A Major Project - II report on

AGE DETECTION USING FACIAL FEATURE

Submitted in partial fulfillment of the requirement for the award of degree of

Master of Technology
In
Software Technology

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This is to certify that the thesis entitled **"AGE DETECTION USING FACIAL FEATURE"** done by **Yatindra Mungre** (Roll No. **2K14/SWT/518**) for the major project-II for the award of degree of **Master of Technology** Degree in **Software Technology** in the **Department of Computer Engineering**, Delhi Technological University.

The Major Project II is a bonafide piece of work carried out and completed under my supervision and guidance. To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any degree or diploma.

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ABSTRACT

The project presented here is an attempt to use Facial feature Extraction for human image. The applications instigated from such an attempt will result in to a set of extracted facial features. Using these facial features various recognitions can be derived. Age recognition is the primary recognition, which is under research for various requirements.

The project is an attempt to use a basic feature detection algorithm for images which contains human image. The applications instigated from such an attempt will result in facial feature detection of image which has human in it. It tries to draw understanding of unique age detection methods using PCA for facial feature extraction and KNN as classifier.

The idea can be describes in 5 steps process. In which first step is involved with capturing the image either by camera or through database. The second step to preprocess image and capture the face object. Third and fourth step is for feature point extractions (i.e. for different facial component like lips, eyes, forehead and chin) and feature space reduction. The final step is for age classifier.

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INTRODUCTION

1.1 OVERVIEW

Age detection using facial feature requires extraction of the facial feature [1]. And based on extracted feature, it can be classified further in order to detect age. The facial feature extraction is the first step of various age detection. As the feature plays an important role in age detection therefore selecting the set of feature point is an important task. There are methods available for detection of facial features, using image detection, feature extraction, analysis and classification methods.

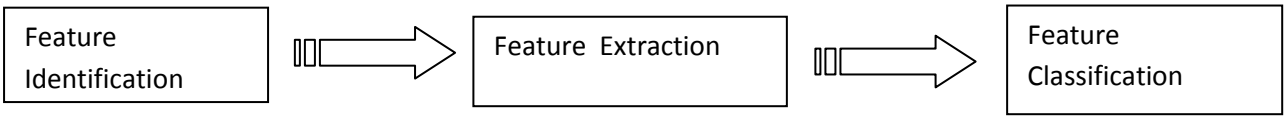

Figure 1 Three Phase View

1.1.1 Facial Image Capture

For the feature extraction of facial images [3, 19], the face in the selected images should initially be detected with all its boundaries. Face detection is a trivial task for human brain, but it has been one of the difficult problems which are handled by the machines.

1.1.2 Feature Extraction

Various feature extraction [4, 5] and reduction methods are available. Linear Discriminate Analysis reduces dimensionality while preserving the class discriminatory. In case for facial images age detection using Principle Component Analysis, features can be distinguished as linear uncorrelated variable. Gabor wavelet could extract feature at an aligned angle (i.e. orientation), but sensitive to local variation. Discrete cosine transform is useful for extracting global feature. But it is sensitive to illumination direction. Principle component analysis uses orthogonal transformation. It converts a set of observations of correlated variable to set of linear uncorrelated variables.

No. of principal component should be less than no. of original variables. First principal component has the largest possible variance. Each succeeding component has highest variance to the orthogonal preceding element. PCA [2] can be done via Eigen value decomposition which is factorization of the matrix in canonical form.

1.1.3 Feature Classifier

The classification of facial feature [6, 7] to recognize the age is the final step. There are various types of classification method available. Naïve Bayes classifier considers that a particular feature of a class is unrelated to the presence of other feature.

Radial Basis Function has been used in many applications like prediction, function approximation and classification. Multi layer perceptron uses artificial neural network that maps sets of input data onto a set of appropriate output. It follows supervised learning technique. K-NN classifier approximates the instances, locally.

The computation is deferred till classification. It is the simple machine learning algorithm without any parameter. In k-NN classification, it maps the output to a class which is closely related. An observation is get assigned to the group most common surrounded by its k nearest neighbors (k is a positive integer, typically small). The preponderance vote of the neighbors can allocate an observation.

1.1.4 Problem Statement

- The aging progress is uncontrollable. The aging affects the appearance very slowly, however the changes due to aging will further degrade. In order to provide an efficient system to determine the age, a large training set is mandatory requirement. With available data base is available for free is not sufficient.

- Existing age detection algorithm [9] relies on global features (global facial feature extraction, wrinkle analysis, artificial neural network and global Face image database).

- Current implementation [10] will help to enhance the accuracy based on more localized and an easy to implement algorithm. In case of people within same localized environment [11] this strategy can be more useful and accurate.

1.2 PRINCIPAL COMPONENT ANALYSIS

Using Principal component analysis (PCA) a set of observations of certainly related variables can be converted into a set which consist of non-correlated variables. These non-correlated variables can be termed as principal components. If there are N observations with P variables, then the number of noticeable principal components will be minimum of N-1 observations and P variables.

The strategy used in this, is as follows. The first principal component has the most available change (this component the most significant as per the data change) and next following component if it is orthogonal to earlier components, must have larger

change and so on. And such a set will be non-correlated orthogonal set. The relative mount of the original values can impact the PCA.

Gabor Wavelet, Linear decimate analysis and various other feature detection techniques are used other than PCA, However PCA found to be simpler in comparison to the available feature extraction and reduction.

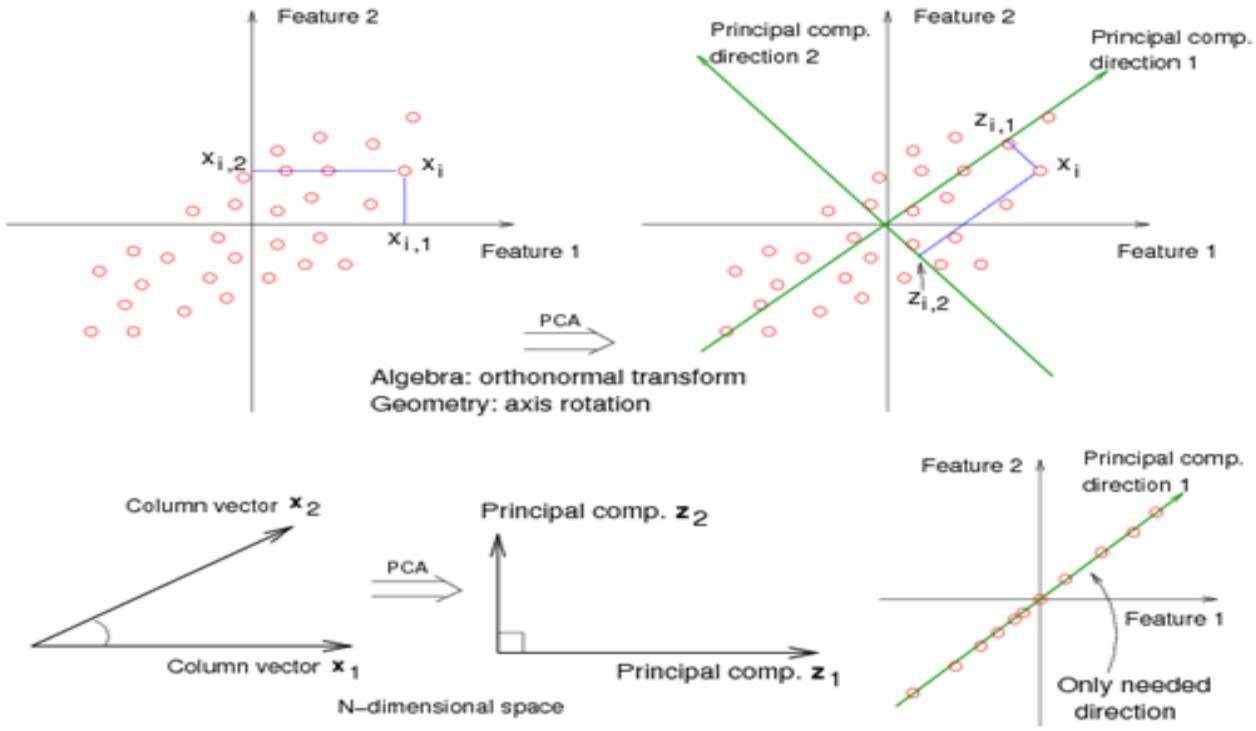

Figure 2 Principal component vector

1.2.1 Dimension Reduction

The primary task after identifying the feature points is to remove nonessential dimensions of data matrix (d) by reducing it to a (k) dimensional sub data matrix. The aim to increase computation efficiency without compromising the major information, which needs to be good enough for recognition or predictions. This gives rise to the decision of choosing the size of reduced dimensional space, so that it could represent the data well enough which results into better computational efficiency without hampering the prediction and recognition algorithm.

