Face Recognition Using Contour and Discrete Cosine Transform

Syed Muhammad Rafi[1], Mohsin Khan[1], Shahzad Nasim[2], Sheikh Muhammad Munaf[1]

***Abstract*—Face recognition from human pose databases is a very famous work and many researchers add their interest in this field because of its diversity and working range. Biometric information processing have an impression on face recognition. It can be a vital component of natural human-machine interfaces. Face recognition using Contour and Discrete Cosine Transform (DCT) comprises to recognize the human face image from the database. In this research six hundred images of 200 persons are used with two different expressions. The images of database must be converted into 2-D format which is appropriate for the recognition of face because the recognition of color images are very typical. Two famous algorithm Geodesic distance transform for the extraction of geodesic distance paths and discrete cosine transform are used for the feature extraction process. The face was detected manually by taking the seed point on the nose of human face. For the extraction of paths fast marching algorithm is used. Affinity of Geodesic is intensity variation and this could extract more and more information from face images. This Geodesic distance also helped us to obtain the contours of the face. Contours are helpful to extracting the more exact features of images. In the end Discrete Cosine Transform (DCT) is applied to all the images that derived DCT coefficient. Euclidean distance for the classification of images are also used for the final analysis of images. The results are comparable to the state-of-the-art face recognition techniques**

***Keywords*— Weighted Distance Transform, Discrete Cosine Transform, Euclidean, Contour, 2D-images, KNN**

INTRODUCTION

Face recognition abide various fascination for viewers because of its communicative properties. Face recognition algorithms have a broad effect with respect to the condition of the inclusive social situation. For security reasons currently in the world, face recognition is very effective. Even if other methods of biometric personal identification exist, like iris scans or finger-print analysis. These practices needs the support of the persons who engage in these systems, whereas a personal identification system based on investigation of frontal images of the face is often effective without the member's support. A very effective application of face recognition that there will be a system in which no ATM card is used for transaction and camera in ATM machine recognize the person, it means that the face could replace the commonly used passwords.

[1] Ziauddin University Karachi
[2] B. Nusrat Bhutto Women University

Contour matching and modeling used in a very powerful sense. According to Leibe et al. [1], Contour and shape based methods are regarded most appropriate for handling the generalization requirements needed for object recognition. It is very suitable for representing local features of images and it has a very positive response over registration of images. A Contour based approach done a good job when Hui Li et al. [2] used active contour model for multi-sensor image registration. In this algorithm contours are used for 2D images and it really achieved in best regard. Face recognition also has an effect of object recognition. Shape characterization using skeleton extraction is vital for many applications as character recognition; data base analysis, or shape analysis in medical imaging, which leads to important decisions in diagnosis of some diseases [3]. In Fig 1 we can see the implementation steps of our proposed algorithm.

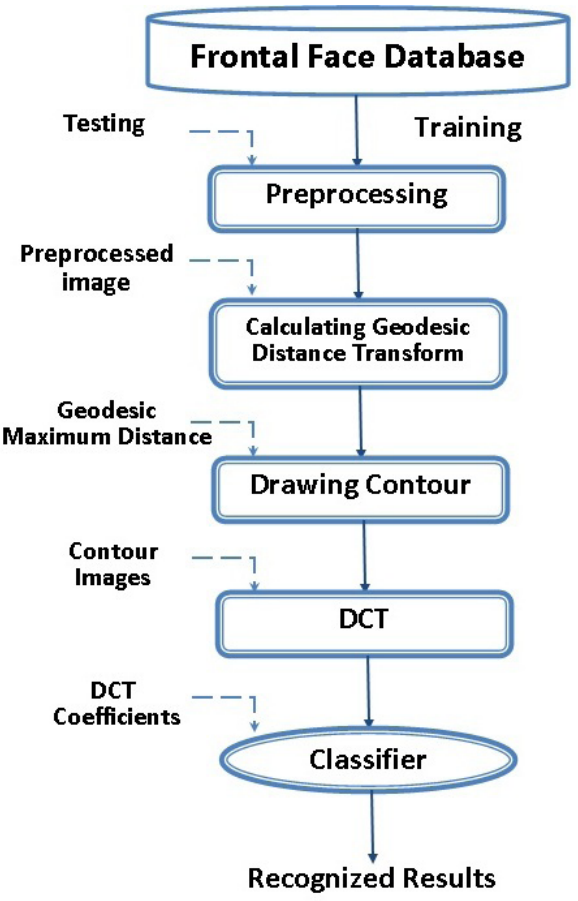

Fig.1. Implementation Steps

Nowadays, Geodesic distance transform is also very famous.

