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Analytical and Comparative Study of Face Detection and Face Recognition Techniques for Visually Impaired and Blind People

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Abstract: ***It is from the beginning of the mankind history that humans suffered innumerable disabilities, however from all these disabilities the most long-lasting and common is blindness. As per the statistics given by World Health Organization around 39 million people are blind whereas 285 million people are visually impaired and around 246 million where detected to have low vision. With this given statistics by W.H.O around 90 percent of world's population who are visually impaired are in- habitants of developing countries. The new innovations in the domain of Science and Technology we have discovered that technology is used to ease mankind's life [1]. Thus, the main objective of this research paper would be to showcase measure which would recognize the people by detecting the face which is apparently most important function of our eyes. This is considered to be as a boon for mankind who cannot see as well as visionless and especially if a blind's important part like retina and veins which are dysfunctional. This research will not only initiate the measures to put an end to difficulties experienced by the visually impaired but we shall also study the differences between the algorithm which would act as a catalyst in the process.***
Keywords: Technology, Blind, Vision, Disabilities, Face Recognition.

I. INTRODUCTION

The Branch of Biometrics received prominence and marked its place as one of the most relevant option for recognition since many years due to feasibility in the technology which was made available after an intensive research in this process. They were also able to detect the loopholes in various system of identification. One can rightly say that efforts are still being made in order to produce a more user-friendly mechanism which is able to meet the requirements of various systems in field of security, thus leading to more accurate outcome to safeguard systems and secure their privacy. Solid Techniques of recognition which are based on different biometrics feature such as recognition of iris and the fingerprint scanner are already in existence which need the participation of individuals. From all of these human faces the one which is the most important and relevant which features and brings out as one of the significant choice for recognition. Similarly, a process which is based on frontal images is of no use without these, coordination. The most, important benefit that comes out of face recognition is that it can be processed without any physical touch or contact. As per the given statistics in the abstract which stated around 285 million people are visually impaired. With, across 30,000 problems with respect to visually impaired been added each year and many more in the world. The root cause of blindness are defects in retina, cornea, glaucoma and macular degeneration. The most important disadvantage for blind person is to identify other person in masses or group meetings and other professional situations. Amongst those the ones who are highly vision impaired make use of different prominent object like white cane or at times also have a guide dog in order to avoid different obstacles. However, In spite of all the needed objects the identification of the people who they meet is highly impossible until they themselves reveal their identification to them. Few of the hardest challenges faced by the blind's who are living independently are the identification of known humans, objects and independent navigation. In order to reach safely these people are expected to identify the obstacles on their way. Whilst doing the recognition the blind must first need's to know that there is someone is in front of them. There could be times where people can deceive the blind by stating that he is someone else, sadly the blind people have no choice but to trust the people's words because its not always possible to recognize people with their voice every time and thus this research will emphasize on how it would be easy for the blind people to recognize people whom they meet in their everyday life, as they will be able to detect people due to the face recognition and will also be able to get an audio message about the person stating "This is so and so person" which will make the blind speak to these people without any introduction, without any fear and also will make blind independent as he will not be dependent on others for the introduction of the people whom they meet [2]. .

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II. PROCESSING OF FACE RECOGNITION

A face detection system is one of the computer applications used automatically to identify a person with the help of visual digital image or video frame from a particular video source. And one of the ways to carry out this process is by differentiating selected face character sticks from the image and facial database.

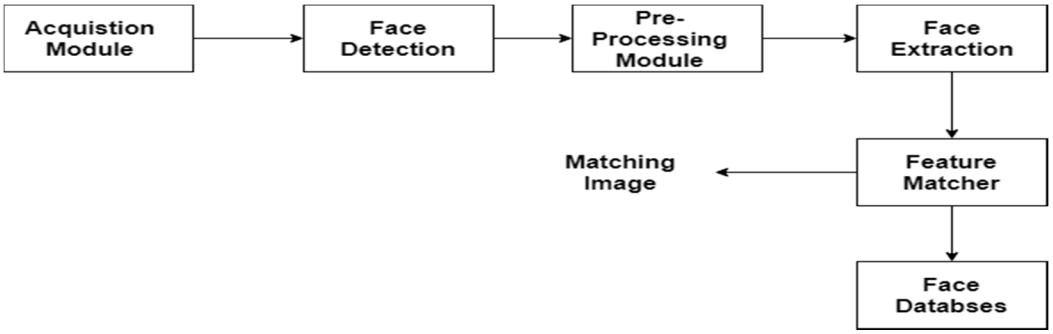


Figure 1-General Overview of face recognition [3].

