An Intensified Approach to Face Recognition through Average Half Face

Sourabh Arora
Department of Computer Science and Engineering
Global Institute of Management & Emerging Technologies
Amritsar, India
sourabharora91@gmail.com

Shikha Chawla
Assistant Professor
Department of Computer Science and Engineering
Global Institute of Management & Emerging Technologies
Amritsar, India
shikhachawla.gi@gmail.com

***Abstract*— Face recognition has broad excitement in the latest trend in image processing. Face recognition refers to identify a specific individual in digital image by analyzing and comparing patterns. It has numerous benefits which attract every sector but there are some issues such as more time consumption and lesser accuracy which degrade the user services. To solve this problem we proposed a highly accurate and fast method to reduce the execution time. The proposed method uses average half face approach because overall system's accuracy is better in it rather than using the original full face image. The proposed method can be used to recognize both 2D and 3D images. It mainly includes the average half face creation, feature detection, full face recognition through average half face using distance metrics and finally checking system's accuracy along with time consumption. The proposed method is based on eye, nose and mouth detection.**

***Index Terms*—Face recognition, Image processing, Accuracy, Average half face, Distance metrics.**

I. INTRODUCTION

In computer science, image processing is a form of signal processing in which input is an image and output is either an image or a set of characteristics related to an image. Mainly it is a technique to enhance raw images received from cameras or sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-to-day life for various applications. During last three decades, various techniques have been developed in Image Processing. These techniques are developed for enhancing images that are obtained from unmanned spacecrafts, space probes and military reconnaissance flights. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software etc

In most image processing techniques, images are treated as a 2D signal and standard signal processing techniques are applied to it. There are two main methods of image processing, one is Analog and other is digital. Analog image processing is an image processing task that is conducted on two-dimensional analog signals by analog means. The most common example of analog image processing is Television images. The digital image processing refers to processing of digital images by means of digital computers. Digital images are composed of a finite number of elements and each of which has a particular location and particular value. These finite numbers of elements are called picture elements, image elements or pixels.

Section II discusses the related work done in the field of face recognition in image processing. Section III describes the proposed method Section IV and V provides the recognition analysis and experimental results respectively. Section VI we conclude with our work.

II. RELATED WORK

There are many research works carried on related to face recognition. Numerous methods, techniques and schemes are proposed for achieving better face recognition accuracy using a small computational time.

Vashisht et al [1] described the use of average half face in face recognition. The approach used included the application of elastic bunch graph method in face recognition using three features head, nose and ear. The paper focused on the point that the half face provides better results than full face in face recognition systems. Josh Harguess and J.K. Aggarwal et al [2] compared the use of average half face with use of original full face using six different algorithms applied to 2D and 3D databases. It described two steps for the construction of average half face from full frontal face images; first the face image is centered and divided in half and then two halves are averaged together. The resulting average half face is applied as input to the face recognition algorithm. The six algorithms are Eigenfaces, Multi-linear Principal Component Analysis (MPCA), MPCA with Linear Discriminant Analysis (MPCA-LDA), Fisherfaces or Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), Support Vector Machines (SVM). Anuar [3] et al described face analysis detection of nose tip location as an important task. They proposed a method to detect nose tip region in large rotation variation based on the geometrical shape of a nose. They used morphological approach to obtain nose tip region candidates consist of highest point density. Harguess et al. [4] presented an analysis to increase the accuracy on 3D face recognition using pattern of symmetry in the face. They compared face recognition results for the eigenfaces face recognition algorithm with average half-face data and full face data by performing experiments on a 3D face data set of 1126 images. Zhang et al [5] described the comparison of three face recognition algorithms and their

978-1-4673-6540-6/15/$31.00 ©2015 IEEE

comparison i.e. classical methods Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Elastic Bunch Graph Matching (EBGM). They tried to find out which one is better to recognize the face of a human personality.Paul viola, Michael J. Jones [6] proposed a method named viola jones using which the detection of face and various features could be done from facial image. The method they proposed was quick for detection and one of the most efficient till today.

