RESEARCHERID
THOMSON REUTERS

[ICRTCET-2018]

ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

FACE RECOGNITION USING DWT-SVD BASED FEATURE EXTRACTION METHODS

B. Elisha Raju[*1] & Satyanarayana Murty. P[2]

[*1]M. Tech (DECS), Department of ECE, Vishnu Institute of Technology (VIT), Bhimavaram, Andhra Pradesh, INDIA

[2]Professor, Department of ECE, Vishnu Institute of Technology (VIT), Bhimavaram, Andhra Pradesh, INDIA

ABSTRACT

Face Recognition (FR) is a physical biometric used to distinguish a registered person among the group of people. The training process involved in face recognition requires a large database to identify a face using extracted features. The challenging problems of FR systems are storage of large database and lighting conditions of an image. In this paper, the single sample of each individual person is placed in training data and illumination constant normalization is performed to address these problems. Under different lighting conditions, the image obtained by the thermal cameras is given as input to two level Discrete Wavelet Transform (2D DWT). Singular Value Decomposition (SVD) is used for the features extraction of the coefficients of a low-frequency band of 2D DWT. The features of the testing image are compared to get the recognized person and the recognition rate is increased by using this algorithm.

Keywords: *face recognition, DWT, SVD, Recognition rate, illumination.*

I. INTRODUCTION

Biometrics is the measurement and analysis of unique physical characteristics like face, fingerprint, iris, palm print etc., or behavioral characteristics such as signature, voice patterns, walking style etc., especially as a means of verifying personal identity. In present era, face recognition (FR) system obtaining substantial attention in biometrics from researchers. The process of FR system involves detection and verification of the face images by comparing the features of the different images stored in database. This technique is used in security systems. FR system made easy to identify a person using facial features rather than the other traits that are used to verify a person in the database. The problem of FR system is the variations in pose i.e. head rotation and tilt, light intensity and angle, facial expression, aging etc. In the previous models different algorithms like Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), Discrete Cosine Transform (DCT) and Hidden Markov Models are used to address these problems but the recognition is not better than the proposed work of this paper.

The FR system requires a large database to recognize a person but in this paper, only single sample/pose of each individual person is considered for training and for this sample, facial features are obtained and stored in a database for comparing with the testing samples. The testing can be done with the different samples by considering only one sample of individual in training set of facial features.

Applications of FR system include security application, personal device login, smart cards, online payments, criminal identification, healthcare etc. FR system used in some of the various applications like online payments to make the payments easy without using any cards. In this application face technology used to make a payment so that the user need not to carry any credentials along with him because he is the access to make a payment by considering his face.

In the following sections there are complete details of the idea of the proposed solution which is explained in section II and section III gives brief details about the implementation steps of the proposed solution and followed

by the section IV which shows the results obtained by the proposed method and finally concluded the FR system with the required results.

II. LITERATURE SURVEY

Vaidehi et al., proposed an algorithm for DCT based Face Recognition using Fisher Linear Discriminant (FLD) in which the image is reduced using the DCT and FLD is applied to the selected DCT coefficients [1]. FR using DCT and FLD requires more training images to recognize an unknown person and the database consists of 60 persons is acceptable and is not accurate, if the database is increased. Dabbaghchian et al., proposed an algorithm for Feature extraction using DCT and Discrimination Power analysis in which the features mean and variance of DCT coefficients were used [2]. The recognition rate (RR) achieved is 80% and the database consists of 15 persons and the RR is reduced if there is variation in the brightness level of the images in the database. Hongtao [3] et al., proposed an algorithm for FR system using DWT and two dimensional Principle Component Analysis (PCA) in which 3 to 5 images are used for training and wavelet coefficients are used as features it is accurate up to 40 persons and there are no considerations about the illumination and the pose variations. Danyang [4] et al., proposed a Face Recognition using SVD which consists of singular values of SVD as features and it is not accurate if the database is increased and it requires a large database for training i.e., 5 poses of each individual person to recognize with the unknown faces of persons in the training database [4]. However, the disadvantages of the DCT & FLD, DCT &DPA, DWT &2D PCA and SVD requires more samples in the training, RR degrades with the variations in pose and brightness and inaccurate when the database is high. Thus to overcome all these considerations an algorithm is proposed i.e., FR system with the DWT and SVD feature extraction methods.

III. BACKGROUND

The idea of the proposed solution involves segmentation of face, feature extraction from face regions, recognition/verification. The lighting intensity can be normalized to a uniform illumination by using the equalization techniques. The feature extraction processes use Discrete Wavelet Transform, Singular Value Decomposition algorithms. In FR system, the test image is compared with the training images by considering the facial features and the distance between those features are measured in order to identify the registered person. Eigenvectors of the SVD are considered as the features in the verification process and distance between the training features and the testing features is measured by using the SVD.