The idea is to generate eigen vectors of a data matrix and collect them in a reduced data matrix. In order to define the value of component, every component is mapped to a value which can be defined as the weight of the corresponding component. Now in

order to reduce dataset, less informative values components needs to be dropped, since some of significantly larger magnitude could represent the data set well and can be used as prediction model or recognition.

In order to standardize the data. Either from Singular Vector Decomposition or covariance/correlation matrix, eigen vectors and eigen values can be calculated. Form calculated eigen values, descending sorted order could be applied to identify the corresponding eigen vectors. Now based on all selected eigen vectors, we could achieve the dimensional reductions, without losing data which is required for prediction.

1.3 K-NN CLASSIFIER

Pattern recognition, the k-nearest neighbor's algorithm (k-NN) is observation based method used for classification and recognition. It requires a feature space which consist of training sets which are closet of k both the cases. In order to identify a particular group or a range, classification can be used. Whereas a particular number is required, regression is used.

In k-NN classification, it maps the output to a class which is closely related. An observation is get assigned to the group most common surrounded by its k nearest neighbors (k is a positive integer, typically small). The preponderance vote of the neighbors can allocate an observation. In the event where only single neighbor is available, nearest then the object is simply assigned to the class of that single nearest neighbor. In k-NN regression, the output is the characteristic for the object. This value is the mean of the values of its k nearest neighbors.

The classification of the feature for age recognition can be done using various methods like Radial Basis Function, Multiplayer Perception, and support Vector Machine. KNN classifier uses the Euclidean distance method to calculate the distance. A test Item can be recognized to a class where from it has shortest distance.

In machine learning, K-Nearest Neighbors is one of easy to implement and important classification algorithms. Since it required training data set, this is a type of supervised learning. For domain and intense application in pattern recognition, data mining and intrusion detection, K-NN can be used where applicability revolves around more locally to the available data sets.

In real-life scenarios, where distribution of data is unimportant and available data needs to be exhausted based on the already available group, K-NN algorithm is found far superior than other algorithms which assumes Gaussian distribution of the given data.

In case if we are given some prior data (also called training data) which is exhaustive in nature, the classification will be better so as to identified into the groups by an attribute.

The basics of algorithm can also be understood as follows. Store the training samples in an array of data. And each element of this array represents a tuple (x, y). Calculate euclidean distance of an item from the available data set from the group. Make set S of K smallest distances obtained. Each of these distances correspond to an already classified data point. Return the majority label among S.

Local change of the data can impact the k-NN algorithm, and may limit its usage.

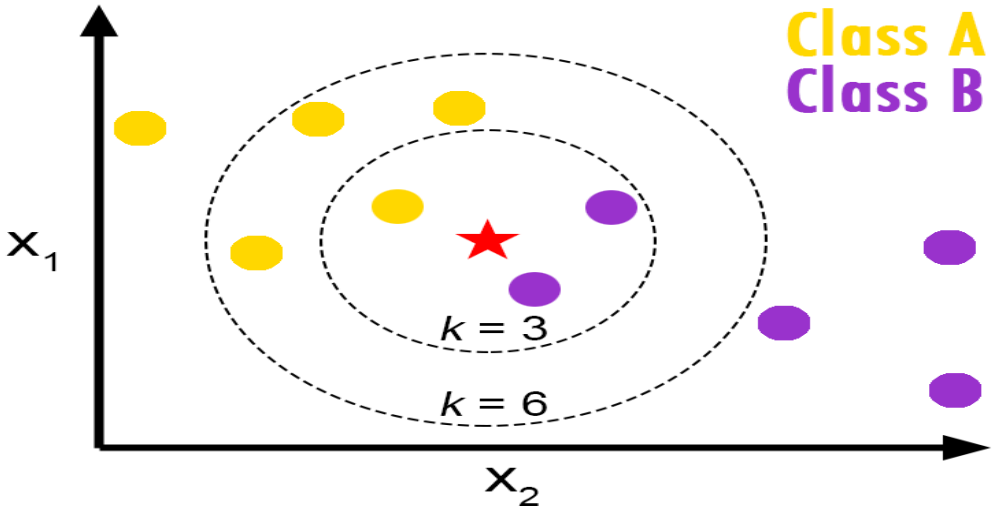

Figure 3 K-NN classifier

1.4 VIOLA JONES ALGORITHM

It possess an important property of Real-Time detection of objects by training of the images which is relatively slow, but its detection is quite fast. Viola-Jones algorithm uses principle of scanning a sub-window, which can detect presence of multiple faces in a given image. However standard image processing approach rescales the image in to different sizes and then make use of a detector of fixed size to identify multiple faces in a given image.

Thus instead of rescaling or resizing input image the algorithm runs detector of varied size multiple times over the same image. Thus the basic building block of the detector composed of the integral image. Haar Wavelet can be represented by rectangular frames.

1.4.1 The Scale Invariant Detector

In Viola-Jones face detection algorithm the first step includes conversion of an input image into an integral image. Under this to the concerned pixel's entire sum of all the pixel to the left and above it is computed. Thus inside any given rectangle and by using any of the four values around a particular pixel, sum of all pixels can be calculated. And eventually these values represents the coordinates of the integral image. The rectangular input image coincides with it.

Earlier rectangle will be included in both rectangles i.e. one after it and one below it. Hence the sum of earlier rectangle will also be included in the calculation. Using features consisting of more than two rectangles the algorithm analyses the given sub-window. The various features types are shown below.

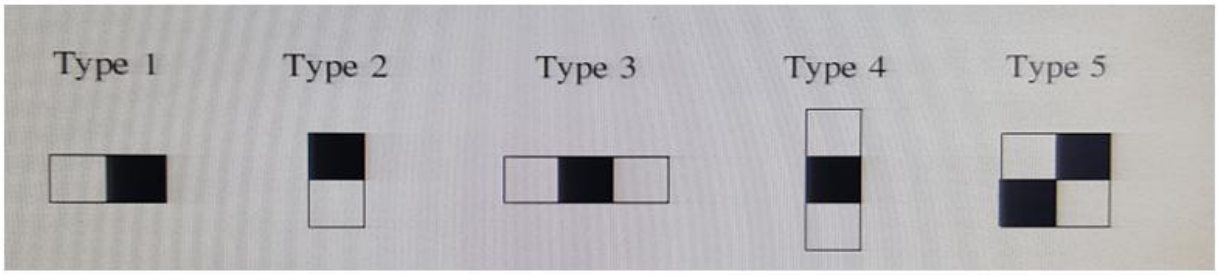

Figure 4 Types of feature

When sum of all the white object(s) is subtracted from sum of all the black object(s) we obtain a single value which represents feature of the image. Also it is empirically found that the result accuracy increased if base of resolution 24*24 pixels is used. On evaluating all the different positions and sizes of the feature as above figure, nearly 160K various images can then be made.

1.4.2 The AdaBoost Algorithum

Out of 160.000 features few consistently gives accurate result when used on frontal facial image. In order to such accuracy, Adboost needs to be modified. AdaBoost is being used by Viola-Jones, which is machine learning boosting algorithm which from weighted combination of weak classifiers makes a strong classifier. A weak classifier can be assumed as a feature, as described mathematically below expression.

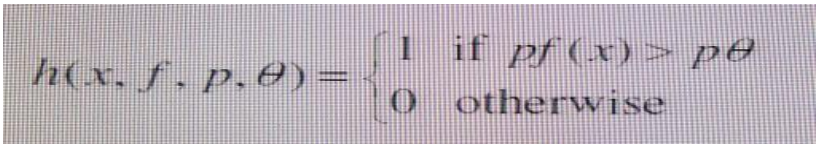

Figure 5 Weak classifier representation

Where x is a 24*24 coordinate sub-space, f is the feature being applied, p the polarity and @ symbol is the threshold for selecting a positive (a face) or a negative (a non-face).

Out of 160K features only few are potentially weak classifiers, so the AdaBoost algorithm has been tailored to include seldom largest feature values.

It determines the best polarity, feature and threshold. In order to extract the major contributing feature, every feature on the training data set needs to be re-calculated, when a weak classifier is introduced. The value of the weighted error is used to choose the major contributing feature.