In this proposed method face recognition is most accurate and very fast. It can be applied to many databases such as 3D, Japanese female facial expression (JAFFE), FEI face database, Face Recognition Data-University of Essex, UK etc.

III. PROPOSED METHOD

Proposed method is based on the face recognition through average half face. Using the average half face the accuracy of the recognition increases rather than using full face [1]. The main features that are used from face are eye, nose and mouth. The proposed method makes use of Viola Jones for detection and a new distance metrics based algorithm for recognition. The previously used recognition algorithms are not used such as elastic bunch graph, LDA, MPCA, PCA etc.

The proposed method is divided into two categories i.e.

Phase-1(Detection)

Phase-2(Recognition)

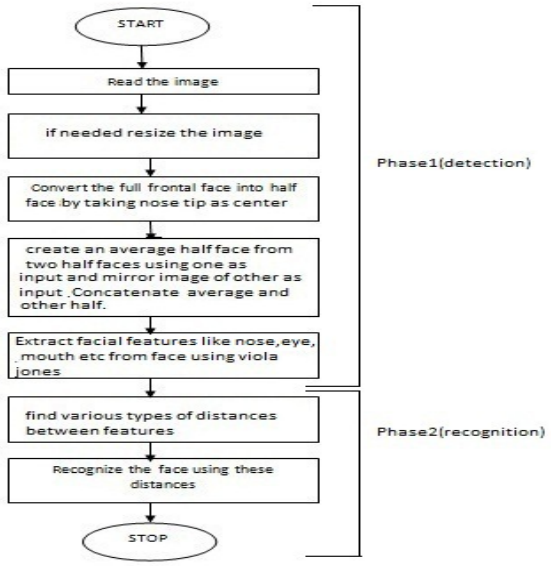

Fig. 1. Proposed method

The detection part mainly includes the reading of input image. The input image is mostly a full frontal face image. The image can be of various sizes so there is a size fixed to which the image will be resized. The input image is then split into two halves left and right. The mirror image of one and the other half as it is, are averaged together to form an average half face. The average half face is then concatenated with the other half face (the half face whose mirror image is created). After this Viola Jones detection method is applied. The face and features like eye, nose and mouth are detected. Then the diagonals are drawn in between boxes and points are marked on average half face where diagonals meet. The face graph is drawn after the points are marked. The recognition part includes the measure of two types of distance classifiers i.e. chebyshev and cityblock distance. The distances are recorded and then the full face image is recognized using these distances from the average half face. The recorded distances for different people between various features of their face will not be same. This is another reason for better efficiency performance of the proposed system.

A. Phase -1 (Detection)

1) Creation of half face

To create a simple half face, the full face image is centered about the nose to represent the data as symmetry as possible. The symmetry means two spatial halves of the face images data are equal. One half is called left half face and other is called right half face [4]. The image can correctly be divided into two halves only if it is centered using nose. It should be kept in mind that the average half face can only be created from simple half faces otherwise creation of average half face is not easily possible.

2) Creation of average half face

To create average half face we use both left half face and right half face. Both the left half face and right half face are averaged together (reversing the columns of one of the halves) [2]. It should be clear that the columns of the one half-face must be reversed so that the two half-faces are aligned before averaging [1]. After creation of average half face two main things that must be done are concatenation and feature detection. The concatenation is done between average half face and other half face. The other half face is the half face whose mirror image is created.

3) Viola jones detection method

The viola jones detection method is one of the fastest detection methods. This method can be used to detect face as well as facial features. The main advantage of using Viola Jones is that it can be applied to both grayscale as well as colored images. We don't have to convert the colored image into grayscale just as we do in edge detection methods for feature detection. The basic principle of the Viola Jones algorithm is to scan a sub-window capable of detecting faces across a given input image [6]. Another advantage of viola jones is that it can be applied to open mouth images quickly whereas previous methods do not detect open mouth easily. The viola jones in proposed method is applied after concatenation process.

4) Face and features detection

The facial area is first detected from image using viola jones method. The features that are included in proposed method are eye, nose and mouth. These three features are used to remove the shortcomings of previous researches that included the facial feature "ear" to recognize the face. The people with turban cannot be recognized with facial feature "ear" because their ear cannot be detected. In proposed method the Viola Jones recognize the features by drawing boxes. The diagonals are then drawn in between the boxes and a point is marked where the diagonals meet.