The frontal image of the individuals is considered for the training purpose and then it is given as input to DWT. Now, DWT classifies the input image into four distinct bands called Low-Low (LL), Low-High (LH), High-Low (HL) and High-High (HH). The process of feature extraction is carried out by the considering the sub-band LL. The LL band consists of the low-frequency components in which there is more details about the content of the image. The input image is compressed by using the DWT algorithm so instead of using the whole image, a sub-band of the input image is considered. This implies that complexity of obtaining features from the whole image is reduced when a sub-band is used for the feature extraction.

A. DWT of an image

In general, the pixel values of an image are converted from one domain to another domain by using the transform techniques. To analyze the image in both time and frequency domains, wavelet transform is applied to converts the pixel values of an image into wavelets used in different applications. The sub-division of an image using DWT is as shown in Fig 1.

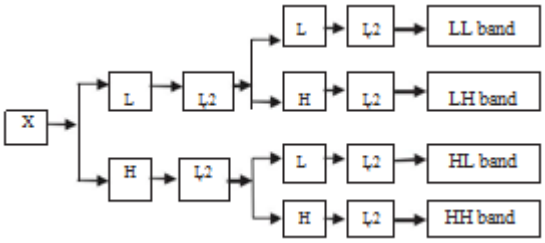

Fig 1. Block diagram of DWT

The sub-bands of the image obtained using DWT are LL band, LH band, HL band and HH band. The size of the sub bands must be same as that of the size or resolution of original image. To maintain the same size, the number of samples in the sub-bands must be decreased and this can be achieved by decimation or down sampling of each sub-band in each level of the process involved in DWT.

DWT has a time-frequency localization property so this property helps to use a single sample instead of many samples in the training process and the recognition of anonymous person made informal with the time-frequency localization.

B. SVD of an image

SVD is the transform technique that can decompose a system or image into three orthogonal matrices. The three orthogonal matrices are in the form of multiplication of two unitary matrices (F, O) and a diagonal matrix S. SVD is a significant linear numerical transform used in image processing to decompose the image into orthogonal matrices. SVD is first implemented on square matrices and later on, it was modified to apply on rectangular matrices.

A rectangular matrix M of size a×b will be decomposed into three matrices using SVD

$$M=FSO^{T} \quad (1)$$

An orthonormal set can be formed from the column vectors of F, Where F is an orthogonal matrix of size a×a. The orthogonal matrix O of size b×b form an orthonormal set by using the column vectors of O.

The diagonal elements of matrix S are said to be singular values and these values are decreasing gradually. Eigenvalues are formed by the square values of the singular values.. The matrix form of singular values is as follows:

(2)

$\sigma_1, \sigma_2, \sigma_3 \ldots, \sigma_n$ are called singular values and the relation between the singular values is given by Where $\sigma_1 \geq \sigma_2 \geq \sigma_3 \geq \ldots \geq \sigma_n \geq 0$

IV. IMPLEMENTATION STEPS

The database used in this FR system consists of the 1000 images of 100 individuals each person having 10 samples. The AT&T database [4] of 40 persons is considered in which 400 images each of 10 samples are used. The Yale database of 30 individuals each of 5 samples is used. This FR system is also performed on my own database consisting 12 persons each of 5 samples. For training database, a single sample [10] of each individual is taken and for the testing purpose, the remaining samples to be considered. The illumination variation problem is achieved by considering the normalization [9] of the images by using the Histogram equalization technique.

A. Histogram Equalization

In general, a histogram is the representation of frequency distribution of an image at each gray level [7]. In this paper, the training and testing database consists of grayscale images. These images are captured at different conditions and the brightness and contrast levels are vary from one image to another. The RR is reduced when the images are used as it is in the database.

So the images must be normalized to constant illumination. Histogram equalization is the best method to normalize the image to a constant normalization. The contrast of an image [8] can be increased by using Histogram equalization, particularly close contrast values are used to represent the data of an image. Thus histogram process is the best technique to distribute the intensity levels over the entire image.

By using this process the low contrast level can be attained to achieve the high contrast level. The frequency intensity values are effectively spread over the entire image using the histogram equalization.