It is the shortest path between the two points. The geodesic distance path is essentially an effort to represent the facial curvatures of face. The work of Ashraf at el.[4] by using Weighted distance(he used weighted distance instead of geodesic) also very significant and gave a new innovative idea for Geodesic distance paths extraction fast marching algorithm[5,6] is used and this distance is used in contour calculation. Before Fast marching, the FEI face database[7] that used for this purpose is must be aligned and set in 2D (means two-dimension) format. Geodesic distance is used in contour extraction and with the help of this local features of images are obtained. But these features were not very informative. Then Discrete Cosine Transform (DCT) [8] is used for finding the DCT coefficients and extract more exact features. This DCT also helped us and reduced the dimension and also neglect useless information. Classification is a very important step and here Euclidean distance is used which is a very famous classifier for the classification of images. Later in this paper the literature review on face recognition is discussed. Then the next section discussed the whole proposed method of research, and end this research with results and conclusion.

BACKGROUND

Face recognition has appealed researchers in last few eras because of its extensive kind of applications. Face recognition is a varied field and many people include in it like psychologist, neurologist and computer scientist. That's the reason diverse types of methods [9] used in last 40 years. It is not possible to review whole field comprehensively here. That's why only relevant works appear and focusing on related methods. The main theme of this research is focused to extract the features in terms of facial curvature and recognize them in an efficient manner. There are three main approaches for feature extraction of face recognition systems that cover most of the area of face research. They are holistic, analytic and hybrid approaches. Let's looked them in detail.

A) Holistic Based Approach

First, In holistic whole image is given as an input. Images in holistic are controlled to be normalized and properly aligned. Another feature in this technique is that the size of face images largely affects the computational strength and memory demands. Principal component analysis (PCA) [10] is the famous method of holistic approach in which Eigen faces are the main component, extracted from statistical analysis of training faces data set. PCA under same lightning condition mostly performs well for the frontal face images.

Discrete Cosine Transform (DCT) [11] is another holistic approach. Ahmed et al. [12] in early 70s introduced the DCT for the very first time. It is related to the Fourier transform but uses only real numbers. By computing discrete cosine transform on cropped images of faces, facial features are easily extracted and a small subset of feature vectors are achieved in a zigzag pattern from the DCT output [13]. For face recognition, these feature vectors of DCT are used in different classifier for classification process. Template based is the structural matching methods. In this method local features such as the eyes, nose and mouth are first extracted. Then this extracted features are given as input. It uses edges, texture, color, motion, facial features etc. Template modeling is used as holistic approach, and in this regard Muhammad Sharif at el. [14] used hidden Markov model by taking three logical steps.

B) Analytic Based Approach

The another approach of the surveyed methods for automatic face recognition analysis from posed images uses an analytic approach to face representation and applies feature-based method for the extraction of features from an input image. It is the structural matching methods and mostly rely on local features like nose, eyes and mouth etc. Geometric based approaches are also similar to feature based approaches and use distance, angle position and other relations between the facial components.

The work of yow [15] is very best in this regard in which human face detected through geometric features and spatial filters. Gabor wavelets [16], show a major role for facial representation in its graph matching methods. Local feature representation mostly consists of wavelet coefficients for different rotations and scales built on fixed wavelet bases. These locally estimated wavelet coefficients are robust to distortion, rotation, illumination change, scaling and translation. Most researchers claimed that geometric based approaches are better than appearance based approaches. They used fiducial point on the face to extract geometric features.

C) Hybrid Approach

In hybrid approaches both local features and holistic way is combined to extract the image. The modular Eigen-faces method[17] uses both global Eigen faces and local Eigen features. They locally extract the nose eyes and mouth in different images and also take multiple views of face images. Hybrid methods are more powerful and appropriate in that sense it used both above approaches capability and power. In this regard Reza Sadeghi [18] presented some very good approaches that how to make an effective face recognition method that shows good response and also produce significant impact over previous methods.

PROPOSED METHOD

Contour based face recognition using discrete cosine transform is the main theme of this research but geodesic distance is also during processing of images. Geodesic distance only focuses on intensity variation of facial curvature. Because of this intensity variation in human faces we can capture more and more information which is very helpful to recognize images accurately. But here this geodesic distance is used to draw the contours on human face. Proposed method

consists of following steps, It can be seen in Fig 1.