Thus with the combination of the Integral Image, Modified AdaBoost algorithm and the computed efficient features, face detector can be implemented but still needs certain additional inputs.

1.4.3 The Cascaded Classifier

The Viola-Jones face detection algorithm uses detector of new size every time it scans the same image. There is high possibility in a group photo that there can be objects which are non human faces.

This realization formulates a new problem statement i.e., In order to find faces, It removes the non-faces quickly.

Thus one single strong classifier will not be that effective since the time complexity in the calculation is independent of the input. And this raises the essentiality of cascaded classifier.

The cascaded classifier contains stages of strong classifier. Each stage determines whether the given sub-window is a face or not. When a non-face is identified by a sub-window of a given stage it is discarded quickly. Backwards, if a face is detected it is passed to the next stage. More the number of stages an image passes through, higher is the chance face is identified by the sub-window.

In a single stage classifier, to limit the false positive rate, we may initially accept false negatives. Thus, at the first stage false positive is not a problem as succeeding stages sorts and filter away. Thus at very initial stages of operations of Viola-Jones, many false positives values can be included. As a result the rate of false negatives will be minimum in the final stage.

Thus when trained a given stage, say n, then the false negatives generated by the n-1 stage. Thus using a cascade of stages Viola and Jones face detection algorithm quickly eliminates face candidates. As the stages progress the requirement at each stage becomes strict and hence more difficult for candidate to pass to the next stage. When a candidate passes all the stages successfully face is detected.

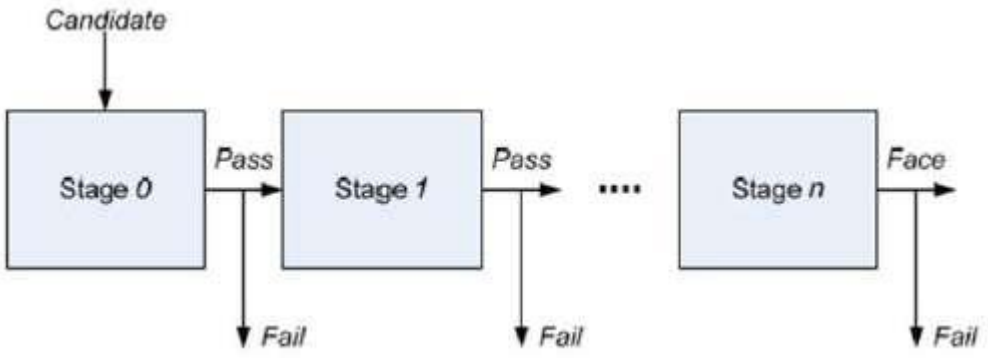

Figure 6 Cascade of stages

1.5 AGE RECOGNITION

Facial features of an human face is affected by age, since it affect the appearnace of the human face i. e. The age influences the apperance of human. The facial contour, features (eyes, lips, forehead) and feature distribution of the face can be impacted by the face. Other attributes like skin color, wrinkles and facial lines are also get changed as age progress.

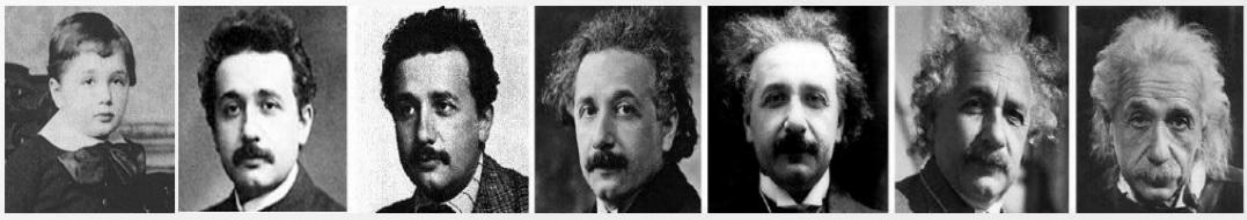

Figure 7 Facial image changes

There are various models which can be used for age recognition. One of them is based on the dimensions and ratio of the human faces. Another is based on the analytical face model. Few of them uses closed ages sampels techniques to learn the recuced dimensional aging trend. In addition to above there is aging related features based algorithum extracted from face images. Age recognistion can also be understood as an special probeleme to conclude it as a classfication where age is a range or a group, or regession where age is detemined as a number. For classfication probelems K-NN, Multilayer perceptron and self- organizinng map can be used.

1.5.1 Ratio And Measurement Based Models

Various ration like horizontal difference of eyes to vertical distance from eyes to nose/mouth or chin, can be a basis of estimating the age. As per reaserch these algorithum can be useful fto identify where the large age diffrence is avaialable. But in case where the data sample is distributed, this algorthum have limited use. Also the frontol postion could also impact heavily to this. It is irrespective to texure infromation. All such tests are done on small data sets.

1.5.2 Aging Pattern Subspace

There models uses aging pattern of single person to estimate or predict its future appeareance. In order to use such estimation all the images is required for a aging pattern. This is critical challenge to calculation /estimation, since aging pattern is always incomplete.

Using this pattern only a single person's image in a progression can be used for age estomation , and this is called as aging pattern. In lerning phase, we need to find out the aging pattern. whereas in age estimation stage it tries to identify the image based on the avialable aging patterns.

The goal is to learn a aging pattern from a representative subspace. In case of many missing valuess, PCA can used exploration of the missing data. In order to predict the

age a strategy can be used to reconsruct a facila image of predcicted age with minimum error.

1.5.3 Manifold Based Recognition

It is supervised learning, in which mapping form face images is the basis of age estomation. In this type of learning closed ages sampels are used. And it doesn't require many images of same person at differnet ages. In order to improve the estimation sufficency, it require many images labled with age.

Few approache like orthogonal locality preserving projections, conformal embedding analysis locally adjusted robust regression, and synchronized sub manifold embedding.

1.5.4 Feature Appearance Based Recognition

There feature appearance based recognistion uses face appeareance in order to calculate the range of the age group. The face shape and texure can significantly affect the estimation process. Along with biologically global or local feautre can be helpful for such estimations.

These algorithum rely on both texure (wrinkles) and shape (geometry) features. The texure features could be used thorugh algorithum like Local binary pattern. For shapes features henetic algorithum can be used. A face image can also be views as a decomposed parts from coarse to fine. A feed forward model can be used in such recognistion.

Chapter 2
LITERATURE REVIEW

2.1 FACIAL IMAGE CAPTURE

Swami & Vadivel [12] introduced a three phase segmented system. First phase preprocess face and detects it. Second phase extract facial features [18] like nose, forehead, chin and eyebrows. The third phase introduces data reduction methods and face classification so that emotions can be recognized.

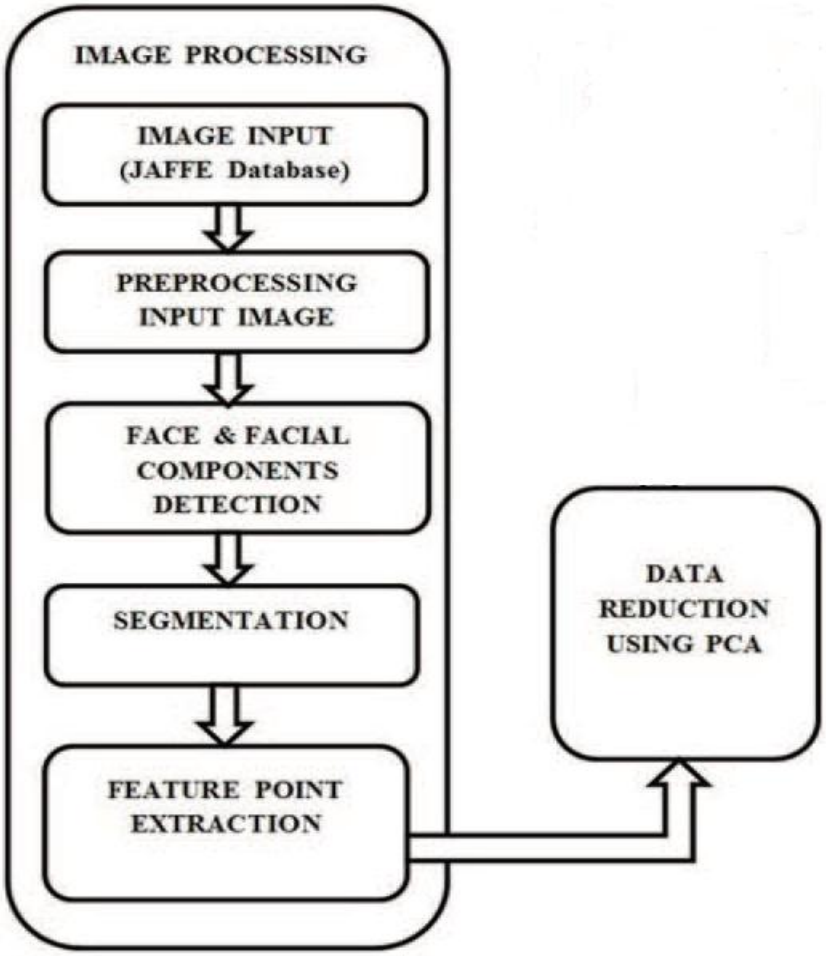

Figure 8 phase segmented system

For feature extraction, every pixel in the original image is compared with the threshold. If pixel intensity is more than threshold it is referred as zero, and vice versa. Noise gets removed using this.