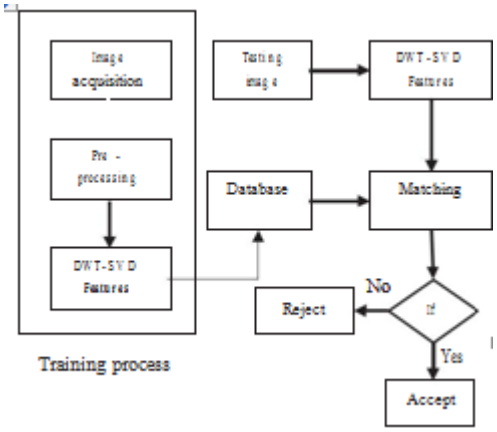

Fig 2. FR Block diagram

The images are trained by using the feature extraction methods DWT and SVD. The image acquisition involves capturing the images under different conditions and pre-processing is illumination constant normalization and this is achieved by histogram equalization. The process of feature extraction involves, application of DWT to an image and LL band is considered for the features extraction through the SVD. The coefficients are applied as an input to the SVD and the singular values are used as the features and those features of each person are kept in database. In the process of testing, an unknown sample of the person is taken and then feature were extracted. Now comparing the testing features with the features of training database. The distance measured between the features is the sum of squared difference. A Threshold value is maintained based on the distance between the features and if the distance between the features of testing and training is less than the threshold value then the person is recognized.

V. RESULTS

The training images are tested with the unknown samples of each individual and the registered images are recognized with the testing images and the process is repeated for different databases. With the standard AT&T database, RR is achieved better and it is faintly decreased with standard Yale database. The better results are achieved with my personal database i.e., 95% and the recognition rate (RR) of image is given by

$$\text{Recognition rate} = \frac{\text{number of correctly recognized persons}}{\text{number of tested persons}} \quad (3)$$

The time taken for the training of the single samples of each individual is 3 seconds and the testing time for the recognition of known face with an unknown face is 0.5 seconds. The recognition of faces using low light intensity is

acceptable upto 20% of brightness variation from the original image. The recognition rate of different databases achieved are tabulated as follows

TABLE I. DWT and SVD results

Database	Recognition rate
AT&T	100
Yale	98
Own database	95

The images are tested by varying the contrast and the brightness of the image. The maximum variations of contrast and brightness of images are as shown in Fig 3

Fig 3.Image Illumination variations

VI. CONCLUSION

The localization property of time -frequency domain in DWT algorithm yields to use a single sample of each person for training and the testing is done several times with the different databases and the recognition rate is 100% with the AT&T database and the RR is 98 for the Yale database and the RR is 95 for my own database. Instead of using more training samples, with the single sample better RR is achieved and RR is not effected by the variation of Pose and illumination. This work can be extended by considering the different pose and illumination variations which can be varied up to more than 30% of original image and with less number of features.

REFERENCES

1. *R. Chadha, P. P. Vaidya and M. M. Roja, "Face recognition using discrete cosine transform for global and local features," 2011 INTERNATIONAL CONFERENCE ON RECENT ADVANCEMENTS IN ELECTRICAL, ELECTRONICS AND CONTROL ENGINEERING, Sivakasi, 2011, pp. 502-505.*
2. *S. Dabbaghchian, M. P. Ghaemmaghami, A. Aghagolzadeh, "Feature extraction using discrete cosine transform and discrimination power analysis with a face recognition technology," 2010 PATTERN RECOGNITION, vol. 43 (4), pp. 1431-1440*
3. *V. Vaidehi et al., "Face recognition using discrete cosine transform and Fisher linear discriminant," 2010 11th International Conference on Control Automation Robotics & Vision, Singapore, 2010, pp. 1157-1160.*
4. *F. Samaria and A. Harter, "Parameterisation of a stochastic model for human face identification," 2nd IEEE Workshop on Applications of Computer Vision, December 1994, Sarasota (Florida).*
5. *Y. Hongtao, F. Ping and M. Shengwei, "Face recognition with DWT and Two-dimensional Principal Component Analysis," 2007 8th International Conference on Electronic Measurement and Instruments, Xi'an, 2007, pp. 1-86-1-89.*
6. *Danyang Cao and Bingru Yang, "An improved face recognition algorithm based on SVD," 2010 The 2nd International Conference on Computer and Automation Engineering (ICCAE), Singapore, 2010, pp. 109-112.*

ISSN 2348 – 8034
Impact Factor- 5.070

7. *"Online Webster's Dictionary: Histogram" from http://www.merriam-webster.com/dictionary/histogram*
8. *W. Zhihong and X. Xiaohong, "Study on Histogram Equalization," 2011 2nd International Symposium on Intelligence Information Processing and Trusted Computing, Hubei, 2011, pp. 177-179.*
9. *K.K. Varadarajan, P.R. Suhasini, K. Manikantan, S. Ramachandran,"Face Recognition Using Block Based Feature Extraction with CZT and Goertzel-algorithm as a Preprocessing Technique," Procedia Computer Science, Volume 46, 2015, Pages 1458-1467, ISSN 1877-0509,*
10. *C. Lu, W. Liu and S. An, "Face Recognition with Only One Training Sample," 2006 Chinese Control Conference, Harbin, 2006, pp. 2215-2219.*