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An Appearance Based Method for Emotion Detection from Face Image

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Abstract: Humans can use vision to identify objects quickly and accurately through their Emotion. Computer vision trying to emulate human Expression from Digital Image Inputs. In this paper an appearance based method is proposed for emotion detection using face image. In this appearance method DWT (Discrete Wavelet Transform) and PCA (Principle Component Analysis) is applied for feature extraction and SVM (support vector machine) is used for emotion classification. The experiments are conducted on a well-known face image datasets (FERET and Indian Face dataset) and achieved acceptable classification rate.

Keywords: Image Pre-processing, Enhancement, Segmentation, Classification, Feature Extraction

I. INTRODUCTION

Visual information plays an important role when people communicate with each other. When we look at a person's face, not only we discern who he/she is, but also process other information about him/her, such as gender, ethnicity, age as well as his/her current state of mind through his/her expressions. In this paper we propose to develop a system that can automatically detect the expression from the facial images. It will help in increasing human-machine communication with accuracy. This facial communication can be used to predict the performance of an employee by Human Resources Department (HRD) of a company or it can predict the intention of any illegal activity to be committed which can improve our security system.

A computer system with this application (Expression Recognition) has a wide range of applications in basic and applied research areas, including man-machine communication, security, law enforcement, demographics studies, psychiatry, education and telecommunication. The biometric technology we are proposing for surveillance and HR department (for employees' performance evaluation) is a new paradigm. The proposed work in this paper aims to design a system to recognize the expression of the face images. This system is designed to monitor an area of interest and automatically identify the person of interest as people pass through the area. The system proposes to work on detecting face using face detector from the image followed by feature extraction. These extracted features are used to co classifiers for elementary emotional states (neutral, anger, disgust, fear, joy, sadness, surprise). The proposed method uses Wavelet with PCA (Principle Component Analysis) method to extract features and SVM (support vector machine) is used for emotion classification. Experimental results show that proposed feature extraction give an acceptable emotion classification rates on different datasets.

The paper is organized as follows. Section 2 gives a review of the related research. The proposed emotion classification system is described in section 3. Experimental results are presented in section 4 and finally, section 5 concludes the work.

II. LITERATURE REVIEW

Widanagamaachchi [1] has done work with number of different parameter to calculate various emotions using neural Networks and Log-Gabor Filters applying on digital images. Neural network based solution combined with image processing is used in organizing the entire emotions: Happiness, Sadness, Anger,Disgust, Surprise and Fear. Colored frontal face images are given as input to the prototype system.After the face is detected, image processing based feature point extraction method is used to extract a set of selected feature points. Finally, a set of values obtained after processing those extracted feature points are given as input to the neural network to recognize the emotion contained.

Vinay, arpita and kanika [2] have examines more than one emotion such as (Happy, Sad, Worry, Bored, Surprised) etc. in February 2011. There is different method to examine these emotions previously like- DHT (Discrete Hartley Transform),Sub-image Based Features. The five emotions that we have been working on i.e. happiness, grief, anger, surprise and neutral were successfully identified on the majority of images used.

The degree to how well facial region as well as lips detected varied from picture to picture depending on multiple factors. Generally no false emotion were found or wrongly interpreted in this method. The only problem was that database generation was done only on limited faces.

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Rani and Garg [3] have done work on emotion using different approaches. They have examine using Automatic emotion detection techniques and HCI (Human Computer Interaction). In this paper the automatic facial expression recognition systems and various research challenges are overview. Basically these systems involve face recognition, feature extraction and categorization. Various techniques can be used for better recognition rate.

Ratliff and Patterson [4] examines emotional states based on still images of the face with AAM (Active Appearance Model).There is a different emotion such as (fear, joy, surprise, anger, disgust, sadness and neutral) which is used to generate different results using AAM.
Using the AAM as a feature method has proven successful even with a simple Euclidean-distance classification scheme which shows the different results like- 80\% to 90% according to different expressions.

Anchaland Rohit [5] proposed a facial emotion recognition using the hybridization of neural network with ICA(Independent Component Analysis) as well as genetic algorithm using following expression such as Sad, Happy, Surprise, Angry, and Neutral.

