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Face Recognition under Variation in Resolution Using Enhanced Local Ternary Pattern

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Abstract: Face is an important biometric trait that has been used for various application of today's technology. Face recognition comprises recognition of an individual identity to others on the basis of facial features. Facial features provide low accuracy due to variation in illumination and resolution of the images. In this paper an approach has been proposed that overcomes the issue of low recognition accuracy under low resolution captured images. In this paper texture features based approach that has been developed from the local ternary pattern by using two different groups of neighbour pixel values. On the basis of these two different groups texture features have been computed by comparing these values with centre pixel value of particular regions. By using local codes developed from the particular region whole image features have been computed using different codes from different regions. In this paper an approach that is combination of filtering and feature extraction has been proposed so that better face recognition can be achieved. On the basis of parameters analysis proposed work outperforms as compare to exiting approaches.

Keywords: Face recognition, DCT, DWT, LDA, LTP, LBP and PCA

I. INTRODUCTION

I.I Digital Image Processing

An image that comprised rows and columns contains pixel values at x and y co-ordinates of the spatial domain. The value of the single pair of x and y represents pixel intensity value. The combination of these values having number of rows and columns has been known as digital image. Digital image comprises information about the surrounding environment. The information provided through pixel values has been introduced as digital image or picture that locates various location points and representations.

I.II Biometric

Biometric is the field of digital image processing that has been used for authentication and validation process. Biometric has been used as uniqueness features of an individual so that a person's identity can be claimed. Various traits are available that can be used in biometric recognition process. Face Fingerprint, Iris, and voice are the major biometric traits that have uniqueness from other individuals. In this paper face has been used as biometric traits for face recognition.

I.III Face Recognition 0

Face is the important traits that can be used for individual verification. Face has major advantage that human brain can easily recognize individual from face because it's an easy remarkable attribute of an individual. Human has the capability of remembering human face up to thousands of years so that humans can be easily remembered after long gap in meeting. Face has variability's that are due to burdens of life events, age factors, changes in hair style and distractions that are due to glasses are major factor that can change look of the individual that not easy to recognize. In the process of automatic face recognition features from face images have been extracted that has been used for recognition process.

I.IV Types of face recognition

In the processing of face recognition two different processes has been defined that are based on matching of the individual face to many face that is known as face recognition and one matching of the individual features have been known as face verification. On the basis of these two different classes face recognition has been done so that facial features can be used for recognition and verification process.

I.IV.I Face Verification (or Authentication)

Face Variation [1] is the process that has been used for matching of an individual identity to the single person's identity. In this process of face verification a single person identity has been matched with another person identity so that claiming of an individual identity can be verified. To verify individual identity features from the query sample has been matched with features from claimed sample. On the basis of matching decision individual identity has been claimed. Face verification performance has been measured on the basis of various performance evaluation parameters that have been used for computation of recognition accuracy. FAR and FRR are the basic performance evaluation parameters that has been used for face recognition.

I.IV.II Face Identification (or Recognition)

Face identification has used for matching of single individual identity to multiple identities on the basis of facial features. In the process of face identification this is known as matching of face from one to many. On the basis of face recognition process features from the facial images have been extracted that has been used for matching process to dataset images features. On the basis of distance classifier distance between facial features and database features have been computed so that decision can be evaluated. Distances that have been computed from face dataset image features have been sorted in an order so that minimum distance containing image can be extorted from the dataset. Image which have minimum distance from query image features has been evaluated as maximum matched image to query image.

I.IV.III Face Representation

Face representation is the major task that has used in face recognition process that is face representation. Face representation has been done on the basis of alignment of facial part of the image. In this process face alignment is major factor because facial region must be available in straight manner so that face identification can be possible and feature from facial region can be easily extracted [1]. Face image must contain proper visibility of face attributes that are nose, eyes, lips and mouth. On the basis of these attributes features from facial part can be easily extorted that can provide better recognition accuracy to overall system. Pose variation and resolution are the major factors that affect the performance of face recognition system. Three types of approaches have been implemented in the process of face recognition that is template based, appurtenance based and structure based.

