AGE INVARIANT FACE RECOGNATION

Thesis submitted in the partial fulfillment of requirement for the award of degree of

MASTER OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

IN

SIGNAL PROCESSING AND SYSTEM DESIGN

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JULY 2015

DECLARATION

I,TUSHAR, hereby certify that the work which is being presented in this thesis entitled **"Age Invariant Face Recognition"** by me in partial fulfillment of the requirements for the award of degree of Master of Engineering in Electronics and Communication Engineering in Signal Processing and System Design from Delhi Technical University, Shahabad Daulatpur, Main Bawana road, Rohini sector 7, New Delhi 110042, is an authentic record of my own work carried out under the supervision of Mr. Ajai Kumar Gautam, Assistant Professor in the Department of Electronic and Communication Engineering.

The matter presented in this thesis has not been submitted in any other university/institute for the award of any other degree.

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It is certified that the above statement made by the student is correct to the best of my knowledge and belief.

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ACKNOWLEDGEMENT

First of all I would like to thank God , who has always guided me to work on the right path of the life. My greatest thanks are to my mother who has given and built the strength in me to complete this work. I am indebted to my sisters for their inspiration and ever encouraging the moral support, which enabled me to pursue my studies. I gratefully thankful to my father who has given me the strength and optimism to achieve in studies. I am also very thankful to my relatives and friends for social support.

This work would not be made into reality without the encouragement and able guidance of my mentor and guide Mr. Ajai Kumar Gautam Assistant professor in the department of Electronic and Communication Engineering. His guidance and mentorship and gripe on the topic made this work easy and made it done in time and in a enjoyable way. His mentorship paved ways to the direction which I could not have had even the slightest glimpse of these techniques.
He gave me feedbacks which helped me writing this Report.

I am also greatly thankful to the faculty of the ECE department for their co-operation and help.

TUSHAR

ABSTRACT

Age invariance face recognition(improved techniques) is an emerging field of engineering in signal processing. The face recognition is a technique prior to the age invariance face recognition technique. To achieve the face recognition in the computer we have to put some image in the computer and by some algorithm it recognize the whether the image has any human face or not however. As it is emerged from the extensive research in the different discipline in the signal processing and image acquisition engineering.

There are various steps before the actual achievement of the age invariance face recognition and acquisition devices. First of all the acquisition devices there are various acquisition devises which are video camera, laser, thermal, acoustic, UV, act. these sensors gives the input to the algorithm which uses the input to find the proper result. Second thing is the algorithm which recognizes the human face from the given data image there are several approaches to the face recognition like posing, illumination, occlusion, edges, contour, color, scale, this are the factors which are used to find the face of the human being. In the image processing the first task is find the pixels and then the mask then the finding on the lines and edges and the contours then the various shapes which in turn will help the computer find the algorithm which finds or detects the shape of the object and then the computer find whether the shape resembles the human face or not the other features are detected. soon the human face is detected the next task is to find the algorithm which classifies that face with data in the data base. there are several techniques to find the face recognition.

Face recognition system is a system which rely on the data stored in the computer storage images of the human subject are taken and stored and at the time of the actual face recognition the image are compared with the data images and the results are compared with different standard data set for confirmation. There are many techniques which currently being used to recognize face and are employed in a very wide applications such as identification in banking data, security areas where authenticity of a person is critical and must provide real time identification, in surveillance of large area and many more applications but one that the face recognition algorithm get stuck on is that identifying the person who has been aged and has had a different facial features now to find the algorithm which can recognize a person regardless of its age.

To accomplish this there have been many technique have been proposed to tackle that problem in analytical way. As the variation in the face in very unpredictable and terribly complex as we know intuitively that every person ages differently and one analysis a cannot be used to determine the ageing of other person. one of the technique is using SELF PCA based method in which self Eigen and Periocular Region is used. Other method is MULTIVIEW DISCRIMINATIVE LEARNING FOR AGE INVARIANT FACE RECOGNITION in this method it is taken in the account that the local features are more robust to age variations in this method there are

three local descriptors are taken in account these are SIFT (scale invariant feature transform), LBP (local binary patterns), GOP(gradient orientation pyramid) and the results are tested on the FG-NET face aging dataset for efficiency. there are another method called A DISCRIMINATIVE MODEL FOR AGE INVARIANT FACE RECOGNITION in this SIFT,MLBP(multi-scale local binary pattern) serve as a local descriptor and to avoid over fitting it uses MFDA (multi feature discriminant analysis), the other method which is based on PERIOCULAR BIOMETRICS in this WLBP (Walsh- Hadamard transform encoded local binary patterns) and UDP (unsupervised discriminant projection) collectively. so far we are done with the feature extraction now the next step is the dimension reduction the reducing the dimension is very important because it reduced the redundant data in the procedure and we have few technique to do it first is PCA (principle component analysis) there is also another method called NONLINEAR TOPOLOGICAL COMPONENT ANALYSIS in this method KRBF is used to reduce the data and alpha shaped constructor is used extraction and various classifiers are used to classify the image.

In this thesis, I have proposed method in which the reduction of data is done by the combination of the KFBR and MFDA, features extraction is done by the combination of MLBP,SIFT and LBP and face matching is done by multiple LDA based classifier and maximum a-posteriori probability Gaussian mixture by using adaptive boosting algorithm.

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ABBREVATIONS

PCA	PRINCIPAL COMPONENT ANALYSIS
LDA	LINEAR DISCRIMINATED ANALYSIS
KARNEL PCA	KERNEL PRINCIPAL COMPONENT ANALYSIS
SVM	SUPPORT VECTOR MACHINE
ANN	ARTIFICIAL NEURAL NETWORK
DSMT	DEZERT-SMARANDACHE THEORY
SIFT	SCALE INVARIANT FEATURE TRANSFORM
MLBP	MULTI SCALE BINARY PATTERNS
LBP	LINEAR BINARY PATTERN
DWT	DISCRETE WAVELET TRANSFORM
AAM	ACTIVE APPEARANCE MODEL
MCW	MAXIMUM WEIGHTED CUT
KRBF	KERNELIZED RADIAL BASIS FUNCTION

CHAPTER 1
INTRODUCTION

1 INTRODUCTION TO AGE INVARIANT FACE RECOGNITION.

1.1 INTRODUCTION TO FACE DETECTION.

There are many area where face detection is needed like in security area passport and identification it has been very cumbersome to have people detect faces of human because it is waste of time and human get tired and angry and have excuses so to handle and rectify this problem technology has provided some tool to do the job is effective manner like we can use the computer algorithm to provide such data that can be used to so do this job more effectively and efficiently without complaining of tiredness or fatigue or getting angry.

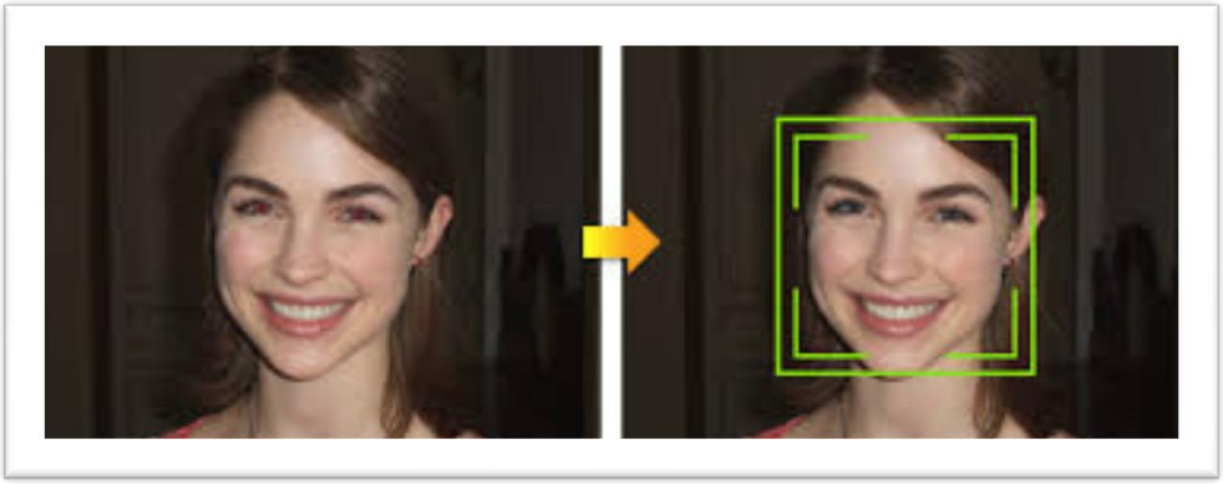

Figure 1.1: face detection example

1.2 TECHNOLOGY BEFORE COMING TO FACE RECOGNITION .

First of all we have to have the fundamental foundation and basic blocks which lead us to have the initial structure for the face detection and the further face recognition and age invariance face recognition and these basic blocks are the fundamental of the image and signal processing. Signal processing is field which deals with the processing of the signal and performance of the system involves in the process signal processing procedure involves include various transformation like the time to frequency transformation and frequency to time transformation. like the Fourier transformation, Laplace transformation, z transformation, wave-let transformation, Gilbert transform, Hilbert transform. Signal and system is the field in which various system are modeled to various input and give particular u output.

1.3 IMAGE PROCESSING

Image processing is the field in which the analysis of the image are done and various process and transformation are dome on the image.

Image processing are many types analog image processing in which the image is the analog in format and processing is done like developing the image from the negative frame it is very time consuming and cumbersome and have high level of the noise related interference which degrade the quality of the image. this technology is very primitive and slow. on the other hand the mew technology the digital image processing.

1.4 DIGITAL IMAGE PROCESSING

Digital image processing is the fast growing technology which rely heavily on the signal processing and on the computer computation capability available.

There are many process in the image processing as follows;

image acquisition is the process in which the image is captured by the various devices like the optical camera, laser camera , radar, UV camera , and other devices.

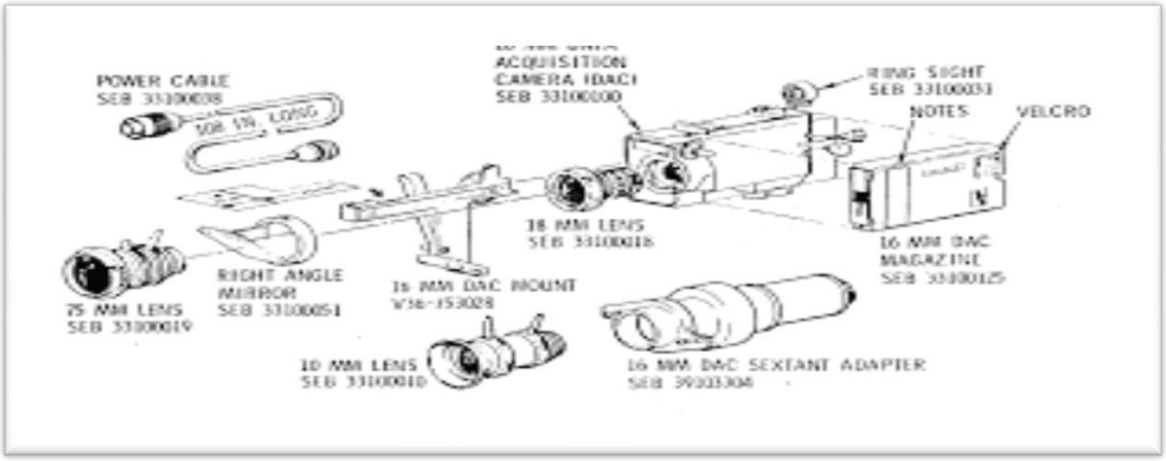

Figure 1.2: image acquisition

1.4.1 IMAGE ACQUISITION DEVICE SENSORS

There are three types of image acquisition device sensors dot sensors, line sensors, array sensor .

Dot sensor is which capture one point of area of the image at a time.

Line senor is which capture one line of the image at a time.

array sensor is which capture in two dimension at a time.

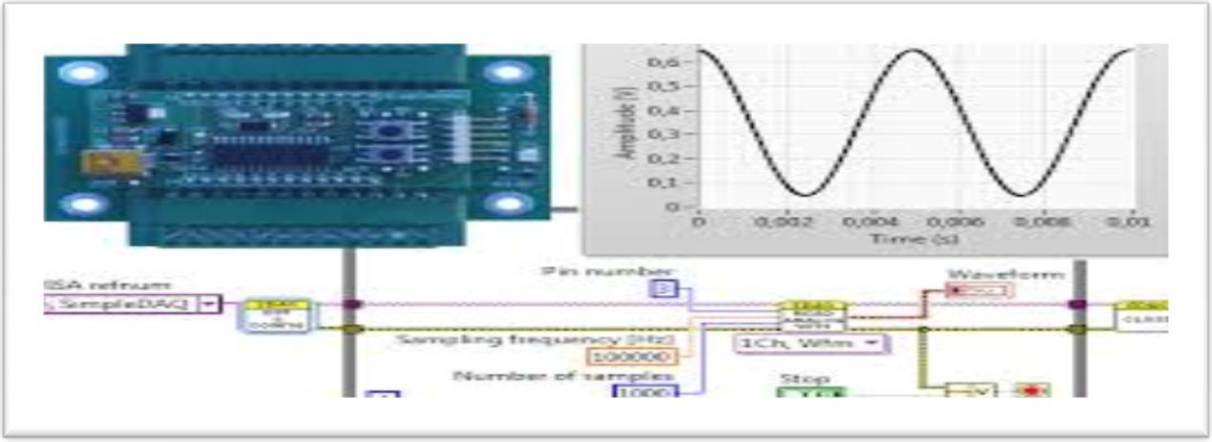

Figure 1.3: image acquisition device sensors

The various operations in the signal and system are:

Convolution: this is the operation in which the input is given to the system of known impulse response and the output is calculated. $y(t) = \int_{-\infty}^{+\infty} x(t-\tau).\delta(\tau)d\tau$where y(t) is output response, x() is input signal and $\delta(\tau)$ is the impulse response of the system, the above system is continues time system and the discrete time system would be $y[n] = \sum_{-\infty}^{+\infty} x[n-k]\delta[k]$.Time delay: in this operation the time delay is introduced in the input so it can be sensed in time domain that it is delayed. the time delay is important where we have to have the causal system otherwise it could be the system where the system have the features which reflects the essence of being the non causal system. $x(t)\ is\ the\ input\ signal$.y(t)=x(t-t0), where the t0 is the delay.

Time advance : in this operation the time advance is introduced in the input so it can be sensed in the time domain that it is somehow originated before the system is energized in this operation the system becomes the non causal type system and this kind of system mostly unstable in most cases. x() is the input signal. y(t)=x(t+t0), where the t0 is the advancement. Time reversal: in this operation the system is revered in time domain and the mirror image of the signal is taken. x() is the input signal. y(t)=x(-t).