III. SYSTEM OVERVIEW

Proposed emotion classification system shown in Fig. 1 of pre-processing, feature extraction, and classification modules.During training phase, face images first pre-processes in the pre-processing module, then features are extracted and stored in the database.

These stored features are used to train the classifier. In the testing phase,features of the test face image are extracted and examined by the classifier to find the emotion and gender of the test image.In this study, features are formed by combination of DWT with PCA and SVM is used as Classifier for detecting the emotions, i.e., happy and sad.

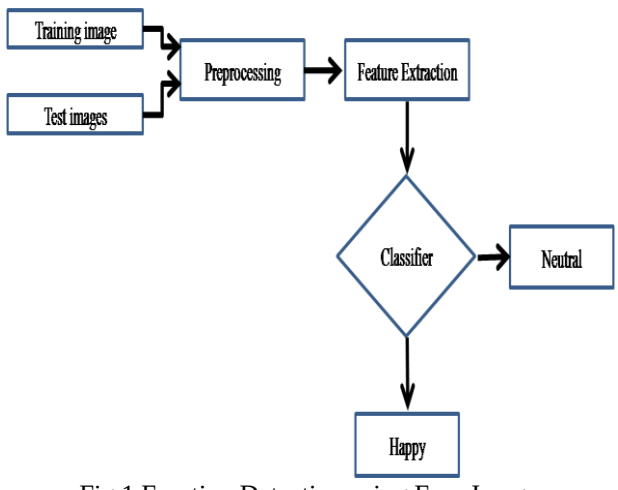

Fig.1 Emotion Detection using Face Image

A. Pre-processing
Pre-processing of an image is an important step ina emotion recognition system. It helps to increase the quality and reliability of optical inspection.

In this module the face is cropped from the image and the cropped face image is converted in the gray-scale form so that it is easy to enhance the image.

B. Feature Extraction
With the help of feature extraction the meaningful features and the region of interest are extracted from the input face image. In the feature extraction method AIPCA (Approximation Image Principle Component Analysis) is used.

In this work PCA is applied on Approximation Image (AI) to find the features for classification. AI is obtained by applying discrete wavelet transform on cropped face image.

C. Approximation Image
Approximation images (AI) are generated by applying discrete wavelet transform (DWT) on the cropped face image. DWT is a time frequency signal analysis method. It can be used to decompose a face image into many sub-band images with different spatial resolution, frequency characteristic and directional features [6]. The approximation and details coefficients are computed by applying DWT on the face image up to two levels.

Approximation coefficients contain the lowest frequency components and details coefficients contain the highest frequency component of an image. Instead of considering the entire coefficients, only approximation coefficients are taken for further procedure. Approximation coefficients contain low frequency Components of face image, which carry whole information of the face.

The change of expression and small scale obstruct does not affect low frequency part but the high frequency part of the image only. More than two level decomposition of face image result in information loss and hence, not considered in this work.

D. Principal component analysis
For feature extraction process, PCA is applied on the AI. By applying PCA on AI reduce the computational time of overall process, which tends to improve the overall performance of the system [7].

Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components.

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The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding components.

The resulting vectors are an uncorrelated orthogonal basis set. PCA is sensitive to the relative scaling of the original variables.

E. Classification

The extracted features from the feature extraction module are given input to the classifier module. In this work Support Vector Machine (SVM) and KNN are used for classification.

Support Vector Machine is a supervised learning algorithm which has been based on the concept of hyper planes that aims to separate a set of objects with maximum distance. After extracting the features from image, SVM determines some support vectors from the feature space.

These vectors help to determine the optimal hyper plane [8]. SVM divides the dataset into training and testing data sets, where each sample in the training set contains one target value and observed features.

SVM classifiers generate a decision boundary based on the training data set, which helps in predicting the target value of the testing data set. The proposed work employs Radial Basis Function (RBF). The k-nearest neighbors (KNN) is a method forclassifying test samples based on nearby trainingexamples in the feature space.

