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FACE RECOGNITION UNDER VARIATION IN ILLUMINATION USING HYBRID OF PCA AND DCP

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Abstract: Biometric traits have been widely used for various aspects in digital transaction and for security purposes. Uniqueness of biometric traits makes them to be useful under different applications. Face is a biometric trait that has larger uniqueness from other individuals as compare to other biometric traits. Face can be widely used for surveillance, criminal detection and recognition. In this paper a hybrid approach has been proposed that has been used for face recognition process so that better accuracy can be achieved. This approach has been simulated under different facial representations that are variation is resolution, poses and illuminations. Proposed approach provides better face recognition accuracy under low resolution face images resulting in a more effective approach that can be widely used for criminal recognition that are caught under CCTV footage.

Keywords: Biometric Traits, DCP, PCA, and LBP

1. INTRODUCTION

1.1 BIOMETRIC: various traits of the individual have been used for identification of person's identity based on unique attributes of the biometric [1]traits. Various biometric traits have been used for identification of one's identity to other ones on the basis of features. In the field of biometric different biometric traits have been used that are speech, fingerprint, iris and face. These traits have been used in the process of biometric recognition because these have uniqueness in terms of features and representation from each individual. These traits have no common interference between one people to other person.

On the basis of biometric traits features recognition and matching of the individual identity has been achieved. Various types of features have been extorted from the biometric traits samples that have been used in recognition process.

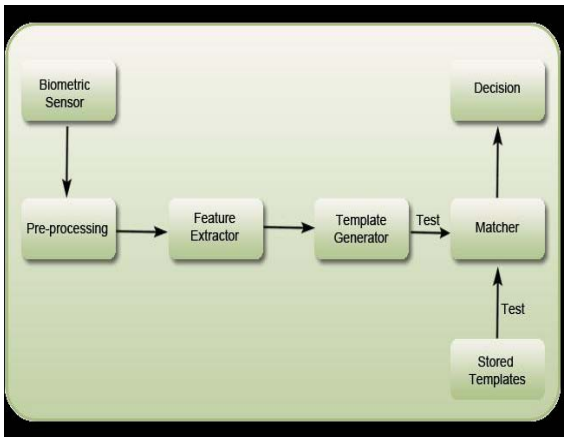

Fig 1: Biometrics system components

1.2 BIOMETERIC SYSTEM: biometric system is the whole system that has been used for the processing of the biometric traits and used for feature extraction. These extracted features have been used for matching with dataset features and on the basis of matching decision has been done.

Biometrics Trait: biometric trait is the unique sample of the individual body part that has uniqueness from other human body part. This consists of face, fingerprint, palm-print and iris. These traits have unique identifier such that no similarity can be identified between two different individual biometric traits.

Biometrics Instance: Biometric instance represents a particular identification to a single individual biometric for example, left eye, right thumb and left hand geometry.

Biometrics Sample: A particular instance of a specific instance is an individual biometric is captured by the biometric sensor.

Biometrics Template: biometric samples that has been used in the process of biometric recognition used for feature extraction. These features that have been extracted from the samples have been act as biometric template that can be used for recognition process.

Biometric query (or simply query): the biometric sample that has been used for matching process to the dataset samples from which biometric template has been generated has been known as biometric query. On the basis of biometric template biometric query matching decision has been made.

System Threshold: the minimum value that has been used for matching of the biometric query to database template has been known as system threshold. On the basis of system threshold various parameters have been analyzed.

1.2 CHARACTERSTICS USED IN BIOMETRIC

In biometric system various characteristics have been used for recognition process. In biometric recognition process different types of traits have been used that have been described below.

1.2.1 Face: face [2] is a common biometric trait that has been used for recognition process under various applications. Facial images that has been captured from video sources and capturing devices can be used in the process of face recognition. Face provides better representation of the individual identity. Various types of approaches have been used in digital image processing for face recognition process. These approaches are based on shape, appearance and texture features.