Multiplication : this operation is also called the modulation in this operation the output of is obtain by multiplying the two signal in time domain or convolving them in the frequency domain. $y(t) = x1(t).x2(t)$ Where the y(t) is the output and the x1(t),x2(t) are the input

signals. Multiplication : this operation is also called the modulation in this operation the output of is obtain by multiplying the two signal in time domain or convolving them in the frequency domain. $y(t) = x1(t).x2(t)$ Where the y(t) is the output and the x1(t),x2(t) are the input signals.

Time scaling : in this operation the coefficient of the independent variable of time is multiplied with some rational no provided if the signal is continuous otherwise the multiplying coefficient must be time compression in discreet time signal in time scaling there are two operation depending upon the coefficient if the coefficient be greater than one then the time scaling will be called time compression otherwise time expansion. y(t)=x(at). Amplitude scaling : in this

operation the signal is multiplied with any rational number 'a' and the output of the operation will either be of small amplitude or of large amplitude depending upon the value of the factor. y(t)=a.x(t).

Differentiation and integration : in this operation the original signal is differentiated or integrated if the signal is continuous time signal and the output it taken by applying these operation over them. $y(t) = \int_{-\infty}^{\tau} x(\tau)d\tau$, integration. $y(t) = \frac{d}{dx}x(t)$, differentiation. Difference and accumulation : these operations are dome on the discrete time signals to find difference or accumulation e which are analogues to the differentiation and integration. accumulation $y[n] = \sum_{k=-\infty}^{n} x[k]$ and deference and y[n]=x[n]-x[n-1].

The various transforms in signal processing are.

Laplace transformation is very powerful transformation in the field of mathematics it is a very essential tool in the signal processing Laplace transform provides us the tool which we can us to analysis signal in frequency domain or vice versa. Laplace transform is applicable in only on the continuous time signal domain. in Laplace transform we can have any obituary signal transformed into the frequency domain or vice versa.

There are many operation which can be done in the Laplace domain so in many time it preferable to do and perform the operation in the Laplace domain because in frequency domain many times the operations become less difficult to operate and less computationally expensive. the various operation are time scaling, amplitude scaling, time shifting, convolution, signal modulation. $Y(s) = \int_{-\infty}^{+\infty} x(t).e^{-st}\,dt$ y(s) is the Laplace transform of the signal x(t).

There are many criteria in which the possibility of the Laplace transform like the signal should be integrate able in the domain, the region of convergence must be restored.

There are two parts in the Laplace transform which are the real part and the imaginary part now there is the beauty of the transform is that when the imaginary part is used the transform is that when it is used the imaginary part the transform becomes the Fourier transform.

The Laplace transform is used in many problem like circuit and network synthesis and analysis and the control system designing and other engineering disciplines.

Fourier transform is the most versatile and used transform in the signal processing and communication and not only in the electronics and communication engineering but also the other disciplines to like in the field of mathematics and biology and astronomy, metrology etc.

Fourier transform is the basic building block of modern electronics because it has provided us with power to analyze the signal in the frequency domain which further provide the important information about the frequency response and the bandwidth required by the system which otherwise could not be possible and would make us impossible to design even the basic electronic devices which we have designed so far because without it we would not be able to analyze and synthesis the system requirement in time as well as frequency. $X(\omega) = \int_{-\infty}^{+\infty} x(t).e^{-j\omega t}dt$X($\omega$) is the output and x(t) is the input. this for the continuous time signal . and for the discrete time signal is, $X(\delta) = \sum_{-\infty}^{+\infty} x[n].e^{-j\delta n}$

The Fourier transform required some condition to be met before the transform takes place and these conditions are the drichtlet criterion and these conditions are three.

1. signal must be integrtable in the domain.

2. signal must have finite number of discontinuities in the domain.

3. signal must have finite number of the maxima and minima.

This transform is analogues to the Laplace transform but it deals the signal in discrete domain the Laplace transform cannot be found of the discrete signal so to find the transform of the discrete signal we have use approach since the z transform is almost the same the Laplace transform. It has same existing condition as Laplace transform requires. it also has the real and imaginary parts and conditions and the if the real part is not considered then the transform becomes the Fourier transform of the discrete time signal. $X(z) = \sum_{-\infty}^{+\infty} x[n].z^{-n}$ x(z) is the output and x[n] is the input.

Fourier transform and z transform are very useful transform in analyzing the signal and system but there is very huge limitation to applying these transform to the signal in the computer because computer is a digital machine and it has limited memory and these transform gives the output in the continuous signal form which otherwise require infinite space of memory which is

however impossible so to we had to find the way to store the output in the finite space in the computer because other wise these transform are useless in digital signal processing area and technology so to rectify this discrete Fourier transform was developed.

DST transform discredited the continuous form of the output of the transform into discrete form. This transform is used to implement the DST in computers uses the truncation and other limitation and computer space management. There are many system in signal and system field and these are Linear system are those system which give the output which can be analyzed by homogeneity principle. Non linear system cannot be analyzed by homogeneity principle. Time variant system are those system which show different output with deferent time variable. Time invariant system are those the system which s do not produce the different output for different time variable.

Causal system are those which give response to the input which are in the present or in past. Non causal system are those which give response to the input which are even in the future. Static system are those which give response to the present input. Dynamic system are those which give response to any input regardless of the tense. Stable system are those which give finite response to bounded input. Non stable system are those which give infinite response to bounded input.

1.4.2 IMAGE ENHANCEMENT

image enhancement is the process that in quality of the image is in the judgmental view for the subject which tests it or in other words the image enhancement is subjective process.

Figure 1.4: image enhancement

1.4.3 IMAGE RESTORATION

It is the process by which the images are restored or get cleared from the noises which get associated with the image at time of the image acquisition or other process. there are several processes by which the image restoration can be done like filtering in the special or frequency domain. filter which are used to have the filtering process are high pass filter , low pass filter, inverse filter, Gaussian filter, elliptical filter and these filter are used to filter out the noises which are Gaussian noise , salt paper noise , periodic noise etc.

Restoration unlike the image enhancement is a objective process where the image is restored in fixed and mathematical manner by using various transform and operation.

By using appropriate tool in the image processing tool kit we can easily restored images provided which can be restored.

Figure 1.5: image restoration

1.4.4 IMAGE SEGMENTATION

If we want to do the processing in the image some time it becomes very difficult to do that because image processing requires large computation capacity so it would be waste of the memory of the computer because many times the process which is needed to be performed on the image is only on the small portion of the image so we must have the capability divide the image in desired or in definite manner so the power of computer may not waste in most time. there are many techniques which are used to do division of image and it is called image segmentation and these techniques are based on color , intensity , texture , etc.

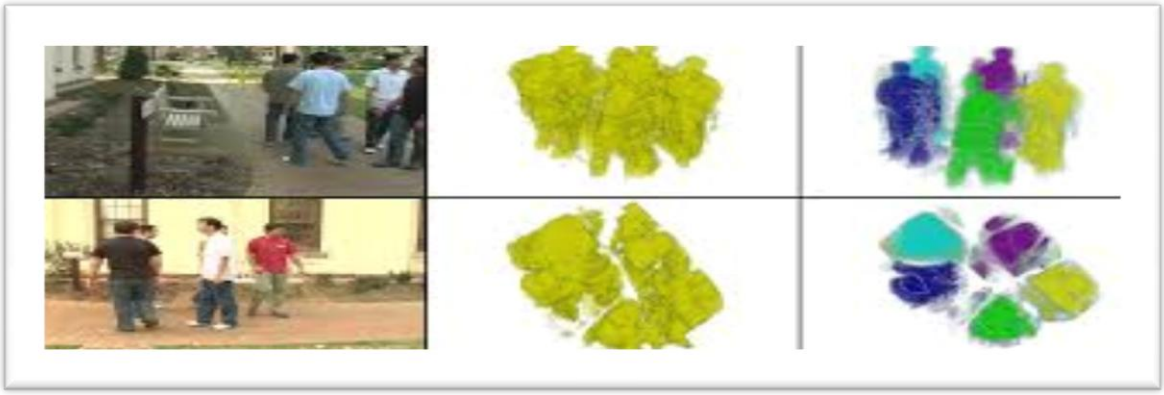

Figure 1.6: image segmentation

1.4.5 TYPES OF OPERATION AND THEIR DOMAIN

There are various operation which can be done on the image like gamma correction , inverse image , Rayleigh correction and these are the special domain operation.

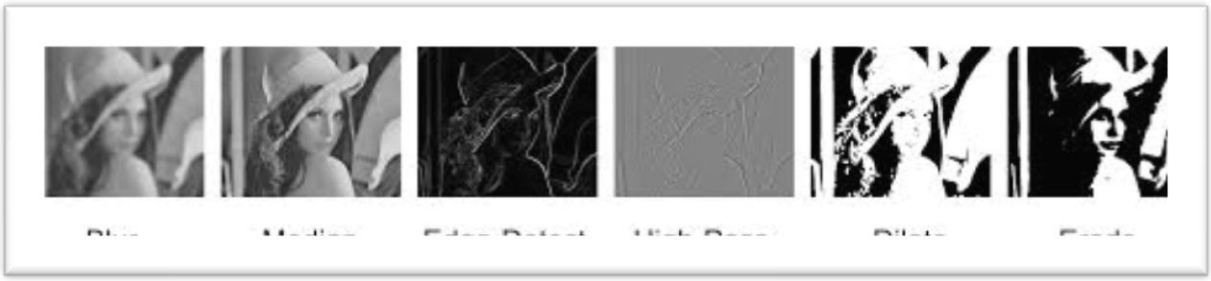

Figure 1.7: types of operation and their domain

There are many operation which belong to the frequency domain which are low pass filtering , high pass filtering , band pass filtering , Gaussian filtering etc.

Figure 1.8: types of operation and their domain

1.4.6 THE VARIOUS KINDS OF OPERATORS IN THE IMAGE PROCESSING

1. Edge detection- edge detection is the process in which the change of the intensity in the image is detected as a Edge between the two regions of the image which are having different color, intensity , illumination , etc. there are several method to have it done one of the method is the Soble operator which uses the first derivative in the image to find out the intensity change in the image , there is other method in which the change in the color hue in the image are there the separation between them gives the edge in the image. Edge detection is the most basic fundamental of the technology which deals with the detection of the object because without the edge detection the other detection may not work properly. there many filters which can do this like the Prewitt filter, Roberts filter, Laplacian filter, Emboss filter, Edge dog filter, etc.

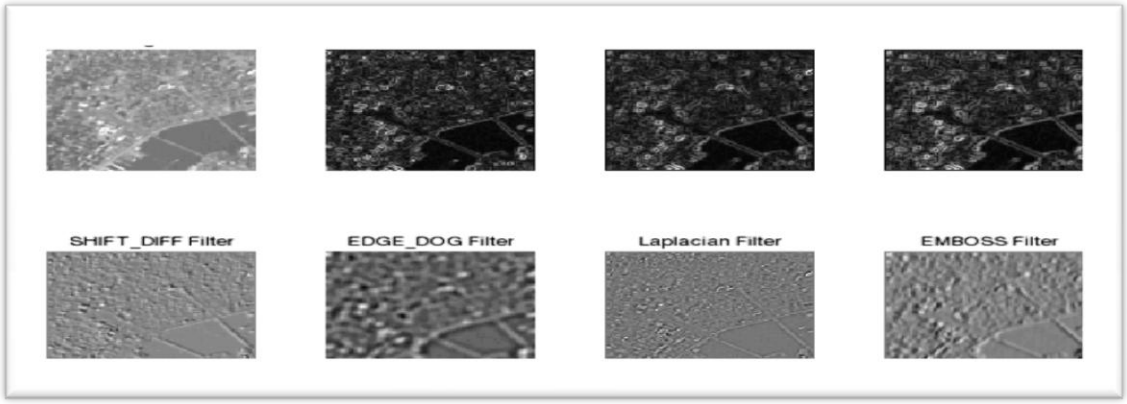

Figure 1.9: Edge detection

2. Color detection-color cue is the major factor in the image because most of the image in today's world is made up of the color so the color detection is the very useful in long run. it is the easiest detection in the row because having color detected gives the power of the separation of the objects of the deferent color very easily and the image segmentation can be performed very easily.

Figure 1.10: Color detection

3. texture detection- it is the process by which we can actually separate the two deferent surface from each other by detecting the deference in the surface structure of the plane because it is the nature reality the no surface can have same texture exactly the same so we can use that property to detect two surface or the foreground from the background. the texture detection is very useful when the foreground and background have the same color because in that case it is very difficult to separate the two surface from each other by color detection or other.

Figure 1.11: texture detection

4. contour detection - it is the very useful detection scheme because it provides the very foundation of the object detection and recognition , it provides the necessary information about the shape of the object , it gives the outlay of the object shape whether the object is circular ,square, rectangle , cube, elliptical , cuboids, etc.

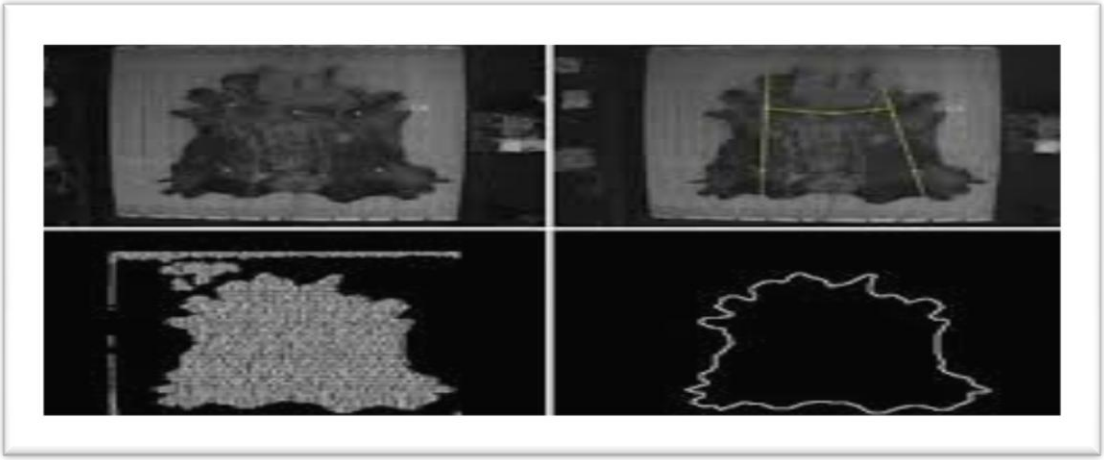

Figure 1.12: contour detection

1.5 OBJECT DETECTION

object detection is the immerging field in the signal processing and image processing technology as the technology needed to detect object shape has already been in the improving or say in the advance stage. we can move farther to the field of the object detection which is a base for further development of the face detection because without the object detection there would no be any face detection as we have already developed the technology of the contour detection and the texture and color and edge detection. object detection is the way we can move to the face detection in the area because now we have the tool to detect the shape of the object in testing , it make use the available technology which are color , texture , edge detection and it is used in the whether the object is round , rectangle , cubical , cubic, etc. as we know the human face has a definite shape and it can be detected with the help of the computer algorithm and not only the human face human body , human facial features , and human movements can be detected to this is the basic requirement in the further study of the human computer interface.