I.V Face Acquisition Techniques

Face image acquiring has been depends upon the application in which that has to be used. In the process of application that has been used for criminal identification and surveillance purpose [2][3] must be done using video camera or by static camera. But the images that are available in the dataset must be captured through static high quality cameras so that effective face recognition accuracy can be achieved. Approaches of image accusation and face recognition are depends upon the application that is using concept of face recognition. Face recognition approaches have been divided into three different categories on the basis of face accusation. The approaches that have been used for process of face recognition based on approaches that have to deal with intensity images and video sequences and information that required infra-red or 3-d sequences of images. The following discussion sheds some light on the methods in each category and attempts to give an idea of some of the benefits and drawbacks of the schemes mentioned therein in general.

I.VI Organization of Paper

Section I contains the introduction of face recognition and various methods that have to be used for face recognition Section II contain the related work of face recognition approaches based on texture, shape and structure features, and provide information about research gap, Section III contain the architecture and essential steps of methodology with flow chart, Section IV describes results and discussion of face recognition based on different resolutions and texture features , Section V concludes research work with future directions.

II. Related Work

The author in [4] proposed an approach that has been used for face recognition process based on texture features that has been computed using global and local Gabor features. In this process a filter has been applicable on the image that divides whole image into small non-overlapping blocks so that features from each block can be extracted and used for face recognition process. in the process each block features that has been computed using local and global filter for all non-overlapping blocks have been fused using Generalized Two-Dimensional Fisher's Linear Discriminate (G-2DFLD) approach. Due to feature fusion size of the feature vector has been increased up to an extent that has been managed by using PCA (Principal Component Analysis) approach. PCA approach reduces the feature dimensions by commuting Eigen values from subsets of the features that has been used for recognition process. The author in [5] proposed an approach that has been used for face recognition process based on texture features using LBP and LPQ approach. In this approach frequency domain and spatial domain features have been extracted from the image so that features set can be developed that provide better representation of face features over spatial as well as frequency domain. In this process LBP that is texture feature approach has been implemented on the spatial domain frequency and the image has been used for computation of binary codes that has been concatenated to develop a feature vector. LPQ has been implemented on frequency domain region of the image so that local phase quantization approach computes the feature vector that contains information about frequency domain region. After this process both feature vector has been merged in single feature vector that has been used for face

recognition process. The author in [4][6] purposed a technique that has been used for process of face recognition based on Wavelet theory and LBP approach. In this process image has been divided into various sub bands using DWT approach. These sub bands contains various frequency domain information about the images so that image can be used for feature extraction using LBP approach. These sub bands under goes LBP feature extraction approach that has been done using dividing sub bands into further non uniform overlapping blocks. On the basis of the non-overlapping blocks various binary codes has been generated. These codes have been histogramlly contaminated so that feature vector can be developed. On the basis of feature of the query image and dataset image decision of recognition has been made. On the basis of the recognition decision accuracy and other parameters of face recognition has been developed. This approach has been validated on ORL dataset as well as YALE dataset. The author in [7] purposed an approach for face recognition system that has been used for god avatars. In this process texture features have been extorted from avatars image. LTP has been implemented in this paper that is much sensitive to noise. On the basis of LTP texture features have been computed from avatars faces. Avatar faces are not easy to recognize due to various changes in the face of avatars. Because teeth and other attributes of avatars not similar to human faces so these faces are not as easy process to recognize. To recognize these features in efficient manner these features have been used on the basis of texture features. LTP use two different histograms codes that are upper codes and lowers codes. These two codes have been merged so that feature vector of texture features can be developed. That can be used for recognition system. The author in **[8]** purposed an approach for face recognition using the low resolution images. In this paper the problem is main in the low resolution the images features severely degrades detail of face image. In this paper resort the image by down sampling and interpolated to develop image database. Feature extraction is done to develop differential feature sub-space. Low resolution image with illumination variance has been has been normalized and feature extraction. Similarity metrics are used for matching of the input image with the database image. This approach provides the best results for face recognition. This approach provides the best accuracy for the face recognition. The author in **[9]** purposed fuzzy based approach for face recognition process. In this process of feature extraction KNN has been used that divides the image into different classes. Fuzzy membership values have been extracted from each class that has been developed using KNN classifier. The membership values have been computed for all the classes that are available in the process of face recognition. On the basis of membership values all patterns have been classified under different classes so that CFLDA approach can be developed that can be used for process of face recognition.