1) Preparation of Image Database
2) Calculation of Geodesic Distance transform
3) Drawing Contour
4) Apply Discrete Cosine Transform (DCT)
5) Classification

A) Preparation of Image Database

Algorithm of this research took FEI face color database and this database already used in most of the researches of face recognition. This database consists of Brazilian people mostly of different human color and race. It contains 600 images of 200 persons and for this proposed method only 3 images of each person with one neutral, one smiling and last one with different illumination is used for the recognition of face. The images must be in 350x280 pixels and all are properly aligned and cropped. The images must be converted in two dimensional or gray scale because color images are very typical to recognize.

Image acquisition is the process in which th esystem maintain the initial process and setup the system to achieve the criteria. FEI database is very famous during many researches. Below

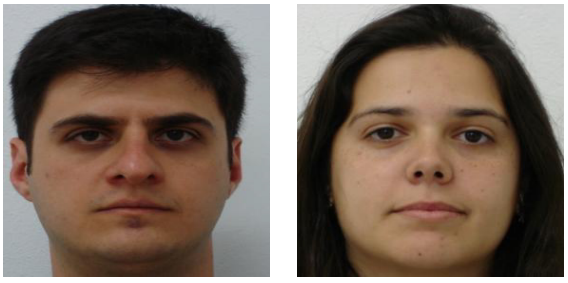

Fig 2 is the FEI image for our algorithm.

B) Calculation of Geodesic Distance Transform

Fast marching algorithm is used for the extraction of geodesic distance transform. Raster scanning is another method but fast marching is more appropriate and easy to use. This method first time introduced by James A. Sethian, a famous mathematician. The algorithm of fast marching used to solve boundary value matters of Eikonal equation.

$$F(x)|\nabla T(x)| = 1$$

Boundary value tells the progression of closed curve as a function of time T with speed F(x). This distance can be calculated when the normal to the curve at any point provides the direction of extension of the curves. Fast marching is similar to Dijkstra algorithm which is the special case of level set methods while fast marching is faster than level set methods. For geodesic distance the algorithm require a starting point and this point most appropriately would be took on the nose of human face. This point also called a seed point. This seed point actually calculates the geodesic distance transform over the whole face. Geodesic calculated the different distance values but for the next step only maximum distance value is used for further calculation.

C) Drawing Contour

Contours are the main point on which whole research depend, they must be accurate and in sensible way and hopefully helpful in the processing of images. It is a popular mathematical measure. Here contours on human face can be drawn by taking the maximum distance value of geodesic distance transform. Distance is already calculated, so its maximum value is used for the calculation of contours. They are very suitable for capturing the local features of image but there must be a care that contour spacing must be same over whole image. Following are the contour images with respect to their 2-D images that take out all the local features of image which helped us to recognize the image. Total 15 contour images were extracted from each single image. In Fig 3, 4 we can see the images in grayscale and applied
contoured images correspondingly.

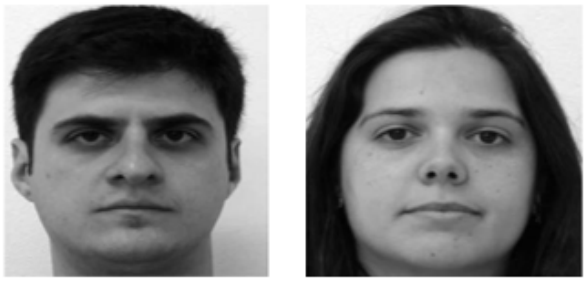

Fig. 3. 2D or Grayscale Images

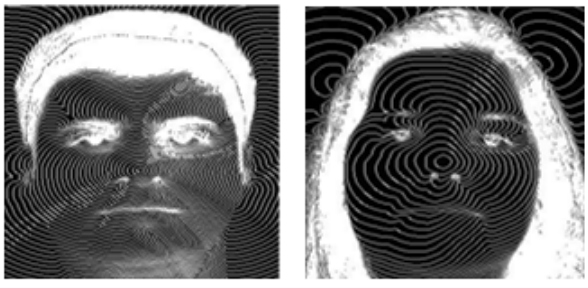

Fig. 4.Contour Images

D) Apply DCT

Discrete Cosine Transform referred as DCT is a well-established data compression technique. Ahmed et al. introduced it first time in early 70s. Ahmed proposed the use of DCT-II and also used it more dimension reduction.