The above, flowchart is the architecture of recognition system which absorbs images of people and then reveals possible identity of that person. There are different stages to this process of which detection stage is one of the first and primary stage which includes detecting and navigation a face in the image. The second stage of this system is the recognition stage which is also called as the feature matcher where relevant information needed to discriminate is saved and the identical whether recognition output is given with the help of face database.

The following sub-topic will now explain different stages of face recognition process.

1) Acquisition Module: This is the first point of entry of the face recognition systems. It is the primary module where the image is taken under consideration and is presented to the system. In simple words this stage will now ask the user to portray face image to face recognition system. The key highlight of acquisition module is that it can request face image from various environment [5].

2) Face Detection: The face detection is one of the artificial intelligence technology which will showcase the locations and varied sizes of human faces in digital image. It recognizes only the face and will ignore any other objects such as tress, buildings and any other bodies. It can be considered as one of the more generic case of face localization or navigation. In face localization primary task is to navigate the locations and sizes of known faces usually it is one. In this method the face is processed and matched according to face image in the database. The consequence of the identification can be area of face district overall and area of face locale with facial highlights, for example, mouth, eyebrows, nose and so on. The identification strategies are at some point hard to arrange principally in light of the fact that the vast majority of calculations make mix of techniques for perceiving faces so as to build the precision.

Principally discovery is characterized into two major groups such as Image Based Methods and Knowledge Based Methods which is explained in below diagram.

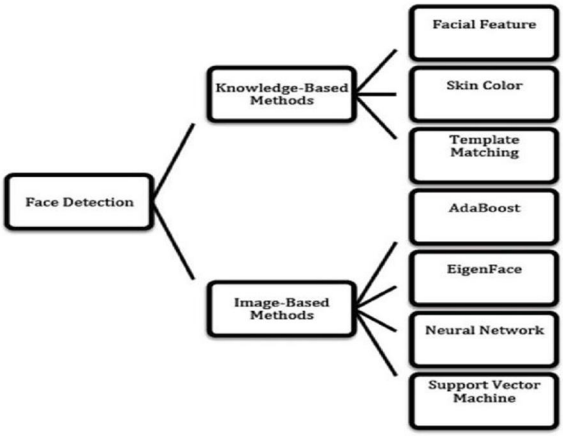


Figure 2-A Primary Classification of face detection Techniques [3-4].

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3) *Pre-processing Module:* In the given module with the help of various filters face images could be normalized and if they needed can also be enhanced in order to improve the performance of recognition system.
4) *Feature Extraction Modules:* This given module is a result of composing feature vector which is enough to represent the face image. There are many feature-extraction modules namely

a) Principal Component Analysis
b) Linear Discriminant Analysis
c) Semi-supervised Discriminant Analysis
d) Neural-Network Based Method

These are algorithms which is the foundation for most of the research in the discipline of face recognition [6].

5) Feature Matcher Methods: The main aim of feature matcher and selected algorithms is to choose a subset of the extracted features which could result in the smallest error in the classification. The relevance of this error is the one that make feature selection be dependent to classification methods used. The most significant approach to this issue would be to highly examine each possible subset and select one which full-fills the criterion function. However, this can sometimes become an unaffordable task with terms of computational time.
6) *Available Face Databases:* In order to test face recognition a database of face is needed. Once a face recognition algorithm is developed a test it produces to locate its recognition rate. There are various databases that are available however, the accurate one should be selected as per requirement. Following are some of the most commonly used face databases: -

a) *Yale Face Database:* This database is divided into two parts which is Yale Face A and extended Yale Face Database B. It consists of fifteen varied subjects [14 males, 01 females]. Various conditions are taken into consideration in facial images like variations in an expression which could be happy, sad, normal etc. Secondly, lighting conditions like right, left, center and picture with glasses were inclusive. However, no editing has been done on the images. Even though Yale database is one of good choice of initial test but it is a step forward from AT & T Database as it represents more difficult problems. Extended Yale Face Database is a dataset which consist of 2414 images of around 38 subjects. Here, the focus is on more on extracting feature apt to illumination and thus they are available in cropped version it is made up of 4,000 color image with 126 different people in which there are [70 males, 48 females] these pictures were taken under strict environment but with variation in their facial expression illumination and occlusion with sunglasses, scarfs and hairstyles [7].
b) *XM2VTS Face Database:* Consists of 1000 Gigabytes of video sequences and speech recordings taken of 295 subjects at one-month intervals over a period of 4 months (4 recording sessions). Significant variability in appearance of clients (such as changes of hairstyle, facial hair, shape and presence or absence of glasses) is present in the recordings. In each of the 4 sessions a “speech” video sequence and a “head rotation” video sequence was captured. This database is formulated to test systems designed to perform multimodal (video + audio) identification of humans by facial and voice features [7].

