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DCT-PCA based Automatic Facial Expression Recognition Using Facial Patches

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ABSTRACT:

Facial expression, being a fundamental mode of communicatinghuman emotions, finds its applications inhuman-computer interaction (HCI), health-care, surveillance,driver safety, deceit detection etc. Tremendous successbeing achieved in the fields of face detection and facerecognition, affective computing has received substantialattention among the researchers in the domain of computervision. Extraction of discriminative features from salient facial patches plays a vital role in effective facial expression recognition.The accurate detection of facial landmarks improves the localization of the salient patches on face images. This paper proposes anovel framework for expression recognition by using appearance features of selected facial patches. A few prominent facial patches,depending on the position of facial landmarks, are extracted which are active during emotion elicitation. These active patches arefurther processed to obtain the salient patches which contain discriminative features for classification of each pair of expressions,thereby selecting different facial patches as salient for different pair of expression classes. One-against-one classification method isadopted using these features. In addition, an automated learning-free facial landmark detection technique has been proposed, whichachieves similar performances as that of other state-of-art landmark detection methods, yet requires significantly less execution time.

Keywords : Facial expression analysis, facial landmark detection, feature selection, salient facial patches, low resolution image.

I INTRODUCTION

In recent years, although much progresses has been done in the field of human-computer interaction (HCI) but facial expression recognition with high recognition rate is still a very challenging problem and become a core topic in the field of computer science and HCI. Facial behavior is the source of information to determine person's mood and emotions. Facial expressions have been categorized in early 1970s by Ekman's studies. He has stated that humans have six senses where each sense represents a specific emotion such as anger, happy, sad, fear, surprise and disgust. There are many application that uses Facial expression recognition such as Robotics, security, health-care, human machine communication, human behavior detector etc. Mostly, Facial Expression

Recognition basically performed in three major steps:

- Face detection
- Feature Extraction
- Facial Expression Classification

The primary need of Face Expression Recognition system is Face Detection which is used to detect the face. The next phase is feature extraction which is used to select and extract relevant features such as eyes, eyebrow, nose and mouth from face. It is very essential that only those features should be extracted from image that have highly contribution in expression identification. The final step is facial expression classification that classifies the facial expressions based on extracted relevant features. There are different methods of features extraction such as appearance based method, geometric based method, texture based method etc. and in the current research mostly used methods are geometric based method and appearance based method. Geometric based feature extraction method, extract feature information using shape, distance and position of facial components and appearance based feature extraction method uses appearance information such as pixel intensity of face image. After getting the features, classification methods are applied to recognize facial expression.

II. LITERATURE SURVEY

Recently Dhall et al. reported higher performance ofLocal Phase Quantization (LPQ) in facial expression recognition.In Local Directional Pattern Variance (LDPv) isproposed which encodes contrast information using localvariance of directional responses. However, Shan et al. found LBP features to be robust for analysis of low resolutionimages. Therefore, we used the LBP histograms asappearance features.

PCA and LDA are used as atool for dimensionality reduction as well as classification inexpression recognition. In authors reported the higherMajumder, A.; Behera, L.; Subramanian, V.K. et al. have presented an appearance feature based facial expression recognition system using Kohonen Self-Organizing Map (KSOM). Appearance features are extracted using uniform Local binary patterns (LBPs) from equally sub-divided blocks applied over face image. The dimensionality of theLBP feature vector was reduced using principal component analysis (PCA) to remove the redundant data that leads to unnecessary computation cost.

Jizheng Yi; Xia Mao; Lijiang Chen; YuliXue; Compare, A. et al. have proposed a novel FER algorithm by exploiting the structural characteristics and the texture information hiding in the image space. Firstly, the feature points were marked by an active appearance model. Secondly, three facial features, which are feature point distance ratio coefficient, connection angle ratio coefficient and skin deformation energy parameter, were proposed to eliminate the differences among the individuals. Finally, a radial basis function neural network was utilized as the classifier for the FER.