1.2.2 Fingerprint: fingerprint has been used as the biometric traits from last century. Various ridges points

have been extracted from the finger tips. On these fingertips various lines have been linked to each other that have different joints and bifurcations. From these finger lines various features have been evaluated so that better features from fingerprint can be extracted and used for biometric recognition process. Fingerprint from the individual have been captured using fingerprint sensors so that these can be used in recognition process.

1.2.3 Palm Print: palm print is another biometric trait that has been used for recognition process. Palm print has been captured from hand geometry. Various lines from the hand geometry have been extorted and these lines have been preprocessed so that better features can be evaluated from these lines. Based on hand geometry various location points have been extracted that has been act as feature vector so that better recognition can be achieved.

1.2.4 Iris: iris is an important biometric trait that has been used for biometric recognition system. On the basis of iris recognition eye internal images have been captured so that segmentation can be done and iris region from the eyes can be extracted. Iris of any individuals has no matching with other than him.

1.2.5 Speech: speech is biometric trait that can be used for biometric recognition system. Speech is combination of vocal tract and nasal cavities. Speech features have been changed due to age factor and medical conditions. So recognition under speech at various age levels does not provide effective efficiency.

1.3 Face recognition phases: face recognition has been done in different phases that are for face detection and face recognition. In this process face has been detected from the facial images so that better representation can be done and better features can be extracted from face samples.

1.3.1 Face Representation: face representation [3] is the first phase of face recognition process. In the process of face recognition various approaches have been used for feature extraction so that better representation can be done. In process of face representation modality of face has been verified so better features can be extracted. Face represented provides information about various face attributes that are nose, eyes and lips. Face representation has been widely used in various techniques of face recognition that are texture based, shape based and structure based.

1.3.2 Face detection: face detection [4] is the process to extract facial region from the image of the individual. In this process face region has been identified so that face representation can be done. In this process elliptical head structure based approach has been used so that facial region can be extracted from the dataset.

1.3.3 Face identification: face recognition [5] is the process so that query image features can be matched with dataset features. On the basis of features face recognition has been done. One's person identity matching has been done on the basis of decision making system. Performance of face recognition has been depends on various factors that are pose, illumination and scale.

2. REVIEW OF LITERATURE

Changxing Ding, et al [6] "Multi-Directional Multi-Level Dual-Cross Patterns for Robust Face Recognition", in this paper author proposed a novel approach for face recognition that is robust to different issues in face recognition that are change in illumination, pose variation and expression changing. In this paper multi directional dual cross pattern approach has been used so that features from face images can be extorted and better recognition rate can be achieved. In this approach Gaussian operator has been implemented so that effect of the illumination of the features can be reduced and DCP has been implemented on both holistic and component levels of the face image. on the basis of DCP facial texture features have been computed that provide information about the facial components in encoded form. The proposed approach in this paper has been accumulated on different dataset and efficiency of the proposed approach has been measured. Various datasets that have been used in the proposed work are FERET, CAS-PERL-R1, FRGC 2.0, and LFW databases indicate that DCP outperforms the state-of-the-art local descriptors.

Kyungnam Kim [7] proposed a technique PCA for face recognition. PCA is the approach that has been based on Eigen value and Eigen vectors so that better feature representation can be achieved. PCA is method that has been used for face feature extraction on the basis of conversion of 2-D image to 1-D vector so that features from the 1-D vector can be generated. On the basis of 1-D vector covariance matrix and subtracted image has been generated that has been used for computation of Eigen values. Face recognition has many applicable areas. Moreover, it can be categorized into face identification, face classification, or sex determination. The most useful applications contain crowd surveillance, video content indexing, personal identification (ex. driver's licence), mug shots matching, entrance security, etc. The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space. This can be called Eigen space projection. Eigen space is calculated by identifying the eigenvectors of the covariance matrix derived from a set of facial images (vectors).