III. MECHANISM OF FACE RECOGNITION

This face recognition technique can be used by the blind people with the help of the two major techniques namely which are the “Smart Phone” and the “Smart Cane” which would help them to recognize the person whom they meet in their day to day life. The given block diagram will help us to understand the mechanism of the entire face recognition technique. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

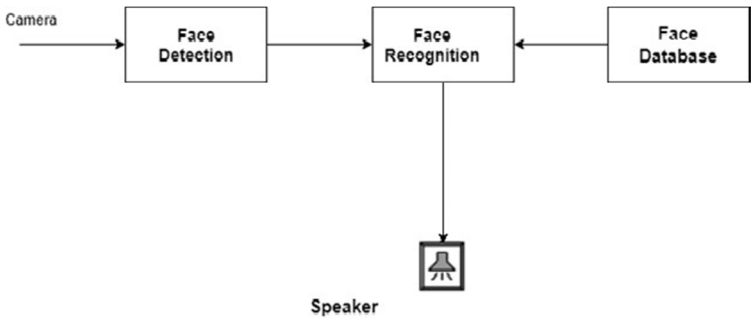


Figure 3- General layout of face recognition techniques [6].

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It Shows the technique of the face recognition system for the blind and visually impaired. As, shown in the block diagram the system will detect the face of person meeting the blind person with the help of camera. The detected face shall then be processed by one of the algorithms of face recognition to find out if it belongs to the stored database of friends and family or not. Immediately after this process the system shall announce to the blind person the name of that person.

A. Smart Cane

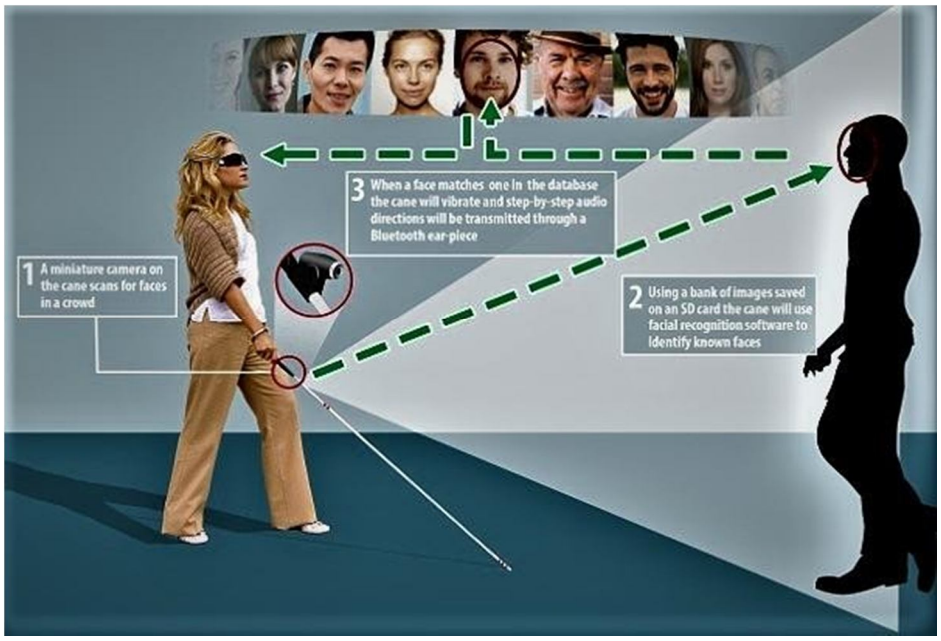


Figure 4-Diagrammatic view using smart cane[8].

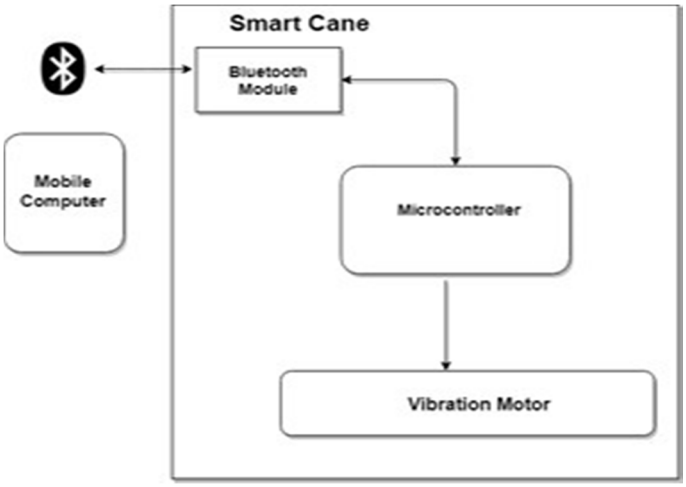


Figure 5-Working of smart cane for face recognition [9].