For Face detection, below procedure is followed. From the foreground, facial image is located. From scanning center of the image and find uninterrupted high intensity

pixels (foreground color) after uninterrupted black pixels. The center pixel is chosen from the center on the image and has binary value as 1. Distances from left, right, up and down for the edges of the face are measured as M1, M2, M3, M4. These width parameter are used for identifying the facial components.

Figure 9 Facial Components

Using Fuzzy Clustering (FCM) algorithm lip region is detected. Using color and coordinate of the facial image, segmentation of the lip can be done. Mouth region can be assumed as a curve which has many minima based on intensity profiles. And from the detailed research. It is found that first minima can be assumed as top lip and third minima as bottom lip region.

In order to locate the eyes, various threshold can be used [10]. From the initial threshold (T_o), input is split in to two set of images. Now comparing with the preceding threshold (T_{old}), and pixel intensity of both set of images, average value is calculated. Using template matching scheme eyes are localized. From matching template and matching sub space of the image is mapped. It will be minimized in next step. In order to identify exact match, matching part of the image and highest correlation covariance of the template can be identified. As eye region has a sharp contrast [11, 14] when compared the other part of the face.

After locating different facial components, feature point are extracted. In all there are eyebrows, lips, right eye and left eye {(4+4) + (8) + (8+8)} = 32 points are considered. From 32 observed feature points, for x and y coordinate, 64 values are calculated. PCA is used to reduce these 64 variables to 10 components.

Figure 9 Feature Points Extraction

2.2 FACIAL FEATURE DETECTION

Ho Lip Chin , Marsyita Hanafi and Tanko Danial Salka [13, 20] used a facial components detection method based on Viola Jones method. It uses an integral image which is an intermediate image. As in the below figure the pixel value of original image is suppose x, y. And in four memory references the pixel position or coordinates will be calculates as the sum of the coordinates of above and left of the original pixel.

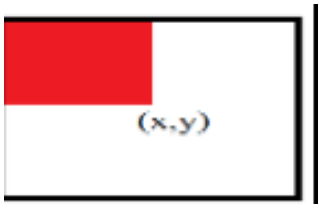

Figure 10 Original coordinate

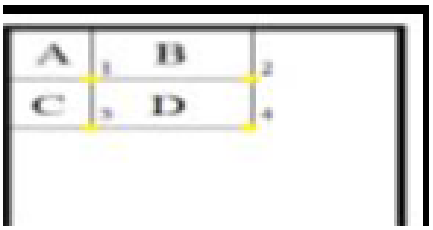

Figure 11 Four integral references

The integral image is sum of the pixels values above and left of the original pixel.

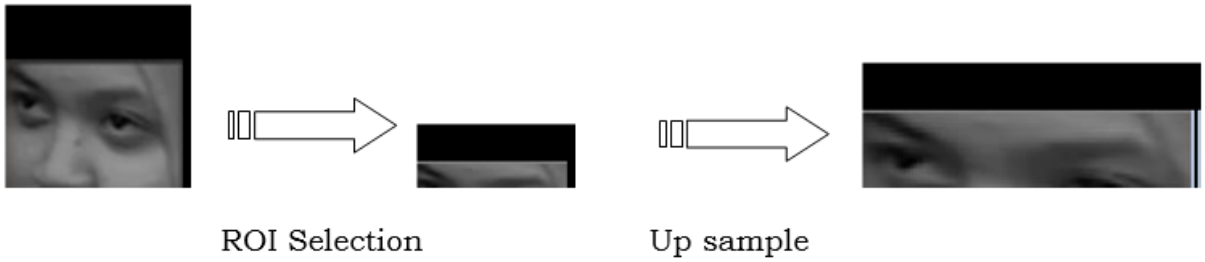

Figure 12 ROI Selection and Up Sample

For eye detection, eye region [14, 21] is located at the third quarter of the face from the down. Detected face region is converted into gray scale to reduce noise. By up-sampling the region of interest, the difference between the samples gets highlighted. And it is easier to locate the eyes.

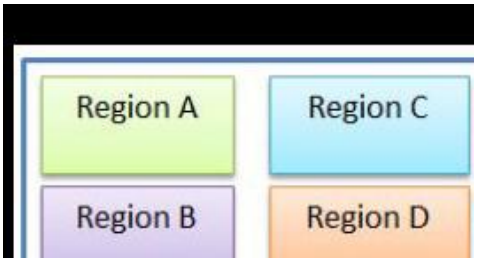

Figure 13 Mean comparison

The eye region can be detected in one of the above 4 sub area. These sub area can be understood as one probable eye region based on the face poses. The comparison can be explained as follows.

1) From the foreground the probable left eye location would be region A or region B. However the region is selected based on the mean intensity.

2) From the foreground the probable right eye location would be region C or region D. However the region is selected based on the mean intensity.

2.3 MORPHOLOGICAL OPERATION

Anamika Singh, Manminder Singh and Birmohan Singh[32] proposed a method from the frontal face images using sobel edge detection and morphological operation. In the first phase image is resized and convert to gray scale. Further in order to calculate face boundaries sobel edge detection is used. Final face was utilized for extraction of eyes for facial image with the help of morphological operations.

Figure 14 Conversion to grey scale

For easy storage and same size processing, the image is resized to 384x288. Edge detection can only be used with gray scale image, so conversion to grey scale is mandatory.

Figure 15 conditional dilation

Using sobel operator it gives the better edges boundaries. Edge technique converts an image to binary image. An image which has black background and human face is traced by white pixels is condition dilation. To identify the face region is described as above.

2.4 SHARED NEAREST NEIGHBOR

Yun-lei Cai, Duo Ji ,Dong-feng Cai[28] used a classification method in which they used a new method as shared nearest neighbor. In this approach they used a shared nearest neighbor, know information of the samples and a measurement of closeness.

The patent can be understood as a multi-level tree distributed architecture, as defined by international patent classification rules. Below figure shows one example of it. From the common ancestor, all the derived child nodes have familiar properties. On seldom basis of familiar properties of various inputs, measuring degree of closeness is tough challenge. Thus, efficiency of the classification method could be affected, and such extraction can result into a turbulence.

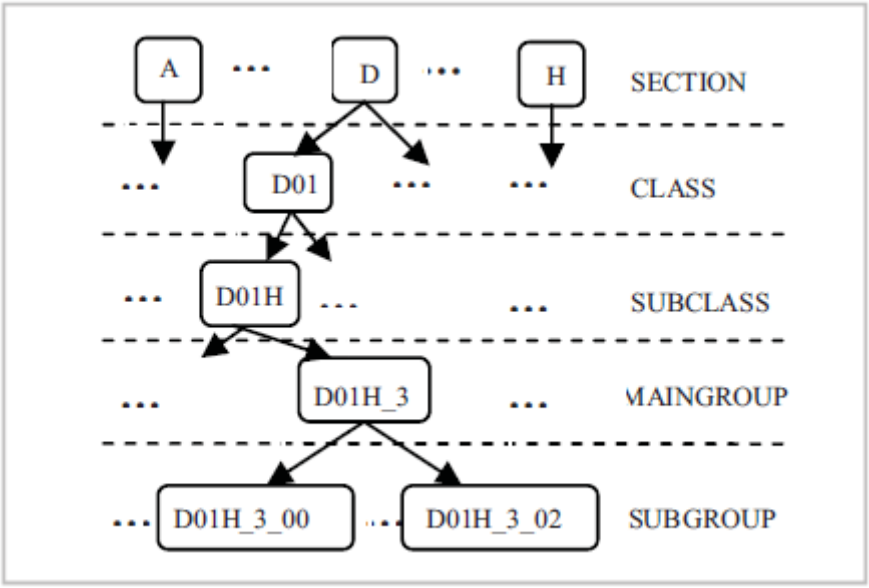

Figure 16 Multilevel structure

Based on any favorable result a closeness formula can be selected. QC as an extent of closeness between input I and J. If we sort the samples in descending order, we could define a threshold value W. Now a set, which has at least extent of closeness equivalent to threshold can assumed as potential neighbor of I.

