was lower than the others.

In 2016 Rieksen, R.H., *et al*, [19] has designed to make a perfect selfie that can be used with a passport photo in face recognition software. Three distinct cascades have been introduced for use in the Viola-Jones detector. It studied the efficiency and stability of all three cascades. It was found that the combined cascade provides the best tradeoff between the consistencies of results.

In 2018 Dalai, R., *et al*, [20] proposed that a tree based gradient boosting algorithm be compared to Adaboost and Surfbased algorithm.More classes need to be recognized with more features, so an undue amount of effort and time is needed for the calculations performed. So, using our algorithm, some of the neighboring classes are assigned to the same level to minimize the number of tree nodes.It shows that the speed of calculation has been enhanced and is better than the surfing and adaboost algorithm.

In 2019 Heusch, G.,*et al*, [21] has presented a new database to overcome existing face recognition issues in selfie biometrics. Thereare numerous baseline tests in multiple face verification scenarios fitted with this new database. In each of the modalities, selfie face verification tests are carried out on a number of modalities. Then, there is a convergence of various algorithms, but also different modalities are RGB, NIR and Depth maps. Expression, the poses are always frontal and extreme illuminationconditions are the major drawbacks of these approaches.

Table 2.4 The summary of the Selfie Face Recognition and the performance of selfie images for a Biometrics are tabulated below,

Ref . no	**Author & year**	**Title**	**Feature extraction algorithm**	**Classification algorithm**	**Accuracy %**	**Recognition rate %**	**Error rate %**
[11]	Subedha, D., *et al*, 2020	Analysis of face recognition using docface+ selfie matching	learning based descriptor LE, the hand-crafted feature LBP and a high-dimensional LBP feature	Transfer learning using AM-SoftMax	99.67 %	99.60%	0.33 %
[12]	Priadana, A. et al, 2019,	Face detection using haar cascades to filter selfie face image on instagram	Web Data Extraction	Haar Cascade Classifier forHuman Face Detection	64.65 %	60%	35.35%
[13]	Ahmadinejad,	A comparative study on pca and kpca	kernel principal components	-	86.44 %	Lighting-96% orientatio	13.56%

	M.M. et al, 2016	methods for face recognition	Analysis (KPCA)			n-85% scale-64%	
[14]	Wang, J.S., *et al*, 2019	Face Recognition Method Based on Improved Gabor Wavelet Transform Algorithm	Improved Gabor wavelet transform	nearest neighbor distancedetector and Euclidean distance	93%	80%	7%
[15]	Zainuddin, Z., *et al*, 2017	Implementation of the LDA algorithm for online validation Based on face recognition	Linear Discriminant Analysis (LDA)	Euclidean distance	93%	93%	7%
[16]	Jayanthi, T. and Aji, S., 2014	Face recognition using kernel principal component analysis	kernel principal components Analysis (KPCA)	-	81-91%	FERET-91.23 ORL-87.56 UMIST-81.98 AT&T-79.34	9-18%
[17]	Zhang, G., *et al*, 2016	Image intelligent detection based on the Gabor wavelet and the neural network	Gabor wavelet transform	back propagation (BP)neural network model	93%	86.23%	7%

[18]	Pei, Z.,*et al*, 2019	Face recognition via deep learning using data augmentation based on orthogonalexperiments	data augmentationusing geometric transformation	Deep Learning Using CNN	86.3%	83.3%	13.7%
[19]	Zafar, U.,*et al*, 2019	Face recognition with Bayesian convolutional networks for robust surveillance systems	Exponential Linear Unit (ELU), and Scaled-ELU (SELU)	Bayesian deep convolutional neural networks (B-DCNN) using SoftMax	74.6%	81.2%	14.5%
[20]	Guo, G.D., *et al*, 2001	Boosting for fast face recognition	Principal Components Analysis (PCA)	AdaBoost algorithm	85.79%	85.98%	14.2%

Selfie face recognition is a difficult dilemma in the area of image processing and CV that has gained a lot of interest in current years due to its numerous applications in various domains. A thorough analysis of recent developments in the face recognition method has been researched and discussed in this chapter.

2.8 Summary

This chapter makes the following contributions as, it evaluates the performance of many algorithms which works to recognize the persons.In order to overcome these challenges, the methods of Selfie face recognitionneed to be proposed.However, due to the limited variation in the data set, the proposed work overcomes allthe problems in the face recognition system.Furthermore, the literature shows that some of the evolved techniques have a high recognition rate, while others have a low rate, resulting in a satisfactory recognition rate. This chapter is dedicated to this issue, and the established technique has demonstrated high rates for all recognized selfie faces.To the best of our awareness, this is the only effort in the field of selfie that has been examined under different conditions. Unlike other work in thisfield, no significant performance has been observed.

CHAPTER 3

FACE DETECTION ON SELFIE IMAGES

3.1INTRODUCTION

This chapter will concentrate on face detection on selfie images for real-time applications. It is important in a broad range of applications, including safety access control schemes and content-based indexing video retrieval arrangements. Face detection is being used in a number of ways these days, most notably on image web servers such as Picasa, Photobucket, and Facebook.The instantly tagging feature informs other people of whom the person in the picture is, which put inaninnovativeaspect to sharing photos with the people in the picture. It's about recognizing faces in pictures. While it may seem to be aneasy task for humans, it is extremely difficult for PCs and has become extensivelypremeditated research topics in recent period.

Face detection is the basis for all facial image processing algorithms, including face orientation, face modelling, face recognition, facial expression recognition, age prediction, and many others. It is complex due to a variety of aspects such as size, position,orientation, posture, facial expression, lighting conditions, and occlusions [22]. Many of the issues raised above imagine that the key is a face image that has been cropped to only include the face area. Selfie face recognition systems often employ a face detector to locate the face before employing a separate recognition algorithm to recognize it.Face recognition can be achieved by extracting facial features from an image. This is only possible if a face is recognized. As a consequence, the initial step in face recognition should be known as face detection. What makes face detection different from traditional objectdetection?It is possible to notice changes in facial expressions, posture, and other characteristics. As a result, face detection becomes more difficult.

A PC algorithm that decides the positions and dimensions of selfie faces in random (digital) representations is known as face detection. It only looks for facial features and disregards the rest of the details. The aim of selfie face detection is to establish whether or not there are any faces in an arbitrary picture and, if there are, to arrival the image position and area of each face. Object-class recognition is a subset of face recognition [23]. Object-class detection aims to identify and size all entity in an image that belongs to a certain category.Face detection is the task of identifying a face in a picture or video, while face recognition is the method of recognizing an object from a picture. Face detection responds to the question "Where is the face in this image?" Face recognition, on the other hand, addresses the question, "Who is this person in this picture?" Face detection is a two-class pattern recognition problem. There are two types of forms: face and non-face. The aim of a face detection system is to differentiate between these two types of faces. The two classes are face and non-face.

(a) **(b)**

Figure 3.1 Face Detection (a) Input image (b) Output of detected face image[62]

An example for input and output of a face detection system are given in Fig. 3.1 (a) & (b). The image is taken from the popular Bao image dataset. Input to a face detection system is a natural photographic image that may contain zero or more faces. This input is processed by the system and output is the original image with face annotations in some format. For the purpose of illustration, in Fig. 3.1 (b), a rectangle is drawn around each detected face.

3.2 METHODS OF FACE DETECTION

Face detection is a difficult crisis in processor vision since the selfie face is anintricate entity with a high level of changeability in form. These techniques have been researched for a number of years, and the researchers have predicted significant progress. The majority of face detection methods are designed to identify frontal faces in good lighting conditions [24]. There are four types of face detection methods: knowledge-based, appearance-based, feature invariant, and template matching. The different face detection methods are seen in Figure 3.2.

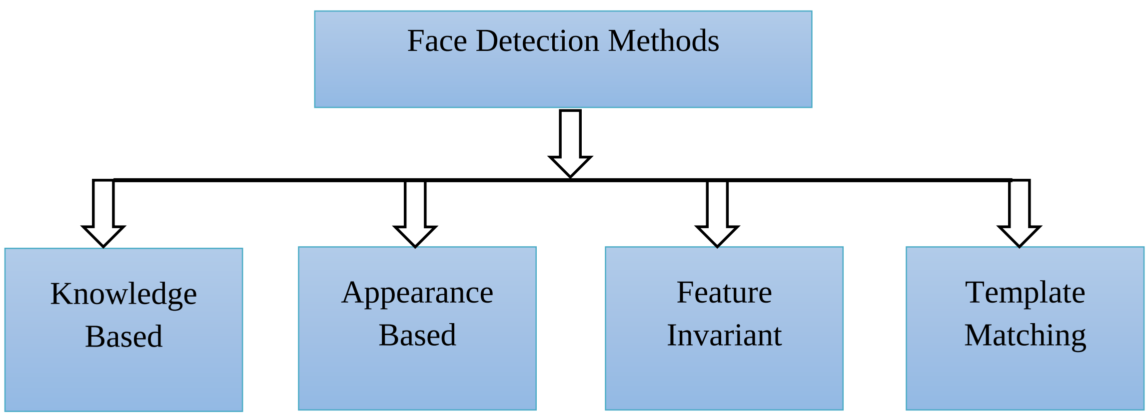


Figure 3.2Methods of Face detection

a) KnowledgeBased Methods

Thesetechniques are rule-based process that uses the researcher's facts of selfie faces to establish rules. They are commonly used to portray the relationships between facial traits [25]. One disadvantage of this method is the difficulty of translating individual comprehension into precise rules. These techniques are developed specifically for facial recognition.

b) Appearance Based methods

The appearance-based techniques diverge from the template matching methods in that these methods use machine learning methods to derive discriminative aspects from a pre-labeled trained set.

c) Feature Invariant Methods

Feature invariant approaches look for structural features that appear independent of posture, perspective, or lighting conditions and then use them to find faces. These ways are also used to identify people's faces.The features in a face image are useful information for face detection. They include invariant features that enable the detection of faces in various poses and lighting conditions.

d) Template Matching Methods

Some common models of a face are saved to identify the face as a complete or individual facial feature.A pre-selected facial template defined by experts is used for comparison with the input image which should confine the characteristicchangeability of facial appearance. The template matching is based on the face pattern and is operated by a manually determined and parameterized feature [26]. Size, pose, and shape variations, on the other hand, may degrade the method's efficiency. These systems have also been used for recognition of faces and localization.

3.3 PROPOSED METHODOLOGY

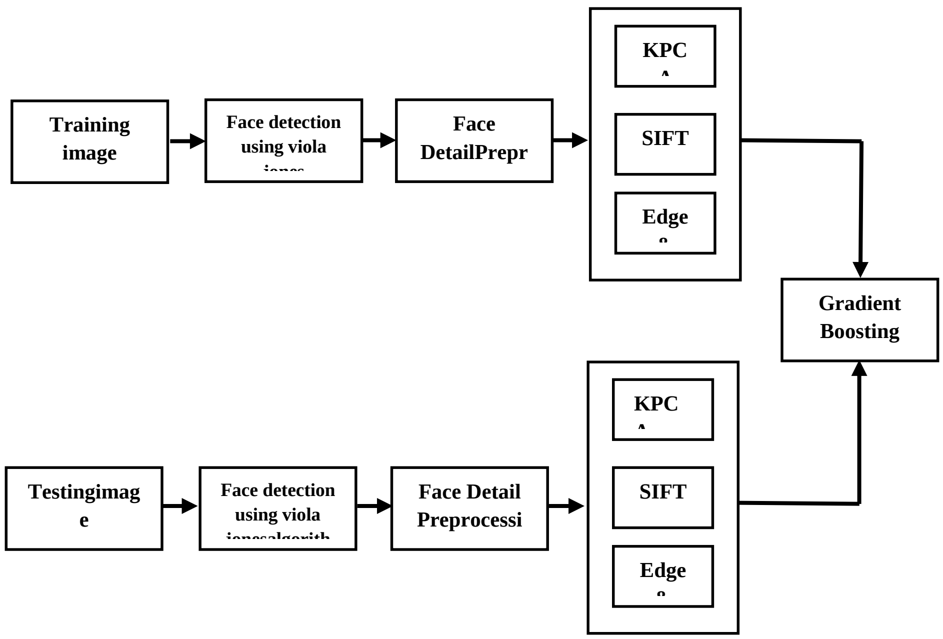


Figure 3.3 Block diagram of proposed method

Figure 3.3 shows the intended methodology, is categorized into two foremost stages: initial part refers to the training set intent primarily on enhancing the facial recognition systemwhile the subsequent section directed on the testing set to take a selfie face image of people commencing in a workplace or a construction. Using viola jones algorithm, the Haar Cascade Classifier will be employed to the acquired selfie images to spot out particular faces, which will be utilized as an inlet to the Face Recognition System.Some advanced Face detail preprocessing techniques are applied to the detected images to perk up their superiority and extracts the features by using various face recognition algorithm. Then, the extracted face should be recognized and each section are briefly explained below,

3.4 FACE DETECTION BASED ON VIOLA JONES ALGORITHM

Viola Jones is used to measure the face entity, which corresponds to the flow shown in Figure 3.4, in which the grayscale image is scanned per-sub-window using AdaBoost and Cascade Classifier to look for positive features [27]. The Viola Jones face detection system is powered by scanning window classifiers that have been carefully trained. Face detection is a problem of pattern classification with two modules: "face" and "non-face." The non-face class contains visuals that can depict anything other than a "face," whereas the "face" class contains or restricts all images of faces. To detect faces in the input, both images are evaluated, and images of areas known as faces or non-faces are employed. Following that, based on the findings of face detection, shows the number of features in an image.