A system for face recognition is embedded in smart cane for visually impaired and blind people. This system will detect the face of human and will inform the blind person the information of the person who is standing in front of himself/herself. Blind people will be able to know the personal information from the cane which will generate vibration patterns as per the each learned person. The given figure is one of an excellent example which is to be expected in life of blind people. As, when the blind person will meet the other person the visual signals will immediately be transformed into tactile signals using the camera and vibration motto. As, we can see that the glass camera shall capture the front view of the blind person. As, we know that the most of the blind people use cane with the motive to avoid obstacles therefore the face recognition system embedded in cane itself.

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B. Android Device

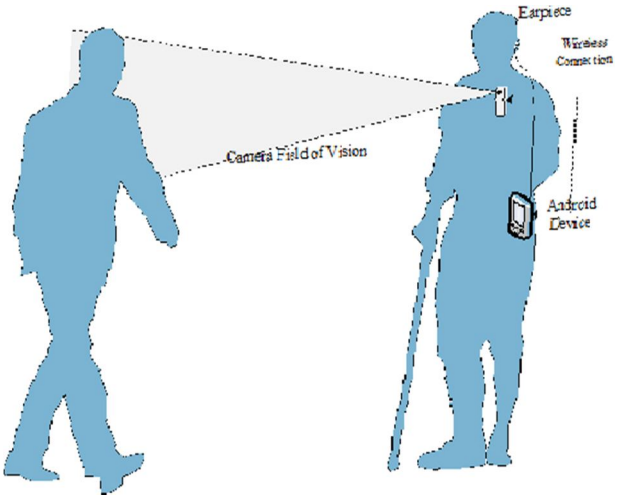


Figure 6- Diagrammatic view through android system [10].

In today's generation android is one of the major mobile platform and thus it is also used to build the face recognition functionality on it. Due, to its character sticks of open architecture and support for multitasking and accessibility features android is considered to practice accurate face recognition with less time consumption. The android devices come along with, the integrated camera and speech recognition and also with the engines like text-to-speech of which few improvements are made of easyinput and output due to this it becomes easy to produce a good user-interface for the blind which would prove beneficial for blind users. The face recognition system embedded on an android device will not only make it more universal but also accessible and applicable all over the world. Another important advantage of android platform is that the system comes along with the support to 4G Internet connectivity which would be used in future enhancements and scope. During the execution of this process the native android camera was previously used to stream the faces in the camera frame. But now in the future process we will be implementing camera modules that will be implemented into the glass which will be worn by the user considering that the position of camera is of utmost importance for accurate collection of faces and in order to get proper angles or faces that can be detected accurately [11].

IV. TWOBRANCHES OF FACE ALGORITHM

A. Face Detection

Though the process of face detection is complicated the face detection algorithm usually begin by searching for the human eyes. Eyes, are one of the valley region and is also considered as a simplest feature to detect. After, the detection the eyes immediately the algorithm will make an attempt to detect the other facial regions namely eyebrows, nose, mouth, iris, nostrils. Once, when the algorithm indicate that it has detected a particular facial region it can then be apply various test in order to validate whether it has detected a face or not. In, this particular research paper we will discuss and compare the two major algorithms used for face detection which are Viola-Jones and Kanade-lucas-Tomasi.

1) *Viola-Jones:* The generic foundation of Viola-Jones algorithm is based on the idea of scanning a sub-window which is capable of grasping faces around a given input image. The normal image processing functionality would be to rescale the input image to varied sizes and then work on the fixed size detector through these different images. This particular approach however turns out to be time consuming as there is lot of calculation of varied size images involved. On, the other hand to the basic approach of Viola jones where the detector is rescaled instead of input image and run the detector many times In opposition to the standard methodology Viola-Jones rescale the identifier rather than the info picture and run the finder ordinarily through the picture – each time with an alternate size. At initial one may suspect the two ways to deal with be similarly tedious, yet Viola-Jones have contrived a scale invariant identifier that requires a similar number of figuring's whatever the size. This indicator is built utilizing a supposed indispensable picture and some straightforward rectangular highlights reminiscent of Haar wavelets. This particular algorithm was a result of the effective research carried out by Paul Viola and Michael Jones in the Year 2001 which is why the algorithm is named after these two researchers. [12]. There are four stage of processing this algorithm which are as follows:-