Lk can be assumed as number of shared neighbor for the input I and J. Now in case where number of shared neighbor extends, the likeliness of their belonging to same class will be enhanced.

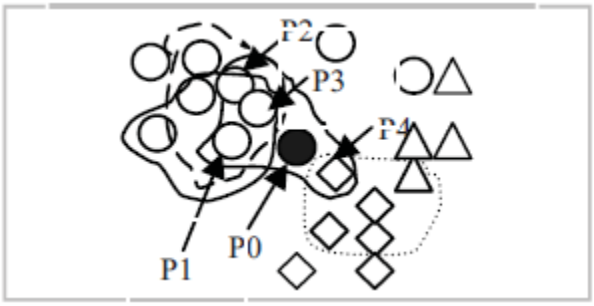

Figure 17 Shared neighbor

If we set neighborhood extent as 4, Po and P4 will not be sharing any neighbor. Since Po has already shared 3 neighbor as p1, p2, p3. In order to identify the information about the neighborhood, closeness between inputs can be controlled by neighborhood extent. As in our case, p0 and p1, p2, p3 has a better extent of closeness. A larger extent of closeness will result into inputs which have more similar properties. For more precise evaluation, neighborhood extent should be carefully chosen.

2.5 SELECTION OF THE K PARAMETER IN THE KNN

Ahmad Basheer Hassanat, Mohammad Ali Abbadi, Ghada Awad Altarawneh [30] used a method in which focuses on major limitations of KNN. In KNN there is no model which uses output to train. Also due to sufficient efficiency requirement usually large training data set needs to be used. It largely impacts time complexity of the algorithm. Also selecting right K is very challenging due to the fact, the intrinsic behavior of training samples itself.

In this they tried used a similar search pattern which tries to reduce the larger training set, and keeps the only a sub sequence of the training set which needs to be used for prediction model. It tries to remove any redundancy in the training set. In addition to above there is one more way was applied, which further compacts the training set. The second way considers output instead input for further reduction of training set. It removes the training set where efficiency of the classifier is not at all affected and also there is no chance of any prominent error.

By avoiding the even classifiers, the algorithm speed will be increased since training data set is reduced by half. Also the probability of exact same number of votes for two different sub group will be nullified. Through initial experimentation it shows there is

no major impact on efficiency of the algorithm. Above points gives the rise to select an odd K.

Since it gives focuses center around to the selection of K with nearest neighbors. Using weighted the KNN classifiers can be associate to provide better result. Through experimentation, we could deduce easily that the weighting function which uses the inverted logarithmic function could be better in many scenarios, described as below.

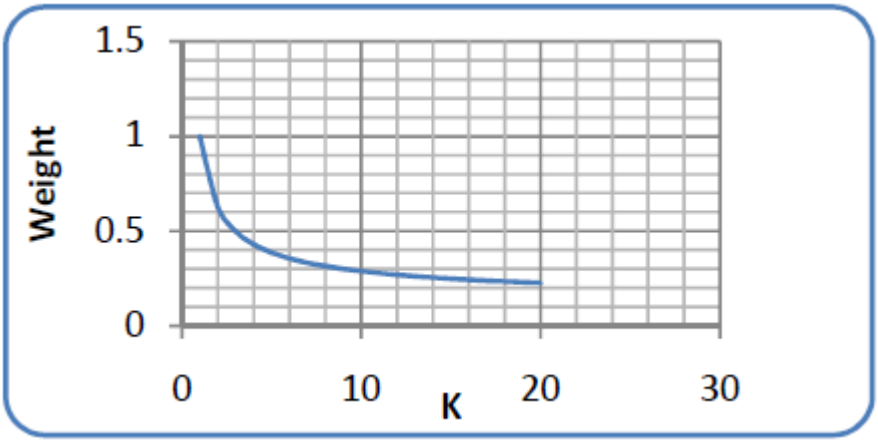

Figure 18 Inverted logarithmic function

To understand the classifier in the example. Let's suppose we have 2 different group. One group is represented by red rectangle and another group is blue circle.
Now in order to find out an unknown green triangle.

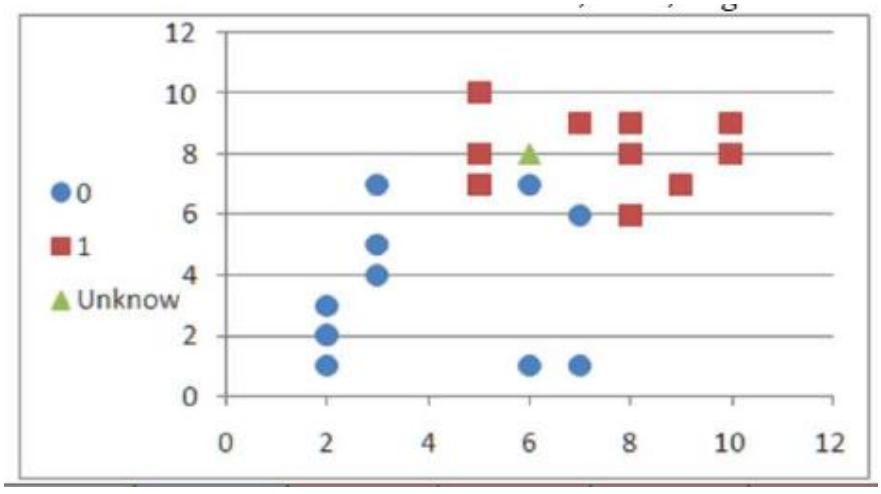

Figure 19 sample example

Class	0	1	1	1	1
Order	1	2	3	4	5
weight	1	0.63	0.5	0.43	0.39

Table 1 Sample Weight

Now using the odd classifiers method and adding the corresponding weight, the unknown input (green triangle), recognized to be group 1 (red square). And finally based on the weighted sum, it will be calculated as.

k	WSo	WS1
1	1	2
2	1	1.13
3	1	1.95
WS	3	3.08

Table 2 Weighted sum

2.6 AGE IDENTIFICATION USING FACIAL IMAGES

Sneha Thakur, and Ligendra Verma[31] used wrinkle analysis from facial images for age recognition. In their research they tried make a system which could categories the facial image out of four boundaries as kid, teenager, mature and senior.

Eye, nose tip, tope of forehead, chin and side of the face, has the major impact from the facial image to identify the facial features. The various measurement and ration gets changed as the age progresses. And this is idea which uses craniofacial growth. And even a slight changes in position of these primary features can be related and used for age recognition.

For mature category, it has found that main features remain constant, but there is slight change in the side of the face. These positional calculation can help to categories other groups. In kid, the ration of distance between eyes and distance between nose and lip is exactly same. Also two primary wrinkles on cheeks and one on forehead is also captured for further age estimation.

Chapter 3
OVERVIEW OF WORK DONE

3.1 PROBLEM STATEMENT

Existing age detection algorithm relies on global features (global facial feature [17, 18] extraction, wrinkle analysis, artificial neural network and global Face image database).

Current implementation will help to enhance the accuracy based on more localized and an easy to implement algorithm. In case of people within same localized environment this strategy can be more useful and accurate.

The Initiative for "AGE DETECTION USING FACIAL FEATURE" is carried out. Module of the process like "Face Detection", "Feature Extraction" and classification is targeted.

3.2 OBJECTIVE OF THE PROPSED WORK

The main objective of this work is facial feature extraction and age identification. For facial feature extraction, PCA is used. Whereas for classification, KNN specifier is used.

"Face Detection" is done by using the Voila Jone's algorithm [9, 17]. Age classification is done by using K nearest neighbor classifier which is used for improving prediction performance based on localized data instead of focusing on the global features. The idea behind using this methodology is to recognize age with easy to implement model, yet focusses on improved performance in case of localized data.

The age recognition is classified based on the facial features [28] like eye, lip, chin and forehead. The age group is targeted for group wise 20-25, 26-30, 31-35. 36-40, 41-45 and 46-50.