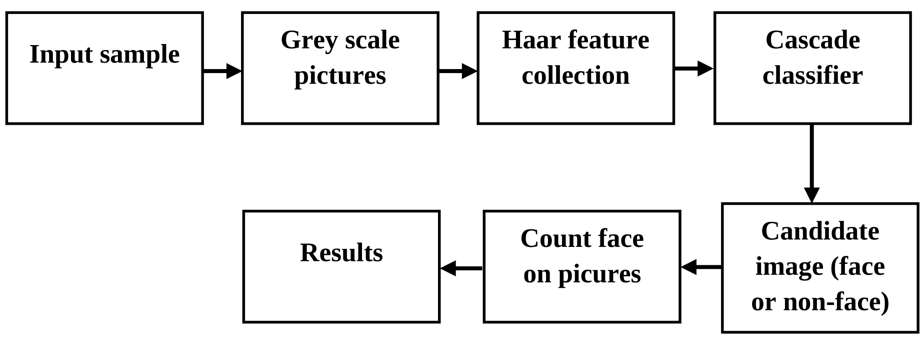


Figure 3.4 Proposed block diagram of face detection

Various face detection schemes have been expanded and implemented sofar but the use of robust face detection is always preferred to any otherapproaches. In our research, we investigated and employed a relatively straightforward but highly successful face detection algorithm that includes selfie face images.In previous systems of face detection, higher frame rate wasachieved by supplementary information like image difference or pixel color incolor images [28]. This is achieved by a special algorithmfor face detection called “Viola Jones Algorithm.” The algorithm is mainlyclassified into three main parts viz. image representation i.e., Integral image, alearning algorithm Adaboost and finally cascade.

The proposed face detection system can be considered as most clearly distinguished and accurate approach from previous methodologies in their ability to find faces tremendously fast. The Voila Jones algorithm is robust, real time and mainly focuses on face detection only (and not recognition). Robust means the detection rate is very high. It can be used for many practical applications thus making it a Real Time practical application [29]. This algorithm tells the faces descriptions from the non-faces i.e., it is used to distinguish the faces from the selfieimage.

The initial step in developing a face recognition method is to identify/detect the face images present in selfie images. Viola and Jones proposed an AdaBoost learning-based technique for creating a successful real-time face detector. The implementation of rectangle elements, integral images, and classifier cascade structures resulted in both a betterrecognition rate and a quick calculation [30]. However, sufficient memory space is required to store the integral images, which is a problem. Furthermore, random data access to memory is a critical prerequisite. Despite being more rapid and more robust, classifiers are still deliberate because they calculate the features for the intact selfie image. The Viola Jones algorithm detects the face part in selfie images by performing the following steps:

- The selfie imageis given to the Viola Jones algorithm for the face detection process. It uses Haar method to detect selfie face.
- A scheme known as the integral image is used in the Viola Jones algorithm for quick computation of features. The features described in the selfie image are used to distinguish the face from the non-facial portion.
- The integral image is then fed to the AdaBoost classifier, which chooses the most useful feature set for the detection process.
- For identifying the face part from a selfie image, the selected features are fed into a cascaded combination of classifiers.

Algorithm:

The Viola-Jones face detection method starts by converting the input data into an integral image.

The number of the pixels top and to the left of x, y, included, is defined by the integral image at x, y:

$$ii(x, y) = \sum_{x' \leq x, y' \leq y} i(x', y') \ (3.1)$$

where i (x, y) represents the original image's pixel value and ii (x 0, y0) represents the image integral value.

Only four values from the integral image can be used to measure the number of pixels in rectangle ABCD.

$$\sum_{(x,y) \in ABCD} i(x, y) = ii(D) + ii(A) - ii(B) - ii(C) \ (3.2)$$

Since the pixel sum of the shadedrectangular regionsubtract the pixel sum of the white rectangular region is used to measure a Haar-like feature value, each can be calculated as the sum of six values from I:

$$f = -I(x_1, y_1) + I(x_2, y_2) + 2I(x_3, y_3) - 2I(x_4, y_4) - I(x_5, y_5) + I(x_6, y_6)(3.3)$$

The AdaBoost learning procedure is as follows:

1. Provided a set of training sample images (x1, y1), ..., (xn, yn), withyi = 0 and 1 for negative and positive instances, respectively.

2. Set the count t = 0 for the classifier.

3. Although the percentage of negative samples that are refused is less than 50%,

3.4.1 INTEGRAL IMAGE BASED ONHAAR LIKE FEATURES

Several approaches have been anticipated, ranging from Viola-Jones-based algorithms to merged high-level method based on sophisticated pattern recognition systems. Face detection refers to the technique of detecting a face in a photograph without recognizing it.Paula Voila and Michael Jones came up with this plan. The goal of this research is to use the Haar Cascade technique to detect selfie face images. It is a machine learning algorithm that detects traits in images after being equipped with a huge number of positive and negative samples.We use this technique because it is simple and effective [31]. The haar cascade classifier approach is one of the most dependable and fast methods for detecting faces in photographs, and it can be used in instantaneous applications.

2	**2**	**2**
2	**2**	**2**
2	**2**	**2**

(a)

2	**4**	**6**
4	**8**	**12**
6	**12**	**18**

(b)

Figure 3.5 (a) Input image (b) Integral image

The Haar Cascade Classifier is used in this study to identify selfie faces using the viola jones algorithm. Haar features are the key component of a haar cascade classifier for detecting selfie faces. The haar's characteristics are used to spot the occurrence of the traits in the given picture. An integral image is used to construct Haar-like feature classifiers [32]. Each pixel in the integral image stands for the change in clarity of the preceding pixel in the image. This is skilled by comparing each pixel to the cumulative number of all pixels above and to the left of the pixel in concern. This is demonstrated in figure 3.5.

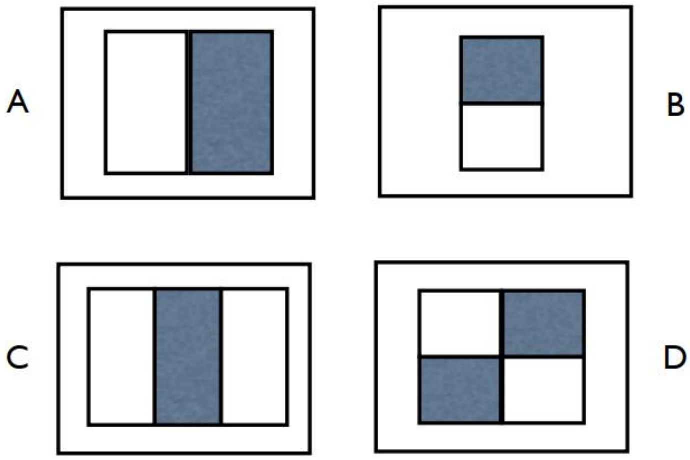


Figure 3.6 Integral image: A and B: Two rectangular attributes, C: Three rectangular attributes, D: Four rectangular attributes

The perception of integral images is used for the rapid calculation of rectangular features. In the rectangular corners, four values are required to calculate the spatial resolution in the given rectangle. The pixel value (x, y) in the integral image is the number of pixels on top and to the left (x, y).

Rectangular feature value f =Σ (pixels value in white region)- Σ (pixels value in shaded region)

The importance of a two-rectangle function is the difference between the number of pixels in the two rectangular regions. Figure 3.6 shows an integral picture centered on Haar-like elements. Both areas are adjacent horizontally or vertically and are of the same size. The three-rectangle function is used to compute the difference between the number of the two outer regions and the centre rectangle. To conclude, four-rectangle characteristics compute the dissimilarity between the slanting pairs of rectangles. These traits are calculated using the integral image.Haar features are used to identify the occurrence of the characteristics of a known image [33]. Each function creates a particular value by deducting the number of pixels in the shaded rectangular region from the number of pixels in the white rectangular region. The training set image must be the similar size as the input image used for object detection for the classifier to work properly.

The Voila Jones framework computes the Haar like features in a persistenttime by the use of integral image. And this is one the main characteristics ofusing the Voila Jonesframework.A grayscale image is used just in order to for efficient computation. Thedissimilarity of grey gradient may be favour as another type of grey image,this type of one valued feature characterized in form of the grey image. Anillustration is shown below Figure 3.7.

Figure 3.7 Scanned images from Haar-like features

To detect faces, scanning is performed on the image, beginning in the top left corner and terminating in the base right corner, and each feature generates a unique value.To detect selfie faces, scanning is performed several times in an image and these features are the rectangular features for quick selfie face detection. Therefore, the limitations of therectangle features are largely overcome by their extreme computational efficiency.The Viola-Jones algorithm begins assessing these features in the provided image with a 24x24 window as the base window size.Cascades are trained against image datasets by running multiple classifiers one by one (stage) [34]. These positive images consist of the desired features and images without the desired features when considering all possible haar characteristics parameters, such as type, position and scale. It is almost impossible to do that. Therefore, the solution to this issue is the use of the AdaBoost algorithm that can find the best features. A method called AdaBoosting will increase the weight of incorrectly sorted image data and then run another classifier. These characters are weak classifiers. As linear combinations of weak classifiers, Adaboost constructs strong classifiers.

3.4.2 ADABOOST ALGORITHM

As previously mentioned, approximately 160,000 characteristic values can be computed within a finder at the base determination. Viola-Jones uses a modified version of the Adaboost calculation developed by Freund and Schapire in 1996 to discover these characteristics. AdaBoost is a machine learning algorithm that stands for Adaptive Boosting. It can be used in conjunction with other learning algorithms to enhance presentation.Weak learning algorithms are combined so that a boosted classifiercan be obtained to get the final output. This final output is much better inmany terms than the one with single classifiers.The first face detector based on Adaboost was proposed by Voila and Jones [35].This was a real time application. In this, they formed a strong classifier bycombining weak classifiers which was called as the node classifier. It wasused to construct a robust cascade which has enhanced cascade as facedetector. Every classifier was implemented by using Haar-like features andskilled up with the Adaboost algorithm.Using AdaBoost, the classifier is designed by choosing a limited quality of essential features from a large library of potential features. To increase classification speed, the learning process must remove the vast mainstream of accessiblecharacteristics and concentrate on a limited collection of essential features. The AdaBoost Learning Algorithm works by forcing each weak classifier to depend on only one function.

Similarly, Viola and Jones discovered that the base scale of the Adaboost classifier is 24 x 24. The entire picture is subsampled to distinguish the faces. In this case, more than 160,000 features have been measured for each sub-window, and these features are fed into the classifier. AdaBoost is an efficient tool for selecting a limited range of useful functions. The aim is to distinguish positive and negative examples so that only a small number of examples are incorrectly identified [36]. To accomplish this, a weak learning algorithm is built to pick a single rectangular function that achieves the separation of positive and negative instances.A method called AdaBoosting will increase the weight of incorrectly sorted image data and then run another classifier. Thisalgorithm develops the "strong" technique of classifier as the linear mixture ofthe weighted general "weak" technique of classifiers as shown in the equation (3.4).This weak classifier regulates the optimal threshold function to reducemisclassification.It can be presented as,

$$h(x, f, p, \theta) = \begin{Bmatrix} 1 & if\ pf(x) < p\theta \\ 0 & otherwise \end{Bmatrix} \quad (3.4)$$

where $h(x, f, p, \theta)$ is a weak classifier, x is an image, p is a polarity and the threshold θ determines whether x is positive (a face) or negative (a non-face).

3.4.3 CASCADED CLASSIFIER

Cascading refers to the process of concatenating several classifiers. It is a perfect example of group learning. The data from the output of one classifier is approved on to the next classifier in the cascade. It is more efficient, which means it takes less time to compute. According to Viola and Jones, a smaller number of effective and improved classifiers can be created [37].Several negative sub-windows will be rejected by these boosted classifiers, while almost all positive cases will be found. Simpler classifiers discard the majority of the sub-windows, so additionalintricate classifiers are required to reduce the false positive rate.