IV. EXPERIMENT AND RESULTS

The proposed system simulations are performed using MATLAB. The performance is measured by recognition rate (RR). The recognition rate is the percentage of correctly classified face images with the total number of face images in the testing set.

A. Face Databases

The evaluation of the proposed system has been done by using a number of publicly available face databases having sufficient amount of male and female images with their face expressions taken in conditional as well as unconditional Environments.Face databases used in this work are

(a) FERET [9]
(b) FEI. A [10]

A few pre-processed face images from these databases are shown in Fig. 2

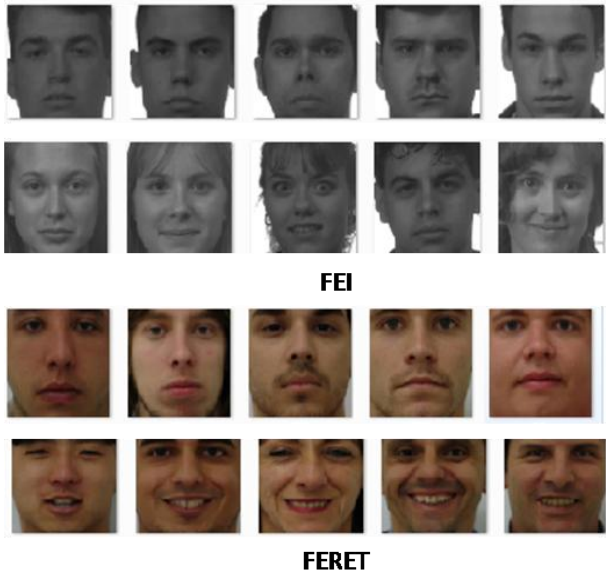

Fig.2 Face Image Database

B. Performance Measures

This work uses 2-fold cross-validation in which the entire dataset is divided into two sets, say D1 and D2, of equal size. The system is trained with D1 and tested on D2, followed by trained with D2 and tested on D1. Finally, results are averaged out. The advantage of this 2-fold cross validation is that both training and test sets are large. Datasets trained with 50% of images is tested on the remaining 50 images, and each sample image is used for both training and testing during each fold. Although evaluation may have some variance with two-fold cross validation, it reduces the computation time which is an important requirement for a real life system.

The main objective of the proposed system is to correctly recognized the emotion the face images (happy/sad).The system is developed with the aim of real life deployment and hence the criterion suits to the purpose,i.e., Recognition rate (RR \), has been used to explain performance of the system. Recognition rate finds out how many images are correctly recognized the emotion by the system.The Recognition rate is the percentage of correctly recognized emotion from face images with the total number of face images in the testing set. The RR% of a system is defined by

$$RR\% = T1/T2 * 100$$

Where, T1 denotes the number of correctly recognized emotion from face images and T2 is the total number of face images in the testing set.

C. Experimental Analysis

In this proposed system we have three classifications results i.e. emotion detection. Considering the classification of emotion, the proposed system has achieves 82.56% of recognition rate (RR) with the FEI

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database and achieves 60.94% of recognition rate(RR) with the FERET database from K-nn. Considering the SVM as Classifier, the proposed system has achieves 87.69% of recognition rate(RR) with the FEI database and achieves 71.67% of recognition rate (RR) with the FERET database. Table 2 compares classification rates achieved for the proposed approaches with k-NN and SVM classification techniques. SVM gives the highest classification as it non-linearly maps samples in higher dimensional space and has less numerical difficulties as compared to polynomial kernel.

TABLE I
Recognition Rate (RR) of an approach

Classifier	FEI	FERET
K-NN	82.56%	60.94%
SVM	87.69\%	71.67\%

V. CONCLUSION

In this research work, activity has been made with the reorganization of emotions from the face images by exploiting the performance of KNN Classifier, PCA, and 2D-WT. As the proposed approach aims for the face images only. The next step that would essentially be followed is to classify along with their expressions with videos also.

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BIOGRAPHY

Dr Preeti Rai. She is associate professor at GGITS Jabalpur. She has done her PhD work in image processing. Her areas of interest are image processing, biometric, machine learning and image forgery.

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