3.3 MOTIVATION

The aging progress is uncontrollable. The procedure of aging is slow and irreversible. The collection of sufficient training data for age estimation is extremely laborious.

The main motivation for age recognition using facial image features [31, 32] so as to Age-specific HCI, satisfy preferences of all ages, provide age specific access control, security and surveillance.

Chapter 4
PROPOSED WORK

4.1 OVERVIEW

In the proposed approach, The Input image is provided through the camera. In order to locate the facial image, it needs to be pre processed first. Using Viola jone's method Facial-feature parts i.e. eyes, lips are located. Extraction of feature-points is followed after this. Corresponding PCA [18] features are also plotted with extracted facial feature. K-NN is used for classification. Based on Euclidean distances of the captured face class, the age is detected from the test database.

4.2 ARCHITECTURE

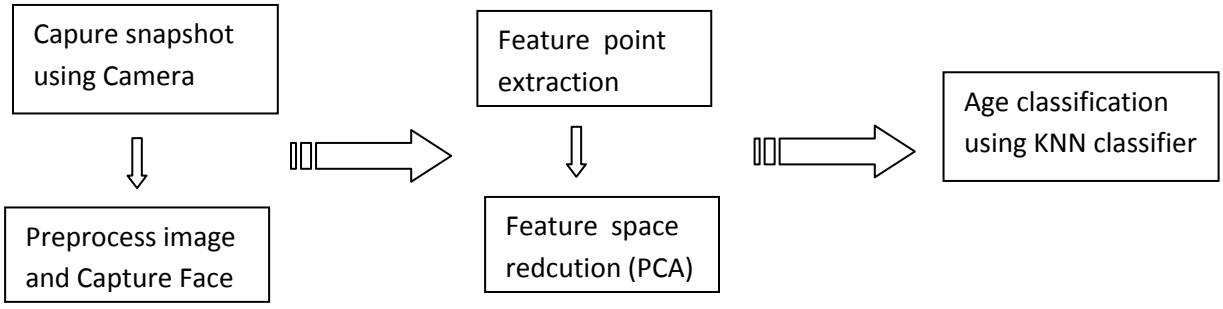

Figure 20 Architecture

4.2.1 Capture Snapshot using Camera:

Using MALAB functions Camera is started in Video mode. Video data can be axes to display the preview. Using step function it is separated to show only required preview.

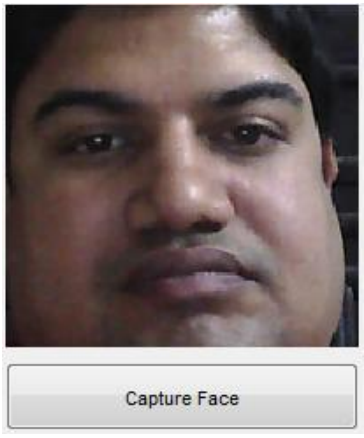

Figure 21 Capture through camera

In addition to the new image from camera, Images from database can also be retrieved.

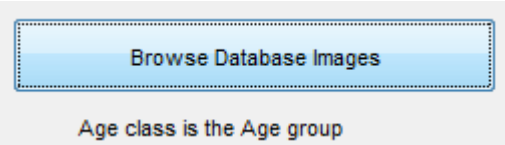

Figure 22 Browse Database

Now to detect facial image in an image using Viola-Jones algorithm [19], MATLAB provides "cascade object detector" system object of vision class. The output of the function is stored as image of 128 x 128 pixels.

4.2.2 Process image and Capture Face:

In order to capture the only face rectangle below algorithm were applied. Essentially for getting the exact face rectangle [20], only required area needs to be cropped. And details which are not essentials needs to eliminate recursively. Using this way Face rectangle is extracted from the taken capture facial image.

We defined the steps between snapshot and from image using Viola Jones. And in order to separate we first define copy of the image as Im1. For each pixel in the original image, we modified x and y position with reduced steps and then copied to image copy Im1 to display.

4.2.3 Feature Point Extraction:

Once face is captured as a face rectangle. Facial features are extracted [21] as eyes, forehead, chin and Lips.

4.2.3.1 Eye Extraction:

For the eye extraction start and end boundary needs to be clipped from the extracted phase rectangle. Start boundary can be calculated as below

Start of eye = difference of (middle of the image and 0.2 of the image), so that forehead can be excluded.

Figure 23 Eyes Extraction

For end boundary of the calculation below function is applied.

End of eye= 5 units above middle of the face.
Now eye can be extracted from the provided face rectangle matrix. Now every pixel in between eStart and eEnd is saved eye feature.

4.2.3.2 Lip Extraction:

For the Lip extraction start and end boundary needs to be clipped from the extracted phase rectangle [22]. Start boundary can be calculated as below

Start of lip =difference of (full face length and last quarter of the face), so that start of the lip can be captured properly.
For end boundary of the calculation below function is applied.

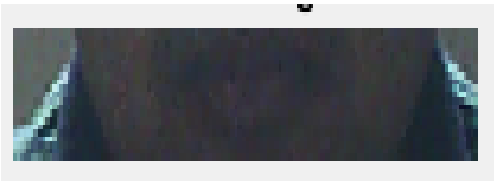

Figure 24 Lip Extraction

End of lip =difference of (full face length and 20 units), so that start of the chin can be excluded.

For the Lip extraction start and end boundary needs to be clipped from the extracted phase rectangle. Start boundary can be calculated as below.

4.2.3.3 Forehead Extraction:

Figure 25 Forehead Extraction

The region above eyes will be calculated as forehead.
Start of forehead = Start of eye (reverse calculation for easy implementation);

For end boundary of the calculation below function is applied.

End of forehead = starting 20 units to exclude hair portion;

For the Forehead extraction start and end boundary needs to be clipped from the extracted phase rectangle.

4.2.3.4 Chin Extraction:

For the Chin extraction [23] start and end boundary needs to be clipped from the extracted phase rectangle. Start boundary can be calculated as below

Figure 26 Chin extraction

Start of chin = 20 units past from the end of lip;

For end boundary of the calculation below function is applied.

End of chin = 20 units earlier end of max face length;

For the chin extraction start and end boundary needs to be clipped from the extracted phase rectangle.

After getting the clipped images for eye, lip, forehead and chin, using 'sobel' edge detection, the feature points are extracted.

4.2.4 Feature Space Reduction:

Using PCA feature [24, 25] are reduced so that it can be in comparable format. PCA can be extracted directly form the extracted feature.

For every feature point i.e. eye, lip data matrix of r-by-c matrix. Principal components are arranged along the y axis (columns) and observations are arranged along the x axis (rows). The corresponding weight matrix will be c-by-c. So that if the columns are arranged in the descending order of component variance, it will help to reduce the non-essential data and keep only major informative data. This is can also be termed as singular value decomposition (SVD) algorithm.

For storage purpose, we store mean and standard deviation of the feature point array. Finally using this process we will have 8 feature spaces for one facial image. It is mean and standard deviation for forehead, eye, lip and chin.

A plot can also be drawn to compare the corresponding PCA feature for the extracted facial feature. Extracted features Eye, Lips, Forehead and chin are saved based on mean and standard deviation. The mean and start of the facial featured are saved in the database.

4.2.5 Feature Classification:

K-NN is used for classification. Based on Euclidean distances of the captured face class, the age is detected from the test database. Calculating the mean image and compute the average face image. In order to find the Train number as upper limit to find out the max searches from the class. The difference between the test image and all the centered training set is set as Euclidean distance. Test image belongs to images in the training set from where it has minimum distances.

Calculating the deviation of each image from mean image. Computing the difference image for each image in the training set. Merging all centered images. K-NN is used for classification. Based on Euclidean distances of the captured face class, the age is detected from the test database.

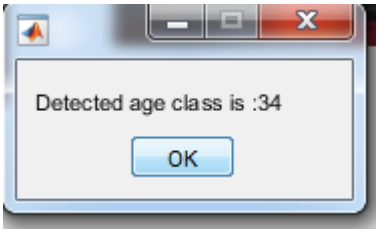

Figure 27 Detected age class

Since we know input and output in advance from training samples. The System can be trained so as to easy classification later once we actually test the software.