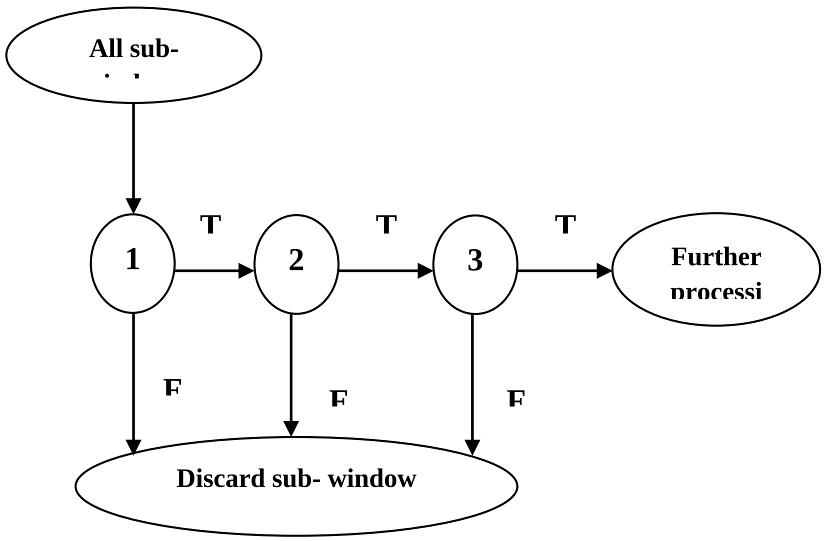
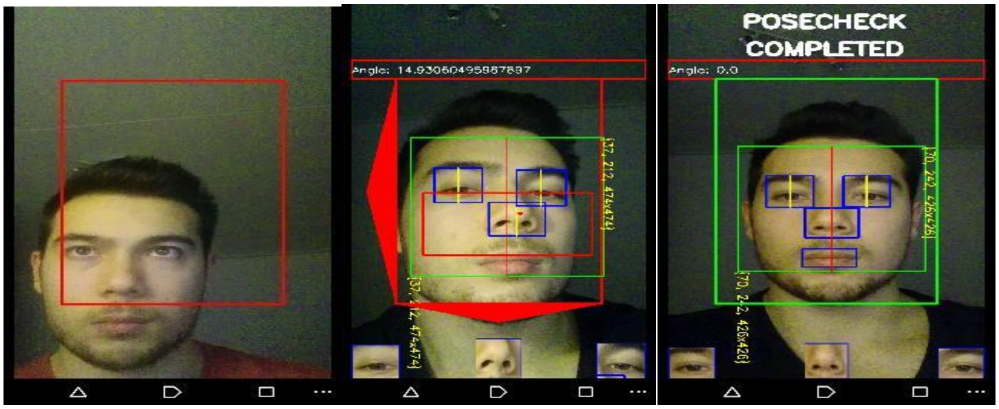


Figure 3.8Schematic representation of cascade classifier

Figure 3.8demonstrates a collection of classifiers that have been added to each sub window. The preliminary classifier discards a hugequantity of unconstructive examples with very slight processing. In the subsequent layers, more computation is used to remove additional negatives. A filter cascade works by initiating a second classifier if the initial classifier produces a positive result, a third classifier if the second classifier produces a positive result, and so on. If a negative result is obtained at any point during the process, the sub-window is rejected. The role of each phase is to decide whether or not a particular sub-window is a face. When a given stage orders a sub-window to be a non-confront, it is instantly thrown.

Application

In order to have a better live concert, the application is needed and must be consistent. The start of the project consists of an instance code called the OpenCV face-detection. This system uses Viola Jones detection to detect faces. The front camera has to be used as a selfie. In our scenario, our face was shown upside down while showing the inbound webcam frames to the screen [38]. By flipping the framework 180 degrees, this was resolved. In the top left corner, the initial position {0,0} of the display is for the horizontal phone. The initial position {0,0} is in the upper right corner when the device is held in selfie mode. The picture has to be repositioned by ninety degrees for the face detection to work.



(a) **(b)** **(c)**

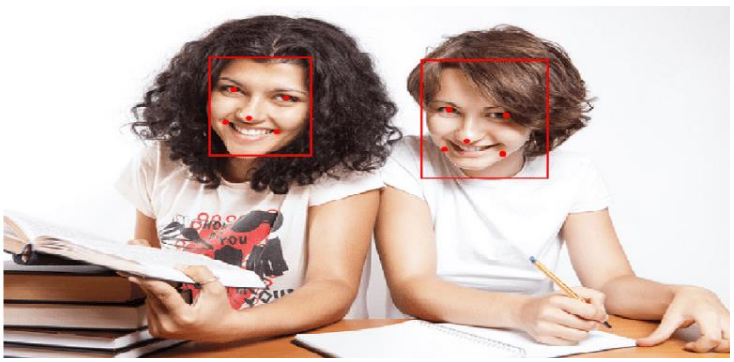
Figure 3.9 (a) and (b) the specifications are not satisfied, (c) the specifications are satisfied

The area in which the user is asked to place his/her face has been created if the user needs to receive feedback on the screen. This region is a normal red outline, which means that the user has not fulfilled the specifications for a perfect selfie. The color changes from red to green if these specifications are met. Figure 3.9there are three examples where the specifications are not fulfilled in the first two cases and the specifications are fulfilled in the third case.

3.5Implementation of Viola-Jones Method for Face detection in MATLAB

MATLAB has built in package of Viola-Jones face detection method. Themodule of Haar features, Adaboost and Cascaded Classifier is performed internally inMatlab. The code of face detection is placed in the appendix.

(a)



(b)

Figure 3.10 Face Image; a) Reference Face, b) V-J Face Detection result

Example of FDDB database reference image is shown in Figure 3.10 (a). Result ofViola–Jones face detection method is shown in Figure 3.10 (b) where it extracts preciseface region. If face is cross then it requires performing rotation transformation toprepare it straight.

Same methodology is applied on multipleimages too, but itcan have multiple selfie face that to be detected one by one.Figure 3.11 shows a test image with white highlights. The cascade classifier method for detecting facial shapes is the primary step in identifying a face. AdaBoost Learning and Integral Image are the next steps. AdaBoost learning improves the previous process's face type by having a huge and precise detection number. This is for the reason that the precedingfindingsacquired preliminary feature data.

Figure 3.11 test image for face detection

3.5.1 SquarePattern Formation

The Integral Image process follows next. When you process the haar function, a four-sided figure pattern will form about the previously processed face pattern. The haar function must verify that the previous process's face data is accurate. Figure 3.12 shows a box forming around each white field. The location of the rectangular box on the face model in the face region is adjusted during this process.

Figure 3.12 initial rectangular box formation

Many non-face regions, such as hands and regions with textures similar to skin color, are also chosen. As a result, such boxes must be discarded. The methods used for this purpose are described below.

- Since faces often fall more than 100 pixels underneath the image, lesser boxes about 100 pixels under the icon were rejected.
- It is common for the face and neck to be identified as two different boxes. As a consequence, they must be combined into a single package. As a result, boxes that are similar to each other are combined. The row width threshold is set at 70 pixels, while the column width threshold is set at 25 pixels.

3.5.2 DETECTED IMAGE

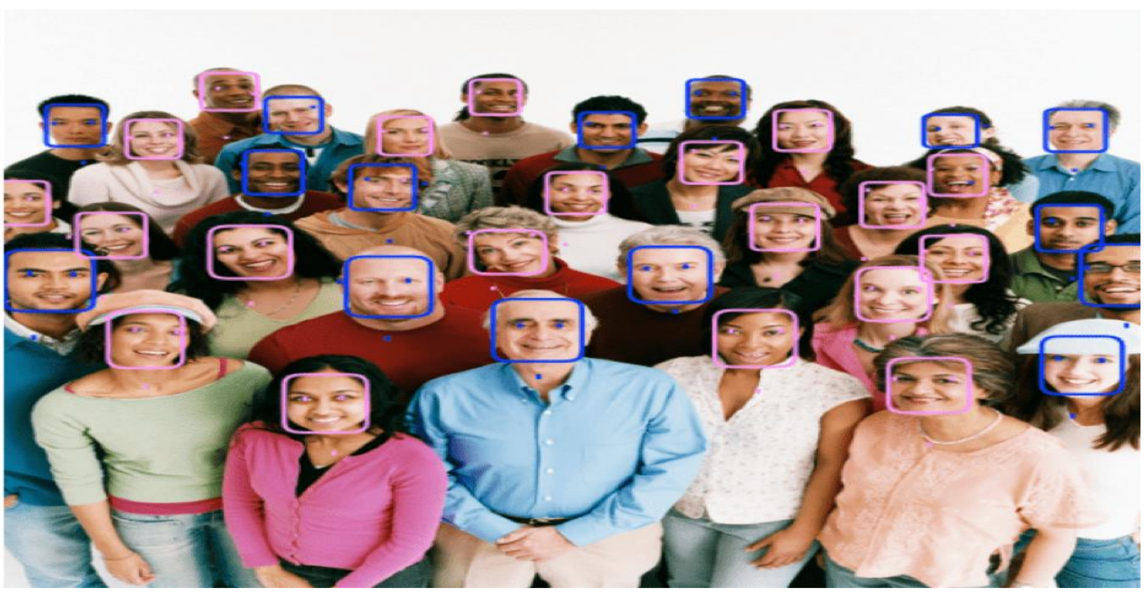


Figure 3.13 Detected image

In figure 3.13, all the faces were detected correctly. The experiment was repeated after the background was colored, and the results were perfect. Furthermore, the experiment was carried out on another picture in fig 3.14. The accuracy of face images is evaluated by uploading multiple images.

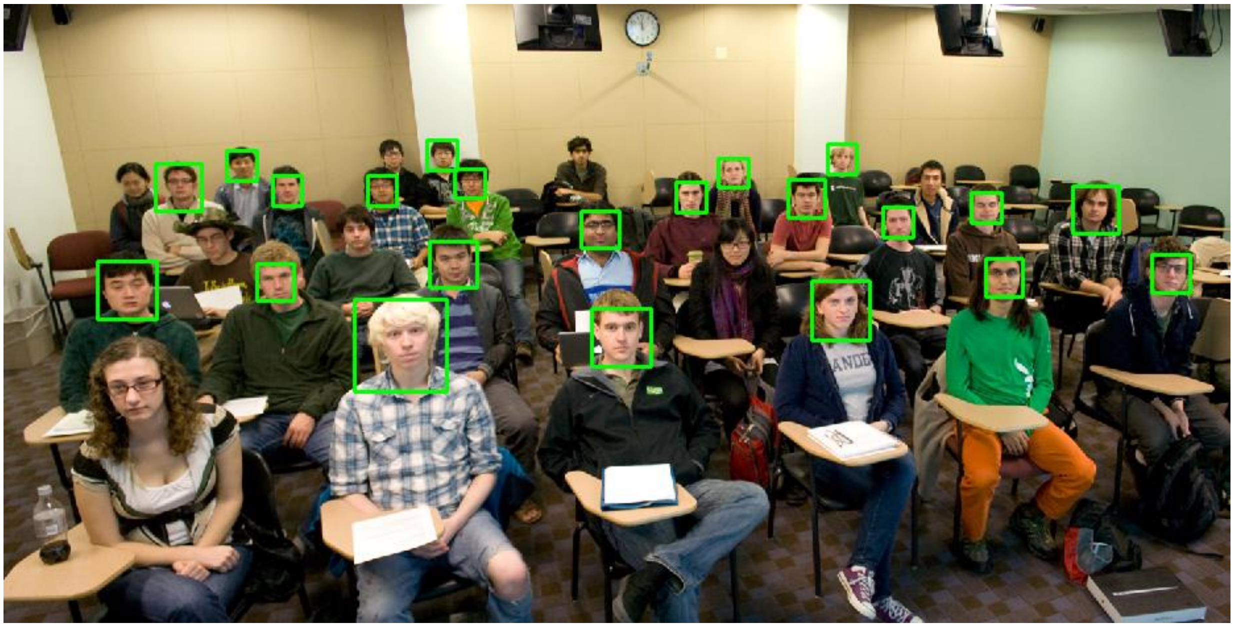


Figure 3.14 another image

Images with a wide variety of colors (the majority of which were in the skin color category) generated false results. A better result was obtained after modifying the filter coefficients and varying the colorseries in fig 3.15 and some non face area was misidentified as face.

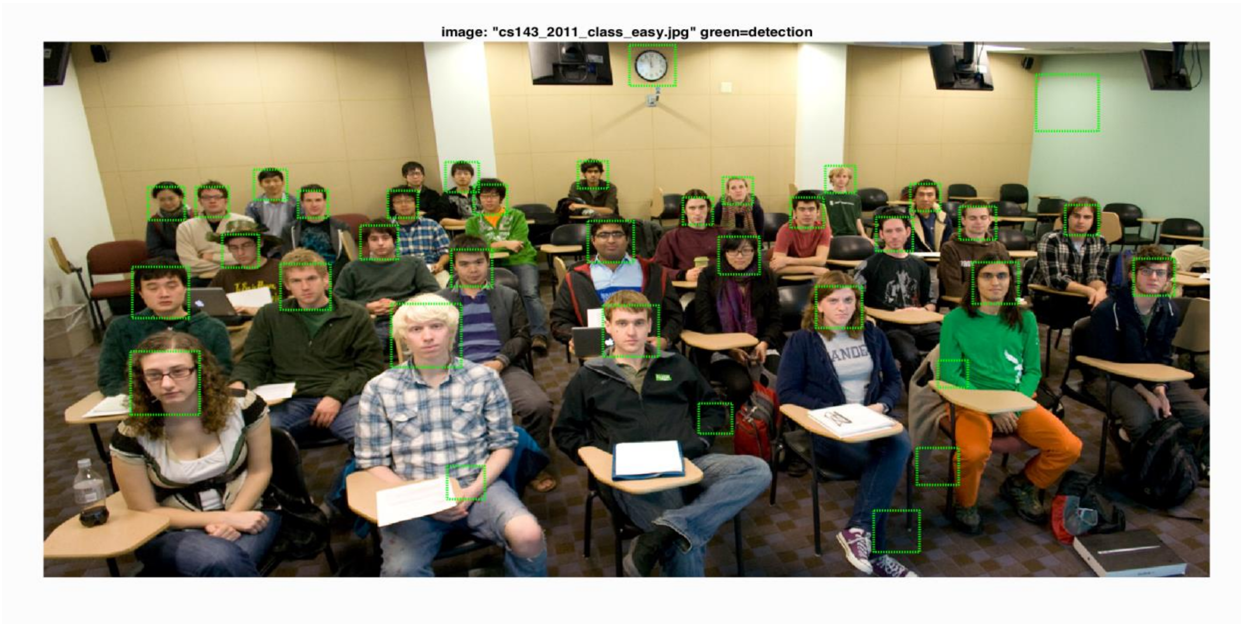


Figure 3.15Final detectedresults

3.5.3 TABLE OF RESULTS

Table 3.1

Image details	Resolution of images	No. of faces	No of box formation	No of merge	No of false detection	Not detected faces	Timing
Image 1 with white highlights	1024×325	35	33	2	0	0	30 sec
Image 2 with colored highlights	1024×355	30	22	1	5	1	30 sec

Table 3.2Evaluation Result of Face Detection using FDDB dataset

Table 3.2 shows the detection rates on FDDB dataset compared with theexisting recent method. Fig 3.16demonstrates the evaluation on the datasetgraphically, which shows that the proposed method outperforms existing method.