Kai-Tai Song; Chao-Yu Lin et al, presented a temporalreinforced approach to enhancing emotion recognition from facial images. Shape and texture models of facial images were computed by using active appearance model (AAM), from which facial feature points and geometrical feature values were extracted. The extracted features were used by relevance vector machine (RVM) to recognize emotional states. they have proposed a temporal analysis approach to recognizing likelihood of emotional categories, such that more subtle emotion, such as degree and ratio of basic emotional states can be obtained.

Lisai Li; Zilu Ying; Tairen Yang et al. have proposed a novel algorithm for Facial Expression Recognition (FER) which was based on fusion of gabor texture features and Local Phase Quantization (LPQ). Firstly, the LPQ feature and gabor texture feature were respectively extracted from every expression image. LPQ features are histograms of LPQ transform. Five scales and eight orientations of gabor wavelet filters are used to extract gabor texture features and adaboost algorithm was used to select gabor features. Then they obtain two expression recognition results on both expression features by Sparse Representation-based Classification (SRC) method. Finally, the final expression recognition was performed by fusion of residuals of two SRC algorithms.
Li Xia et al. proposed the expression classification method based on SVM for the defects of the traditional classification methods. It realizes fast classification with a relatively small sub-classifier combination, reducing the classification error. Experiments shown that the multiclassification method based on SVM can obviously reduce the training and testing time and improve the classification performance.

Abdulrahman, M.; Gwadabe, T.R.; Abdu, F.J.; Eleyan, A. et al. proposed a facial expression recognition approach based on Gabor wavelet transform. Gabor wavelet filter is first used as pre-processing stage for extraction of the feature vector representation. Dimensionality of the feature vector is reduced using Principal Component Analysis (PCA) and Local binary pattern (LBP) algorithms. K-Nearest Neighbour with Euclidean distance (L2) used as the classifier.

Sobia, M.C.; Brindha, V.; Abudhahir, A. et al. have generated a model of a wheelchair command interface that does not require the other's hands. It includes 3 major modules. They are face detection, facial expression recognition and command generation. The software contains digital image processing for face detection, principal component analysis for facial expression recognition and generating a command signals for interfacing the wheelchair.

Myunghoon Suk; Prabhakaran, B. et al. have developed system uses a set of Support Vector Machines(SVMs) for classifying 6 basic emotions and neutral expression along with checking mouth status. The facial expression features for emotion recognition were extracted by Active Shape Model (ASM) fitting landmarks on a face and then dynamic features were generated by the displacement between neutral and expression features.

III. PROBLEM OUTLINE

EXISTING SYSTEM

The existing method is found to perform well consistently in different resolutions, hence, providing a solution for expressionrecognition in low resolution images.

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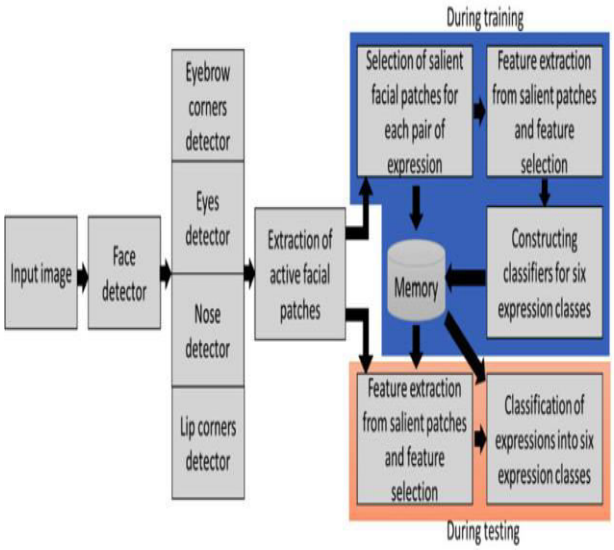

Fig 1: Proposed method

A low pass filtering was performed using a 3x3 Gaussian mask to remove noise from the facial images followed by face detection for face localization. Both the eyes were detected separately using Haar classifiers trained for each eye. The Haar classifier returns the vertices of the rectangular area of detected eyes.TheROIs for lips and eyebrows were selected as a function offace width positioned with respect to the facial organs. To detect the lip corners, we will follow the following algorithm.