DCT gain lot of popularity when Wang (1984) classified DCT into four different transformations named DCT-I, II, III & IV. So this research used the DCT-II which can be more suitable for gray level images.

As discussed above that 15 contour images were extracted for

each single image of database and these contour based matrix are used in this step. DCT (discrete cosine transform) are applied on all contour images and this gave us the actual features of image. It also neglected the waste information and refines the images. DCT also reduced the dimension of the images and gave us DCT coefficients. These DCT coefficients are used for classification to check the final accuracy of this algorithm. The general equation for a 2D (N x M image) DCT is defined as follows:

$$F(u,v) = C(u)C(v)\sum_{x=0}^{N-1}\sum_{y=0}^{M-1} f(x,y)\cos\left(\frac{\prod(2x+1)u}{2N}\right)\cos\left(\frac{\prod(2y+1)v}{2M}\right)$$

where, $u = 0,1,\ldots,N-1.\ v = 0,1,\ldots,M-1$

$$C(u), C(v) = \sqrt{\frac{1}{N}}$$

when $u, v = 0$

$$C(u), C(v) = \sqrt{\frac{1}{M}}$$

E) Classification

Classification is the most important step of automatic face recognition. In this step the accuracy of final result can be obtained. The training and testing procedure must be in accordance with the classifier. In this research Euclidean distance is used for the classification of final images. Euclidean is the "ordinary" distance between two points. The general equation of 2D Euclidean distance is:

$$d(p,q) = \sqrt{p_1 - q_1{}^2 + p_2 - q_2{}^2}$$

Euclidean distance is also actually follow the KNN (K-nearest neighbor) approach. In which the classification is done by the matching of neighboring pixels. For each observation, the algorithm fixed 150 contours and classified the data in terms of 25, 50, 100 and 200 images. But the database contain3 images for every person and it became 75, 150, 300 and 600 images for training. Testing is done in two ways, firstly any one image to other image and second is both images for other image. Classification result showed the fact that recognition is done and the final output is achieved.

RESULTS

Table I is the overall recognition result of our algorithm that showed the maturity level during the contour and DCT stage. Classification can be an important aspect and Table II showed the recognition rate of testing any one image and table III showed testing of both images.

Table I. Recognition Results

No. of Persons	Testing sample images	Recognition rate (%)
200	1	95.7
200	2	74.4

Table II. Testing for 1-Sample

No. of Persons	Recognition rate (%)
25	99.2
50	98.2
100	96.9
200	95.7

Table III. Testing for 2-Sample

No. of Persons	Recognition rate (%)
25	79.5
50	76.2
100	76.1
200	74.4

Upcoming Fig 5 represents the above table's output of recognition vs training sample.

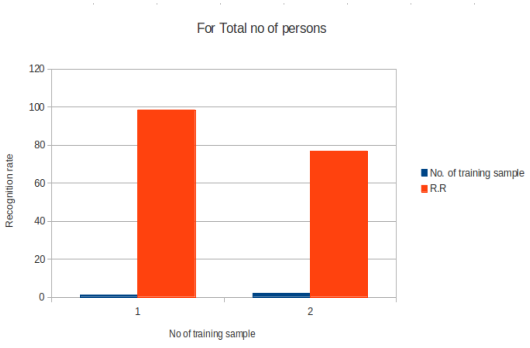

Fig. 5.Graph for Table I

Following Fig 6 and 7 are also showing the recognition result for both training images.

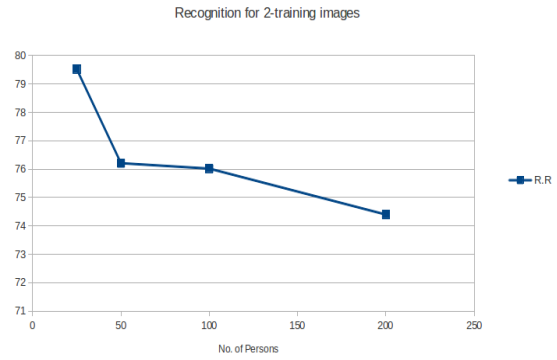

Fig.6. Graph for Table II

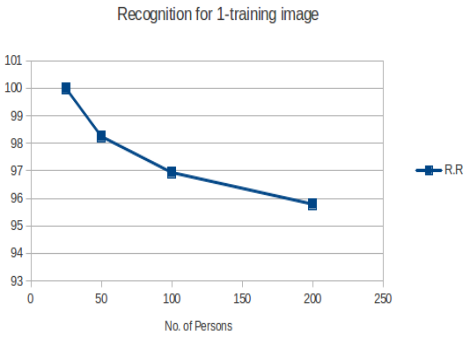

Fig.7 Graph for Table III

COMPARISON

The comparative evaluation is shown in Table-IV, where the better performance of proposed method in terms of recognition rate can be seen. The improvement in recognition rate shows that the use of contours and discrete cosine transform produced the better result.