Detection type	Detectionrate(%)
Local Binary patterns (LBP)	74.5
Modified Census Transform (MCT)	78.2
Semi-Local Binary Pattern (SLBP)	82.8
Semi-Local Modified Census Transform (SMCT)	88.3
Proposed Method	95.4

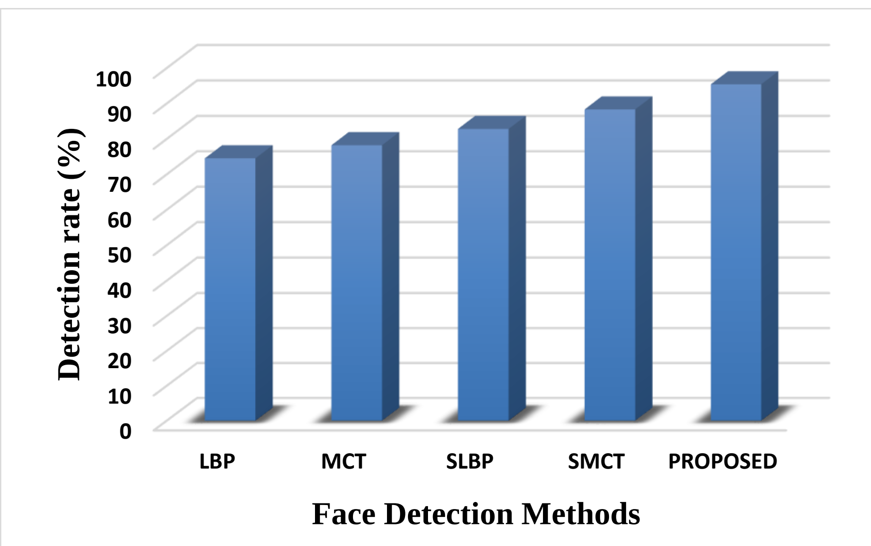


Figure 3.16Evaluation resultsof Detection rates (%)

The proposed method has more advantages over existing methods. Theoptimization unit that rules out non-skin region considerably reduces false positiverate and improves the speed of the detection process. When contrast to existing methods of LBP, MCT, SLBP and SMCT, theplannedschemeattains the detection rate of 95.4%. The Haar-like feature descriptorsis comparatively very less than many existing face descriptors. This reduces the time complexity for selecting thebest feature in eachround and thereby improving overall training efficiency.

3.6 Summary

This chapter proposes the Viola-Jones approach for face detection in MATLAB. Face recognition algorithms were meticulouslycalculated, with a hugequantity of tested sample images,circumstances and variables varied. Most of the aboveresearch effort made use of real-time data. The overall detection rate was 95.4%. When evaluated on a more complicated dataset, FDDB, the proposed schemesdo better than the existing and prior-art methods for face detection.

CHAPTER 4

FEATURE EXTRACTION AND SELFIE FACERECOGNITION

4.1 INTRODUCTION

The subsequentphaselater than face detection in a face recognition system is selfie face recognition. It plays anessentialpart in many appliances such as video surveillance, criminal investigations,forensic applications and face image database management.This is essential in social interactions and highly useful in daily tasks. Face Recognition is currently motivating substantial research efforts because it meets a number of criteria in determining the best biometrics solution. It is highly useful for identifying people at crime scenes, access control, and a variety of other applications.Face recognition has gotten a lot of consideration in current years because of its potential for anextensiveseries of applications [39]. The algorithms used in face recognition are KPCA (kernel principal component analysis), SIFT (scale invariant feature extraction) and Edge& shaping in which we identify an unidentifiedtrial image by comparing it towell-known training samples stored in the database and provide information about the person recognized. These methods work well in a lot of circumstances. As experimentally observed, these algorithms provide varying rates of accuracy under various conditions.

In real-world applications, large visual variations of faces still present high challenges to these tasks. A sensible face recognition system is surely competent of making recognition under different illumination circumstances, facial expression, various poses, shape, size, occlusion face and so on, which remains an important challenge in the pattern recognition [40].Traditional methods for contracting with this problemcan be generallycategorize into three approaches namely,

- Appearance based approach
- Normalization based approach
- Feature based approach

In approaches that are based on appearance, trained samples were taken beneath various lighting circumstances (without any preprocessing) and used to create a universal model of possible illumination dissimilarity. A model that suppresses illumination variations is used in normalization-based techniques (e.g., Histogram Equalization).The third method directly captures illumination-insensible characteristic sets from a given image [41]. The suggested method combines the strengths of all three methods. However, image processing techniques-based approaches are extremelystraightforward and proficient, and they renovate images devoid of any prior knowledge. Because of these considerations, they are mainly used in practical applications.

Figure 4.1 illustrates the various phases of the proposed face recognition process. The following are the general techniques used in the proposed system for facial recognition:

- To perform preprocessing such as contrast adjustment and noise reduction using face detail preprocessing techniques.
- Feature extraction using KPCA, SIFT and Edge& shaping
- Comparing with database using Gradient Tree Boosting algorithm

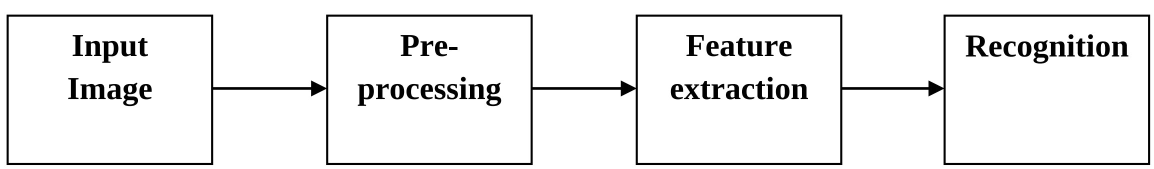


Figure 4.1 Stages of face recognition method

An effective preprocessing method is implemented prior to recognition to resolvewidespread problems in face images caused by a real capture device, such as lighting variations [42]. Preprocessing eliminates the lighting effect without providing any additional details in a range of lighting conditions.As a result, these methods are inapplicable to real-world recognition problems. The preprocessing step functions to eliminate numerous effects of lighting changes while conserving the aspect detail [43]. The significance of preprocessing in a face recognition system is discussed further below.

4.2 FACE DETAIL PREPROCESSING

The significance of a face recognition system's preprocessing stage is determined by its ability to solve some of the issues that may arise as a result of the factors presented. Face images with low contrast can occur as a result of changing lighting conditions [44]. Preprocessing techniques alter an image and prepare it for the next step in a facial recognition system's processing.As a result, providing an effective preprocessing stage with active preprocessing algorithms is crucial for achieving higher recognition rates and making the face recognition system more robust.

Many external variables, such as head orientation, partial occlusion, facial expression, and lighting, may all influence face recognition algorithms. Face images are preprocessed to make them more identifiable to decrease error and improve the recital of the algorithm.In order to increase the clarity of the image quality, this will depictimprovedinformation of the features of the image to be more accurate [45]. The first way is to apply our actual selfie face input to the contrast adjustment technique as described below. In order to choose the one that provides the better results for the detection and recognition of accuracy, which is 1.5(α) and 0.0(β), we tested the various values of alpha and beta for this process, where g (x, y) is the disparity image.

$$g(x, y) = \alpha * f(x, y) + \beta (4.1)$$

In the second step, we analyzed the results of the highly accurate performance of our facial recognition system for different types of filters.

$$F(x, y) = \frac{\sum_{x=-N}^{N} \sum_{y=-N}^{N} I(x, y) W(x, y)}{\sum_{x=-N}^{N} \sum_{y=-N}^{N} W(x, y)} (4.2)$$

Here, W (x, y) - is the weighting function of filter,

I (x, y) - is the image of the input face,

F (x, y) - applied filter

In equation (4.3) we defined CF (x, y) as the function to decrease noise and control disparity effects in the input image as,

$$CF(x,y) = g(x,y) * F(x,y)(4.3)$$

Using the image histogram equalization process described in equation (4.4), the resulting image pixels resulting from the exceeding equation are equalized to finally tackle the lighting problems in the filtered face image.

$$Eq = H'CF(x,y)(4.4)$$

where H' is the standardized cumulative allocation with a utmost value of 255.

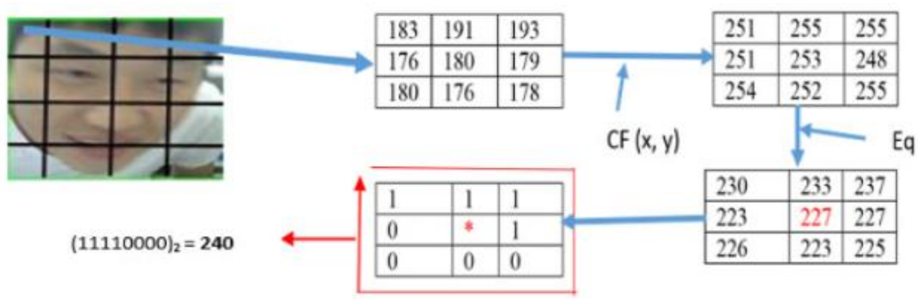


Figure 4.2 steps for preprocessing

Figure 4.3 (a) Original (b) Contrast (c) Filtered (d) Equalized images

The actual impact of the use of equations (4.1), (4.2), (4.3) and (4.4) to evaluate the efficacy of the input figure in order to enhance the accuracy of the facial recognition system as shown in Fig 4.2 and the result can be seen in fig 4.3

4.3 FEATURE EXTRACTION

Feature extraction is a process of dimensionality attenuation used in pattern recognition and image processing. When an algorithm's input data is too large to process and is accused of being commonly inefficient (lots of data but little information), the data is transformed into a simplified description of a set of features [46].The method of altering input information into a series of traits is known as feature extraction. If the extracted traits are carefully preferred, it is presumed that the trait set will remove the requisite data from the given information in order to increase the required output using this deductive method rather than the full-size input.[47], The algorithm used in face recognition is KPCA (kernel principal component analysis), SIFT (scale invariant feature extraction) and Edge& shaping in which we recognize an unidentified test samples by comparing it towell-known training samples stored in the catalogand gives information about the individual recognized.

4.3.1 KPCA ANALYSIS

In some instances, an excellent feature selection approach is task-dependent, and there are some untested methods that work best. The size of the face image is too large. If all the face images were placed in the M^2 dimensional space, they would not fill the entire space, but would instead only cover a very small amount. As a result of the interconnection of several input elements, the dimensions can be greatly reduced [48]. The objective of PCA is to diminish the size of the data space in order to save time by removing the "right" features or key structure of the database. As the framework for our new co-ordinate, the key elements are sufficient to define the majority of the structure in the database. On the other hand, PCA often fails to extract high-level information from images due to a lack of primary vectors used to describe the dataset. The kernel PCA was proposed as a solution to this problem.

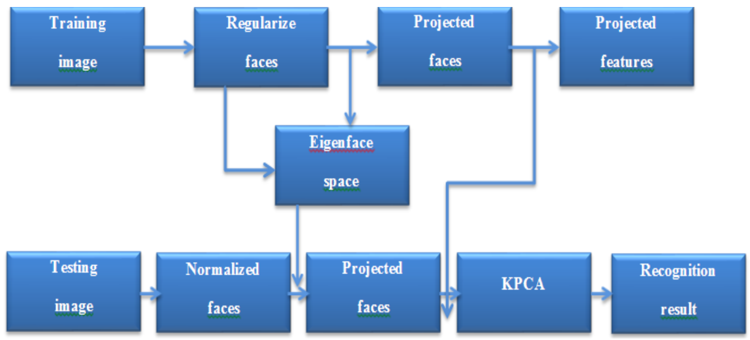


Figure 4.4 General model for KPCA

The kernel trick is used to generate a kernel PCA, which is a nonlinear type of PCA. Kernel PCA starts by using the kernel process to map the unique sample images to a higher-dimensional space. The kernel trick is a process of mapping the findings from a specific set S to an input feature space V, despite having to calculate the mapping directly, since the findings would generate a significant regular pattern in V. Using an effective kernel function, the trick or process is used to avoid indirect mapping. Figure 4.4 shows the general model of the KPCA algorithm. The face image X (A, B) is rewritten as X (A*B, 1), where A and B are number of rows and columns X, respectively. After that, a centralized kernel matrix of training examples is created [49]. After that, the built kernel matrix has its own values and its own vectors computed. The proprietary vectors belonging to the first few largest proprietary values are then collected, resulting in the extraction of features. The feature selection method is then used to remove the nonlinear attributes of the training and testing examples. The sample faces are then identified using a classification model.