1: select coarse lips ROI using face width and nose position
2: apply Gaussian blur to the lips ROI
3: apply horizontal sobel operator for edge detection
4: apply Otsu-thresholding
5: apply morphological dilation operation
6: find the connected components
7: remove the spurious connected components using thresholdtechnique to the number of pixels
8: scan the image from the top and select the first connectedcomponent as upper lip position
9: locate the left and right most positions of connected componentas lip corners

PROPOSED SYSTEM

In the proposed system we are using PCA-DCT technique, by which we can increase the detection rater of the facial expression.Discrete cosine transform (DCT) is a powerful transform to extract proper features for face recognition. After applying DCT to the entire face images, some of the coefficients are selected to construct feature vectors.a new modification of PCA and LDA is proposed namely, DPA–PCA and DPA–LDA. In these modifications DCs which are selected by DPA are used as the input of these transforms. Simulation results of DPA–PCA and DPA–LDA on the database verify the improvement of the results by using these modifications.

IV. METHODOLOGY

Changes in facial expressions involve contraction andexpansion of facial muscles which alters the position offacial landmarks. Along with the facial muscles, the textureof the area also changes. This paper attempts to understandthe contribution of different facial areas toward automaticexpression recognition. In other words, the paper exploresthe facial patches which generates discriminative featuresto separate two expressions effectively.

Observations from suggest that accurate faciallandmark detection and extraction of appearance featuresfrom active face regions improve the performance of expressionrecognition. Therefore, the first step is to localize theface followed by detection of the landmarks. A learning-freeapproach is proposed in which the eyes and nose

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aredetected in the face image and a coarse region of interest(ROI) is marked around each. The lip and eyebrow cornersare detected from respective ROIs. Locations of activepatches are defined with respect to the location of landmarks.
In trainingstage, all the active facial patches are evaluated and theones having features of maximum variation between pairsof expressions are selected. These selected features are further
projected into lower dimensional subspace andclassified into different expressions using a multi-class classifier.

The training phase includes pre-processing, selectionof facial patches, extraction of appearance features andlearning of the multi-class classifiers. In an unseen image,the process first detects the facial landmarks, then extracts the features from the selected salient patches, and finally classifies the expressions.

FACE RECOGNITION

Face recognition technique is a research hotspot in the fields of computer vision and pattern recognition, which is widely used in human-computer interaction, security validation and etc. Up to now, almost all the techniques are based on multi-sample. But in some special situations, such as passport verification and ID card verification, only one image can be obtained for one person, and these techniques may failed. Principal Component Analysis (PCA), proposed by Turk is one of the most important single sample face recognition methods, which can exactly express every face image via linear operation of eigenvector.

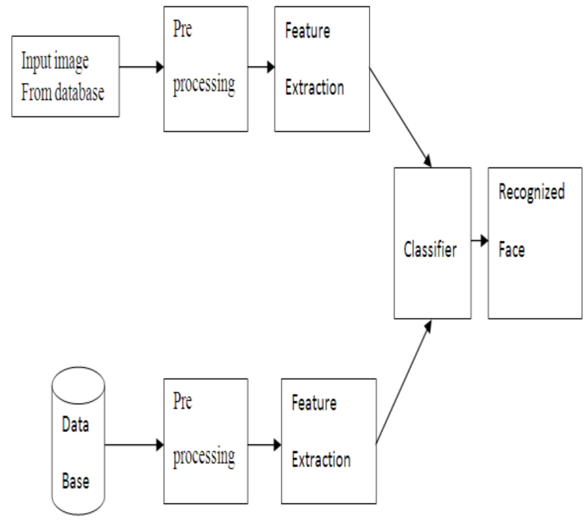

Fig. 2: Face recognition system

Face Recognition Problem

During the past decades, face recognition has received substantial attention from researchers. The challenges of face recognition are the rapid and accurate identification or classificationof a query image. Rapid can be associated to speed and accuracy refers to recognition rate. Most techniques emphasize on the efficiency in getting positive results, but when it comes to implementation, speed is vital. The performance of a face recognition technique should beable to produce the results within a reasonable time. For example, for video monitoring and artificial vision, real time face recognition has a very important meaning. It is very useful that the system can detect, recognize and track subjecting real time. In human-robot interaction, real-time response time is critical. Besides, it also enables computer systems to recognize facial expressions and infer emotions from them in real time.