Pong C. Yuen, J. H. Lai [8] proposed the problem of face recognition using independent component analysis (ICA). ICA has been useful in two different prospective in face recognition. On the basis of ICA various features have been extracted from the images that have been stored in database. The components that have been extracted from face images are independent but not orthogonal. In this paper a novel approach that is based on householder transformation has been proposed for development of new feature extraction from the facial images. all the independent components of the face images are not useful that increase complexity and decrease recognition accuracy. To overcome this issue in this paper a selection algorithm has been used so that a better subset of the IC's components can be used for face recognition process. Various datasets that are namely, MIT AI Laboratory, Yale University and Olivette Research Laboratory, are selected to evaluate the performance and the results are encouraging.

Jian Yang, David Zhang, Alejandro F. Frangi, and Jing-yu Yang [9] proposed a new technique 2DPCA [4] for image representation. Opposed to PCA, 2DPCA is based on 2D

image matrices rather than 1D vector so the image matrix does not need to be transformed into vector prior to feature extraction. In this process mean image has been subtracted directly from the query image and from 2-D vector a covariance matrix has been generated. This matrix has been multiplied with inverse of the covariance matrix so that Eigen values from the matrix can be generated. 2DPCA techniques are applied on the ORL, AR and YALE databases. It shows the recognition rate and recognition accuracy is always higher than that of the PCA. There is one drawback with respect to PCA that is it needs more coefficients for image representation. 2DPCA approach is suitable for the small sample size problems.

Timo Ahomen, Abdenour Hadid and Matti Pietikainen [10] proposed a new approach for image representation by using the LBP (local binary pattern). The face image is divided into several regions from which the LBP feature distribution are extracted and concatenated into an enhanced feature vector to be used as face descriptor .the performance of proposed method is assessed in the face recognition problem under the different challenges.

3. METHDOLOGY

Face recognition is the process of matching an individual identity to the database images on the basis of facial features. In this process face images has been captured and used for feature extraction. In this process of face recognition different approaches has been widely used. Face recognition approaches that has been widely used are prone to pose, illumination and resolution of the images.

In this paper an approach has been proposed that has been used for face recognition under different poses, illuminations and low resolutions.

In this paper hybrid approach has been used for feature extraction from facial images. In this process texture feature and Eigen value based features have been used in combined manner so that better recognition accuracy can be achieved. To optimize best features in face recognition these features have been concatenated into single vector so that optimum feature subset for facial images has been developed.

3.1 DCP (Dual Cross Pattern)

In the process of dual cross pattern based feature extraction image has been used by dividing into 5 by 5 window patches. On all the windows two different patterns has been used for feature extraction from face images. In this process of feature extraction two different layers has been used so that dual cross pattern can be combined into single group. This all steps of dual cross pattern have been illustrated in this section.

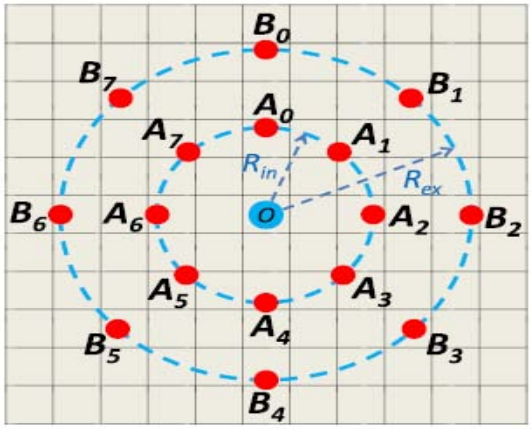

Fig 2 Dual Cross pattern region

This figure represents feature extraction process of dual cross pattern. In these process two different groups of pixels has been selected for feature extraction from the dataset images. These pixel represents by the around in the center pixel that has been represented by O in figure 2.