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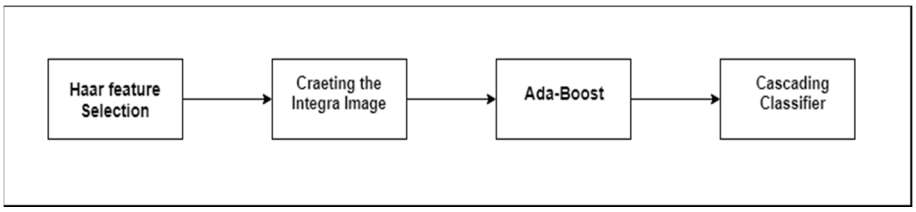


Figure 7-Flow of viola-jones algorithm [12].

2) *Haar Feature Selection:* In simpler terms Haar features are the character sticks which are extracted on the grounds of opposite area on the face and are changed to hard binary (in order to make calculations simpler). Most of faces share common properties like darker eyes, then the upper chicks or nose being more splendid than eyes and brow being more broader than eyes.
3) *Creating the Integral Image:* In this stage around four character sticks are used for beginning process which act as an average of irregularities of human faces from standard one which are - like darker eyes, then the upper chicks or nose being brighter then the eyes or could be the forehead being brighter than the eyes. Viola-Jones takes help of two rectangles feature selection whose value will be defined as (sum of black pixels) – (sum of white pixels) till any pixel (x,y) after transforming face image into feature image.
4) *Adaboost:* It is the learning calculation which makes the establishment or core of Viola-Jones face identification calculation. It delivers a particular number of delicate classifiers which depend on the character sticks which will have a significant measure of errors however will in the long run end up making direct blend of all frail classifier so as to create one classifier which is hearty and solid. The theory is characterized as: $C(x)= \theta(\sigma ht(x) +b)$ where ht(x) has an estimation of either 1 or - 1 relying upon the characterization of being a face or non-face. This ht(x) is the powerless classifier which is increased by a weight grid θ. 'b' is a consistent term.
5) *Cascading Classifier:* After the classifier is set up there are number of other classifier which are heaped in a steady progression so as to diminish successful number of pseudo positive cases for a superior exactness. In light of number of highlights there are different assortments of classifiers that are chosen which are recognize distinctive examples and afterward are set after each other. Ex :- If we select three classifiers which channel result in a steady progression pseudo positive rates of half 40% and 20% at that point all out net powerful false positive rate of whole model may be 2%. Along these lines this specific procedure of falling assumes real job in decreasing the quantity of false outcomes originating from the model.
6) *Pros and Cons of Viola-Jones*

Sr No.	Pros Of Viola-Jones	Cons Of Viola-Jones
1	Has Strong Efficiency to choose features.	It does not works efficiently on side pose as compared frontal face.
2	It scales feature of image but not image itself.	An effect in this algorithm is lightning.
3	It can be used to train different objects like hand	Multiple detection of similar face is an issues.

Table 1

7) *Kanade Lucas Tomasi:* Kanade Lucas Tomasi was discovered by Lucas and kanade and their research was then extended by Tomasi and Kanade. This particular algorithm is used for locating scattered feature points that have a lot of texture for navigating the needed points in a good standard. KLT algorithm is thus utilized for tracking and detecting faces of the human consistently in a video frame. This process is completed by them searching the parameters which allow the deduction in dissimilarities measurements between feature points which are related to previous translational model. We, calculate the displacement of tracked points from one particular frame to another frame and from then this displacement calculation it becomes easy to commute movement of the head. With, the help of optical flow the feature points of human's face are tracked. There are two simple measures by which KLT tracking algorithm tracks and detect the face which are: - In the first step it searches the detectable feature points in the first frame and later is able to track the detected features in the succeeding frame by using the calculated displacement [13].

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Sr No.	Pros Of KLT Algorithm	Cons Of KLT Algorithm
1	Searches good point to track from frame to frame.	Unable to hold consistency in the brightness
2	KLT Makes use of intensity of second moment matrix and distinguishes across various frame to find displacement.	It shows error when the motion is large so in order to fix it key points must be matched.
3	In order to deal with larger movement KLT iterate and use coarse to find search	KLT algorithm can work with minor pixel displacement in order to overcome we make use of pyramidal displacement.