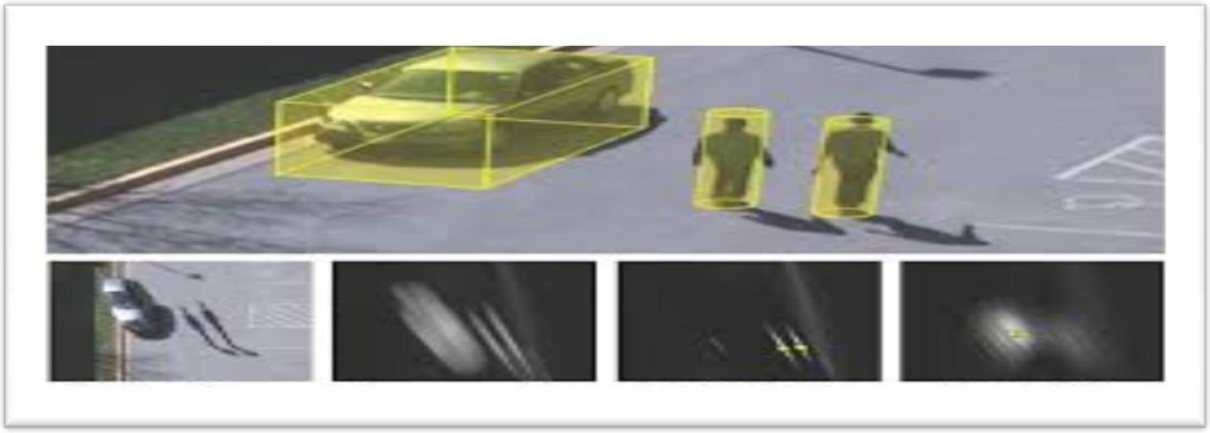

Figure 1.13: object detection

Figure 1.14: object detection

1.5.1 OBJECT RECOGNITION AND INDEXING

Object recognition and indexing is the field in the image processing in which the object is first assumed to be detected and then it is recognize for which category of object it belongs to whether the object is a plane or car or toy or stone or animal or the human being. it has to be recognize to have the usefulness in some sense so the detected objects are must be recognized to put them in the particular category. indexing is the procedure where the recognized object is then indexed to the particular identification so it can be put in the same category where the other same type of the object belongs to . without the object recognition and indexing the field of the human face detection cannot be born.

to recognize the detected object we must need some classifier which classify them to the particular category and these classifiers are based on any algorithm like the PCA , LDA , KARNAL PCA, SUPPORT VECTOR MACHINE , ARTIFICIAL NEURAL NETWORK

Figure 1.15: Object recognition and indexing

Figure 1.16: Object recognition and indexing

1.5.2 OBJECT TRACKING

Object tracking is a field in the signal processing where the location of the object in the sequence of the video whether the video is real time or the stored is fed into the computer and the algorithm finds and tracks the desired object in the video.

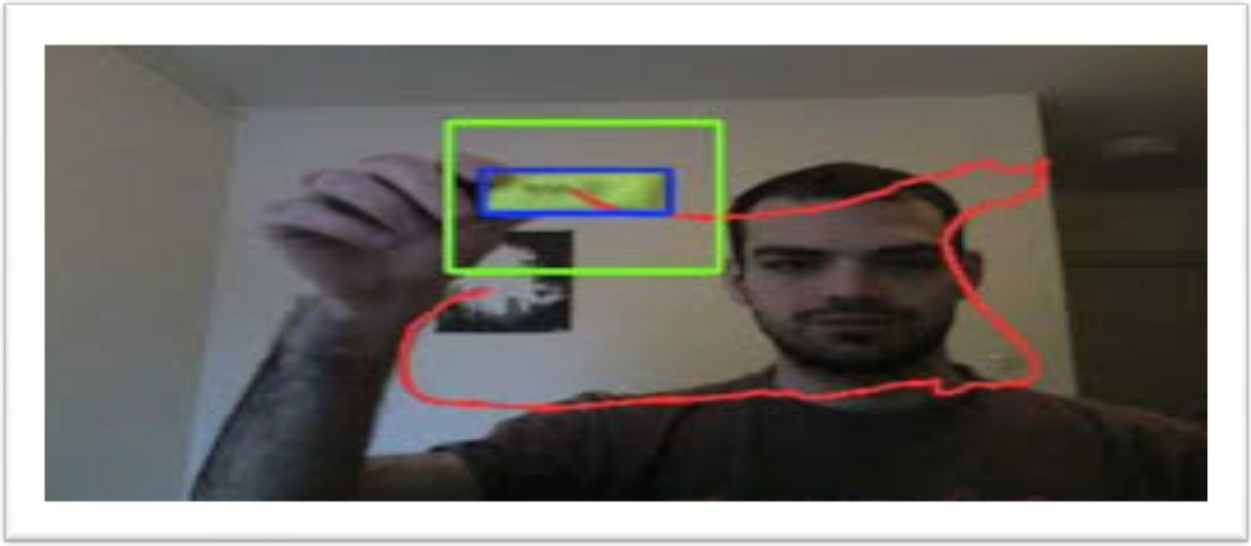

Figure 1.17: Object tracking

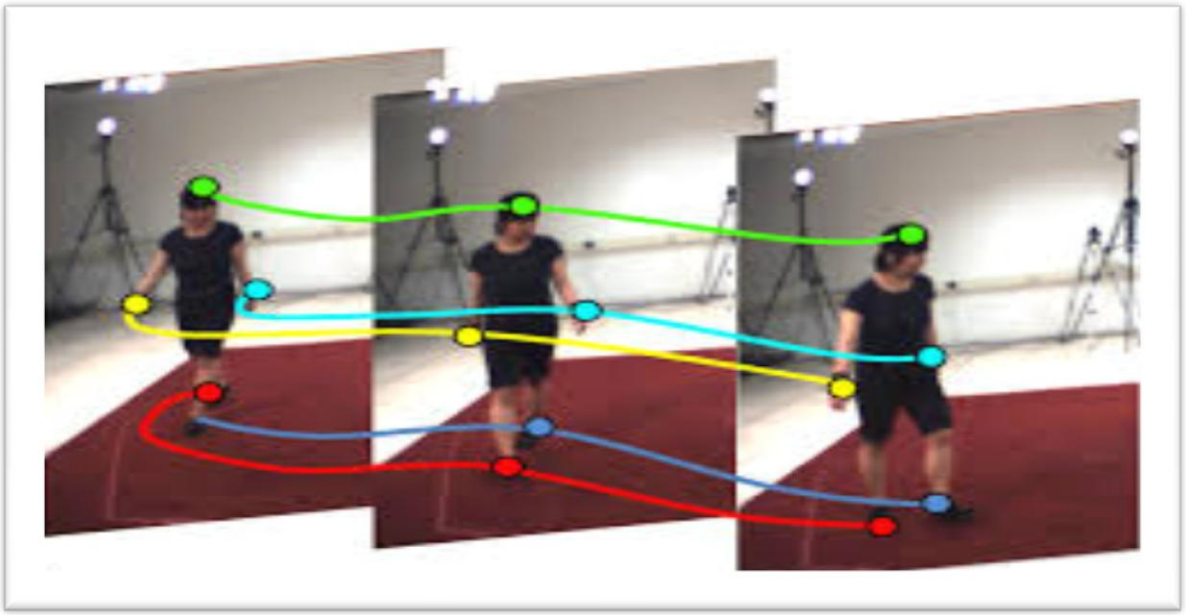

Figure 1.18: Object tracking

1.6 DATA FUSION TECHNIQUES

there are many cases where the data is given to the algorithm from several sensors which may

or may not be same type so there is a high probability that the output of these sensors may conflict each other so to handle these there are few techniques are given to fuse this conflicting data input which could otherwise be very difficult to maintain because the output of these conflicting and fuzzy output can be fuse to obtain the definite result so to be fed into the next level in the algorithm. there are techniques which are used to do this are DSMT (DEZERT-SMARANDACHE THEORY OF PLAUSIBLE AND PARADOXICAL REASONING) this theory is the advanced version of the previous theory given by the DEMSHER SHEFFER THEORY but it is more advance. It has The power set, hyper-power set and super-power set these sets are used in the different cases the power set has the minimum level of flexibility , the hyper power set has medium level of flexibility , and the super power set has the highest flexibility.

There are three models, which are the free DSM model, the Shafer model, and hybrid DSM model which are there to give the required environment to the performance to these sets .

There are some rules to combine and applying the data, which are the classic DSM rule of combination, the hybrid DSM rule of combination, and the proportional conflict redistribution rule of combination.

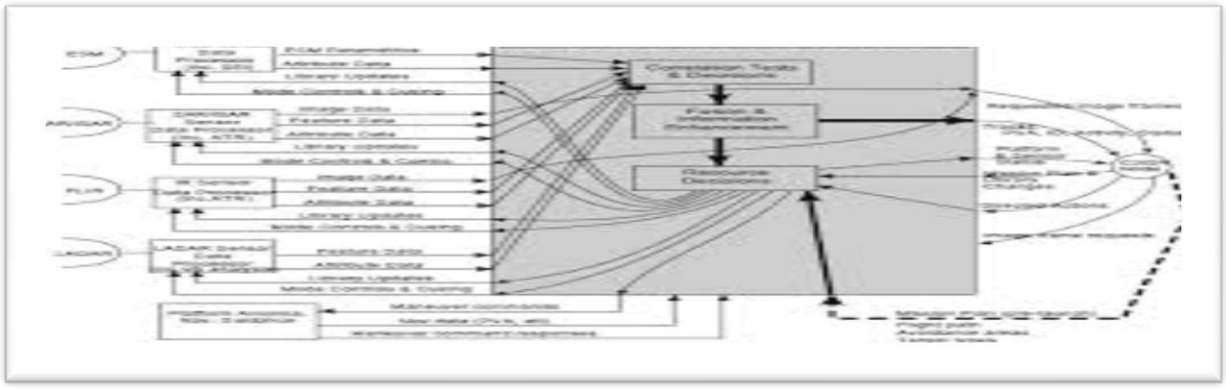

Figure 1.19: data fusion techniques

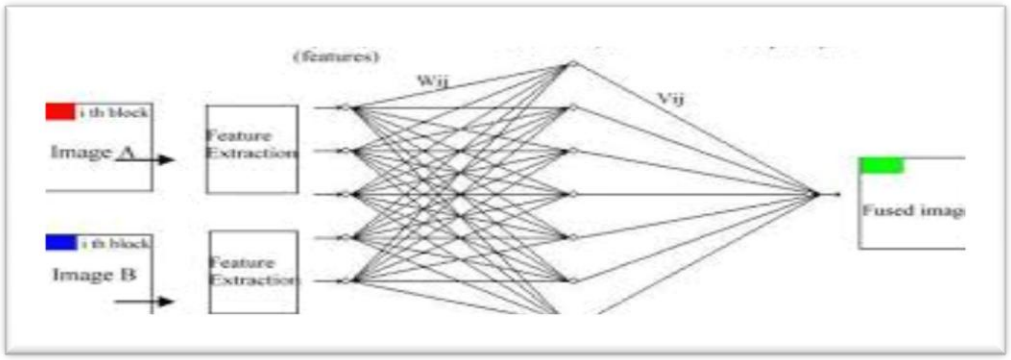

Figure 1.20: data fusion techniques

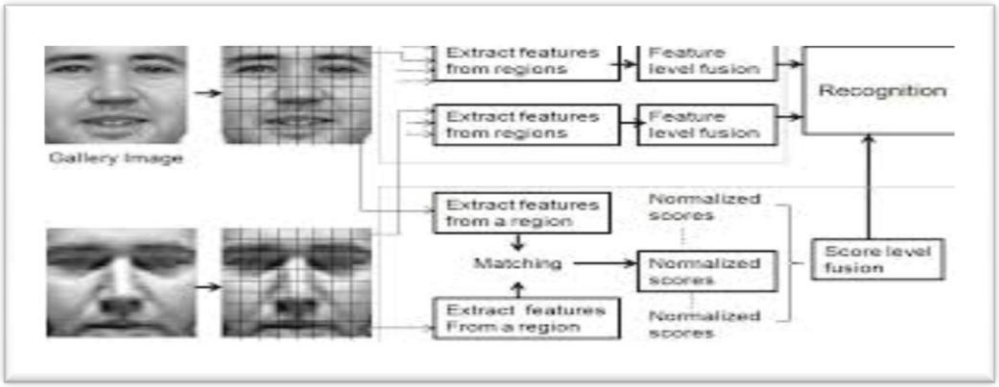

Figure 1.21: data fusion techniques

1.7.0 FEATURES EXTRACTING ALGORITHMS

there are many features extracting algorithm in the image processing there are LDA based features extractor, color based , sift(scale invariant feature transform) algorithm , MLBP (multi scale binary patterns) , linear binary pattern, DWT discrete wavelet transform, AAM (active appearance model). these features extracting algorithm are used mostly in the face recognition and age invariance face recognition.