Given the set of n centered zero mean of the projected sample feature as,

$$\sum_{n} \phi(x_n) = 0 \quad (4.5)$$

To find the projection direction, maximize the variance which is equal to the covariance is given by,

$$C = \frac{1}{N}\sum_{n=1}^{N} \phi(x_n)\phi(x_n)^T \text{ (4.6)}$$

The corresponding eigen vectors and eigen values are given as,

$$Cv_i = \lambda_i v_i (4.7)$$

Here, C is the covariance matrix and therefore,

$$\sum_{i=1}^{m} \alpha_i \phi(x_i) \qquad (4.8)$$

The kernel function of $m \times m$ matrix of K is defined as,

$$K_{ij} = k(x_i, x_j) = \phi(x_i).\phi(x_j) \qquad (4.9)$$

Were, $m\lambda K\alpha = K^2\alpha$

$m\lambda\alpha = K\alpha$

As the result of KPCA can be calculated using,

$$v_i.\phi(x) = \sum_{i=1}^{m} \alpha_i(\phi(x_i).\phi(x) = \sum_{i=1}^{m} \alpha_i K(x, x_i) \quad (4.10)$$

In contrast to PCA, KPCA succeeds in capturing non-linear image features, and outperforms other eigen face-based methods for the identification of selfie faces. It has a more effective extraction process with better implementation.

4.3.2 SIFT FEATURES

Matching an image is asignificant step in the image processing process. SIFT is a popular image matching algorithm which has been used to successfully align images. It is used in computer vision to remove features from images for tasks such as object recognition and matching multiple sights of the similar object. The extracted attributes are scaling and rotation invariant, as well as partially lighting invariant. In order to achieve an appropriate way of adapting images, this study limits the number of extracting features of SIFT operators and key-point removal operators to a certain number, reducing computational complexity and increasing efficiency [50]. SIFT features are often used to recognize the object and face. The main feature of this method is that it makes use of the benefits of a particular approach to choose the better key points. There are four measures involved in the achievement of certain characteristics.

1. Scale space extrema detection

A scale space is created in which interest points, also known as key points of the SIFT method, are identified in the first phase, which involves the detection of stable features. Scanning an image for points of interest that are invariant to the shift in the scale of the image distinguishes them [51]. This is employed efficiently by making a Gaussian pyramid of $G(x, y, \sigma)$ and pointed for local peaks in a series of Difference-of Gaussian (DoG) with an input image $I(x, y)$ is,

$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y) \quad (4.11)$$

therefore, $G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}$ and $*$ is a convolution operator

2. Removal of key point localization

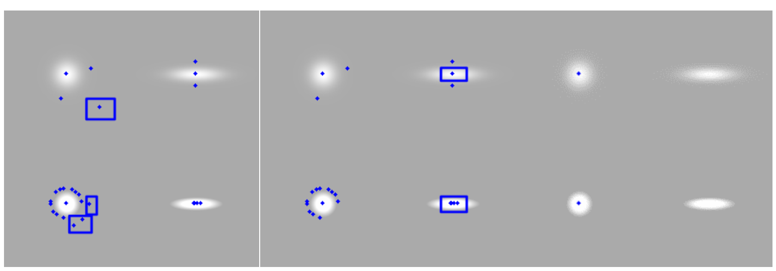
Since scale-space extrema detection generates an extreme number of key point candidates, some of which are unstable, this step is used to filter out unreliable key points. The best main points are chosen at this stage by excluding those with low contrast and weak edge localization. As a result, the ratio of principal curvatures of each applicant key point is tested to exclude unstable edge key points. The main point is held if the ratio falls below a certain threshold.

3. Orientation assignment

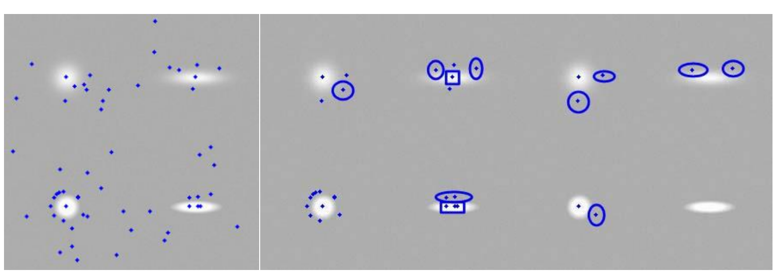
Based on the local gradient of the figure at target points, each main point is given one or more orientations in this process.

4. Descriptor Calculation

Finally, in the region around each key point, the local image gradients are calculated at the chosen scale. Each descriptor includes a 4× 4 array of histograms, and each neighborhood of the pixel is computed 16 by 16 times [52]. Each feature is measured as a vector in a 128-dimensional space known over the key point neighborhood and this section can be explained in fig 4.5.



(k) (k’) (k”)



(p) (p’) (p”)

Figure 4.5 Detected key points: (k)found in a clear image (p) found with noises, **Once the minimum contrast threshold has been applied:** (k’) and (p’) haven’t changed key points, **A threshold was then applied to the ratio of principal curvatures:** (k”) and (p”) final key points remain.

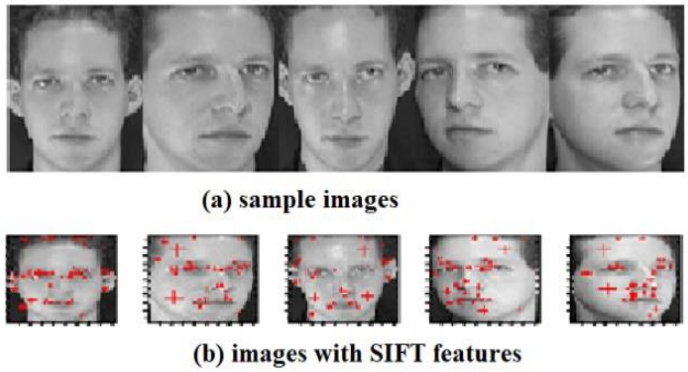


Figure 4.6 Detected key points in the face image

The key points detected in the image of the face are shown in Figure 4.6. Removal strategies will eradicate these key points. These key points, on the other hand, reflect distinct structures such as wrinkles or corners of the mouth. As a result, when applied to face images, the original key point extraction approach to the SIFT algorithm will remove some advanced features. These key points are detached in the SIFT method due to the restriction of image size.

4.3.3 EDGE & SHAPING

Using the block diagram in fig 4.7, we tried to demonstrate the theory of the LEM. To begin with, we will take the RGB image as input, convert it to grayscale, then to binary, then to the edge image detected using Sobel edge detection, invert the edge image detected, and apply an improved LEM algorithm to it, resulting in an LEM image of the input image [53]. Finally, we will compare the LEM image to the database and, if available, we will get the appropriate match.

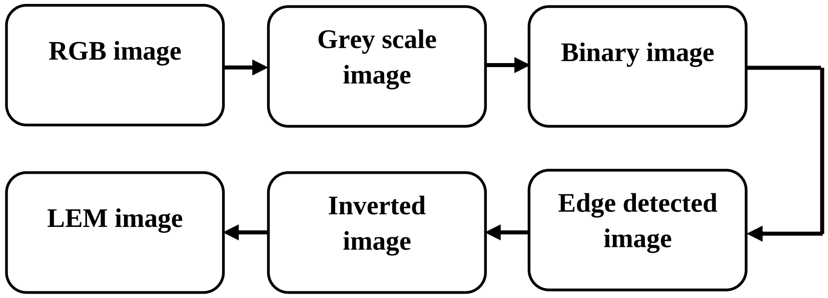


Figure 4.7 Block diagram of LEM

A detailed study of the LEM concept, which covers all aspects of selfie face recognition under 1) different lighting conditions, 2) different facial expressions, and 3) different poses. The fact that the selfie face recognition technique outperformed the eigenface approach in the majority of comparison tests is a very promising finding [54]. In fig 4.8 and fig 4.9 there are LEM images of the respective RGB images of the self-created RGB database under various light conditions and poses.

Figure 4.8Images of RGB

Figure 4.9 Images of LEM

Since it is a low-level figureillustrationresulting from low-level edge map symbol and has a low memory requirement, LEM is predictable to be less sensitive to vary in illumination. It also benefits from high recognition efficiency [55]. There are also no errors in posing variations or facial expressions. As seen in fig 4.8, some figures were obtain in various poses and with various facial expressions, but the LEM of these images, as shown in fig 4.9, were accurate, with no missing or unwanted lines.

After that, an image searching tool known as Active shape model (ASM) is commonly used to extract selfie facial features. ASMs are statistical models of object shape that iteratively distort to match a new image of the object. The point distribution model (PDM) creates shapes by allowing them to differ only in the way that the training set of marked examples allows. The collection of points dominated by the model of the shape represents the shape of the object.

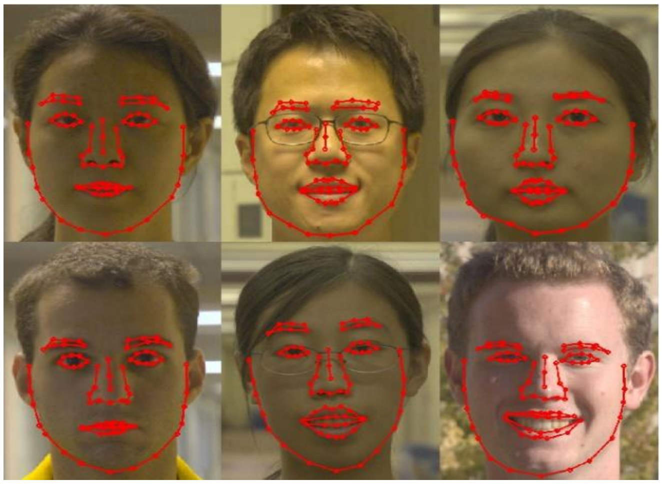


Figure 4.10 Facial feature extraction using ASM

In our experiments, we have called 68 landmarks to illustrate the shape of each face image. The efficacy of the ASM search for selfie facial features will be demonstrated using the IMM Face Database. The facial features in Figure 4.10 have been removed using ASM.

4.4 GRADIENT BOOSTING DECISIONTREE ON FACE RECOGNITION

A classifier that randomly sorts or categorizes data into one or more classes. The use of boosting schemes on regression trees helped in the implementation of the Boosting Trees algorithm. The basic scheme is to create a series of simple trees, each one based on the prediction residuals of the previous tree [56].Gradient boosting is a machine learning method used to crack regression and classification troubles. This approach employs an assembly of weak prediction forms that are linearly assembled to generate the desired prediction. Gradient boosting is a feature of AdaBoost that allows a weak learner to be changed to become stronger, and decision trees with a single split.In order to match a new base learner function, the gradient descent is first determined on each iteration of Friedman's gradient boosting algorithm [57]. Once the best gradient descent step size has been calculated, the feature prediction is updated. The gradient descent formula is shown below.

$$\theta_{n+1} = \theta_n - \eta L'\theta_n \quad (4.12)$$

Whereη is the step size or learning rate, andgradient refers to$L'\theta_n$

This section introduces the gradient boosting decision tree, which can be used to increase localization accuracy. It is a gradient boosting variant that employs a decision tree as the weak prediction model [58]. The previous model's error information is used to match the current model. The predicted values are the sum of all models' predictions. GBDT is one of the most important methods for developing predictive modelsand the basic idea about its functioning has been given below.

- It is important to optimize a loss function.
- Making predictions is difficult for a weak learner.
- To reduce the loss function, use an additive model to incorporate weak learners.

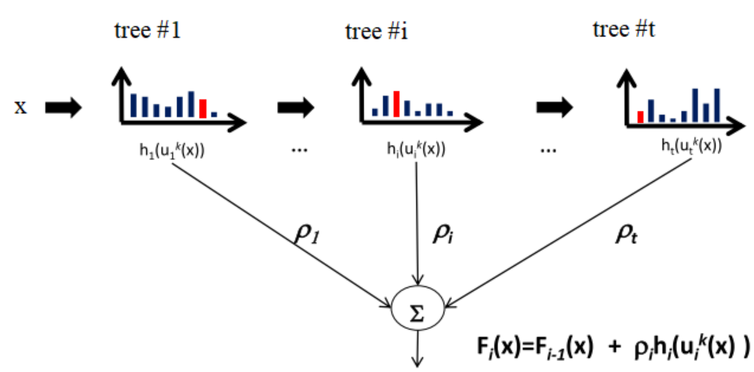


Figure 4.11 GBDT for regression

Figure 4.11 shows the GBDT scheme. The goal of a gradient boosting decision tree is to iteratively minimize the loss function. For the regression task, random binary patterns are used to guide the weak prediction model [59]. In this case, the GBDT makes use of depth-k decision trees.Each tree can be interpreted as a $h\left(u^k(x)\right). u^k(x)$prediction function. Any iteration, the loss function falls into its negative gradient way, allowing the loss function to bereduced easily.