Feature Extraction

Feature extraction is an important method in the fields of pattern recognition and data

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mining technology. It extracts the meaningful feature subset from original dates by some rules, to reduce the time of machine training and the complexity of space, in order to achieve the goal of dimensionality reduction. Feature extraction transforms the input data into the set of features while the new reduced representation contains most of the relevant information from the original data. Feature extraction is a key step of any face recognition system. Feature extraction is a process which transfers the data from primary spaces into feature space, representing them in a lower dimensional space with less effective characters. Up to now, many methods of feature extraction have been proposed, such as knowledge-based methods, feature invariant approaches, template matching methods, and appearance-based methods. Among them, the algorithm of Eigen face, the most widely used method of linear map based on PCA (PrincipleComponent Analysis), has become the mainstream criterion totest the performance of various face recognition system.

Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is a dimensionality reduction technique that can be used to solve compression and recognition problems. PCA is also known as Hotelling,or Eigen space Projection or Karhunen and Leove (KL)transformation. PCA transforms the original data space or image into subspace set of Principal Components (PCs) such that the first orthogonal dimension of this subspace captures the greatest amount of variance among the images. The last dimension of this subspace captures the least amount of variance among the images, based on the statistical characteristics of the targets. The output components from this transformation are orthogonal or uncorrelated, and the mean square error can bethe smallest when describing the original vector with these output components.PCA is a popular transform technique which result is not directly related to a sole feature component of the original sample. PCA has the potential to perform feature extraction, that able to capture the most variable data components of samples, and select a number of important individuals from all the feature components. PCA has been successfully applied on face recognition, image denoising, data compression, data mining, and machine learning. The majority of the applications of PCA are to use PCA to transform samples into a new space and to use lower dimensional representation from the new space to denote the sample. Implementation of the PCA method in face recognition is called eigenfaces technique. Turk and Pentland presented the eigenfaces method for face recognition in 1991. Face images were projecting onto a face space defined by the eigenfaces, and the eigenvectors of the set of faces not necessary corresponded to isolated features such as eyes, ears, and noses. The Eigen faces algorithm uses PCA for dimensionality reductionin order to find the best account of vectors for thedistribution of face images within the entire image space. PCA has been widely investigated. It has become one ofthe most successful approaches in face recognition and themost fully characterized samples. The procedures of Principal Component Analysis consistof two phases, training step and recognition step.

1) Training Step: This step is a process to geteigenspace from training image which

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previously has beenchanged into data matrix. Samples of data, on which thesystem needs to recognize, are used to create an EigenMatrix which transforms the samples in the image spaceinto the points in eigenspace.

2) Recognition Step: This step is a process to geteigenspace from test image which previously has beenchanged into data matrix. These results were then comparedwith results from training phase to get minimum difference.