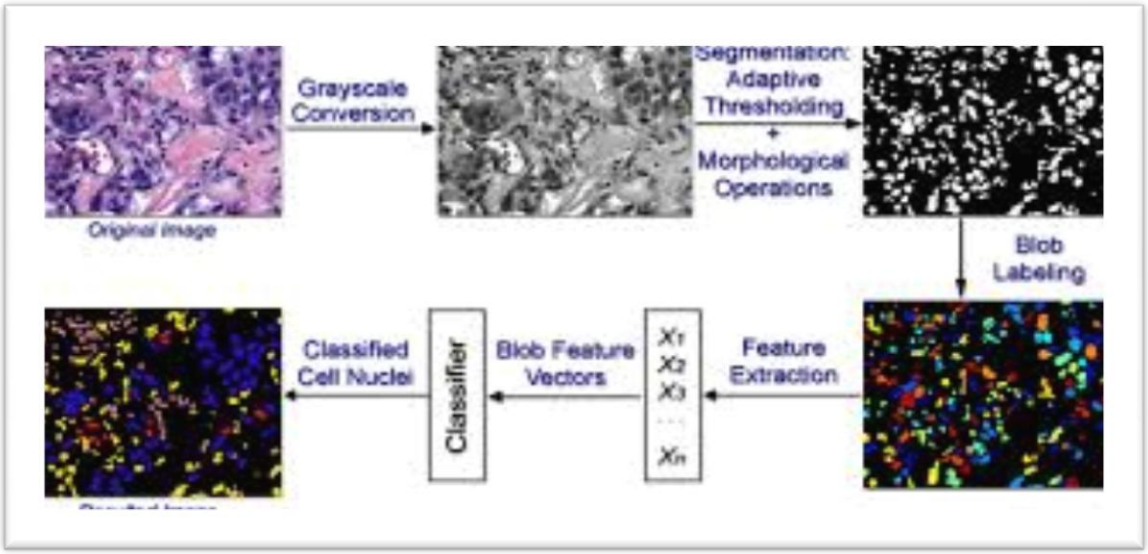

Figure 1.22: features extracting algorithms

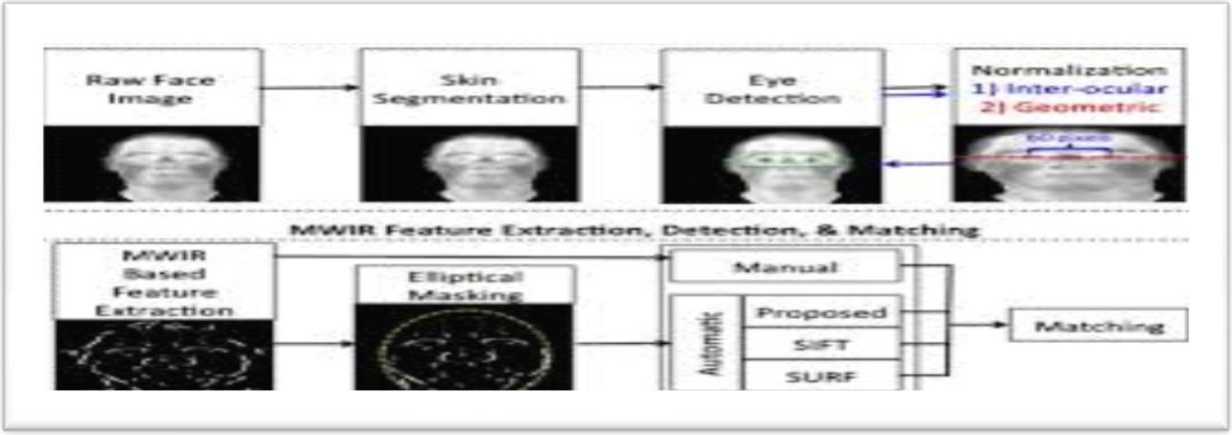

Figure 1.23: features extracting algorithms

1.7.1 DIMENSION REDUCTION ALGORITHM

Dimension reduction algorithm are those algorithm which are used to reduce the extra data associated with the actual data and which are unnecessary to the purpose so it is beneficial to reduce the data in order to increase the performance and make less computational expensive there are various data reduction scheme in the field and they are used to reduce the data at the same time the preserving the necessary data required by the algorithm and these algorithm are PCA (principle component analysis), MFDA (multi feature discriminate analysis), MCW (maximum weighted cut), KRBF (kernelized radial basis function).

Figure 1.24: Dimension reduction algorithm

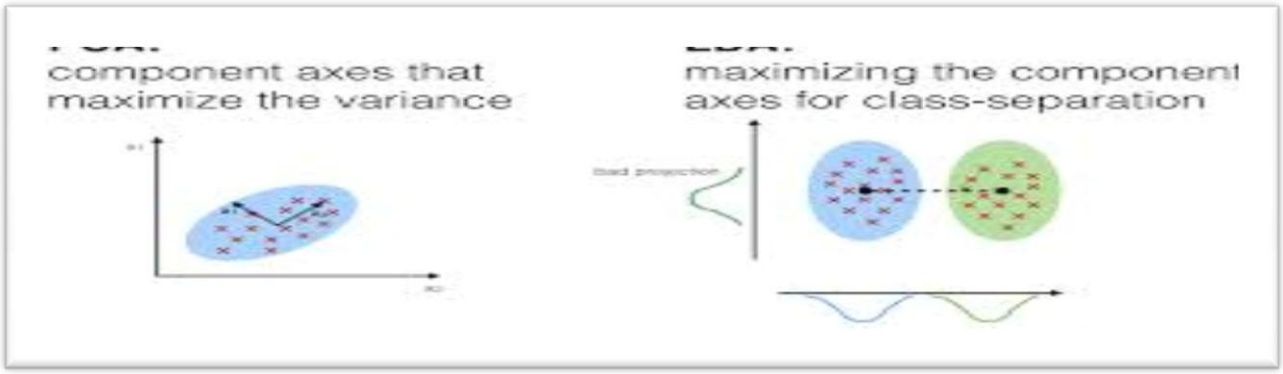

Figure 1.25: Dimension reduction algorithm

1.7.2 CLASSIFICATION

classification is the area in the image processing in which the features which are already extracted are classified into some domain or in other words the we tag them or link them to some category which are or may be old or new . there are many scheme by which we can classify the data and they are based on some algorithm like LDA, support vector machine , artificial neural networks ,maximum a posteriori probability using Gaussian mixture type classifiers ,maximum a posteriori probability using a mixture of multinomial distribution like classifiers.

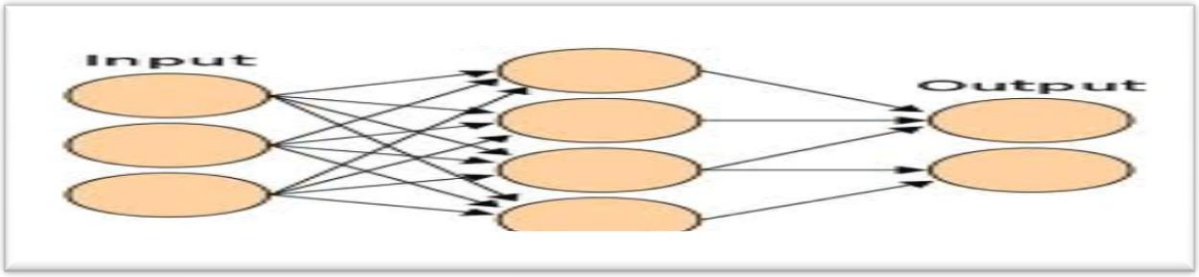

Figure 1.26: classification

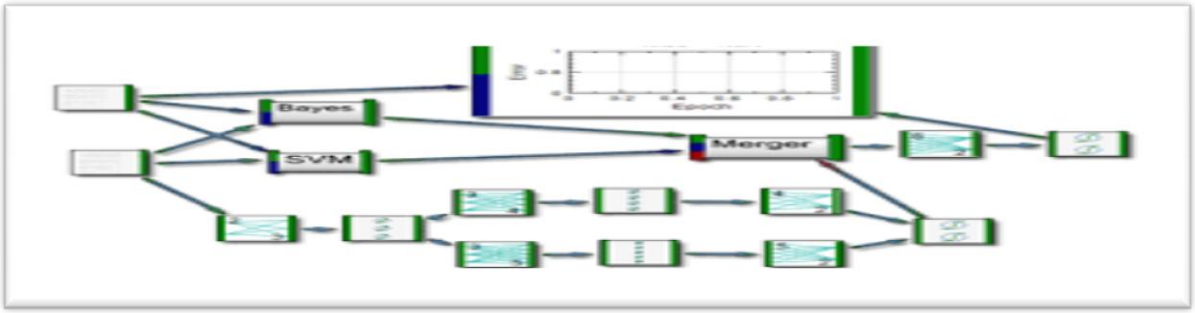

Figure 1.27: classification

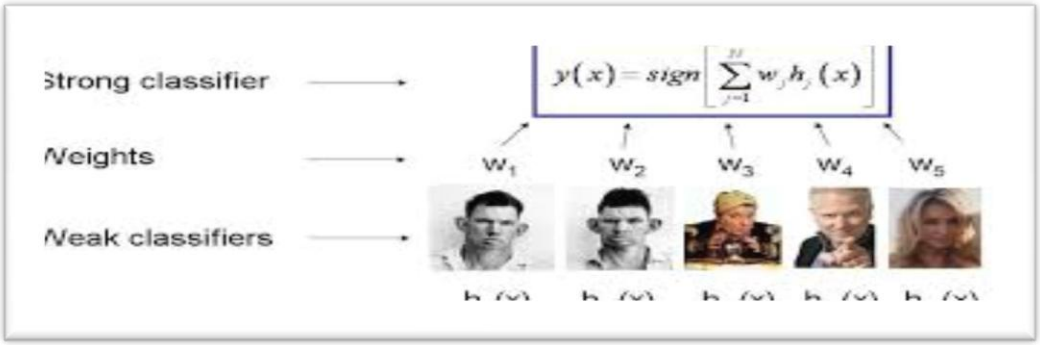

Figure 1.28: classification

1.8 ADAPTIVE BOOSTING

adaptive boosting is the algorithm which is used in many applications , the purpose of the adaptive boosting is sense when the classification is done by many classifiers. when that nothing is perfect in this world so is the classifiers that is one classifier has one quality but lacks in the other area so does other classifiers , some classifiers do well is some condition and fail in other condition like the color based classifier works well in the image where the image has different and distinct colors it can classify the target but it fails when there is less illumination or the target and the background has same color in these situations the classification is not robust and reliable . to rectify that unfavorable situation the process uses the more than one classifier , the thinking behind this is that they use more classifier in which one works in condition and if it fails in some conditions then the other classifier which does not fail in that condition must classify the target. but fuse the output of different classifiers has been a difficult task so the adaptive boosting was developed to tackle that task. what it does , it uses the statistical mathematical approach by which adaptively boost the output of the weak classifier however the strong classifier are there so the strong classifiers do not overwhelm the weak classifiers.

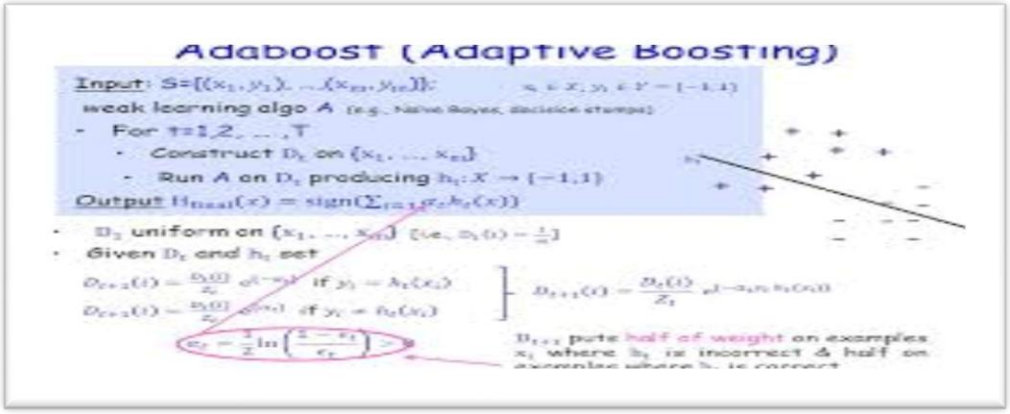

Figure 1.29: adaptive boosting classification

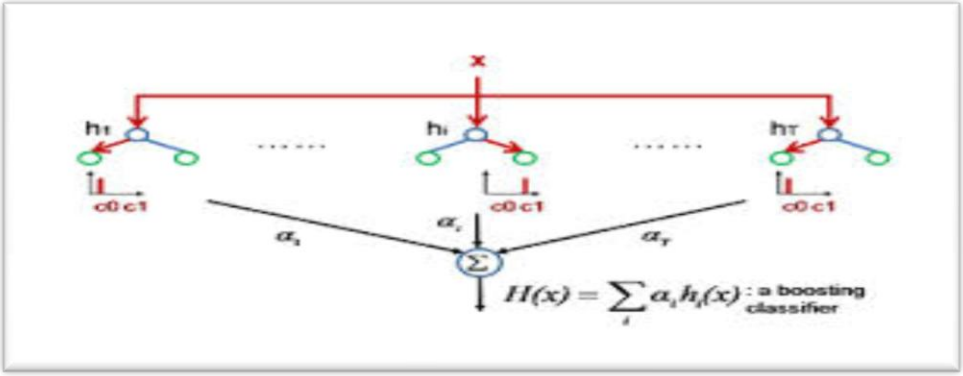

Figure 1.30: adaptive boosting classification

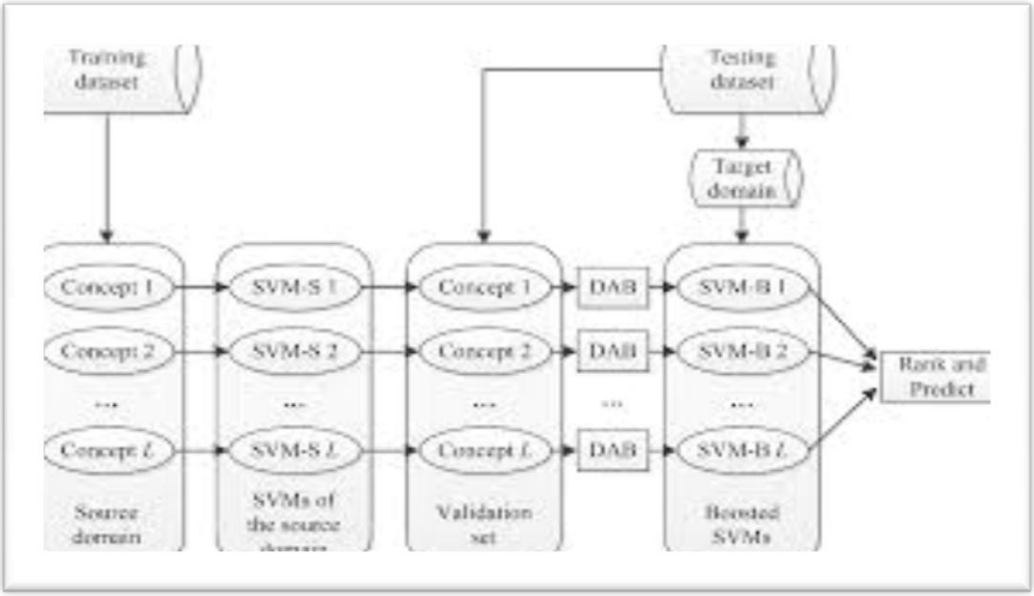

Figure 1.31: adaptive boosting classification

1.9 **FACE DETECTION**

face detection is the technology which uses the all inventions which were done before it the image processing and other technology face detection is very useful in the field where the human detection is crucial and time consuming and frustrating like in the border area and the prison security route , security checkpoints however there are number of condition where the face detection is very essential like in the area where the recognition of the human face is very important because identifying the wrong person could have very serious consciousnesses like in the bank and ATM's which is why it has become very necessary to our daily life. there are very

powerful algorithm present to tackle this problem like the sift , genetic algorithm , ADABOOST algorithm, and various LDA based classifiers.

genetic algorithm is a algorithm which is very heavily used in this field because detection and recognition of the human face is difficult and require very high skill and need to be conditioned before being used in the economical way so the output of the algorithm makes some sense. as we the genetic algorithm is based on the genetic technology which says that the only the strongest, the fastest and the most intelligent species survives and evolve in the nature using that genetic algorithm uses that every algorithm is tested and new algorithm is built which have the features of the previous algorithm and the algorithm can be mutated.