It is done for all three features eye, nose and mouth. The points are marked on average half face and a face graph is drawn.

B. *Phase-2 (Recognition)*

1) Distance Classifiers:-

In this proposed method, once the face graph is drawn the various types of distances between the eye and nose, nose and mouth, eye and mouth are measured and stored in database. The distance classifiers used for measuring pairwise distance between two sets of points are chebyshev and cityblock distance.

2) Face Recognition

The face recognition in proposed system is not done using previous algorithms such as LDA, PCA, and MPCA etc. The face recognition is done using distance based method in which the face is recognized only if all the six distances three each for chebyshev and cityblock match with the input image from database. Three distances are for each classifier because distance between the eye and nose, nose and mouth, eye and mouth are measured for both distance classifiers.

IV. Recognition Analysis

An intensified approach to face recognition has been proposed so that person through average half face can be recognized easily and quickly. Now there is not much concern that a person is wearing turban or his mouth is open. This method has been designed in a manner that the face recognition is easy, quick and most accurate. There have been many methods proposed in this field but they lack in some way for providing accuracy. The comparison has been made between existing methods and proposed method as shown in the table below.

TABLE 1. TIME COMPARISON

Section	Computation time (sec)
Full face [1]	384
Average half face [1]	125
Average half face-DM [1]	99
Proposed method	8

The comparison shows that proposed method tries to deal as quickly as possible. The table 1 represents that the computation time is just 8 seconds in case of proposed method which is close to 100 seconds or above in other methods. Table 2 shows the accuracy comparison of proposed method in 3D database. The highest accuracy recognition values of referred papers have been taken for comparison.

TABLE 2. ACCURACY COMPARISON IN 3D DATABASE

3D database	Recognition Rate
Full face [1]	83.0
Average half face [2]	93.8
Average half face-DM [1]	95.3
Proposed method	97.0

The proposed method provides high accuracy of face recognition in various databases. The accuracy of system is shown in table 3 related to other databases.

TABLE 3. ACCURACY IN VARIOUS DATABASES

Database Name	Recognition Rate
JAFFE database	94.0
FEI face database	96.5
Face Recognition Data University of Essex, UK	96.3

V. Experimental Results

The proposed method has been evaluated with implementation. This method has been verified using MATLAB version R2013a in window 7 environment. The sample of various frontal face images has been taken from various databases to implement the proposed method. The images of various sizes are easily recognized using this method.

The previous methods are either slow or include the detection of ears for face recognition which make them unsuitable for face recognition of Sikh people whereas the proposed method is easily applicable.

Fig. 2. Full frontal face image

Fig. 3. Right half face

Fig. 4. Left half face

Fig. 5. Mirror image

Fig. 6. Average half face

Fig. 7. Concatenated inage

Fig. 2 shows the full frontal face image of a Sikh person that is clicked from some distance. Here the image of a Sikh person is taken to demonstrate that the proposed method does not include the use or detection of "ear" feature of the face. The method is also applicable to people who do not wear turban and their ears are not hidden. Fig. 3 shows the right half face of a person. Fig. 4 shows the left half face of a person. Both the half faces are formed by dividing the full frontal image with nose tip as center into two parts. Taking nose tip as center makes both halves equally divided. Fig. 5 shows the mirror image of left half face. Fig. 6 shows the Average half face of a person. The average half face is constructed by taking the average of right half face and mirror image. Fig.7 shows the concatenated image. The concatenated image is constructed by integrating the average half face and left half face. The detection of facial features is performed on this concatenated image. The whole process of concatenated image construction has to be followed properly. To detect the facial features the facial area is detected first.