TABLE IV. Coparison with DCT & PCA

No. of Persons	Proposed Method (%)	DCT (%)	PCA (%)
25	99.2	99.1	95.5
50	98.2	96.2	92.2
100	96.9	92.3	89.2
200	95.7	91.1	80.1

CONCLUSION

When using both images for recognition, the false acceptance rate should be minimized and false rejection rate should be maximized as compared to that of any one image for testing. The recognition rate for contour based face recognition using DCT is calculated. The recognition rate improves when images are normalized. We also checked result for different observation by changing the number of persons. The results are comparable to the state-of-the-art face recognition technique.

REFERENCES

[1] Leibe B. and Schiele B., Analyzing appearance and contour based methods for object categorization, Computer Vision and Pattern Recognition, Proc. 2003 IEEE Computer Society, IEEE, 2, II-409, (2003)

[2] Li H., Manjunath B. S. and Mitra S. K., Contour-based approach to multisensor image registration, Image Processing, IEEE Trans., 4(2), 320–334 (1995)

[3] A. Kokou M., and Antoine V., Shape characterization on phase microscopy images using a dispersion indicator: Application to amoeba cells, Res. J. of Comp. and Info. Tech. Sci., 1(5), 8–12 (2013)

[4] Ahsraf M., Sarim M., Shaikh A. B., Raffat S. K., et al., Face recognition using weighted distance transform, Res. J. of Rect. Sci., (2014)

[5] Sethian J. A., Fast marching methods, SIAM review, 41(2), 199–235, (1999)

[6] Sethian J. A., A fast marching level set method for monotonically advancing fronts, Proc. of the National Academy of Sciences, 93(4), 1591–1595 (1996)

[7] FEI Face Database, (Last accessed 25/11/2015) http://fei.edu.br/~cet/facedatabase.html.

[8] Chadha A. J., Vaidya P. P. and Roja M. M., Face recognition using discrete cosine transform for global and local features, Proc. Recent Advancements in Electrical, Electronics and Control Engineering (ICONRAEeCE), IEEE, 502-505 (2011)

[9] Zhao W., Chellappa R., Phillips P. J. and Rosenfeld A., Face recognition: A literature survey, Acm Computing Surveys(CSUR), 35(4), 399–458 (2003)

[10] Prasad M., Panda S., Deepthi G., and Anisha V., Face recognition using pca and feed forward neural networks, Int. J. of Comp. Sci. and Tele., 2(8), 79–82 (2011).

[11] Lai J. H., Yuen P. C., and Feng G. C., Face recognition using holistic fourier invariant features, Pattern Recognition, 34(1), 95–109 (2001)

[12] Ahmed N., Natarajan T. and Rao K. R., Discrete cosine transform, 100(1), 90-93 (1974)

[13] Hafed Z. M., and Levine M. D., Face recognition using the discrete cosine transform, Int. J. of Comp. Vision, 43(3), 167–188 (2001)

[14] Muhammad Sharif S. M. M. R. and Shah J. H., Sub-holistic hidden markov model for face recognition, Res. J. of Rec. Sci., 2(5), 10–14 (2013)

[15] A Yow K. C. and Cipolla R., Feature-based human face detection, Image and Vision Computing, 15(9), 713-735 (1997)

[16] Shen L. and Bai L., A review on gabor wavelets for face recognition, Pattern analysis and applications, 9(2-3), 273–292 (2006)

[17] A Pentland A., Moghaddam B. and Starner T., Viewbased and modular eigenspaces for face recognition, Computer Vision and Pattern Recognition, Proc. 1994 IEEE Computer Society, 84–91 (1994)

[18] A Sadeghi R., A comparative face recognition algorithm for dark places, Res. J. of Rec. Sci., 2(9), 92–94 (2013).