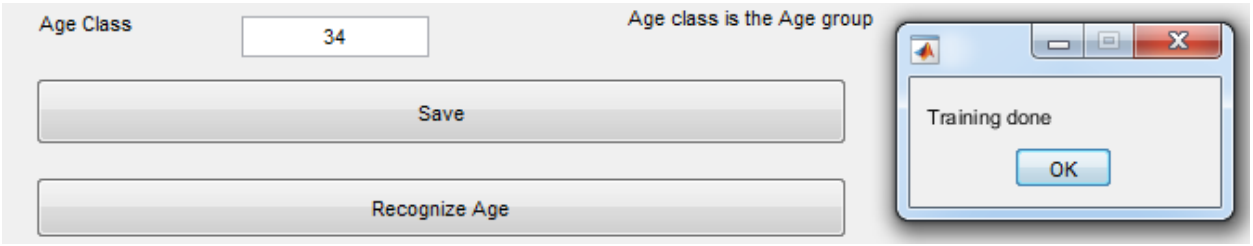

Figure 28 Training

Once the class is identified, user can also provide the feedback if the detection is correct. User has to provide the correct age.

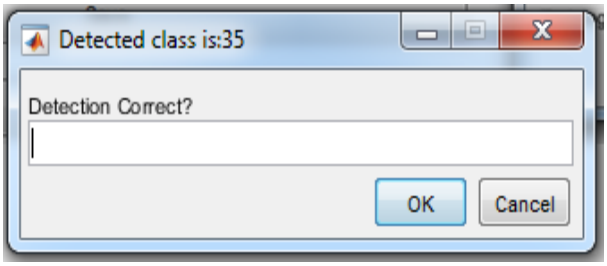

Figure 29 Training

4.2.5.1 Accuracy:

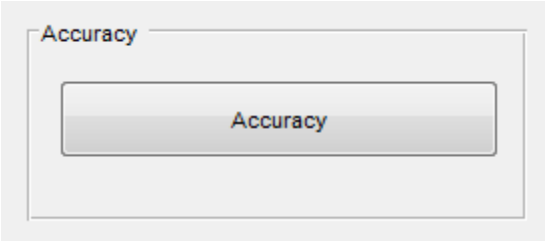

Figure 30 Accuracy

To find the closeness of measure value to the stand value which is known to the user, is requested. And based on matching percentage accuracy is determined.

4.2 FlOWCHART

1. In the proposed approach, The Input image is provided through the camera. In addition to camera the images stored in computer can also be taken.
2. In order to locate the facial image, it needs to be preprocessed first. Using Viola jone's method Facial-feature parts i.e. eyes, lips are located. Extraction of feature-points is followed after this.
3. Corresponding PCA features are plotted with extracted facial feature.
4. K-NN is used for classification. Based on Euclidean distances of the captured face class, the age is detected from the test database.
5. Through accuracy button, accuracy can be checked in percentage for the system.

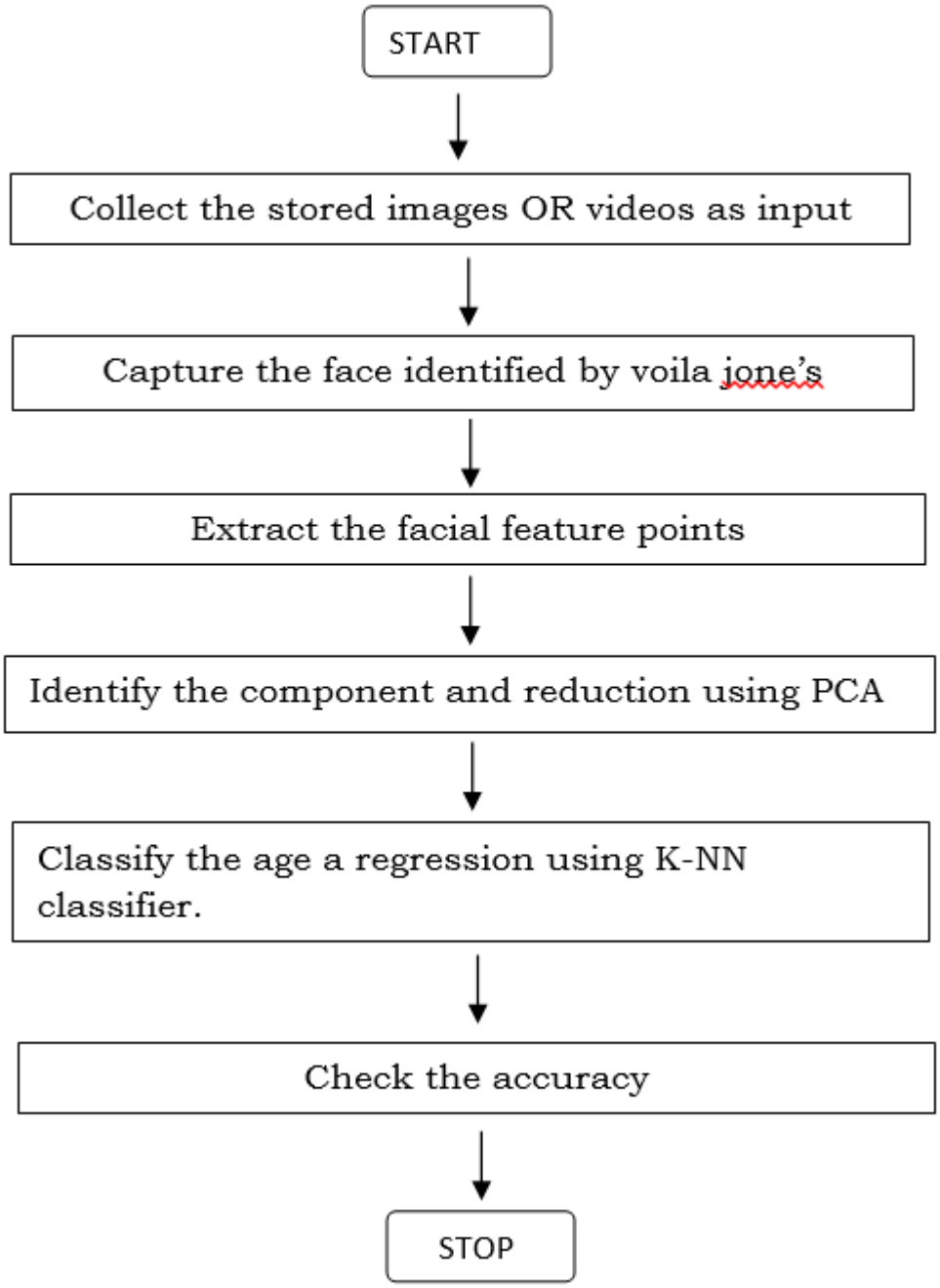

Figure 31 Flow Chart

Chapter 5
EXPERIMENTATION

Various algorithms of facial feature extraction and classification of detected feature for recognizing age can be done. In terms of the feature extraction set, PCA fits the best, since it reduces the feature space to level where it could select to proper feature.

In the proposed approach, The Input image is provided through the camera. In order to locate the facial image, it needs to be pre processed first.

Figure 32 Captured Image

Facial-feature parts i.e. eyes, lips are located. Extraction of feature-points are followed after this. Corresponding PCA features are also plotted with extracted facial feature.

Below is the PCA features based on identified facial features. The plot below shows (columns) values of principal component and (rows) various principal components.

5.1 PROCESS

1. In the proposed approach, The Input image is provided through the camera. In addition to camera the images stored in computer can also be taken.
2. In order to locate the facial image, it needs to be preprocessed first. Using Viola jone's method Facial-feature parts i.e. eyes, lips are located. Extraction of feature-points is followed after this.
3. Corresponding PCA features are also plotted with extracted facial feature.