Various points has been selected from the image regions that has been denoted as {A0, B0; A1, B1; A2, B2; A3, B3; A4, B4; A5, B5; A6, B6; A7, B7} in above represented figure. 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.

$$DCP_i = S(I_{A_i} - I_o) \times 2 + S(I_{B_i} - I_{A_i}) \quad (1)$$

Where value of i belongs to 0 to 7,

$$S(x) = \begin{cases} 1, x \geq 0 \\ 0, x < 0 \end{cases} \quad (2)$$

On the basis of these above defined eq. (1) and (2) various DCP code from region has been computed these codes has been concatenated using encoding method that has been done using logarithmic function. On the basis of this encoding feature vector has been developed.

3.2 PCA (Principal Component Analysis) Face Recognition is the process of biometric trait recognition. In this process, the different face images of persons have been used for recognition process. In this process, the features have been evaluated from different face images using different approaches. In this final work, the face images have been used for extraction of features. Principal Component Analysis (PCA) has been used for extraction of the features from the different face images. This approach generates covariance matrixes for the face representation. The co- variance matrix is used for development of Eigen values and Eigen vector.

In the final methodology, the mean of the face images have computed and the mean of the face sample has been subtracted and mean subtracted face sample is computed from face dataset.

$$\Psi = \frac{1}{N}\sum_{i=1}^{N} X_i \quad (1)$$

This approach has been used for extraction of mean face sample by using equation (1). Then the mean subtracted face sample is computed by subtracting the mean face sample from all training face samples.

$$\Phi = X - \Psi \quad (2)$$

The mean subtracted face sample has been computed by subtracted the mean face sample from the training face sample. After this process the variance matrix A Computed from these mean subtracted face sample that is 2 d variance matrix directly developed from the face sample.

$$M=A.A^T \quad (3)$$

After this process the Eigen features and the Eigen values for the face has been computed that is used the covariance matrix and subtracted face sample. On the basis of subtracted image the Eigen vector has been generated that is based on multiplication of covariance matrix and transpose of covariance matrix. The values that have been computed that are μi that represents Eigen values and v_i that represents Eigen vector. On the basis of these Eigen values and Eigen vector a face matrix has been generated that has been represented in equation (4) and (5).

$$M.v_i=\mu_i.v_i \quad (4)$$

$$\Phi=A.v \quad (5)$$

On the basis of these equations a feature vector has been generated that has been used for face recognition process. Features from all the images that have been available in the

dataset has been computed and stored in database directory so that face recognition has been done.

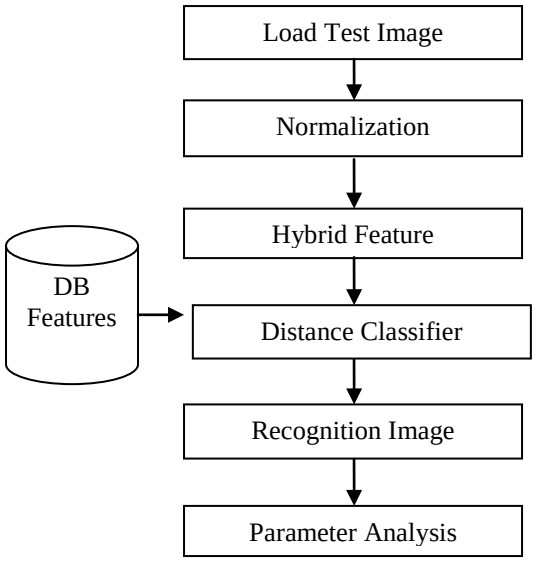

Fig 3 Flow of proposed model

On the basis of hybrid approach features from face images have been computed and stored in the database files. After this process test image features have been computed and used for recognition process based on distance classifier.

4. RESULTS

In the process of face recognition various dataset have been available that have been used for process of face feature extraction and recognition. In this research ORL dataset has been used for face recognition purpose. In this process of face recognition ORL dataset contain 400 images of 40 different individual under different illuminations, poses and variations. Whole dataset has been divided into two different categories that are for training and testing process. ORL dataset has been divided into training dataset using 6 images of 40 individuals and testing dataset has been developed used remaining 4 images of 40 individuals. On the basis of these datasets simulation has been performed that has been used for performance analysis of proposed model.