III. METHDOLOGY

Face recognition is the process of recognition of an individual identity to the dataset images on the basis of features. In the process of face recognition various images have been used for recognition process. Two different phases have been used in the process of face recognition so that face recognition can be done. In this paper a novel approach has been proposed that has been used for recognition process under low resolution. In this process of face recognition low resolution images have been generated on the basis of down sampling of the images so that images can be converted to low resolutions.

The image quality that has been down sampled has been enhanced using various filters so that optimum features can be evaluated from low resolution images. In this process of image enhancement discrete wavelet transformation has been implemented that divided image into different resolution bands that are approximation band, horizontal band, vertical band and diagonal band. Approximation band conation low intensity pixel values of the image that has been further divided by using discrete cosine transformation that divides the image into further sub blocks. Sub blocks of the image undergoes the process of image enhancement using HAAR wavelet filter that use high pass and low pass decomposition filters so that image has been filtered on the basis of filter coefficients. Image quality has been enhanced using proposed filter and after this process reconstruction high passes and low pass filters have been implemented and image blocks have been recombined using inverse discrete cosine transformation approach. After this process image undergoes process of inverse discrete wavelet transformation. Inverse transformation use interpolation of the all other three bands of the image except approximation band and add this to reconstructed band. This process improves the quality of the image from low resolution to high resolution so that effective feature set can be extracted from the image.

After this process feature extraction from the face image has been done using enhanced local ternary pattern approach. In this approach the features set from the image has been computed by dividing whole face image into small blocks of the 5 by 5 so that each block center pixel value can be used for computation of the ternary patterns. On the basis of these pixel values ternary codes have been generated. In this process of ternary codes generation threshold (t) value has been used so that on the basis of threshold value two different codes can be generated and these codes have been histogram concatenated so that better feature sub set from all the blocks can be generated.

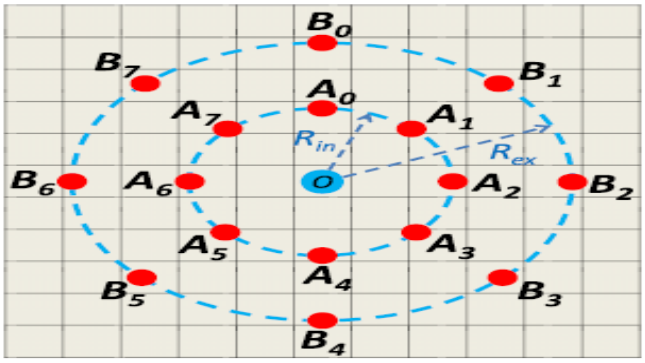


Figure 1 Pixel representation of 5 by 5 block

Above given figure represents pixel representation of single block that has been selected from the image. Two different groups of the pixels have been selected from the region that has been denoted by A_i and B_i. These pixels have been followed by a single center pixel value that has been used for computation of patterns from the images.

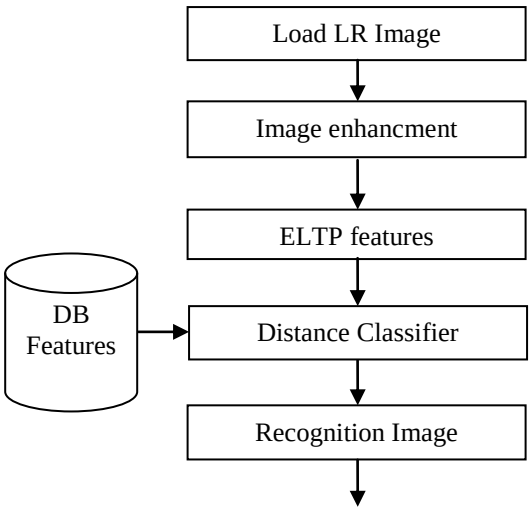
On the basis of these pixel points that are belong to neighbor pixels has been used for computation of different codes that are defined below.

$$LTP_i = S(I_{A_i} - I_o) \times 2 + S(I_{B_i} - I_{A_i}) \qquad (3.1)$$

Where value of i belongs to 0 to 7,

$$S(x) = \begin{cases} 1, & if\ x > t \\ 0, if - t < x > t \\ -1, & if\ x < -t \end{cases} \qquad (3.2)$$

On the basis these equations upper and lower ternary codes for the face image has been computed. These codes have been computed for all the blocks that are available in the images and these codes have been histogram concatenated so that feature subset can be generated. This feature subset has been computed for all the images that are available in the dataset.