Figure 1.32: face detection

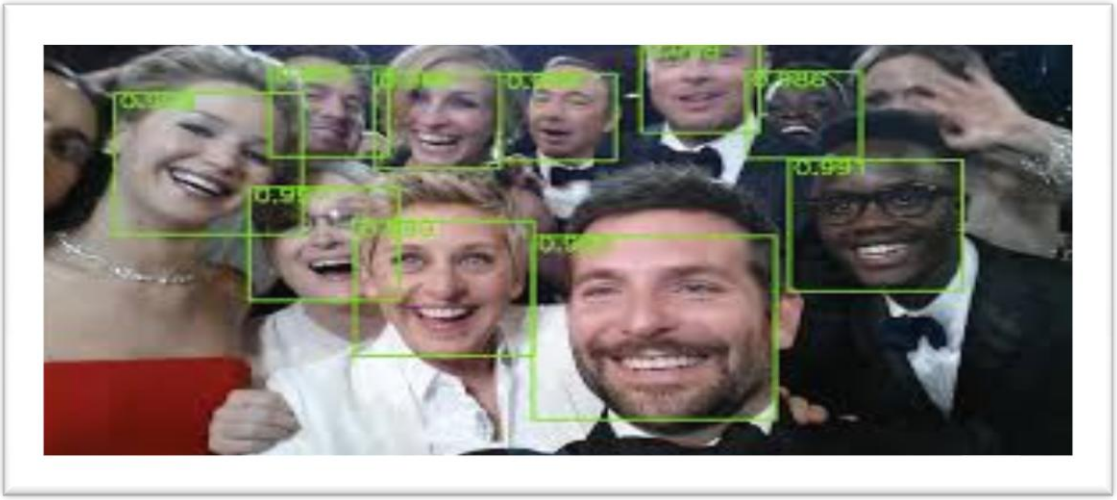

Figure 1.33: face detection

1.10 FACE RECOGNITION

face recognition is the field in which the detected face of human is then recognize and indexes to the name so whenever the person comes to the face recognition program it recognize it. the recognition works as the image or the video is given to the computer then the face of human being is detected after the detection is done the features of the face is then extracted from the face itself and the features are the skin tone , nose shape , eyes , lips , face cut , and then these features are mapped and other detection also taken place like the emotion detection , gaze estimation, HCI systems . based on these features the further process is the classification or the match making which color based classification because the color cue is a very important feature in the face recognition.

Figure 1.34: face recognition

Figure 1.35: face recognition

1.11 AGE INVARIANCE FACE RECOGNITION

age invariance face recognition is the latest technology in the image processing the basic theme behind the age invariance face recognition is that face recognition does recognize the face of the human being very accurately but there is a limitation to the performance of the face recognition algorithm that human face does not remain exactly same throughout the life of the person. the facial feature of the human face change throughout the its life phase so it is the hard problem for the image processing engineering field that how to make an algorithm recognize a face of the person regardless of its age .they uses many approach like the linear discriminated analysis , group matching , nonlinear topological component analysis in which various transform are r uses like SIFT, KRBF, MLBP MLDF.

Figure 1.36: age invariance face recognition

Figure 1.37: age invariance face recognition

CHAPTER 2:

LITERAURE REVIEW

2.1 INTRODUCTION

Prior to starting of my thesis, it is important to have a deep understanding on the existing pages of age invariant face recognition and its various types of codes used in this AIFR. The main sources of the information for the dissertation are books, journal, thesis and the internet.

2.2 LITERATURE SURVEY

PRINCIPAL component analysis (PCA) remains an invaluable tool when one acquires measures on a number of observed variables and wish to generate a smaller number of artificial variables (called principal components) that will account for most of the variance. This variable reduction is motivated by the belief that some observed variables measure the same construct and therefore exhibit significant correlations. The principal components may then be utilized as a predictor set in subsequent analyses. PCA has been exploited in a nonlinear way by means of the kernel trick to derive kernel-based PCA (KPCA) [1]. Other prominent nonlinear techniques include manifold learning such as Isomap [2], locally linear embedding (LLE) [3], Hessian LLE [4], Laplacian Eigen maps [5], and local tangent space alignment [6], which have been proposed in the machine learning literature. These techniques build a low-dimensional data representation using a cost function that maintains local properties of the data. These approaches can be perceived as defining a graph-based kernel for KPCA. Likewise, graph and network embedding techniques have also been introduced as a general framework for dimensionality reduction for the purpose of visualization [7]–[12]. Other formalisms such as generative topographic mapping [13] have been put forward as an attempt to reveal the inverse nonlinear relationship between the set of latent variables and the set of observed variables. Unlike PCA, these latter mappings assume an *underlying causal structure* within the observed variables and thus represent a building block of an exploratory factor analysis. However, most of these techniques are oriented toward the search of a dimension reduction criterion; they have difficulty providing a means that permits the disclosure of the low-dimensional shape formed by the data set. Unveiling shapes would allow the exploitation of mathematical concepts such as homeomorphism, homotopy equivalence, and topological invariance [14], which are precious in many pattern recognition problems such as classification of 3-D protein folds or brain repair after injury.

The main motivation of this research consists of extending dimensionality reduction techniques to derive topological features (e.g., as the shape of the observed data) and to merge them with statistical information. The approach that we propose is viewed as: 1) an integration of a kernelized radial basis function (KRBF) dimensionality reduction method; 2) a construction of α-shapes and extraction of topological features (signatures); and 3) an object classification based on a mixture of multinomial distributions. One would be able to gain an insight into the morphology of shapes formed by the data set in a latent space for a sharper classification task. We show how statistical information can be merged seamlessly with topological knowledge using a multinomial mixture probability distribution. This allows comparing several shapes in the latent variable space. The entire methodology that we have named nonlinear topological component analysis (NTCA) is undertaken by: 1) mapping the original data set to a Hilbert space using a quadratic function: this allows to obtain a more accurate separation of the observations; 2) mapping the obtained set to a set spanned by KRBF; 3) projecting linearly this latter set on a latent space; 4) building a hierarchy of α-shapes associated to the points of the latent space; and 5) extracting topological signatures from the α-shapes for the purpose of classification. In other words, 1)–3) represent a dimensionality reduction technique (that we have named: KRBF), whereby each point of the original data set is mapped nonlinearly to a point in a low-dimensional latent vector space. The cloud of points obtained in the latent space is assigned a hierarchy of α-shapes that represents the original data set. Finally, a group of topological traits are extracted by averaging over the α-shapes to form a template for object identification. Applications of the NTCA formalism are diverse: Biometric sand Forensics can benefit from NTCA since the original data set depicting a topological manifold can be built from different images of the same biometric sample (e.g., fingerprint, face) of an individual. The proposed approach maps this multidimensional manifold to a 3-D α-shape, which is a 3-D-polyhedron (n-polytope). Another application would consist of reconstructing 3-D-MRI images of damaged organs (such as the brain) to identify the causes of the injury, and find its location using the geometrical concept of α-shapes. The organization of this manuscript is described as follows. Section II addresses some basics about the kernel functions and the notion of α-shapes. The concept of NTCA that covers the data distribution in the latent space is introduced in Section III. The parameter estimation of the latent space data distribution is carried out in Section IV. The object classification phase based on multinomial mixtures distribution is laid out in Section V. The application in face identification across ages and the experiments conducted are the object of Section VI. Finally, the conclusion and directions for future work are presented in Section VII.

the target space using a nonlinear transformation based on suitably chosen basis functions. Therefore, the inner product of basic functions $\phi(t1)T \cdot \phi(t2)$ is replaced by a kernel function $k(t1, t2)$, between instances in the original input space. Therefore, instead of mapping two instances $t1$ and $t2$ to the Hilbert space and performing a dot product there, one directly applies the kernel function in the original space. Among the most used kernels, one can cite the Gaussian kernel $k(x, y) = k(\quad x-y \quad) = \exp\{-(x-y)T \_ -1(x-y)\}$, which is an example of radial basis function kernel and the polynomial kernel $k(x, y) = (axT \cdot y+c)d$, where a is the slope parameter, c is a constant term, and d is the polynomial degree. There are several other kernels proposed in [16]; however, it is important to underscore that the choice of a best kernel

depends on the type and structure of the data at hand. For example, there exist kernels for similarities [17], strings [18], graphs [19], and other data structures.

A. Mapping Data Space to Latent Space

The mission in KRBF is to find a representation for the distribution $p(x)$ of low-dimensional latent variables in terms of a number D of data variables $t = (t1, t2, \ldots, tD)$. The computation of this distribution allows the creation of the set of points X that represents the data set in the latent space. The assumption of the existence of a low-dimensional data manifold governed by some latent variables is explained by the fact that: 1) data exhibit substantial correlations between the variables and 2) some data are noisy due to defective sensors. A nonlinear mapping between the original data set and the latent variable space X is performed by first mapping the data set D of RD to a subset De (e stands for extended) of a high-dimensional Hilbert space Hk (endowed with a positive definite kernel function k on D) using a feature space mapping ϕ. The subset De is in turn mapped to a subset B spanned by radial basis functions, and finally, B is projected on the latent space RL via a nonlinear transformation χ to derive the set X. The image x of an element $t \in$ D is computed as $x = (\chi \circ \pi \circ \phi)(t)$, whereby $z = \phi(t) \in$ De, ($t \in$ D), and $\chi(\pi(z)) = \mathbf{W}\pi(z)$, where $\pi = (\pi i)$ ($i = 1, \ldots, Q$) designates a set of fixed nonlinear basis functions, and **W** is an ($L \times Q$) matrix of parameters. Finally, the α-shape geometric descriptor is invoked to compute a family of L-dimensional α-shapes (defined in $A(\alpha)$) assigned to the subset of data points X (Fig. 3). The dimensionality L of the latent space is less than the dimensionality D of the data space and therefore less than the dimensionality H of the Hilbert space. Topological signatures extracted from the α-shapes (polyhedral) characterize the data manifold. These signatures can be used for a classification or a regression task. It should be borne in mind that the motivation for this paper is twofold: 1) it provides a 3-D-visualization in the form of α-shapes (in the latent space) of the data topological manifold and 2) it creates a methodology that merges seamlessly statistical data and topological features within a single probabilistic framework.

Problem Statement and Background

Given a face sample of an individual at age interval $A0$, one investigates if this input face is associated with any of a large number of enrolled faces of individuals. However, some face images of the same individual at different age intervals Ai are *among the enrollees.* In other words, given two face images, can one infer that they represent the same individual but at different age intervals (Fig. 7)? Several features that are responsible for a facial appearance are: 1) the 3-D structure of human faces; 2) the reflective peculiarity of facial skin; and 3) the bilateral symmetry in the structure of facial features in combination with scene-centric attributes such as viewpoint and illumination. One of the main challenges in face identification stems from the alteration of facial appearances. This modification is explained by the combination of several factors such as illumination, facial expression, occlusions, and age. However, the power of face identification across ages is mostly dependent on the ability of modeling some singularities caused by face wrinkles as well as bones structural deformation (e.g., jaw bones) of the enrollee face. The process of aging remains the major cause of significant deformation in the appearance (face texture) and anatomy of human faces. Aging is,

therefore, one of the most compelling challenges for automatic human identification systems and forensics investigation.

Compared with standard face recognition [23]–[28] in which aging is not relevant, age-invariant face recognition remains an intricate task due to an imperfect modeling of facial aging. According to Gerontologists, aging is only partially understood. Within this context, Juefei-Xu *et al.* [29] introduced a technique that utilizes periocular region for age-invariant face recognition. They have applied Walsh–Hadamard transform encoded local binary patterns on periocular regions. Ramanathan *et al.* [30] presented a survey containing a thorough analysis of the problem of facial aging. Several different paradigms and views of this problem have been described in this report. Yang and Ai [31] laid out a learning scheme that permits the face images classification to be based on their age group. Their approach employs a local binary pattern (LBP) as an image operator and derives the LBP histogram that was utilized for texture characterization. They subsequently selected a sequence of local features and performed age classification. Geng *et al.* [32] modeled the aging pattern, defined as the sequence of individual's face images at different ages, by building a representative subspace of these images. The unseen face image age is predicted via the projection in this subspace that can rebuild the face image optimally. The position of the face image in that aging pattern will then disclose its age. Park *et al.* [33] proposed a 3-D modeling technique and a simulated method for age-invariant face recognition. They have expanded shape modeling from 2- to 3-D domain to inject capability for compensating for pose and lighting variations. Li *et al.* [34] proposed a discriminative model by representing each face via a densely sampled local feature description scheme. They have used a scale invariant feature transform and multiscale LBPs as local descriptors. Finally, Bouchaffra [12], [35], [36] devised a methodology that converts a dynamic Bayesian network into a family of α-shapes and applied a Gaussian mixture model for age-invariant face identification.

We have developed a nonlinear age-invariant face recognizer that we named NTCA. This mission has been achieved by: 1) nonlinearly mapping the data topological manifold to a low-dimensional latent variable space; 2) extracting topological features through the computation of the α-shape polyhedron formed by these latent variables; and 3)performing shape classification using a mixture of multinomial distributions. The results obtained have demonstrated the potential of the NTCA approach as a whole. The benefit of expressing $p(x)$ is invaluable since it allows the estimation of some parameters and the generation of other points in case where face images of the same individual are lacking. It also renders the more general weighted *α-shapes concept exploitable.* However, our methodology can still be improved through the use of a more stable clustering algorithm of the zi vectors. Furthermore, a classification with a reject option should be devised to meet the demands of a large-scale application.