V. RESULTS

Fig 3: The trained database image

Fig 4: The test database image

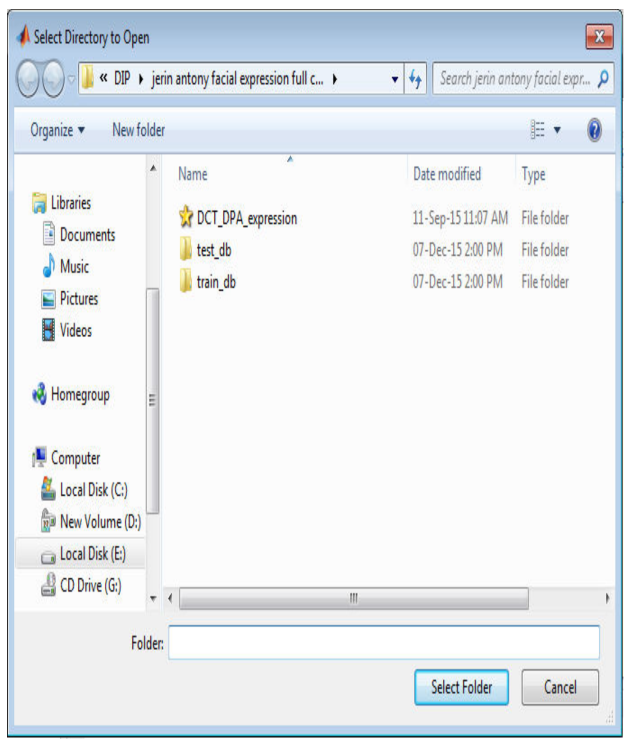

Fig 5: The selection of the test database image

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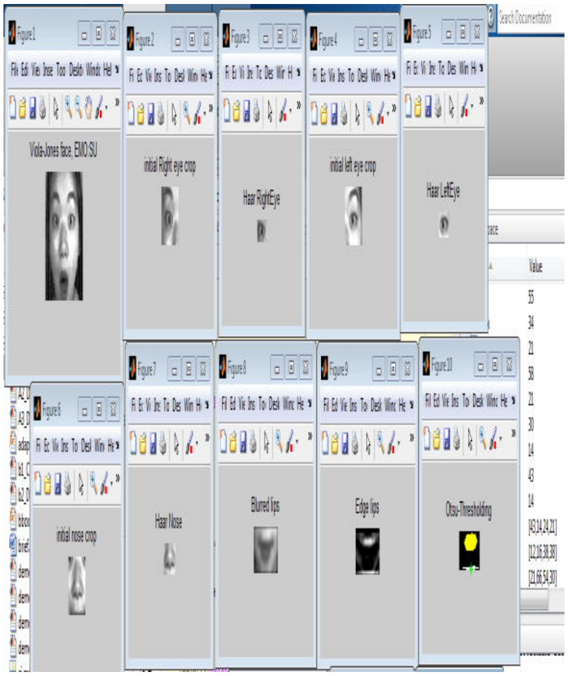

Fig 6: The facial expression results

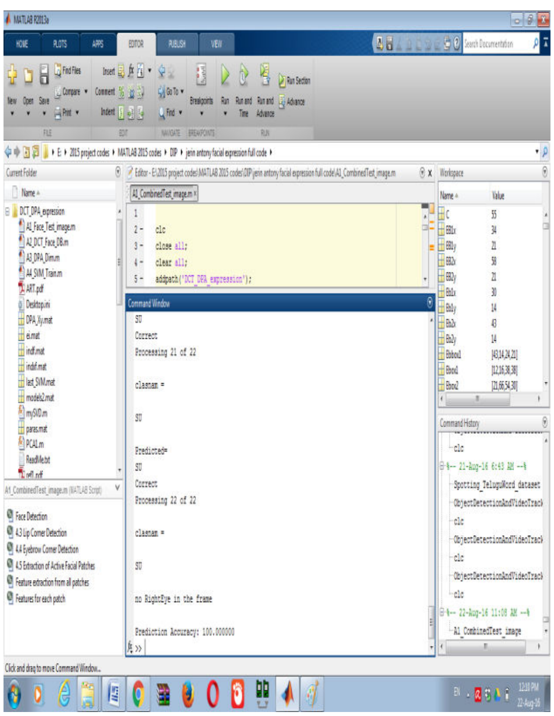

Fig 7: The DCT-DPA facial expression results proves that the detection of facial expression in less time but the prediction accuracy is little bit degrades

VI. CONCLUSION

In general for PCA based face recognition, the increase in the number of signatures will increase the recognition rate, however, the recognition rate saturates after a certain amount of increases. Therefore, in our observation it isbetter to use robust image pre-processing systems, such as geometric alignment of important facial feature points (eyes, mouth, and nose) and intensity normalization which increases the recognition rate and simultaneously decreases the number of signatures representing images in the PCA space. Increase in the number and variety of samples in the covariance matrix increases the recognition rate. In general, the image size is not important for a PCA based face recognition system as long as the number of signatures before PCA-projection is more than the total number of sample images. These findings can provide useful performance evaluation criteria for optimal design andtesting of human face recognition systems.

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