To find a regression function $F(x)$in the GBDTtraining method, thatatlas an input attribute vector x to a intention value y, while reducing the predictable value of theloss function.

$$F(x) = \sum_{t=1}^{T} \rho_t h_t(u_t^k(x)) \quad (4.13)$$

$F(x)$is the sum of$T$ stages of weak regressionfunction. Here ρ_t is the learning rate and $h_t(u_t^k(x))$ is the regressionfunction. The square error can be defined as,

$$L(y, F(x) = \frac{1}{2}\big(y - F(x)\big)^2 \quad (4.14)$$

It is used to solve the optimization problem such that the squared error between the tree prediction and intention values are reduced. The normalized function is defined as,

$$w_i = \frac{||y_i - F_{m-1}(x_i)||^2}{\sum_{i=1}^{N} ||y_i - F_{m-1}(x_i)||^2} \quad (4.15)$$

Here $F_{m-1}(x_i)$ denotes the result of $m - 1$ iterations.

Normalized mean squared error is used as the weight of training samples during the training phase for weak classifiers. Using iterations, a more reliable classifier is modeled based on the current weight distribution [60]. The weighted GBDT processis to improve accuracy and robustness by adaptively changing the weak classifier's error.

4.5 Summary

The GBDT method for face recognition in MATLAB has been proposed in this chapter for recognizing faces. Face recognition algorithms were carefully tested using a large number of test images under different conditions. Much of the preceding work included real-time data. The traits of the test samples were removed in the same way and evaluated to the qualified database. On 98.7 % of the occasions, the recognition was accurate. The plannedtechnique outperforms the common and prior-art methods for face recognition when evaluated on a more difficult dataset.

CHAPTER 5

RESULTSAND DISCUSSIONS

5.1 Feature extraction

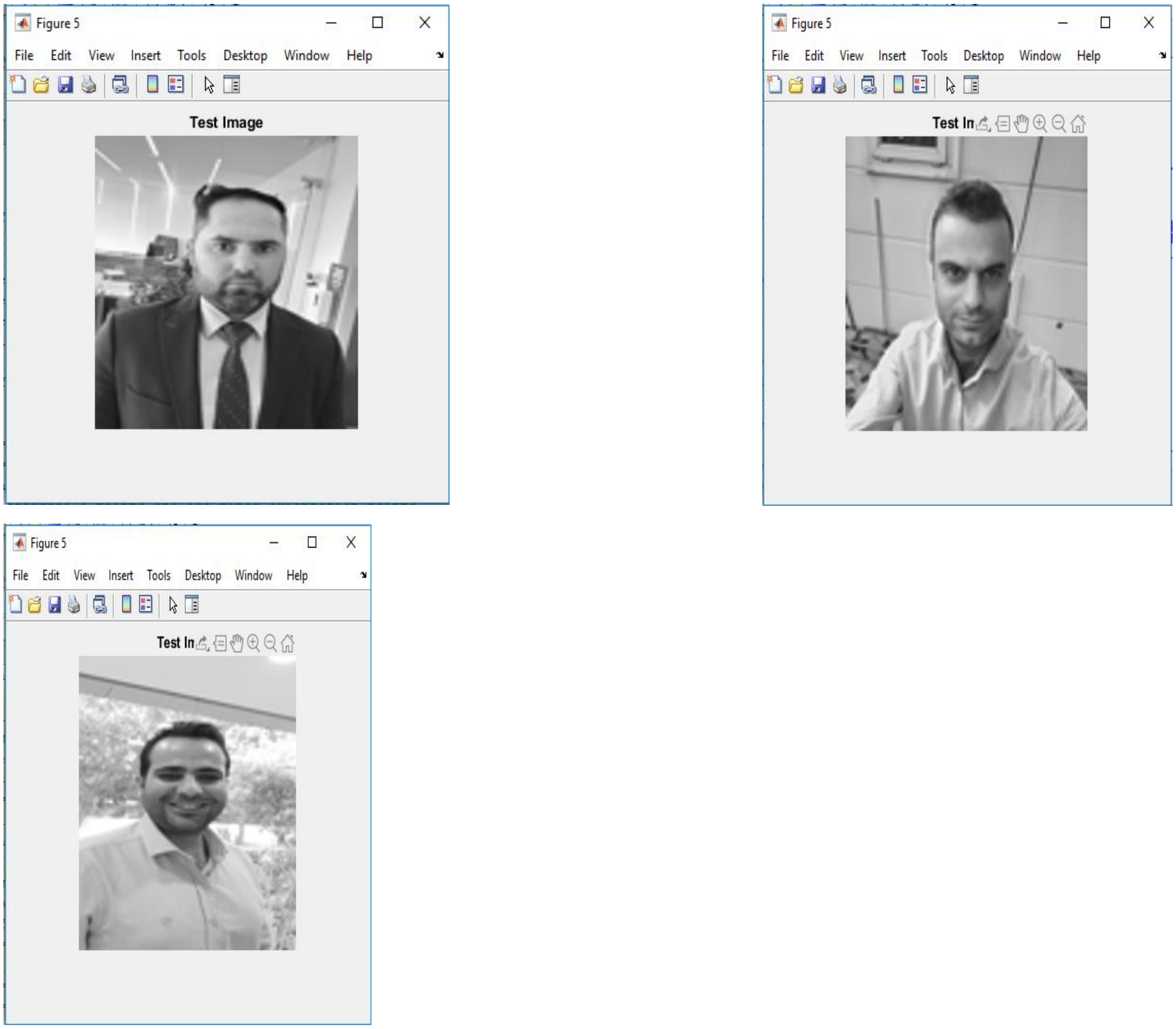
Facial features can be identified by using geometry and their relative position toone another. The method of altering input data into a series of attributes is known as feature extraction.The number of data required to classify a huge amount of information is reduced through the extraction of features.The images are given in the training and testing basis the invariant features are taken from various real time images and the MATLAB coding is written for SIFT algorithm and the output can be implemented.

Matching an image is asignificant step in the image processing process. SIFT is a popular image matching algorithm which has been used to successfully align images. It is used in computer vision to remove features from images for tasks such as object recognition and matching multiple sights of the similar object. The removed features are scaling and rotation invariant, as well as partially lighting invariant.

The real time image from the randomly selected three training persons was tested. Then, employing SIFT algorithms, unnecessary part of the images was removed.Here, we assume three test samples of real time images are shown in figure 5.1 and size of each subject are shown in table 5.1.

Table 5.1 Size of each sample

Samples	**Size**
Subject 1	112×92
Subject 2	112×92
Subject 3	112×92



(a) **(b)** **(c)**

Figure 5.1 A real time test images

In the first step, we recognizepositions and levels that can be repeatedly allotted under different visions of the equal object or prospect. For the identification, we will look forconstantattributes across severallevels using a nonstoprole of scale using the gaussian function.This is employed efficiently by making a Gaussian pyramid of $G(x, y, \sigma)$ and pointed for local peaks in a series of Difference-of Gaussian (DoG) with an input image is seen in figure 5.2

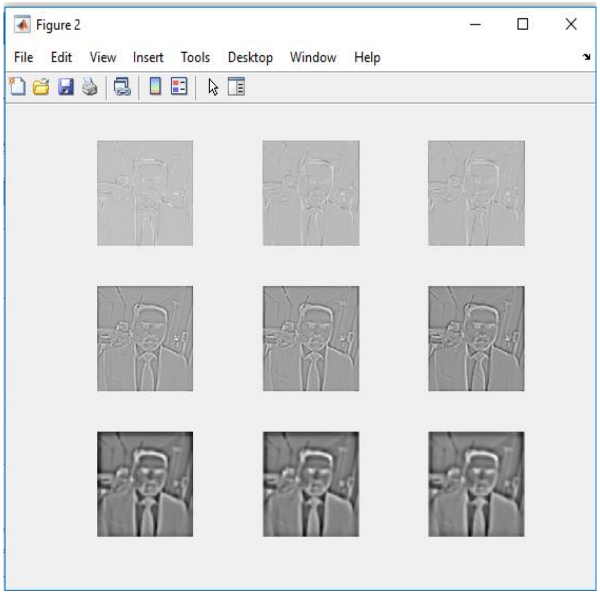


Figure 2
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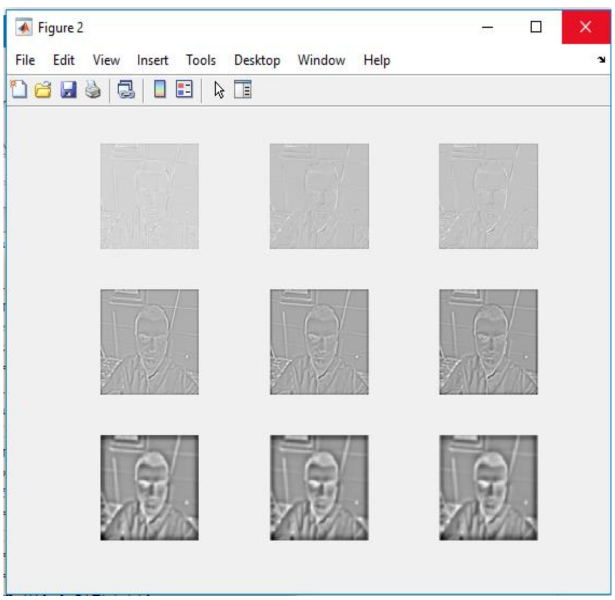
Figure 2
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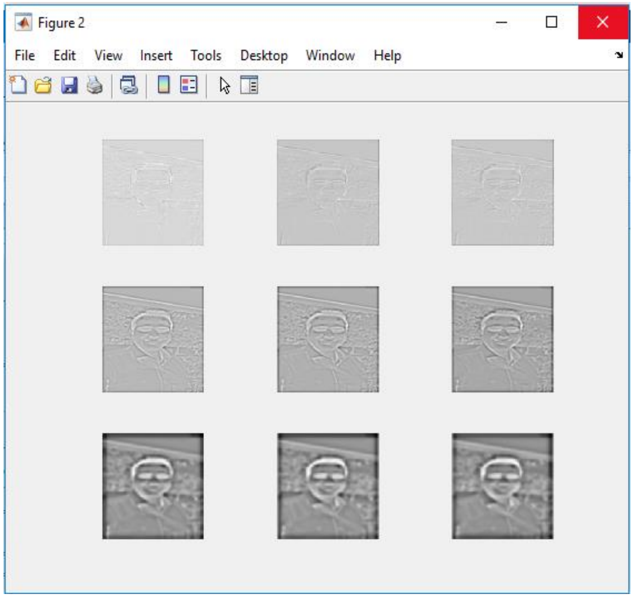
(a) (b)



(c)

Figure 5.2 Scale space extrema detection of each samples (a) subject 1 (b) subject 2 (c) subject 3

After taking the difference of gaussian, we need to detect the maxima and minima in the scale space**.** Since scale-space extrema detection generates an extremeamount of key point candidates, some of which are unstable, this step is used to filter out unreliable key points. The best main points are chosen at this stage by excluding those with low contrast and weak edge localization. As a result, the ratio of principal curvatures of everyapplicant key point is tested to exclude unstable edge key points is shown in figure 5.3.

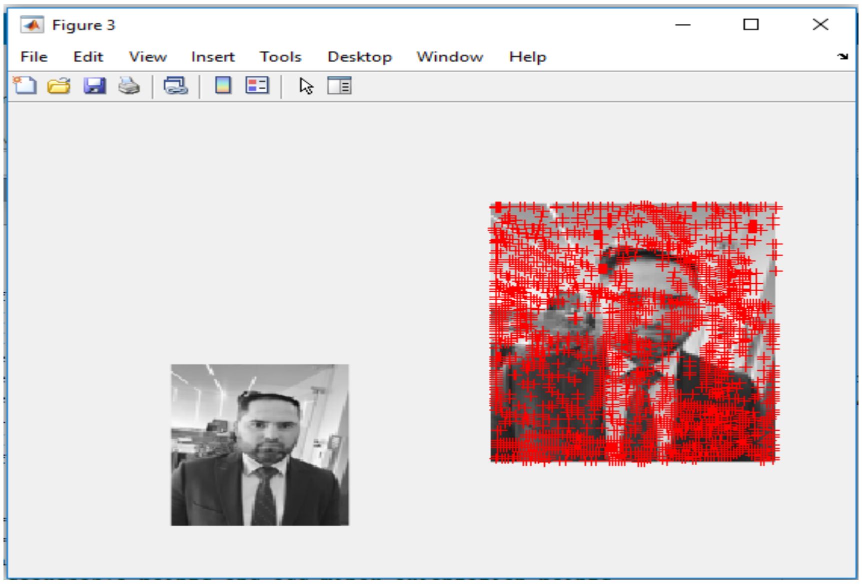


Figure 3
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(a)