Table 2

8) *Face Recognition:* The most relevant implementation of face detection is defined as facial recognition. Face Recognition emphasizes on a bio- metric technology which goes way beyond recognizing when there is a human face present it attempts to find out whose face it is. The process functions with help of computer application which captures digital image of particular human's face (can sometimes be taken by video frame) and distinguishes to the images in a database where the records are stored. Although, the facial recognition is not 100% accurate however, it can very accurately find out whether a person face matches in the stored database. The face recognition process is divided into the following four methods [13] [14] [12].
9) *Knowledge Based Methods:* These are likewise called as standard based techniques which attempts to catch data of appearances and makes an interpretation of them into a lot of specific tenets. It is anything but difficult to envision some basic guidelines for ex: - a face will in general have two symmetric eyes where the eye territory is darker than cheeks facial highlights can be separate between eyes or shading power distinction between lower zone and eye zone. The serious issues with this strategy is intricacy in building up precise arrangement of tenets. In the event that these standards are conventional they are false positive. Further, if rules were quite certain outcomes are false negative. Thought is to make progressive information based strategies to withstand these issues [14].
10) *Feature Invariant Methods:* They make an endeavor to seek in variation highlight of specific face regardless of its point or position. It means to discover auxiliary highlights of face which exist notwithstanding when the view point, lighting condition, present changed. Facial acknowledgment makes employments of various facial highlights like eyes, nose, cheek bones, lips, jawline brow, upper lines of eye- attachments. In the specific technique we first endeavor to inquiry eye simple pixels so it expels bothersome pixels from the picture. In the wake of, performing division process they contemplate each eye simple portion as a competitor as one of eyes. At that point a lot of standards is activity to determinate pair of eyes which are potential when eyes are chosen calculation compute face region as square shape. Four vertexes of face are chosen by set of technique. In this manner, potential appearances are then standardized to fix size and direction. Face district are then confirmed utilizing back engendering neural system.

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11) *Template Matching Methods:* This specific calculation separates info pictures with put away formats faces or highlights. These, strategies endeavor to dissect face as a capacity one can slap to discover a standard example everything being equal. Each element is characterized freely.
12) *Appearance Based Methods:* The models of this strategy are found out from specific accumulation of preparing pictures which catch agent contrasts of countenances. The layouts which are in appearance based strategies are taken from model in the pictures. For the most part, appearance put together strategy depends with respect to method from AI and factual investigation so as to locate the significant character sticks of face picture. These, strategies are likewise being utilized in face extraction for face acknowledgment. There are two major algorithms which primarily worked on appearance based methods are P.C.A Algorithm and L.D.A Algorithm which we will compare and discuss in detail.

B. Principle Component Analysis (P.C.A)

This algorithm works on information theory approach. It extracts important feature in face image and then encodes as efficiently as it can. It is responsible to identify the sub space of image space which is spanned by training face image data decor relates the pixel values. The classical representation is gained by show casing it to coordinate system which is defined by principle components. This projection of face images into principle component in sub space is able to achieve the information, compression, decorrelation and dimensionality reduction in order to obtain decision making. In the mathematical terms principle component of distribution of faces or the eigenvectors of covariance matrix of set of images is sorted by treating an image as a vector in high dimensional face space. The P.C.A algorithm can be applied on given database and we can obtain unique feature vectors using following methods [14]. Imagine there are p patterns and each pattern has T training images of m * n configuration The database is re-assembled in the form of matrix where a particular column portrays an image:-

1) With the help of Eigen values and Eigen vectors covariance matrix is computed
2) Each image coming from the feature vector is then analysed and computed. This feature vector showcases mark of the image. The marked matrix for entire database is then computed.
3) Euclidian distance of the image is computed with all the signatures in the database
4) Image is portrayed as the one which covers less distance with the mark of image in order to identify

C. Linear Discriminant Analysis (L.D.A)

L.D.A is also known as fisher discriminant analysis and is another dimensionality reduction technique. It searches direction which functional efficiently for differences between the data. L.D.A increases the between class scatter and reduces the within class scatter which makes it steady for classification. Lih-Heng-Chang initiated a framework of facial biometric which was based on two sub-space methods which are Principle component Analysis and Linear discriminant analysis. Amongst these the P.C.A is used first for dimension reduction first where the original face images are displayed into lower dimensional face representations. Secondly, L.D.A was initiated in order to give a solution for better discriminant both P.C.A and L.D.A character sticks were showcase to Euclidian distance used as benchmark conveniently. The methods which are L.D.A based outperforms the P.C.A for its both verification and face identification. Fisher discriminizes group of images which belongs to same class and separates images of varied classes. Images are displayed from N2 dimensional space to C dimensional space where C is (number of classes of images). To recognize input test image the displayed test image is compared to each projected training image and later the test image is recognized as one of the nearest training image. The in between class scattered matrix shows how face images are spread closely within classes and between class scattered matrix describes how classes are then separated from each other. Whenever face images are displayed into the discriminant vectors W the face images must be distributed very closely amongst classes and should be later separated between classes as much as possible. In simpler words the discriminant vectors reduces the denominator and increases the numerator.So, the L.D.A algorithms are preferred and being considered as reliable algorithm for this process.