Aging variation poses a serious problem to automatic face recognition systems. Most of the face recognition studies that have addressed the aging problem are focused on age estimation or aging simulation. Designing an appropriate feature representation and an effective matching framework for age invariant face recognition remains an open problem. In this paper, we

propose a discriminative model to address face matching in the presence of age variation. In this framework, we first represent each face by designing a densely sampled local feature description scheme, in which scale invariant feature transform (SIFT) and multi-scale local binary patterns (MLBP) serve as the local descriptors. By densely sampling the two kinds of local descriptors from the entire facial image, sufficient discriminatory information, including the distribution of the edge direction in the face image (that is expected to be age invariant) can be extracted for further analysis. Since both SIFT-based local features and MLBP-based local features span a high-dimensional feature space, to avoid the over fitting problem, we develop an algorithm, called multi-feature discriminant analysis (MFDA) to process these two local feature spaces in a unified framework. The MFDA is an extension and improvement of the LDA using multiple features combined with two different random sampling methods in feature and sample space. By random sampling the training set as well as the feature space, multiple LDA-based classifiers are constructed and then combined to generate a robust decision via a fusion rule. Experimental results show that our approach outperforms a state-of-the-art commercial face recognition engine on two public domain face aging data sets: MORPH and FG-NET. We also compare the performance of the proposed discriminative model with a generative aging model. A fusion of discriminative and generative models further improves the face matching accuracy in the presence of aging.

AUTOMATIC face recognition is an important yet challenging problem. This challenge can be attributed to (i) large intra-subject variations and (ii) large inter-user similarity. shows some of the main intra-subject variations (pose, illumination, expression, and aging) commonly encountered in face recognition. Among these variations, aging variation is N now beginning to receive increasing attention in the face recognition community. Designing an age-invariant face recognition method is necessary in many applications, particularly those that require checking whether the same person has been issued multiple government documents (e.g., passports and driver license) that include facial images. Published approaches to age invariant face recognition are limited. Most of the available algorithms dealing with facial aging problem are focused on age estimation and aging simulation . One of the successful approaches to age invariant face recognition is to build a 2-D or 3-D generative model for face aging . The aging model can be used to compensate for the aging process in face matching or age estimation. These methods first transform the face images being compared to the same age as the gallery image using a trained aging model to compensate for the age effect . While the model based methods have been shown to be effective in age invariant face recognition, they have some limitations. First, construction of face models is difficult and sometimes they do not represent the aging process very well, especially when the training sample size is limited. Further, the facial aging process is very complex and, consequently, in order to construct the aging model, strong parametric assumptions are recognition scenarios. Second, for constructing the aging model, additional information in the form of the true ages of the training faces and the locations of landmark points on each face image are needed. A further constraint on the training set is that the images should be captured under controlled conditions (e.g., frontal pose, normal illumination, neutral expression). Unfortunately, such constraints are not easy to satisfy in practice, especially in scenarios where the face images being compared are subject to significant changes not only in aging, but also in other possible variations such as pose, illumination, and expression. In order to overcome these problems, approaches based on

discriminative models have been proposed for the aging problem. Some of the representative works of discriminative models is, which used gradient orientation pyramid (GOP) for feature representation, combined with support vector machine for verifying faces across age progression. Guo *et al.* investigated the relationship between recognition accuracy and age gap, and reported the performance of two well known algorithms (PCA and EBGM) on a large data set. They also showed some improvement in matching by indexing the gallery based on demographic information (gender, race, height, and weight). In this paper, we address the age invariant face recognition problem by developing a new discriminative approach. We propose a learning algorithm that has the capability to not only address the aging variations, but also handle the other intra-user variations (e.g., pose, illumination, expression). Our discriminative model differs from the models in , in both feature representation and classification, as shown in Section II. Although global appearance based features have been widely used for face representation, it is now generally agreed , that local image descriptors are more effective for face representation. Compared to the global appearance features, the local features inherently possess spatial locality and orientation selectivity. These properties allow the local feature representations to be robust to aging, illumination, and expression variations. Considering that the entire face image (which has high structural complexity) is difficult to be characterized by a single image descriptor, we use a patch-based local feature representation scheme (also called densely sampled local feature description) in this paper. We first divide the input face image into a set of overlapping patches with each patch represented by an appropriate image descriptor. In order to ensure local consistency, we use 50% overlap between the adjacent patches in our approach. We use both the Scale Invariant Feature Transform (SIFT) and Multi-scale Local Binary Pattern (MLBP) since both of these descriptors have been shown to be very successful in image representation. For matching the set of large number of SIFT and MLBP local features effectively and efficiently, we develop a multi-feature discriminant analysis (MFDA) algorithm for dimensionality reduction. In MFDA, local descriptors are combined to construct a robust decision rule by a random subspace fusion model. Extensive experiments are conducted to validate the effectiveness of the proposed algorithm on two public domain face aging data sets: MORPH and FG-NET. Our approach to match two face images of the same person acquired at different ages differs significantly from the previously published approaches. A major difference lies in the fact that our approach is a discriminative one while most of the other approaches construct generative models. A generative model considers the formation of the target subject's face to be controlled by a set of hidden parameters. Different faces of the same subject at different ages are generated under a similar structure with varying parameters. Accordingly, these parameters are used to characterize the target subject's face. shows an example of the aging simulation process using a generative aging model proposed in . However, the aging process which needs to be modeled is highly complex and there are multiple factors that affect the aging which are subject-specific and depend on the specific age range. This motivates our exploration of the discriminative model for age invariant face recognition. Our discriminative model also differs significantly from other existing discriminative models for the aging problem. The methods in were proposed for the face verification task, which is a binary recognition problem, while our approach is proposed for the face recognition task which is a multi-class recognition problem. Further, the methods in proposed the use of gradient orientation pyramid (GOP) for feature representation, followed by the support vector machine

classifier for verification. Our approach, on the other hand, proposes densely sampled local feature description for feature representation, and further develops the MFDA for classification.

The terminology related to fusion of data from multiple sources is not uniform. Different terms have been adopted, usually associated with specific aspects that characterize the fusion. Before we understand the techniques for sensor fusion, it is important to understand the relationship among the fusion related terminologies. The term *data fusion* and *information fusion* can be used interchangeably. Information fusion is the merging of information from disparate sources with differing conceptual, contextual and typographical representations. It is used for consolidation of data from unstructured or semi-structured resource. On the other hand, *multi-sensor integration* is a slightly different term in the sense that it applies information fusion to make inferences using sensory devices and associated information (e.g., from database systems) to interact with the environment. According to Multi-sensor integration is the synergistic use of information provided by multiple sensory devices to assist in the accomplishment of a task by a system; and multisensory fusion deals with the combination of different sources of sensory information into one representational format during any stage in the integration process. Multi-sensor integration is a broader term than multi-sensor fusion. Thus, *sensor/multi-sensor fusion* is fully contained in the intersection of multi-sensor integration and information/data fusion. *Data aggregation* defines another subset of information fusion that aims to reduce the data volume (typically, summarization), which can manipulate any type of data/information, including sensory data.

Information fusion problems are centuries old. There are many applications in which information fusion methods are employed, and information fusion in sensor network is one of them. Wireless Sensor Networks (WSNs) are used to perform distributed sensing in various fields, such as health, military, home etc, in order to have a better understanding of the behavior of the monitored entity or to monitor an environment for the occurrence of a set of possible events, so that the proper action may be taken whenever necessary. WSN consists of a set of sensor nodes that are deployed in a field and interconnected with a wireless communication network. Each of these scattered sensor nodes has the capabilities to collect data, fuse that data and route the data back to the sink/base station. To collect data, each of these sensor nodes makes decision based on its observation of a part of the environment and on partial a-priori information. As larger amount of sensors are deployed in harsher environment, it is important that sensor fusion techniques are robust and fault-tolerant. The redundancy in the sensor readouts is used to provide error tolerance in fusion. The need for transferring information to locally disparate sensors and the need to associate their data both require a mechanism for transporting data of different structure at minimal costs. WSN are limited with the battery life constraints of the nodes, and thus in WSNs, information fusion techniques are applied for accuracy improvement while taking care of energy of the nodes

we focus on the approximation approach of belief functions. This first reason obviously is that it can reduce the computational cost of evidence combination. Furthermore, human find that it is not intuitive to attach meaning to focal elements with large cardinality . Belief approximation

can either reduce the number or the cardinalities of focal elements, or both of them can be reduced. Thus by using belief function approximation, we can obtain a representation which is more intuitive and easier to process. We propose a new method called hierarchical proportional redistribution (HPR), which is a general principle for uncertainty reduction, to approximate any general basic belief assignment (bba) at a given level of non-specificity, up to the ultimate level 1 corresponding to a Bayesian bba. That is, our proposed approach can generate an intermediate object between probabilities and original belief function. The level of non-specificity can be controlled by the users through the adjusting of maximum cardinality of remaining focal element. Our proposed approach can be considered as a generalized k-additive belief approximation. Some experiments are provided to illustrate our proposed HPR approach and to compare it with other approximation approaches.

In this paper we propose a hierarchical bba approximation approach called hierarchical proportional redistribution (HPR), which provides a new way to reduce step by step the mass committed to uncertainties. Ultimately an approximate measure of subjective probability can be obtained if needed, i.e. a so-called Bayesian bba in. It must be noticed that this procedure can be stopped at any step in the process and thus it allows to reduce the number of focal elements in a given bba in a consistent manner to diminish the size of the core of a bba and thus reduce the complexity (if needed) when applying also some complex rules of combinations. We present here the general principle of hierarchical and proportional reduction of uncertainties in order to obtain approximate bba's at different non-specificity level we expect. The principle of redistribution of uncertainty to more specific elements of the core at any given step of the process follows the proportional redistribution already proposed in the (non hierarchical) DSmP transformation proposed recently in. Thus the proposed HPR can be considered as a bba approximation approach inspired by the idea of DSmP.

Face recognition presents a challenging problem in the field of image analysis and computer vision, and as such has received a great deal of attention over the last few years because of its many applications in various domains. Face recognition techniques can be broadly divided into three categories based on the face data acquisition methodology: methods that operate on intensity images; those that deal with video sequences; and those that require other sensory data such as 3D information or infra-red imagery. In this paper, an overview of some of the well-known methods in each of these categories is provided and some of the benefits and drawbacks of the schemes mentioned therein are examined. Furthermore, a discussion outlining the incentive for using face recognition, the applications of this technology, and some of the difficulties plaguing current systems with regard to this task has also been provided. This paper also mentions some of the most recent algorithms developed for this purpose and attempts to give an idea of the state of the art of face recognition technology

Face recognition is a specific and hard case of object recognition. The difficulty of this problem stems from the fact that in their most common form (i.e., the frontal view) faces appear to be roughly alike and the differences between them are quite subtle. Consequently, frontal face

images form a very dense cluster in image space which makes it virtually impossible for traditional pattern recognition techniques to accurately discriminate among them with a high degree of success [35]. Furthermore, the human face is not a unique, rigid object. Indeed, there are numerous factors that cause the appearance of the face to vary. The sources of variation in the facial appearance can be categorized into two groups: intrinsic factors and extrinsic ones [36]. A) Intrinsic factors are due purely to the physical nature of the face and are independent of the observer. These factors can be further divided into two classes: intrapersonal and interpersonal [37]. Intrapersonal factors are responsible for varying the facial appearance of the same person, some examples being age, facial expression and facial paraphernalia (facial hair, glasses, cosmetics, etc.). Interpersonal factors, however, are responsible for the differences in the facial appearance of different people, some examples being ethnicity and gender. B) Extrinsic factors cause the appearance of the face to alter via the interaction of light with the face and the observer. These factors include illumination, pose, scale and imaging parameters (e.g., resolution, focus, imaging, noise, etc.

2.3 MOTIVATION

We propose to create a 3D aging model suitable for the task of face recognition, since the true craniofacial aging model can be naturally formulated in 3D. With 2D projection, growth parameters for landmarks can only be estimated based on a limited number of facial proportions that can be reliably estimated from photo grammetry of frontal images. The proposed 3D model would allow us to incorporate texture into individual facial components such as eye, mouth, and forehead, which is in line with the aging simulation method based on a graph structure [22]. 3D models can also be used to locate muscle fibers, and wrinkles can be generated across and orthogonal to the fibers [9]. The general form of the model is a narrow furrow with a bulge that can be rendered using a modified texture or an additional bump map. The simulation of aging in the texture based on the analysis of muscle fiber structure is beyond the scope of this paper. However, we provide a straightforward image based aging simulation for the texture.

We have proposed a 3D facial aging modeling and simulation method for aging-invariant face recognition. The extension of shape modeling from 2D to 3D domain gives additional capability of compensating for pose and lighting variations. The proposed age modeling method is capable of modeling the growth pattern as well as the adult aging. We have evaluated the proposed approach using a state of- the-art commercial face recognition engine (Face VACS), and obtained improvement in face recognition performance. We have shown that our proposed method is capable of handling both growth-and-development and adult face aging and provide performance. However, we have observed that in a small percentage of cases the proposed aging modeling causes failure of matching after the aging simulation. This shows the need to improve the proposed aging modeling technique. We plan to evaluate the proposed approach to a wider range of images, e.g., the MORPH database. We will also explore the optimal method for building aging pattern space given noisy 2D or 3D shape and texture data by cross validating the aging pattern space and aging simulation results in terms of face recognition performance. Face recognition is still a great challenge in biometrics research, because of the large variations of facial appear- once, caused by head pose, lighting, facial

expression, aging, etc. Among all possible variations, the biggest change of facial appearance in 2-dimensional (2D) face images
probably comes from the three-dimensional (3D) head rotations. With the sensor technology advances, e.g., the recent RGB-D cameras, we study the advantage of using RGB-D images for face recognition, focusing on the challenge of 3D head pose variations. We propose an approach to face recognition robust to head rotations utilizing the RGB-D face images. Unlike the traditional 3D morph able model, our method does not need to learn a generic face model or take a complicated 3D to 2D face registration. We study what is the appropriate scheme to deal with pose variations in order to develop a robust system towards pose-invariant face recognition. Experiments on a public database show that our approach is effective and efficient for face recognition under significant pose changes. Our preliminary result demonstrates the advantages of using the RGB-D sensor for face recognition robust to large pose variations.

2.4 OBJECTIVE OF THESIS

The objectives of the thesis are:

- implementation and analysis of the improved techniques of the age invariance face recognition. the development of the algorithm which would give the better result than the other face recognition algorithm. these techniques are the improved over the previous algorithm .

2.5 ORGANIZATION OF THESIS

This is divided into four chapters

The first chapter present the overview of the age invariance face recognition techniques used for the recognition.

The second chapter has the literature survey of various technologies regarding the face recognition

The third chapter includes the implementation of the approach and new proposed technique

The fourth chapter has the information about the conclusion and future scope.

CHAPTER 3

PROPOSED ALGORITHM

3.1 INTRODUCTION.

There are many area where face detection and recognition is needed like in security area passport and identification it has been very cumbersome to have people detect faces of human because it is waste of time and human get tired and angry and have excuses so to handle and rectify this problem technology has provided some tool to do the job is effective manner like we can use the computer algorithm to provide such data that can be used to so do this job more effectively and efficiently without complaining of tiredness or fatigue or getting angry.