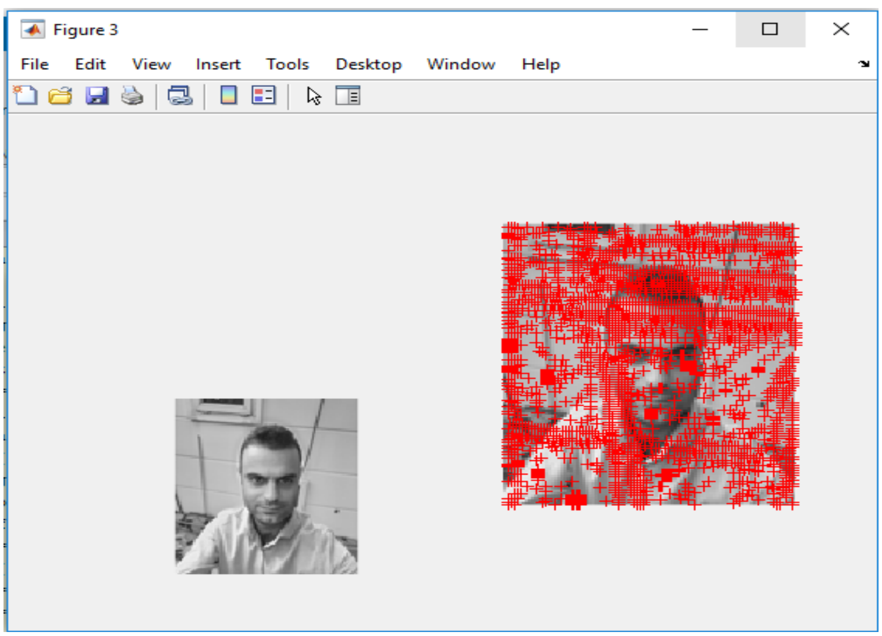
Figure 3
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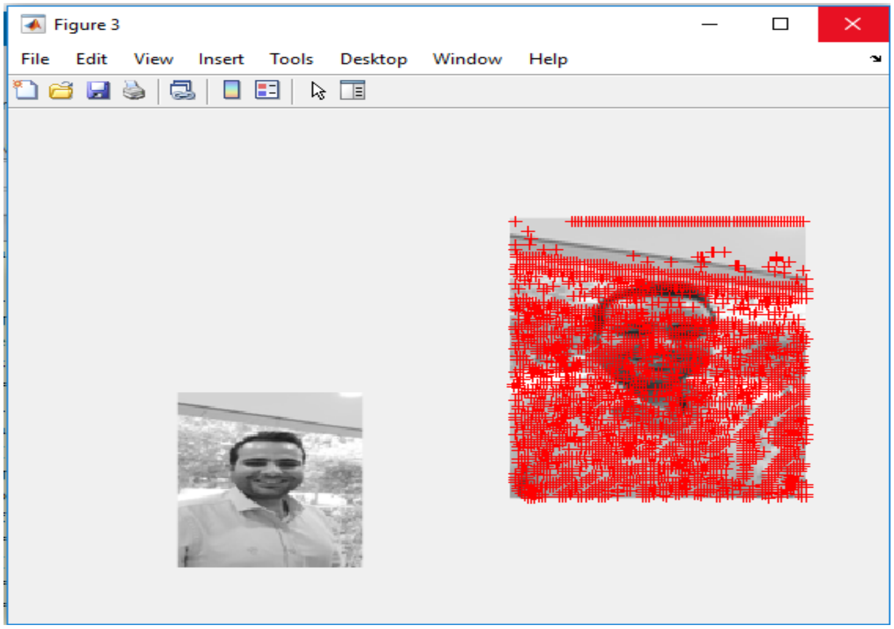
(b)



(c)

Figure 5.3 Key point localization (a) subject 1 (b) subject 2 (c) subject 3

Finally, in the region around each key point, the local image gradients are calculated at the chosen scale. Each descriptor includes a 4× 4 array of histograms, and each neighborhood of the pixel is computed 16 by 16 times.The key points detected in the image of the face are shown in Figure 5.4. Removal strategies will eradicate these key points.

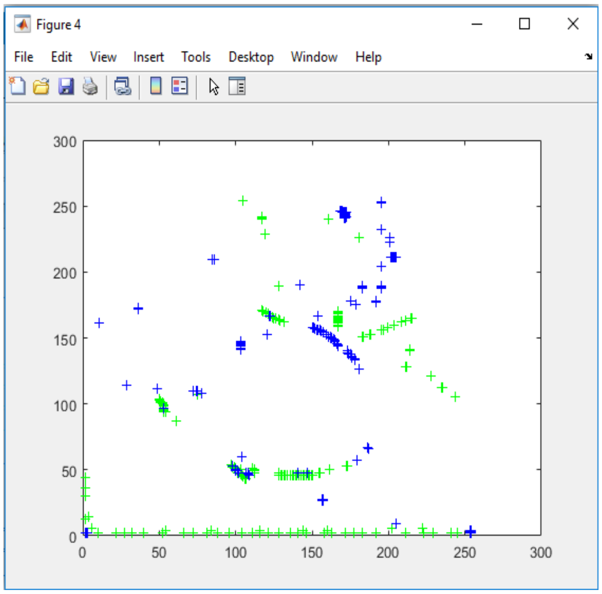


Figure 4
File Edit View Insert Tools Desktop Window Help
0 50 100 150 200 250 300
0 50 100 150 200 250 300

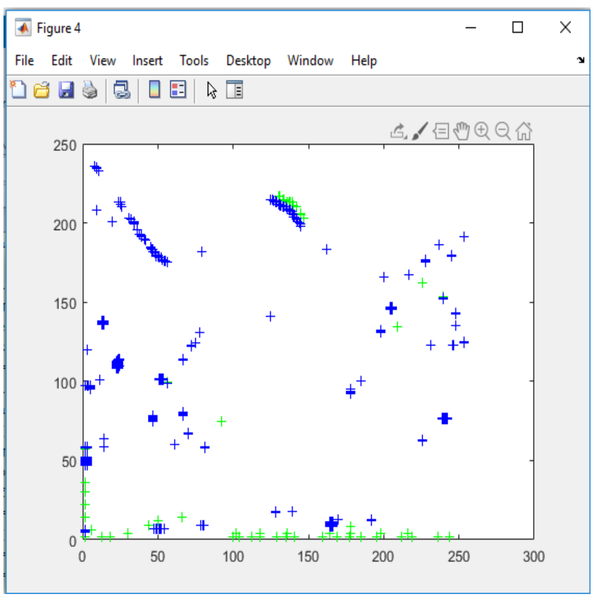
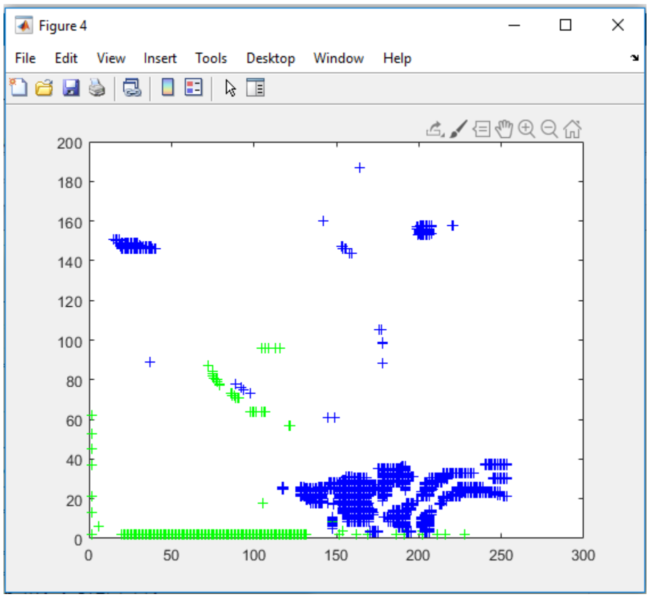


Figure 4
File Edit View Insert Tools Desktop Window Help
0 50 100 150 200 250
0 50 100 150 200 250 300

(a) **(b)**



(c)

Figure 5.4 Keypoint detection of each (a) sample 1 (b) sample 2 (c) sample 3

As a result, when applied to face images, the original key point extraction approach to the SIFT algorithm will remove some advanced features. These key points are detached in the SIFT method due to the restriction of image size. Finally, we get the output of equivalent image of each three samples is given in figure 5.5.

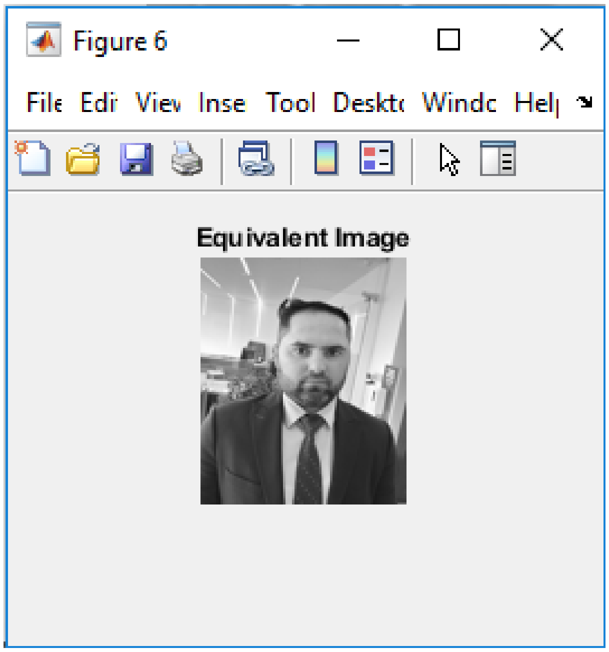


Figure 6
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Equivalent Image

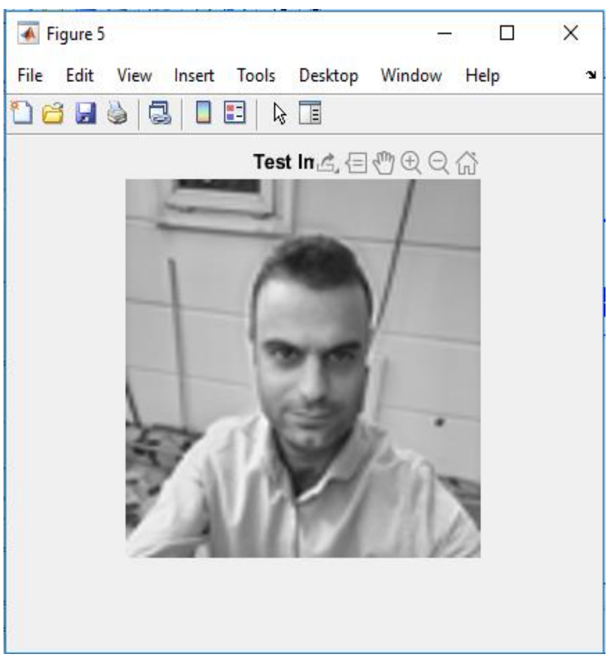
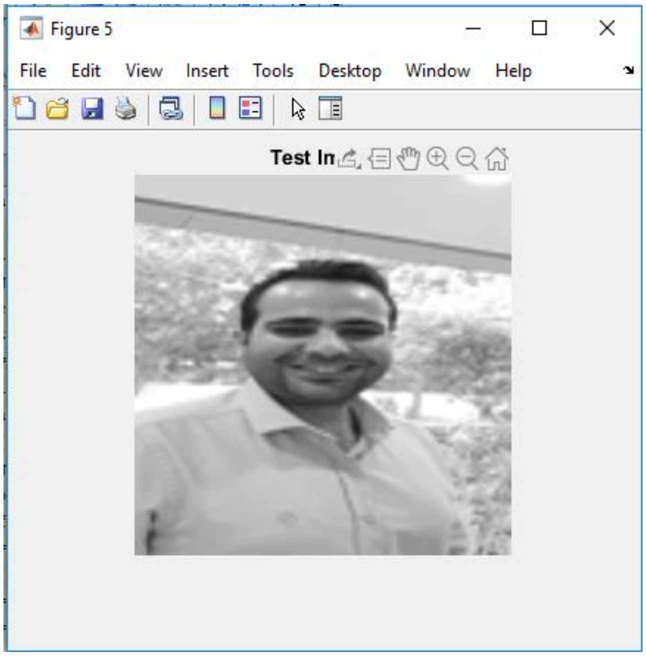


Figure 5
File Edit View Insert Tools Desktop Window Help
Test In

(a) **(b)**



(c)

Figure 5.5 Equivalent image of (a) subject 1 (b) subject 2 (c) subject 3

In order to achieve an appropriate way of adapting images, this study limits the number of extracting features of SIFT operators and key-point removal operators to a certain number, reducing computational complexity and increasing efficiency. SIFT features are often used to recognize the object and face. The main feature of this method is that it makes use of the benefits of a particular approach to choose the better key points.

5.2 Recognition results

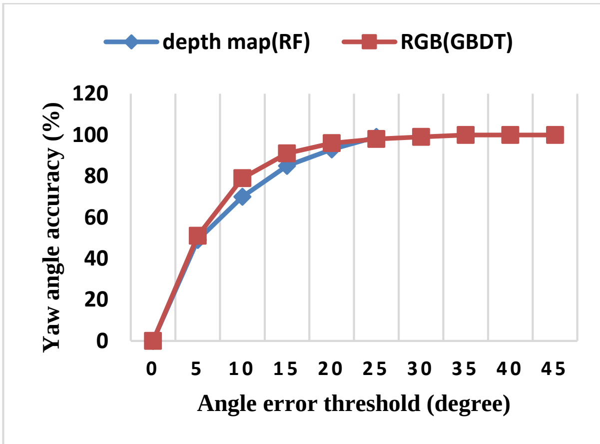
We devise the localization crisis as a regression problem and suggest a GBDT algorithm to handle face pose and landmark localization. The different databases used in the proposed system's training and testing are depicted in figures 5.6 and 5.7. Both training and testing images have been resized to 150 × 150pixels. The experiments are divided into two parts: 1) estimation of facial pose and 2) localization of facial landmarks.