Parameter Analysis

Figure 2 Flow of proposed model

After this process of feature extraction distance classifier has been used so that on the basis of minimum distance decision can be evaluated. Chi square distance classifier has been used in the proposed work.

$$d = \sum_{i=1}^{n} \frac{(x_i - y_i)^2}{x_i + y_i} \qquad (3)$$

On the basis of equation (3) distance between query image features and test image features have been computed so that decision can be evaluated and various parameters can be analyzed for performance evaluation of proposed work.

IV. RESULTS

In this paper face recognition has been done on the basis of texture features so that accuracy of the face recognition can be increased under various changes in face images that are illumination, resolution and pose variation. Face recognition has been done using low resolution images based on texture features that have been computed from the images. In this paper proposed work has been done using AT&T laboratory dataset that contains 400 images of 40 different individual under different illuminations and poses.

Figure **3** Dataset Images

This figure represents dataset images that have been used in face recognition process. In proposed work whole dataset has been divided into two groups that are for training and testing process. On the basis of training dataset features from the dataset images using ELTP approach has been computed and stored in the system memory.

On the basis of proposed approach that has been discussed in section III features from the images have been computed.

These texture features that have been computed are computed from tiny region of the images that has been histogram concatenated so that feature vector for whole image can be developed. Proposed approach computes the features from the dataset images and testing image and use chi-square distance classifier for feature matching so that best image that is relevant to query image can be selected from the dataset.

IV. I Accuracy

Accuracy is calculted on the basis of matched images and mis-matched images from the databse. In this the all the images of database at different resolutions has been tested for martching with database images. On the basis of the mismatching the accuracy of one system has been computed. Total 160 images has been taken for testing of proposed sytem out of 400 face images.

Accurarcy=[100-(Mis-match Images/Total test images*100)]

Table 1 Accuracy for vaious approaches

Resolution	LTP	DCT+ ELTP	DWT+ ELTP	DCT+DWT +ELTP
112*92	85	90	91.25	93.12
64*64	90	91.25	92.50	94.50
32*32	85.62	90	88.70	90.62

Table 1 illustrate the accuracy given by different approaches of face recognition. Accuracy has been computed on the basis of the different resolution of images has been taken for performance evolution of the system for low resolution images.

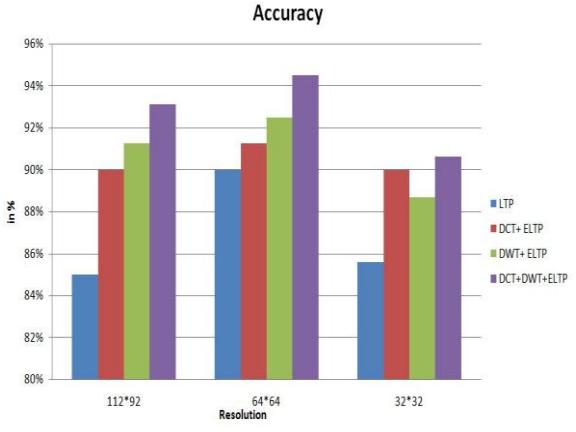


Figure **4** Accuracy graph

This figure represents accuracy fro face recognition under different approaches of face recognition process. On the basis of face recognition process at different resolution accuracy has been computed and the results have been represented under graphical representation. On the basis of graph analysis proposed approach provide better recognition accuracy at different resolutions.

V. CONCLUSION

Face recognition has been widely used in various application of the digital world. Surveillance and criminal identification are the major areas of the face recognition. These areas are suffering from the major issue of mismatching under noise and low resolution. In this paper a novel approach that is based on texture features so that face recognition accuracy can be improved in the low resolution as well as pose variation. On the basis of resolution variation different approaches have been used that enhance that quality of the image and enhanced local ternary pattern approach has been used so that better features from the images can be extorted. On the basis of parameter analysis one can conclude that proposed approach provide better accuracy under low resolution face samples.

In future reference an approach can be derived that can be work on the basis of appearance because texture features has a major drawback is that at background changes accuracy of the face recognition has been decreased.

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