First of all we have to have the fundamental foundation and basic blocks which lead us to have the initial structure for the face detection and the further face recognition and age invariance face recognition and these basic blocks are the fundamental of the image and signal processing.

Image processing is the field in which the analysis of the image are done and various process and transformation are dome on the image.

Image processing are many types analog image processing in which the image is the analog in format and processing is done like developing the image from the negative frame it is very time consuming and cumbersome and have high level of the noise related interference which degrade the quality of the image. this technology is very primitive and slow. on the other hand the mew technology the digital image processing.

Digital image processing is the fast growing technology which rely heavily on the signal processing and on the computer computation capability available.

There are many process in the image processing as follows; image acquisition is the process in which the image is captured by the various devices like the optical camera, laser camera , radar, UV camera , and other devices.

There are three types of image acquisition device sensors dot sensors, line sensors, array sensor .Dot sensor is which capture one point of area of the image at a time. Line senor is which capture one line of the image at a time. array sensor is which capture in two dimension at a time.

image enhancement is the process that in quality of the image is in the judgmental view for the subject which tests it or in other words the image enhancement is subjective process.

It is the process by which the images are restored or get cleared from the noises which get associated with the image at time of the image acquisition or other process. there are several processes by which the image restoration can be done like filtering in the special or frequency domain. filter which are used to have the filtering process are high pass filter , low pass filter, inverse filter, Gaussian filter, elliptical filter and these filter are used to filter out the noises which are Gaussian noise , salt paper noise , periodic noise etc.

Restoration unlike the image enhancement is a objective process where the image is restored in fixed and mathematical manner by using various transform and operation.

By using appropriate tool in the image processing tool kit we can easily restored images provided which can be restored.

If we want to do the processing in the image some time it becomes very difficult to do that because image processing requires large computation capacity so it would be waste of the memory of the computer because many times the process which is needed to be performed on the image is only on the small portion of the image so we must have the capability divide the image in desired or in definite manner so the power of computer may not waste in most time. there are many techniques which are used to do division of image and it is called image segmentation and these techniques are based on color , intensity , texture , etc.

Edge detection- edge detection is the process in which the change of the intensity in the image is detected as a Edge between the two regions of the image which are having different color, intensity , illumination , etc. there are several method to have it done one of the method is the Soble operator which uses the first derivative in the image to find out the intensity change in the image , there is other method in which the change in the color hue in the image are there the separation between them gives the edge in the image. Edge detection is the most basic fundamental of the technology which deals with the detection of the object because without the edge detection the other detection may not work properly. there many filters which can do this like the Prewitt filter, Roberts filter, Laplacian filter, Emboss filter, Edge dog filter, etc.

Color detection-color cue is the major factor in the image because most of the image in today's world is made up of the color so the color detection is the very useful in long run. it is the easiest detection in the row because having color detected gives the power of the separation of the objects of the deferent color very easily and the image segmentation can be performed very easily.

texture detection- it is the process by which we can actually separate the two deferent surface from each other by detecting the deference in the surface structure of the plane because it is the nature reality the no surface can have same texture exactly the same so we can use that property to detect two surface or the foreground from the background. the texture detection is very useful when the foreground and background have the same color because in that case it is very difficult to separate the two surface from each other by color detection or other.

contour detection - it is the very useful detection scheme because it provides the very foundation of the object detection and recognition , it provides the necessary information about the shape of the object , it gives the outlay of the object shape whether the object is circular ,square, rectangle , cube, elliptical , cuboids, etc.

object detection is the immerging field in the signal processing and image processing technology as the technology needed to detect object shape has already been in the improving or say in the advance stage. we can move farther to the field of the object detection which is a base for further development of the face detection because without the object detection there would no be any face detection as we have already developed the technology of the contour detection and the texture and color and edge detection. object detection is the way we can move to the face detection in the area because now we have the tool to detect the shape of the object in testing , it make use the available technology which are color , texture , edge detection and it is used in the whether the object is round , rectangle , cubical , cubic, etc. as we know the human face has a definite shape and it can be detected with the help of the computer algorithm and not only the human face human body , human facial features , and human movements can be detected to this is the basic requirement in the further study of the human computer interface.

Object recognition and indexing is the field in the image processing in which the object is first assumed to be detected and then it is recognize for which category of object it belongs to whether the object is a plane or car or toy or stone or animal or the human being. it has to be recognize to have the usefulness in some sense so the detected objects are must be recognized to put them in the particular category. indexing is the procedure where the recognized object is then indexed to the particular identification so it can be put in the same category where the other same type of the object belongs to . without the object recognition and indexing the field of the human face detection cannot be born.

To recognize the detected object we must need some classifier which classify them to the particular category and these classifiers are based on any algorithm like the PCA , LDA , KARNAL PCA, SUPPORT VECTOR MACHINE , ARTIFICIAL NEURAL NETWORK

Object tracking is a field in the signal processing where the location of the object in the sequence of the video whether the video is real time or the stored is fed into the computer and the algorithm finds and tracks the desired object in the video.

there are many cases where the data is given to the algorithm from several sensors which may

or may not be same type so there is a high probability that the output of these sensors may conflict each other so to handle these there are few techniques are given to fuse this conflicting data input which could otherwise be very difficult to maintain because the output of these conflicting and fuzzy output can be fuse to obtain the definite result so to be fed into the next level in the algorithm. there are techniques which are used to do this are DSMT (DEZERT-SMARANDACHE THEORY OF PLAUSIBLE AND PARADOXICAL REASONING) this theory is the advanced version of the previous theory given by the DEMSHER SHEFFER THEORY but it is more advance. It has The power set, hyper-power set and super-power set these sets are used in the different cases the power set has the minimum level of flexibility , the hyper power set has medium level of flexibility , and the super power set has the highest flexibility.

There are three models, which are the free DSM model, the Shafer model, and hybrid DSM model which are there to give the required environment to the performance to these sets .

There are some rules to combine and applying the data, which are the classic DSM rule of combination, the hybrid DSM rule of combination, and the proportional conflict redistribution rule of combination.

there are many features extracting algorithm in the image processing there are LDA based features extractor, color based , sift(scale invariant feature transform) algorithm , MLBP (multi scale binary patterns) , linear binary pattern, DWT discrete wavelet transform, AAM (active appearance model). these features extracting algorithm are used mostly in the face recognition and age invariance face recognition.

Dimension reduction algorithm are those algorithm which are used to reduce the extra data associated with the actual data and which are unnecessary to the purpose so it is beneficial to reduce the data in order to increase the performance and make less computational expensive there are various data reduction scheme in the field and they are used to reduce the data at the same time the preserving the necessary data required by the algorithm and these algorithm are PCA (principle component analysis), MFDA (multi feature discriminate analysis), MCW (maximum weighted cut), KRBF (kernelized radial basis function).

classification is the area in the image processing in which the features which are already extracted are classified into some domain or in other words the we tag them or link them to some category which are or may be old or new . there are many scheme by which we can classify the data and they are based on some algorithm like LDA, support vector machine , artificial neural networks ,maximum a posteriori probability using Gaussian mixture type classifiers ,maximum a posteriori probability using a mixture of multinomial distribution like classifiers.

adaptive boosting is the algorithm which is used in many applications , the purpose of the adaptive boosting is sense when the classification is done by many classifiers. when that nothing is perfect in this world so is the classifiers that is one classifier has one quality but lacks in the other area so does other classifiers , some classifiers do well is some condition and fail in other condition like the color based classifier works well in the image where the image has different and distinct colors it can classify the target but it fails when there is less illumination or the target and the background has same color in these situations the classification is not robust and reliable . to rectify that unfavorable situation the process uses the more than one classifier , the thinking behind this is that they use more classifier in which one works in condition and if it fails in some conditions then the other classifier which does not fail in that condition must classify the target. but fuse the output of different classifiers has been a difficult task so the adaptive boosting was developed to tackle that task. what it does , it uses the statistical mathematical approach by which adaptively boost the output of the weak classifier however the strong classifier are there so the strong classifiers do not overwhelm the weak classifiers.

face detection is the technology which uses the all inventions which were done before it the image processing and other technology face detection is very useful in the field where the human detection is crucial and time consuming and frustrating like in the border area and the prison security route , security checkpoints however there are number of condition where the face detection is very essential like in the area where the recognition of the human face is very important because identifying the wrong person could have very serious consciousnesses like in the bank and ATM's which is why it has become very necessary to our daily life. there are very powerful algorithm present to tackle this problem like the sift , genetic algorithm , ADABOOST algorithm, and various LDA based classifiers.

genetic algorithm is a algorithm which is very heavily used in this field because detection and recognition of the human face is difficult and require very high skill and need to be conditioned before being used in the economical way so the output of the algorithm makes some sense. as we the genetic algorithm is based on the genetic technology which says that the only the

strongest, the fastest and the most intelligent species survives and evolve in the nature using that genetic algorithm uses that every algorithm is tested and new algorithm is built which have the features of the previous algorithm and the algorithm can be mutated.

face recognition is the field in which the detected face of human is then recognize and indexes to the name so whenever the person comes to the face recognition program it recognize it. the recognition works as the image or the video is given to the computer then the face of human being is detected after the detection is done the features of the face is then extracted from the face itself and the features are the skin tone , nose shape , eyes , lips , face cut , and then these features are mapped and other detection also taken place like the emotion detection , gaze estimation, HCI systems . based on these features the further process is the classification or the match making which color based classification because the color cue is a very important feature in the face recognition.

age invariance face recognition is the latest technology in the image processing the basic theme behind the age invariance face recognition is that face recognition does recognize the face of the human being very accurately but there is a limitation to the performance of the face recognition algorithm that human face does not remain exactly same throughout the life of the person. the facial feature of the human face change throughout the its life phase so it is the hard problem for the image processing engineering field that how to make an algorithm recognize a face of the person regardless of its age .they uses many approach like the linear discriminated analysis , group matching , nonlinear topological component analysis in which various transform are r uses like SIFT, KRBF, MLBP MLDF.

3.1.1: THE PROPOSED METHOD AND ALGORITHM

The proposed method is proposed here that we have two algorithm that is used to recognize the face regardless of the age of the subject and the two algorithms are :

1. first algorithm is the in which the features extraction is done by the MLBP and SIFT and DWT together which is the first level of the algorithm. second level of the algorithm is the dimensionality reduction KRBF. and the third and the last level is the classification which is done by combination of the multiple LDA based classifiers and maximum a-posteriori probability using a mixture of multinomial distribution and this classifiers are assisted by the addaboosting algorithm.

2. In the second algorithm levels are almost the same instead of the dimensionality scheme . in this algorithm I have used the MFDA instead of the KRBF for the dimension reduction.

3.2 ANALYTICAL MODEL.

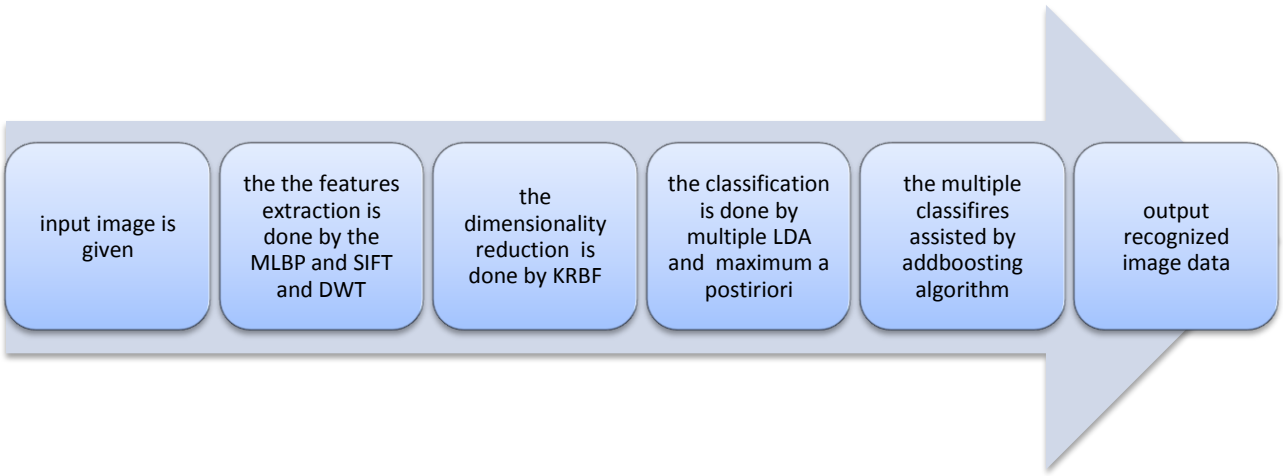

Figure 3.1: proposed algorithm one

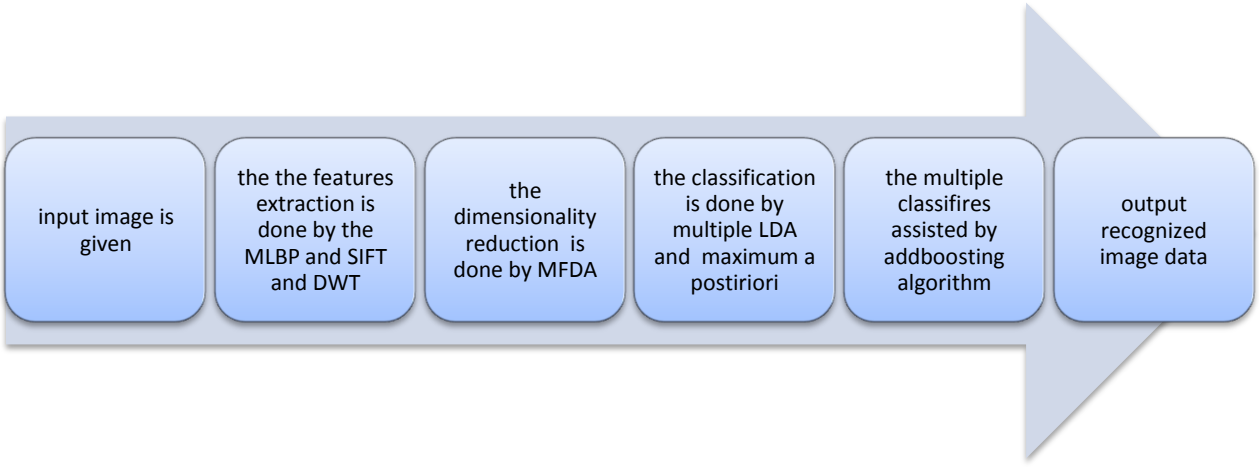

Figure 3.2: proposed algorithm two

3.3 SIMULATION SETUP.

The simulation is done on the mat lab simulation language which is a good platform for the simulation for the software based or in various cases hardware based too . in the simulation the i have performed the algorithms which are proposed by me and having satisfactory results which shows that the algorithm is effective in positive manner . and this algorithm can be used and can be made in a standard template library item in the file.