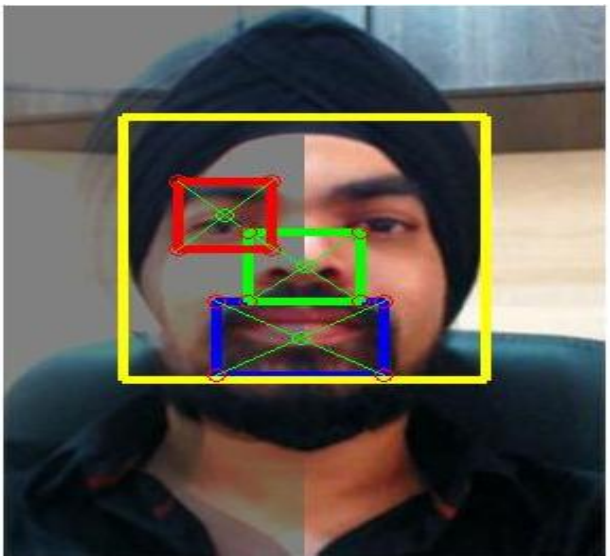

Fig. 8. Face and feature detection

Fig. 9. Feature detection points

Fig. 11. Distance measured and time taken

Fig. 10. Face graph

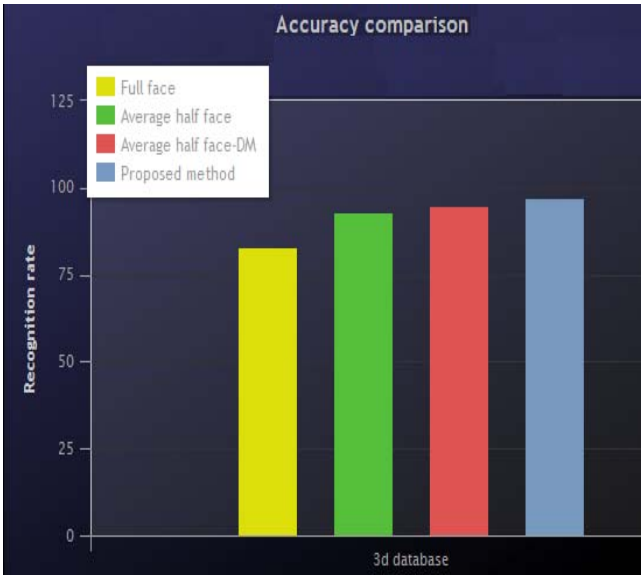

Fig. 12. Accuracy comparison in 3D database

Fig. 8 shows the face and feature detection. The face and feature detection have been done by using Viola Jones. The various features are detected like eye, nose and mouth. The proposed method can even detect mouth feature from open mouth images. These features are then marked by square boxes in the image. After feature detection, we find the center points of features. These center points are shown by circle in Fig. 9. The center points can be easily found just by drawing diagonals of square boxes that represent a detected feature. Fig. 10 shows the face graph of these center points on average half face. Fig. 11 shows the distances between these facial features. The distances are recorded between two features at a time through graph that is drawn. Two types of distances are calculated for better results like cityblock and chebyshev. The logic of two types of distances to be calculated ensure that the accuracy level of system maintained is always high and the system does not underperform at any time even if we deal with a large group of persons at same time.

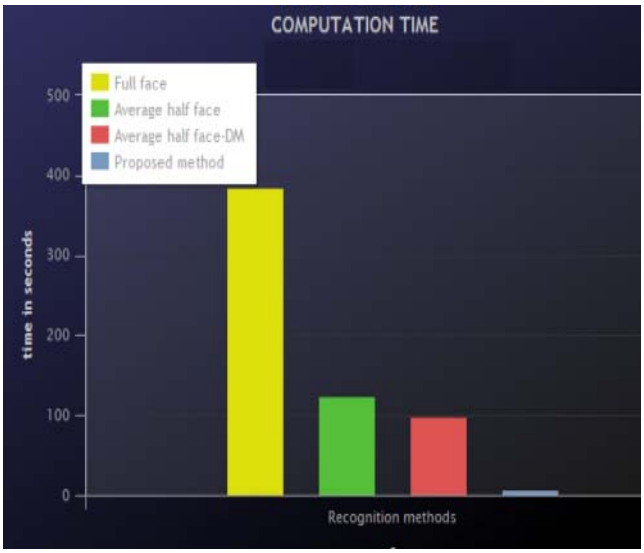

Fig. 13. Computation time comparison

Fig. 12 shows the accuracy comparison in 3D database whereas Fig. 13 shows the computation time comparison. It shows the computation time comparison of full face, average half face, average half face-DM and proposed method.