V. COMPARATIVE RESEARCH OF VARIOUS FACE RECOGNITION TECHNIQUES

After studying the above different algorithms for face recognition I would now Like to make a detailed comparison. The initiated incremental P.C. A – L.D.A algorithm works efficiently in memory usage and is also very important in calculation of first basis vectors. An acceptable face recognition success rate in comparison with many famous face recognition algorithms such as P.C.A and L.D.A are given by this particular algorithm. The two main appearance based techniques namely modified
P.C.A and locality preserving projection are joined in order to give highest face recognition rates.
P.D

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Parameters	Principle Component Analysis	Linear Discriminant Analysis
Overview of algorithms	P.C.A is also known as Eigen face methods and is responsible to reduce the dimension of data	L.D.A is also known as Fishers Linear discriminant analysis and makes use of within class information in order to increase class separation.
Category	It belongs to Appearance based methods	It belongs to distribution based methods
Character sticks	It is used for learning Eigen faces and is unsupervised based algorithm	It is used for learning Fisher faces and is supervised based algorithm.
Memory Usage	The memory usage is High in P.C.A.	The memory usage is Low or efficient in L.D.A
Recognition rate	Recognition rate is better than fisher face.	Recognition rate is better than P.C.A
Data representation	P.C.A has powerful data representation	L.D.A has moderate data representation
Time Consumption	More time is consumed for face recognition	Less Time is consumed for face recognition.
Illumination issues	P.C.A has illumination issues with the head pose.	L.D.A works well with different illuminations.
Dimension reduction	P.C.A algorithm decreases the dimension of data from N2 to M	L.D.A algorithm decreases the dimension of data from N2 to P-1.
Benefits of Algorithms	• It's Simple than L.D.A. • Fast and robust • Works well with high dimensions.	• L.D.A is faster and more reliable than P.C.A. • L.D.A has lower error rate. • Works well with different illuminations.
Limitations of Algorithms	• P.C.A has poor discriminating power. • Recognition rate decreases for recognition under vary pose and illuminations.	• For L.D.A to work efficiently database must be small. • L.D.A also suffers from problem of singularity. • L.D.A can classify only face which is present in face databases.

VI. ISSUES AND CHALLENGES FACED

Although the systems which are emphasized are still proof of concept however preliminary research conducted for developing these solutions has given some important knowledge into kind of capabilities which user expects from such a device and minimum set of requisites which are showed by these prototypes are explained below.

A. System must be small and portable which would allow the user to carry it to various places. This means system should be light in terms of both weight and size

B. It needs to be wearable which would allow continuous interaction between the user and the system and also frees the user's hand which would allow him to do multi tasks.

C. It need to work and operate in real time so that the response given to the user shall be of immediate use to him Ex: - If a person's identity is revealed to user 40secs after that persons first encounter then the information given will not be of any use to him in either a social or security situation.

D. It must be in conspicuous as possible primarily hidden un-obtrusively in the users clothing as multiple studies have now suggested that the visually impaired are not very keen to use devices which would promote that dis-ability and that they rate cosmetic acceptance of device as more relevant than actual functionality which it provides.

E. The device needs to be cost effective as ninety percent of visually impaired would be living in developing countries and 65% are aged who are fifty years or older, the most commercial acclaimed devices are beyond the financial affordability of this

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[population thus careful measures should be taken that when the system reach the mass production stage it should be made affordable for most of the users.

F. One of the most important challenge for facial recognition is change which occurs in persons' age according to his age which means the database image which provides actual recognition today may not necessarily give same recognition rate after five or ten years. This is the reason why it is needed to cover the aging vector in authentication system. In order to cover this system there is a need to update dataset along with age variation.

G. Another important factor associated with face recognition which affects face recognition rate is quality of image itself. The low quality image can hide few of the adaptive facial features these type of poor quality images are thus not effective to give reliable and efficient results. The quality of image depends on various vectors such as image size, resolution, colors etc.