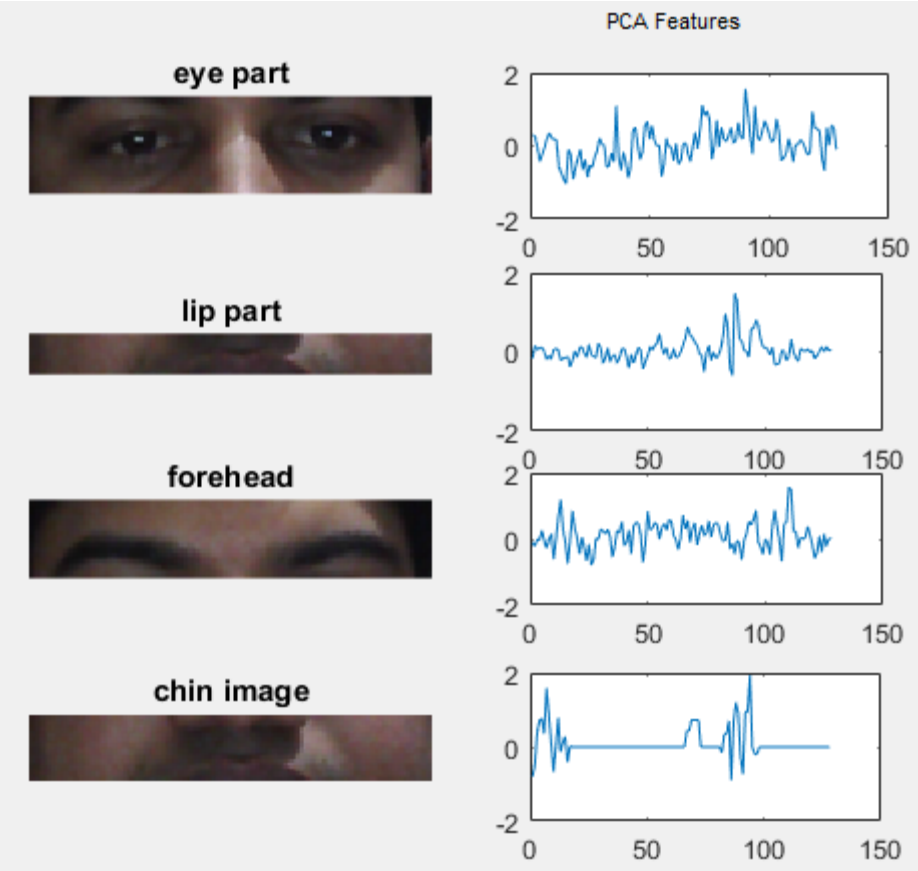

Figure 33 Facial Feature Extraction

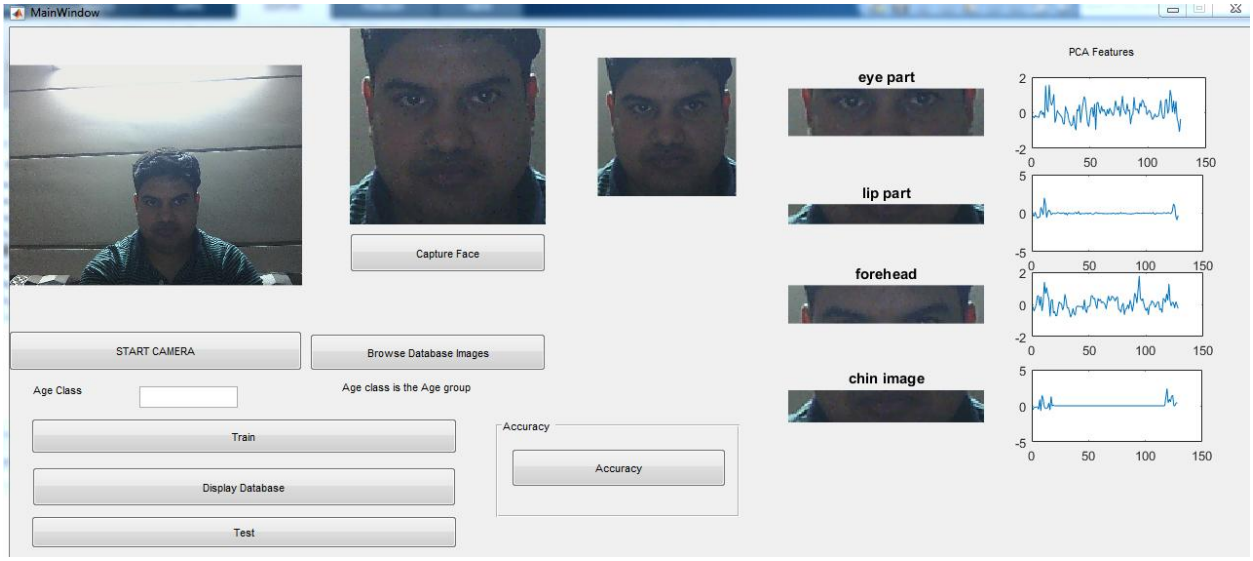

Figure 34 The Process Flow

4. K-NN is used for classification. Based on Euclidean distances of the captured face class, the age is detected from the test database.

5. Through accuracy button, accuracy can be checked in percentage for the system.

5.2 RESULTS

For experimentation, FG-NET aging database, MORPH Database and Gallagher's Web Collected database was used. In addition to above database friends, relatives and colleagues photos were also used.

Age Group	Samples	Accuracy
20-25	10000	79%
26-30	10000	83%
31-35	10000	80%
36-40	10000	80%
41-45	7000	80%
46-50	5000	90%

Table 3 Experimentation Results

5.1.1 False negative

While experimentation, based on near boundary values there are few cases where prediction was false negative, i.e. group members which belongs to group are given as an input. And as per algorithm, they are identified to belong to other group.

Age Group	Samples	False Negative
20-25	10000	21%
26-30	10000	17%
31-35	10000	20%
36-40	10000	20%
41-45	7000	20%
46-50	5000	10%

Table 4 False Negative

5.1.2 False positive

While experimentation, based on near boundary values there are few cases where prediction was false positive, i.e. group members which doesn't belongs to group are given as an input. And as per algorithm, they are identified to belong to targeted group.

Age Group	Samples	False Positive
20-25	10000	21%
26-30	10000	17%
31-35	10000	20%
36-40	10000	20%
41-45	7000	20%
46-50	5000	10%

Table 5 False Positive

5.3 Database

While there is very limited database available for free, and due to this prediction or estimation was challenging. FG-NET face age database contains around 1002 people with 82 pictures. The MORPH database contains 1,724 face images of 515 individuals. These images represent a diverse population with respect to age, gender, and ethnicity.

The freely available face image database are not available in the extent of tens of thousands of images. Such a large database support is required for sufficient prediction model. Short to medium sized data is not useful where sufficient efficiency is required.

Rasmus Rothe, Radu Timofte, Luc Van Gool [31] used a method which forms the IMDB-WIKI dataset. From the IMDB list, they collected a dataset of celebrities and based on information available regarding the age from WIKI or other online format they created the set. They took most popular 100,000 images.

In similar way for this initiative database was used.

Chapter 6
CONCLUSION AND FUTURE SCOPE

The project is an attempt to use a basic feature detection algorithm for images which contains human image. The applications instigated from such an attempt will result in facial feature detection of image which has human in it. It tries to draw understanding of age detection methods using PCA for facial feature extraction and KNN as classifier.

6.1 DISCUSSION

Gabor Wavelet, Linear decimate analysis and various other feature detection techniques can be used other than PCA. However LDA linearly transform the data from original data space to a low dimensional feature but it separates the boundary well. In our experimentation decreasing the number of features will not be useful, since age of people could naturally overlaps in a range. Gabor wavelet is not get affected by rotation, scale and transform, however it is very time consuming and could be impacted due to local variation. The discrete cosine transform focuses on global features. And large illumination variations needs to discard in this. And hence PCA found to be simpler in comparison to the available feature extraction and reduction.

The classification of the feature for age recognition can be done using various methods like radial basis function, Multilayer Perception, and support vector machine. The multilayer perceptron uses feed forward method for producing output. Output for age recognition is overlapped in our case, with various trial and error re-runs may be not be useful. Also the support available using MATLAB is minimal while using radial basis function and multi-layer perceptron. For using SVM, since large dataset is required, it could impact the cost.

KNN classifier uses the euclidean distance method to calculate the distance. A test item can be recognized to a class where from it has shortest distance. It can be applied to data from any distribution for example, data does not have to be separable with a linear boundary. Good classification if the number of sample is large. It has limitation due to the fact of choosing right K. Test stage is computationally expensive. No training stage, all the work is done during training stage Training time is more.

Numerous methods have been made towards recognition of robust facial expression, using different image detection, feature extraction, analysis and classification methods. Development of an automated system that accomplishes facial expression recognition is difficult.

6.2 FUTURE SCOPE

On the basis of project executed, in the future the capability will be expanded so as to do various recognition like Age, Gender or Emotions. In order to study human behavior it can also be utilized for emotion detection. Emotion recognition is the process of identifying human emotion, most typically from facial expressions. Humans

do this automatically, and to develop and enhance computational methodologies is required.

As recognition speed and smaller memory requirements are not a major constraint. One motivation towards age based techniques is to enhance accuracy than already existing feature based algorithms.

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