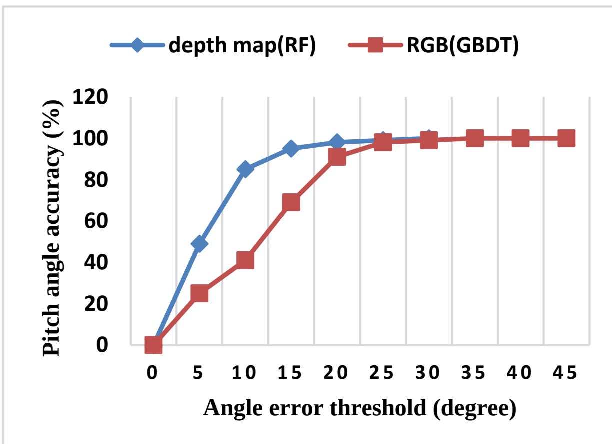
Figure 5.6Trained selfie images for facial landmark localization.[56]**.**

Figure 5.7Images of RGB (upper row) and depth (lower row)

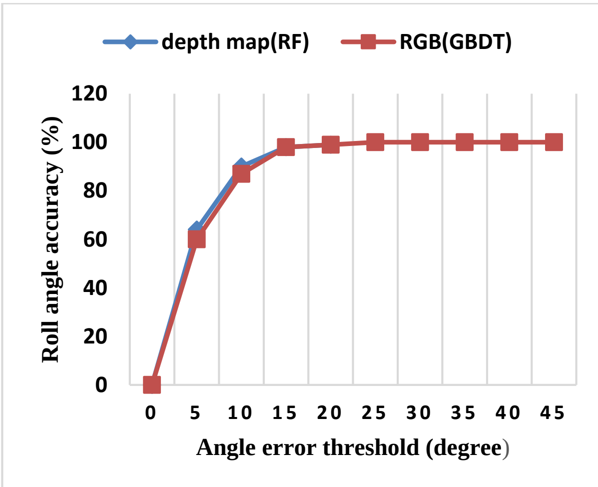
1) **Estimation of facial pose in RGB-D Images**

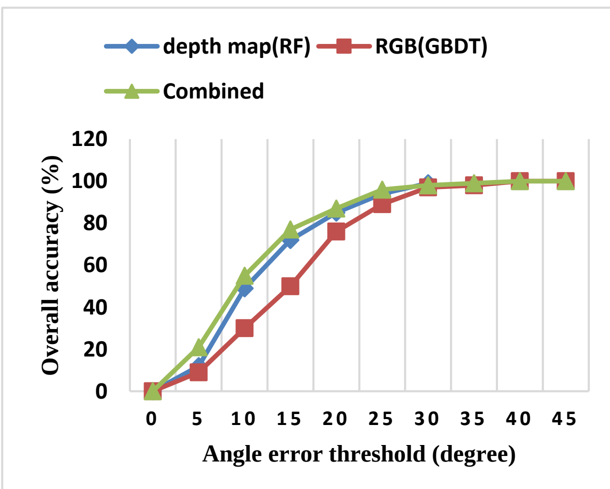
The BIWI Kinect face pose database is used as depth training data in our implementation. The RGB images from the preceding series are used for GBDT-based face pose estimation. We cropped a picture's face based on the marked face core prior to the RGB training process. In Figure 5.8, we use depth maps and RGB images to determine the accuracy of the face pose simulation result (GBDT). This is to demonstrate the efficacy of RGB and depth-based schemes from various perspectives, as well as the efficacy of our RGB and depth input combinations.


depth map(RF)
RGB(GBDT)
Yaw angle accuracy (%)
120
100
80
60
40
20
0
0 5 10 15 20 25 30 35 40 45
Angle error threshold (degree)


depth map(RF)
RGB(GBDT)
Pitch angle accuracy (%)
120
100
80
60
40
20
0
0 5 10 15 20 25 30 35 40 45
Angle error threshold (degree)

(a) **(b)**





(c) (d)

Fig 5.8 (a)-(c) Accuracy of three posesevaluationtechniques (d) Overall posesevaluation

For the yaw angle, we can see in Fig 5.8(a)-(c) that the consequences from the depth maps are fewerprecise than those from the RGB images. For the pitch angle, the condition is turn around. This is due to the fact that the face surfacediminishes rapidly as the pitch rotation raises. The depth cue is more valuable in this situation. In terms of yaw rotation, the depth cue has no bias changes, particularly for the noisy signal in our scenario. It demonstrates that the effects of the RGB and depth inputs are compatible. Furthermore, since the in-plane rotation can be well illustrated by both the RGB and depth cues, both methods provide betterconsequences for the roll angle.Then, in Fig 5.8(d), we compare the two consequences and test the whole accuracy.

We also found that the GBDT regression takes only 0.55 ms to run on an figure. The similarity features and decision tree framework are responsible for the extremely quick results. It is also worth noting that the time spent on this phase is insignificant as evaluated to the depth map-based method, which takes about 30 ms on the similarstage. That is, we increase the precision of face pose evaluation at a low cost.

2) Localization of facial landmarks in RGB-D Images

Initially, we include a comprehensive analysis of the classifier capacity of the planned facial landmark localization method. For training, we use the AFLW database, and for testing, we use the BIWI Kinect face pose database.

Figure 5.9Results ofselfie face landmark localization in the BIWI Kinect face pose catalog. [60]**.**

Figure 5.9 displays RGB images of some of the outcomes from the BIWI Kinect face pose catalog. As we can see, the algorithm is capable of handling cases of dissimilar face rotations. Furthermore, we test the algorithm by inserting random occlusions into the images. Location accuracy suffers as a result of these conditions. However, the landmarks can still be found in the occlusion regions.

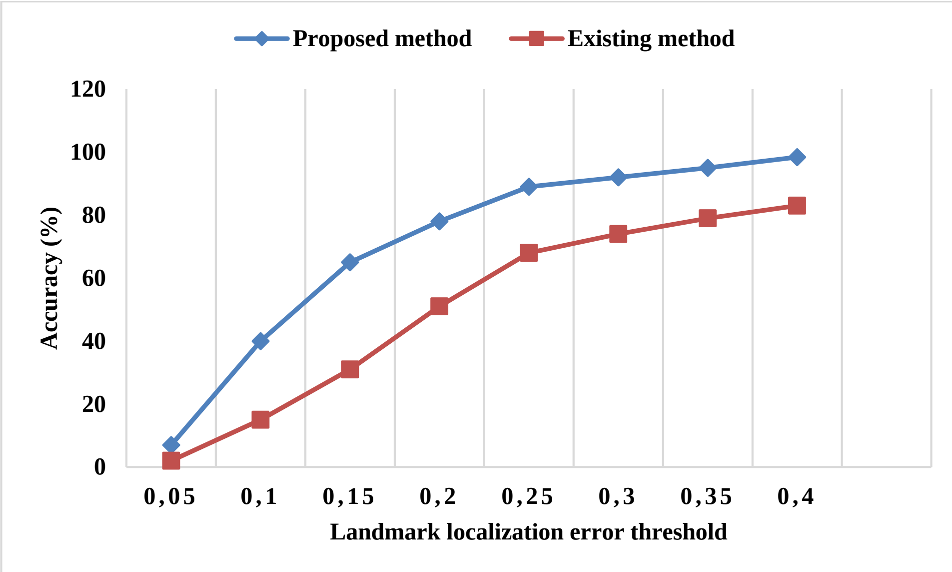


Figure 5.10Evaluation of the accuracy between proposedtechniques with existing method

We perform a quantitative valuation of the accuracy of facial landmark localization. Figure 5.10 contrasts the proposed method's accuracy to that of the current method. It has been observed that our method do better than this prior-artapproach, with the proposed method achieving an accuracy rate of 98.4%. Using depth information, we can attain face pose information, which can help with the landmark localization task. In the test, the running time for a face image is around 20ms.

Table 5.2Evaluation Result of Face Recognitionusing different methods

Table 5.2 shows the recognition rates on existing recent method compared with the proposed method. Fig 5.11 shows the evaluation on the recognition methods graphically, which demonstrates that the proposed method outperforms existing method.

Recognition Type	Recognition rate (%)
Convolution Neural Network (CNN)	83.3
Support Vector Machine (SVM)	87.5
k-nearest neighbors(KNN)	91.9
Bayesian deep convolutional neural networks(B-DCNN)	95.73
Proposed (GBDT)	98.7

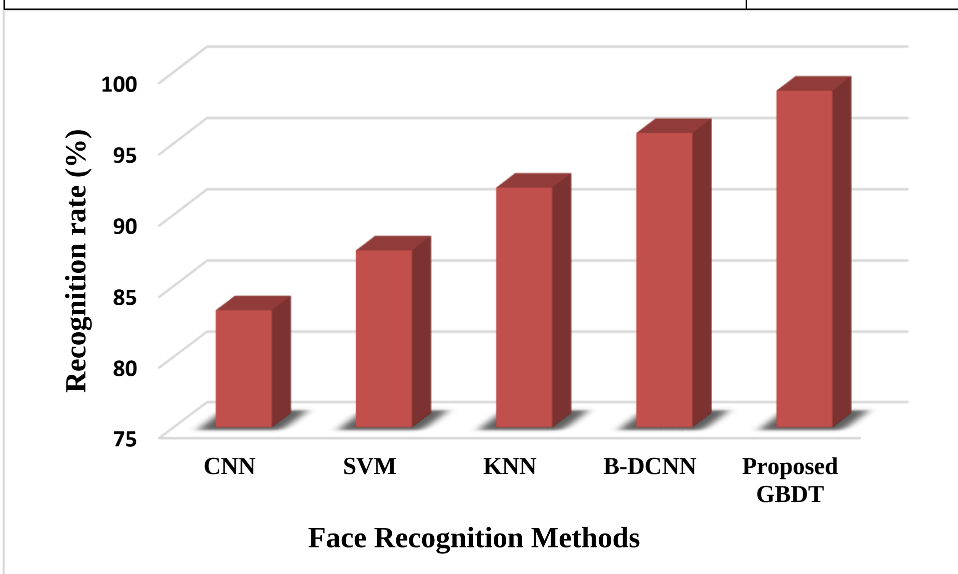


Figure 5.11Evaluation Result of Face Recognition rates (%)

The proposed method has more advantages over existing methods. When compared to the existing methods of CNN, SVM, KNN and B-DCNN, the proposed method of GBDT achieves the recognition rate of 98.7%. This reduces the time complexity for selecting the best feature in each round and thereby improving overall training efficiency.

CHAPTER 6

CONCLUSION AND FUTURE WORK

Face Recognition is currently motivating substantial research efforts because it meets a number of criteria in determining the best biometrics solution. It is highly useful for identifying people at crime scenes, access control, and a variety of other applications.Face recognition has gotten a lot of interest in current years because of its potential for anextensive range of appliances.In our research, we investigated and realized a relatively easy but highly valuable face detection algorithm that takes selfie face images into account. This is achieved by a special algorithm for face detection called “Viola Jones Algorithm.”The algorithms used in face recognition are KPCA (kernel principal component analysis), SIFT (scale invariant feature extraction) and Edge& shaping in which we identify an unidentified test samples by evaluating it toidentified training samples stored in the database and provide information about the person recognized.

Current research in selfie face recognition is focused on improving the face recognition algorithm based on recognized selfie faces, and has achieved acceptable recognition rates under certain limitations and controlled circumstances. Furthermore, the literature shows that some of the evolved approaches have a high recognition rate, while others have a low rate, leading in a reasonable recognition rate. This thesis is concerned with this problem, and the proposed method has demonstrated high rates for all recognized selfie faces.However, due to the limited variation in the data set, the proposed work overcomes allthe problems in the face recognition system. To the best of our facts, this is the only work in the field of selfie that has been examined under different conditions. Unlike other work in thisfield, no significant performance has been observed.

The Viola-Jones method has been implemented in MATLAB for face detection. Face detection algorithms were carefully tested using a large number of test images under different conditions. Overall, the detection rate was 95.4%. In order to achieve an appropriate way of adapting images, this study limits the number of extracting features of SIFT operators and key-point removal operators to a certain number, reducing computational complexity and increasing efficiency. SIFT features are often used to recognize the object and face. The main feature of this method is that it makes use of the benefits of a particular approach to choose the better key points.

In addition, for identifying faces, the GBDT approach has been proposed. Much of the preceding work included real-time data. The features of the test sample were removed in the similar way and contrasted to the qualified database. On 98.7% of the occasions, the recognition was accurate. The proposed technique outperforms common and prior-art methods for face detection and recognition when evaluated on a more difficult dataset.

Aside from our social media lives, facial recognition software will protect us from and avoid other attacks. From smart surveillance cameras to automated medical applications, facial recognition software has the ability to help us create a safer, healthier future. Not only that, but they've added pet recognition, so you can quickly browse pictures of your dog or cat without having to search through your entire photo gallery.

APPENDIX

FDetect = vision. CascadeObjectDetector;%Initializing V-J Face detector

FObj = step (FDetect, Img); % Applying V-J algorithm on Image ‘Img’

Img = imresize(imcrop(Img, FObj), [256,256]); % Cropping and ResizingFace area from the image

The package vision along with CascadeObjectDetector is used to load Viola Jones face detector. Object of V-J FDetect pass with image object Img. It returns facedetection region that loads on human face object. Thus, FObj has face’s top-leftcoordinate along with its height and width. Face height and width is helped in findingbottom right coordinate.

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