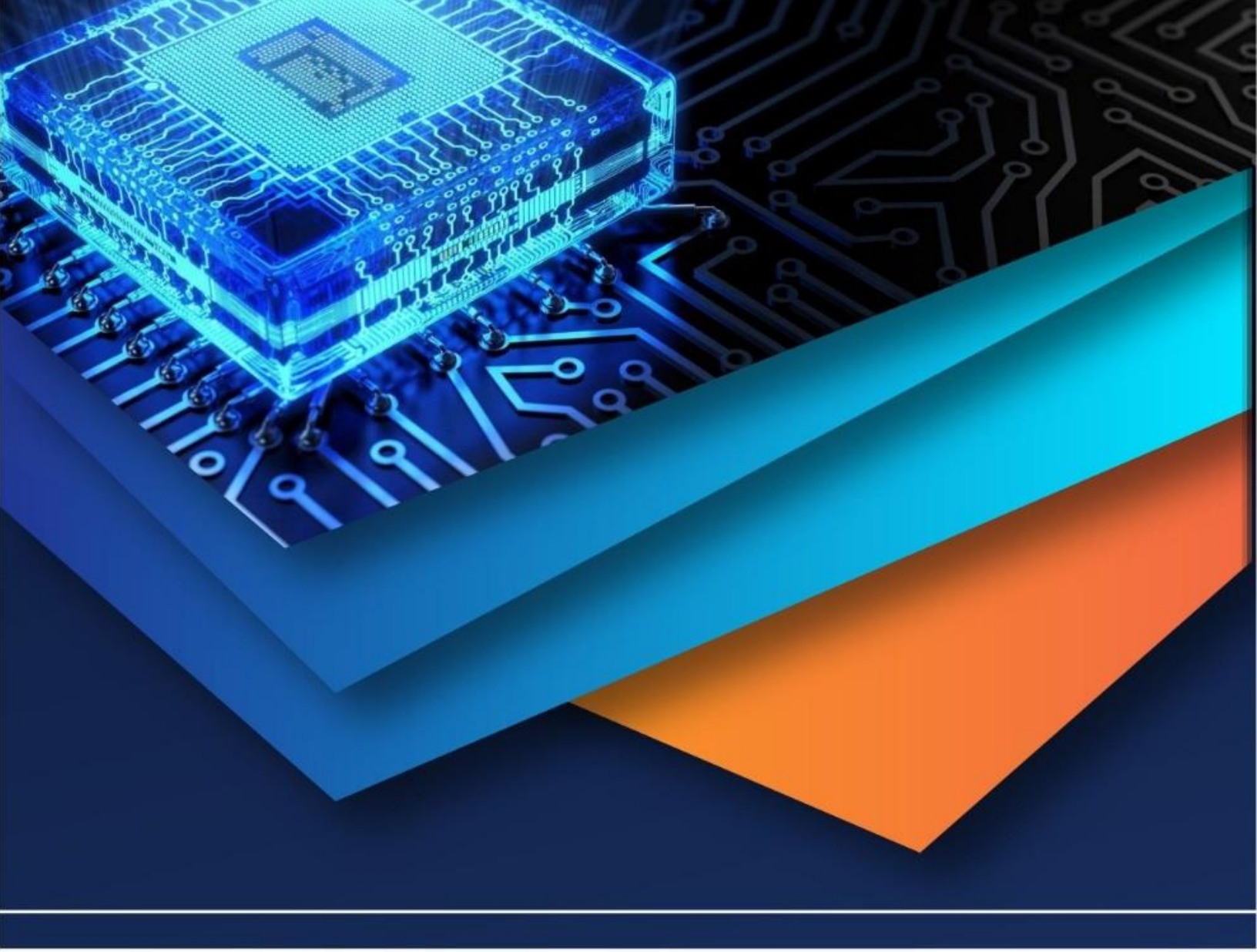
VII. CONCLUSION

The paper has attempted to study various algorithm which play important role in development of face recognition system. The comparisons of these algorithms have also been presented in this research paper along with their merits and demerits in this paper. We, have worked to give a comprehensive study and attempted to survey all relevant and influential algorithms in simpler manner. The major restriction imbide on visually impaired and blind people is their ability to recognize the individuals they know in their various social interactions which also puts them at a big risk from security point of view. An introduction of various systems which are being developed in order to help this population in face recognition tasks was showcased in this paper. Although these systems are very much in their prototype stage but initial research work development and testing of these solutions has presented their feasibility and has also given their valuable insights into need for assistive devices for this tasks . Still there are certain issues and challenges that have already been presented in the research paper still need to be resolved in order to bring these devices in practical deployment and spread across to the world.

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