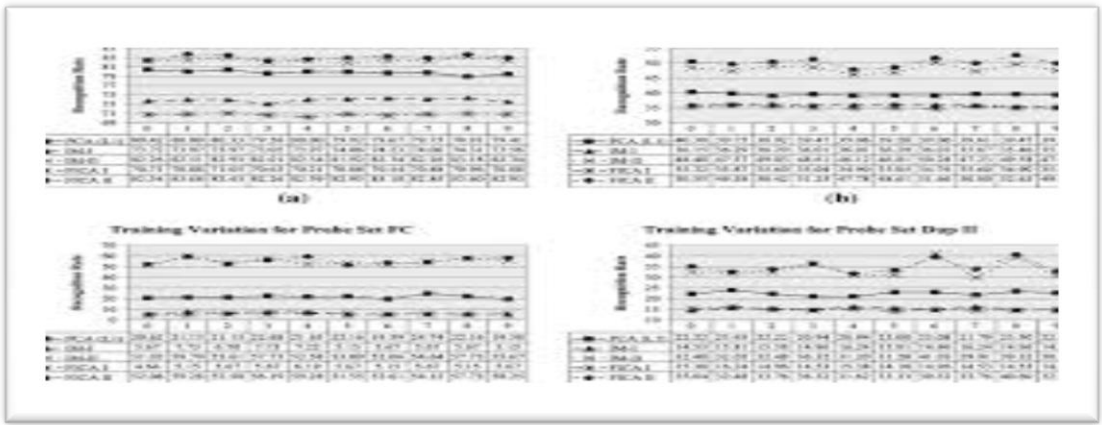

Figure 3.3: SIMULATION

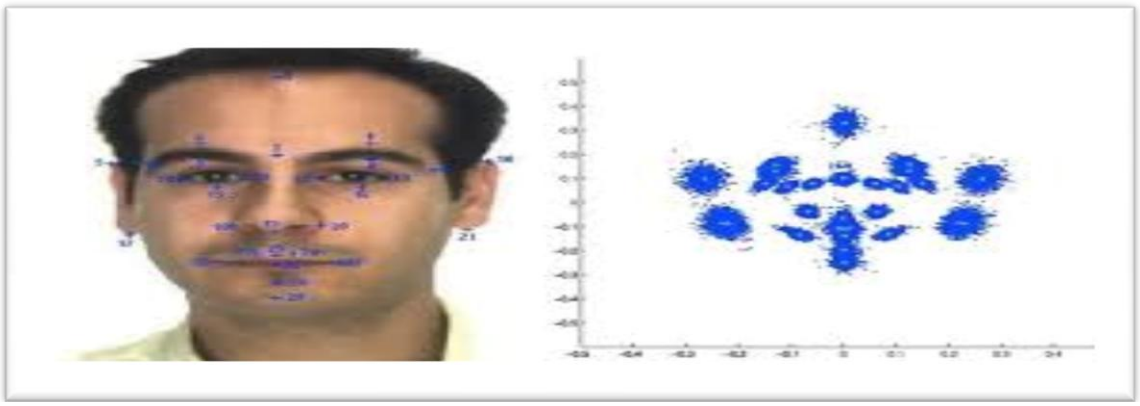

Figure 3.4: SIMULATION

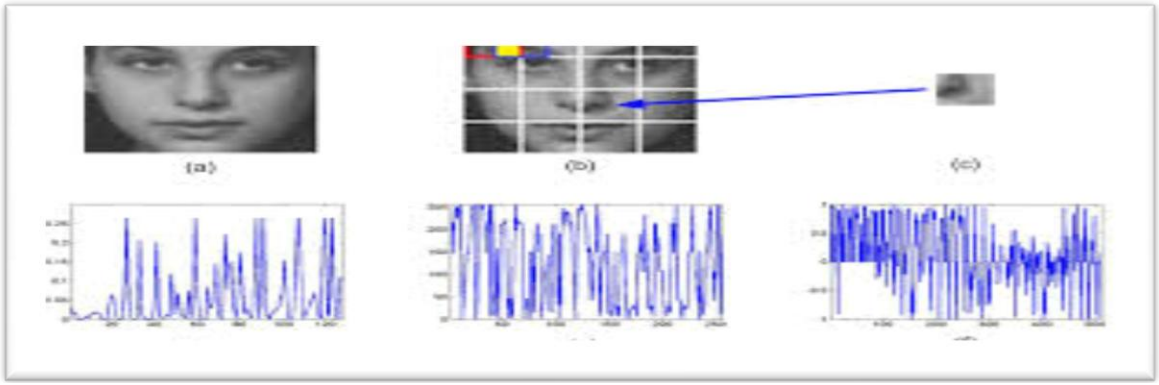

Figure 3.5: SIMULATION

3.4 RESULTS AND DISCUSSION.

The algorithm proposed work well and can be used without requiring any extra hardware or software as all the software needed to simulate this algorithm can written using standard template library function in mat lab and they are easy to assemble in the new algorithm .

CHAPTER 4:

4.1 CONCLUSION.

we have concluded that these algorithms work well and can used effectively and easily and can be just a few more addition to the older versions of the algorithm and simulation packages.

4.2 FUTURE SCOPE.

we can use this algorithm not just in the image processing but also in different discipline of the pattern recognition and machine learning and also in the artificial intelligence software.

REFERENCES

[1] FG-NET Aging Database, http://www.fgnet.rsunit.com.

[2] V. Blanz and T. Vetter. A morphable model for the synthesis of 3d faces. In *SIGGRAPH '99: Proc. 26th annual conference on Computer Graphics and Interactive Techniques*, pages 187–194, New York, NY, 1999.

[3] T. F. Cootes, G. J. Edwards, and C. J. Taylor. Active appearance models. *IEEE Trans. on Pattern Anal. and Mach. Intell.*, 23(6):681–685, 2001.

[4] L. G. Farkas, editor. *Anthropometry of the Head and Face*. Lippincott Williams & Wilkins, 1994.

[5] X. Geng, Z.-H. Zhou, and K. Smith-Miles. Automatic age estimation based on facial aging patterns. *IEEE Trans. Pat- tern Anal. Mach. Intell.*, 29:2234–2240, 2007. (a) (b) (c) (d) (e) Figure 4. Example matching results before and after age simulation for seven different subjects: (a) probe, (b) pose-corrected probe, (c) age-simulated probe, (d) pose-corrected gallery and (e) gallery. All the images in (b) failed to match with the corresponding images in (d) but images in (c) were successfully matched to the corresponding images in (d) for the first five subjects. Matching for the last two subjects failed both before and after aging simulation. The ages of (probe, gallery) pairs are (0,18), (0,9), (4,14), (3,20), (30,54), (0,7) and (23,31), respectively, from the top to bottom row.

[6] R. Heitmeyer. Biometric identification promises fast and secure processing of airline passengers. *ICAO Journal*, 55(9), 2000.

[7] A. Lanitis, C. Draganova, and C. Christodoulou. Comparing different classifiers for automatic age estimation. *IEEE Trans. SMC-B*, 34(1):621–628, February 2004.

[8] A. Lanitis, C. J. Taylor, and T. F. Cootes. Toward automatic simulation of aging effects on face images. *IEEE Trans. Pattern Anal. Mach. Intel.*, 24(4):442–455, 2002.

[9] W.-S. Lee, Y.Wu, and N. Magnenat - Thalmann. Cloning and aging in a vr family. In *VR '99: Proc. IEEE Virtual Reality*, page 61, Washington, D.C., 1999.

[10] H. Ling, S. Soatto, N. Ramanathan, and D. Jacobs. A study of face recognition as people age. In *IEEE International Conference on Computer Vision (ICCV)*, 2007.

[11] X. Lu and A. K. Jain. Deformation modeling for robust 3d face matching. In *IEEE Conf. Computer Vision and Pattern Recognition (CVPR)*, pages 1377–1383, Washington, D.C., 2006.

[12] A. OT'oole, T. Vetter, H. Volz , and E. Salter. Three dimensional caricatures of human heads: distinctiveness and the perception of facial age. *Perception*, 26:719–732, 1997.

[13] U. Park, H. Chen, and A. K. Jain. 3d model-assisted face recognition in video. In *CRV '05: Proc. 2nd Canadian Conference on Computer and Robot Vision*, pages 322–329, Washington, D.C., 2005.

[14] E. Patterson, K. Ricanek, M. Albert, and E. Boone. Automatic representation of adult aging in facial images. In *IASTED '06: Proc. 6th International Conference on Visualization, Imaging, and Image Processing*, pages 171–176, 2006.

[15] E. Patterson, A. Sethuram , M. Albert, K. Ricanek, and M. King. Aspects of age variation in facial morphology affecting biometrics. In *BTAS '07: Proc. First IEEE International Conference on Biometrics: Theory, Applications, and Systems*, pages 1–6, 2007.

[16] P. J. Phillips ,W. T. Scruggs, A. J. O'Toole, P. J. Flynn, K.W. Bowyer, C. L. Schott, and M. Sharpe. FRVT 2006 and ICE 2006 Large-Scale Results. Technical Report NISTIR 7408, National Institute of Standards and Technology.

[17] F. Pighin, R. Szeliski, and D. H. Salesin. Modeling and animating realistic faces from images. *Int. J. Comput. Vision*, 50(2):143–169, 2002.

[18] J. B. Pittenger and R. E. Shaw. Aging faces as viscal-elastic events: Implications for a theory of non rigid shape perception. *J. Exp. Psych.: Human Perception and Performance*, 1:374–382, 1975.

[19] N. Ramanathan and R. Chellappa. Face verification across age progression. In *IEEE Conf. Computer Vision and Pattern Recognition (CVPR)*, volume 2, pages 462–469, 2005.

[20] N. Ramanathan and R. Chellappa. Modeling age progression in young faces. In *IEEE Conf. Computer Vision and Pattern Recognition (CVPR)*, volume 1, pages 387–394, 2006.

21] K. J. Ricanek and T. Tesafaye. Morph: A longitudinal image database of normal adult age-progression. In *FGR '06: Proc. 7th International Conference on Automatic Face and Gesture Recognition*, pages 341–345, Washington, D.C., 2006.

[22] J. Suo, F. Min, S. Zhu, S. Shan, and X. Chen. A multi resolution dynamic model for face aging simulation. In *IEEE Conf. Computer Vision and Pattern Recognition (CVPR)*, 2007.

[23] D. W. Thompson. On Growth and Form. *New York: Dover*, 1992.

[24] J. Wang, Y. Shang, G. Su, and X. Lin. Age simulation for face recognition. In *ICPR '06: Proc. 18th International Conference on Pattern Recognition*, pages 913–916, 2006

[25]F. Samaria, “Face recognition using hidden Markov models,” Ph.D. dissertation, Dept. Eng., Cambridge Univ., Cambridge, U.K., 1994.

[26] D. Bouchaffra, “Conformation-based hidden Markov models: Application to human face identification,” *IEEE Trans. Neural Netw.*, vol. 21, no. 4, pp. 597–608, Apr. 2010.

[27] W. Zhao and R. Chellappa, *Face Processing: Advanced Modeling and Methods*. San Diego, CA, USA: Academic, 2006.

[28] S. Z. Li and A. K. Jain, *Handbook of Face Recognition*. New York, NY, USA: Springer-Verlag, Mar. 2005.

[29] F. Juefei-Xu, K. Luu, M. Savvides, T. D. Bui, and C. Y. Suen, “Investigating age invariant face recognition based on periocular biometrics,” in *Proc. IEEE Int. Joint Conf. Biometrics Compendium*, Washington, DC, USA, Oct. 2011, pp. 1–7.

[30] N. Ramanathan, R. Chellapa, and S. Biswas, “Computational methods for modeling facial aging: A survey,” *J. Vis. Lang. Comput.*, vol. 20, no. 3, pp. 131–144, 2009.

[31] Z. Yang and H. Ai, “Demographic classification with local binary patterns,” in *Proc. 3rd IEEE Int. Conf. Biometrics*, San Francisco, CA, USA, 2007, pp. 464–473.

[32] X. Geng, Z.-H. Zhou, and K. Smith-Miles, “Automatic age estimation based on facial aging patterns,” *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 29, no. 12, pp. 2234–2240, Dec. 2007.

[33] U. Park, Y. Tong, and A. K. Jain, “Age-invariant face recognition,” *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 32, no. 5, pp. 947–954, May 2010.

[34] Z. Li, U. Park, and A. K. Jain, “A discriminative model for age invariant face recognition,” *IEEE Trans. Inf. Forensics Security*, vol. 6, no. 3, pp. 1028–1037, Sep. 2011.

[35] D. Bouchaffra, “Topological dynamic Bayesian networks,” in *Proc. 20th Int. Conf. Pattern Recognit. (ICPR)*, Istanbul, Turkey, Aug. 2010, pp. 898–901.

[36] D. Bouchaffra, “Topological dynamic Bayesian networks: Application to human face identification across ages,” in *Proc. IEEE Comput. Soc. Conf. CVPR Workshops*, San Francisco, CA, USA, Jun. 2010, pp. 1–8.

[37] A. V. Malkapurkar, R. Patil, and S. Murarka, “A new technique for LBP method to improve face recognition,” *Int. J. Emerg. Technol. Adv. Eng.*, vol. 1, no. 1, pp. 1–5, Nov. 2011.

[38] *Alpha-shapes software*. [Online]. Available: http://biogeometry. duke.edu/software/alphashapes/index.htm, accessed 1994.

[39] K. Ricanek and T. Tesafaye, “MORPH: A longitudinal image database of normal adult age-progression,” in *Proc. IEEE 7th Int. Conf. Autom. Face Gesture Recognit.*, Southampton, U.K., Apr. 2006, pp. 341–345.

[40] *FG-Net Aging Database*. [Online]. Available: http://www.sting.cycollege.ac.cy/~alanitis/fgnetaging/, accessed 1998.

[41] A. W. Rawls and K. Ricanek, Jr., “MORPH: Development and optimization of a longitudinal age progression database,” in *Proc. BioID_MultiComm*, Madrid, Spain, Sep. 2009.

[42] J. R. Beveridge, K. She, B. Draper, and G. H. Givens, “Parametric and nonparametric methods for the statistical evaluation of human ID algorithms,” in *Proc. 3rd Workshop Empirical Eval. Methods Comput. Vis.*, Dec. 2001, pp. 1–14.

[43] *FaceVACS Software Developer Kit, Cognitec Systems Gbmh*. [Online]. Available: http://www.cognitec-systems.de, accessed 2004