In this process of face recognition performance of the proposed work has been analyzed using two different approaches of distance classifier.

4.1 Experimental results using Euclidian Distance classifier

On the basis of Euclidian distance classifier images has been used for recognition process. Euclidian distance is commonly used for distance computation between two vectors based on distance formulas.

Table 1 Face recognition accuracy using Euclidian classifier

Resolution	Testing Images	Proposed	DCP
High	160	93.56	90.72
Low	160	92.98	90.62
128 * 128	160	93.48	91.25
64 *64	160	93.26	91.26

This table represents face recognition accuracy of the proposed model using different resolution samples for face recognition process.

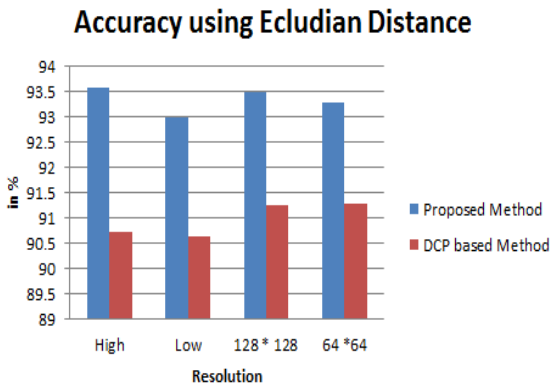

Fig 4 Accuracy Graph using Euclidian

This figure represents accuracy of the proposed work based on Euclidian distance under different resolution of the images. This method outperforms under various low resolutions face images

4.2 Experimental results using Cosine Distance classifier

On the basis of cosine distance classifier images has been used for recognition process. Cosine similarity has been used for computation of distance based on angles. This approach is independent to length of vectors

Table 3 Face recognition accuracy using Cosine classifier

Resolution	Testing Images	Proposed	DCP
High	160	96.55	93.12
Low	160	96.53	93.06
128 * 128	160	96.56	93.12
64 *64	160	93.57	93.13

This table represents face recognition accuracy of the proposed model using different resolution samples for face recognition process.

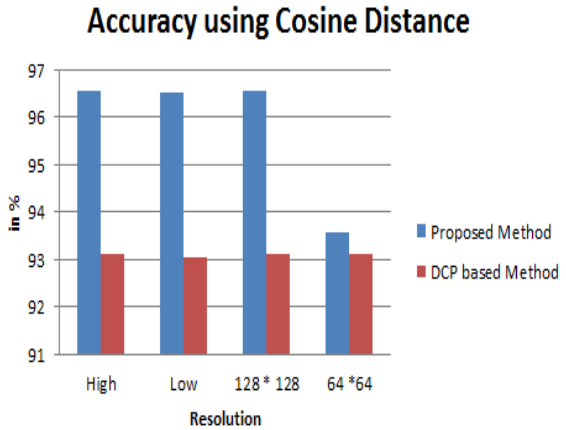

Fig 5 Accuracy Graph using Euclidian

This figure represents accuracy of the proposed work based on Euclidian distance under different resolution of

the images. This method outperforms under various low resolutions face images

5. CONCLUSION & FUTURE SCOPE

Face plays an important role in various application of digital world. Face has been used in various applications that are used in security appliances, individual identity verification. Face recognition has been degraded under low resolution that is major issue under footages or capturing of low resolution of night vision cameras. In this paper a novel approach has been proposed that can be used for low resolution images so that better accuracy can be achieved. Proposed approach is based on texture as well as structure based features so that optimum features from low resolution images can be extracted and used for different purposes. On the basis of performance evaluation parameters we can conclude that proposed approach provide better face recognition as compare to existing one.

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