VI. CONCLUSION & FUTURE SCOPE

Recent trend in digital image processing shows that the lesser accuracy and more computation time are the major obstacles in adopting face recognition. To overcome these issues, this method has been proposed. The method is highly accurate and consumes very less time. It also can be applied to various databases discussed in table 2 and table 3. It helps in recognizing the images of people wearing turban and also open mouth images.

Although the method provides high accuracy still there is scope for improvement. This method is applicable to front face images not to rotated face images so it can be extended to recognition of rotated face images. Also in this method there are two distance metrics used for recognition, three to four metrics can be used to increase accuracy more. So, data classifiers can be extended. In future we will try to apply the proposed method to more databases such as Yale, Yale-B, FERET, AR database etc. Our focus will be on providing high accuracy in face recognition using these databases. For the researchers this paper provides an opportunity of wide future scope.

REFERENCES

[1] V.Sharma, R.Vashisht, "Average half face recognition by elastic Bunch graph matching based on distance Measurement" ,International Journal for Science and Emerging Technologies with Latest Trends,2012.

[2] Josh Harguess, J.K. Aggarwal, "A Case for the Average-Half-Face in 2D and 3D for Face Recognition", International Conference on Pattern Recognition ICPR,2009.

[3] Anuar et.al, "Nose Tip Region Detection in 3D Facial Model across Large Pose Variation and Facial Expression", IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 4,2010.

[4] Harguess, "3D Face Recognition with the Average-Half-Face", International Conference on Pattern Recognition ICPR, 2008.

[5] Chaoyang Zhang, Zhaoxian Zhou, Hua Sun, Fan Dong, "Comparison of Three Face Recognition Algorithms" International Conference on Systems and Informatics, 2012.

[6] Paul viola, Michael J.Jones, "Robust Real-Time Face Detection" International Journal of Computer Vision, 2004.

[7] C.S Chua,F.Han, Y.K HO "3D Human Face Recognition using Point Signature" International Conference on Face and gesture Recognition,pp233-238, 2000.

[8] David White, A. Mike Burton, Rob Jenkins, Richard I. Kemp, "Redesigning Photo-ID to Improve Unfamiliar Face Matching Performance", Journal of Experimental Psychology Applied, American Psychological Association, 2014.

[9] K.V. Joshi, N.C. Chauhan, "Edge detection and template matching approaches for human Ear Detection", International Conference on Intelligent Systems and Data Processing, 2011.

[10] Shidu Dong, Bo He, Qun Jiang, Huaqui Wang, Tongyuan Huang,"A half Face recognition Scheme", Eighth ACIS International Conference,2007.

[11] Manisha V. Borkar, Bhakti Kurhade, "A Research Face Recognition by Using Near Set Theory" International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 4, 2015.

[12] Ehsan Nadernejad, Sara Sharifzade, Hammid Hassanpour, "Edge Detection Techniques: Evaluations and Comparisons", Applied Mathematical Sciences, Vol. 2, issue 31, 2008.

[13] F. Prokoski, "History, Current Status, and Future of Infrared Identification", In Proceedings of IEEE Workshop on Computer Vision beyond the Visible Spectrum: Methods and Applications, 2000.

[14] L. Zhang, A. Razdan, G. Farin, J. Femiani, M. Bae, C.Lockwood, "3D face authentication and recognition based on bilateral symmetry analysis", The Visual Computer,Vol. 22, No. 1, January 2006.

[15] S. Gupta, J. K. Aggarwal, M. K. Markey, A. C. Bovik, "3D Face Recognition founded on the Structural Diversity of Human Faces", IEEE Conference on Computer Vision and Pattern Recognition, 2007.

[16] https://www.data.fei.org

[17] https://cswww.essex.ac.uk

[18] https://www.wikipedia.org

[19] https://www.cs.ubc.ca