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Facial Expression Recognition

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Abstract: Facial expression recognition is one of the important areas due to its wide range of application in the areas such as analyzing emotions, video surveillance, biometric identification and image retrieval. It is one of the interesting subjects on which research is going on to solve the problems occurring in recognition of facial expressions under different lighting, occlusions, face shape/color and orientations. Facial expressions transmit non-verbal communication sign in face-to-face interactions.In this paper, we present Principal Component Analysis (PCA) and

SVM classifier for recognizing the facial expressions of humans.

Keywords: Principal component analysis, Eigenface, SVM classifier.

1. Introduction

A novel method is designed to recognize facial expression. Human face expresses of the authoritative and also provides flexible communication, during general interaction. Facial expressions

shows remarkable communicative signals that represent more than fifty percent of the outcome of a chat message, so recognition of facial expressions indicates it is most important modality in human computer interaction. In human computer interface, if the system can sense and recognize the user's objectives from their facial expressions, it allows the computer to help them by providing suggestions and schemes based on the sensed situation.

As there are variations in human facial expression it becomes difficult to recognize facial expression across the human community. Movements of the muscles beneath the skin of face represent the facial expression. Emotional states of humans are shown by these movements of the skin [3]. Human beings also may make mistakes to identify feelings based on the expression. On the other hand, facial expression recognition by computer is very effective in many applications such as understanding the human behavior and in providing suggestions to human-computer interface.

Recognition of facial expression system needs to solve the following issues such as: detection and location of faces in a disarranged scene, facial feature extraction and classification of facial expression. Facial expressions that are universally accepted are happy, sad, anger, disgust, shock and fearalong with neutral [1]. Automatic recognition of facial

expression is the field of interest because emotions carry more information in communication than words. Facial expression recognition is research field in the region of Artificial Intelligence, Computer Vision and Automation. Recognition of facial expressions is not an easy task due to several circumstances such as lighting, face color and position. Facial expression gives the most important information about the mental state, emotive and even the physical state of conversation [1]. Faces of humans contain the identity, mood and state of mind of person as well. Facial expression recognition is relevant in social life, treatment of patients by psychiatrist, teacher-student interaction, identifying anti-social motives of suspect and in identification of criminal during enquiry. Facial expression recognition has application in security, surveillance, advertisements, marketing and human computer interaction.The rest of the paper is organizedas follows section 2 describes the related work. Section 3 describes working of proposed methodology. Section 4 describes theresults of facial expression recognition system and section 5 describes the conclusion.

Types of expressions

There are six basic emotions (happy, sad, anger, fear, shock and disgust) that are seen among all humans across the universe.There are six universally accepted expressions along with neutral expression:

- Anger
- Happiness
- Disgust
- Fear
- Sadness
- Surprise

Most of the information is conveyed by facial expressions of human beings than the spoken words. Maximum of information is present in facial expression that can be interpreted from face-to-face conversation. Human face acts as an indicator of human emotions and reactions. Humans can identify and realize the behavior or attitudes of each other through the facial expressions but it's difficult for the computers to identify the facial expressions of humans hence the facial expression recognition has become the area of interest from past few decades. For the facial expression recognition to be done there is requirement for the front view of human face image and image captured should not be of different angles. To detect and recognize the facial expression is vital facet of image processing.

Psychologists assume that facial movements and expressions as one of the most essential and precise ways of communicating emotions and reaction among humans. Identification of emotions and feelings is most challenging task to put into words but our behavioral reactions to the expressions are universally accepted as being similar and easily noticeable. For example, like a smile which is accepted universally as conveying enjoyment, lowering of mouth corner which usually represents the feeling of sadness and lips pressed firmlyrepresents the feeling of anger. Facial expression recognition among human beings is easy as they communicate face-to-face but expression recognition by machine is difficult.

Principal Component Analysis (PCA)

Standard technique used in statistical pattern recognition is Principal component analysis. 2-dimensional face image of size

NxN is converted into 1-dimensional of size N^2. Eigenvectors of covariance matrix have close similarity to original face image.

Coordinate axes with high eigenvalues are retained and the rest with low eigenvalues are removed. Mean, eigenvalues and eigenvectors of covariance matrix are computed. For the comparison of face images the distance between feature vectors is performed by calculating Euclidean distance [1].

Eigen face approach

In the Eigen space approach, Eigen face of each expression is calculated. Test image is projected to Eigen space and the closest match is selected. Subspace was formed for all classes of expressions. Test image will be projected to subspace of each expressions rather than projecting to common subspace. Distance between the subspace of each class of expression and test image vector is calculated [2].

2. Related work

Ajit P. Gosaviet al [1], implemented facial expression recognition system using Principal Component Analysis technique and Euclidean distance classifier. Images were resized from 256 x 256 pixel values to 280 x 180pixel values and sobel method was used for face edges identification. By using PCA techniques identified the mean, eigenvectors, eigenvalues such that the comparison is performed on vectors. PCA was performed on train set and also principal components with high values are considered. Euclidean distance from the mean of projected imagewas computed to identify the intensity of expression.Test image was suspected to belong to the class by calculating Euclidean distance of projected test image from the rest of the projected train images are computed such that the minimum value was chosen for identifying the train image that's almost identical to test image. Made use of JAFFE image database recognition rate of 67.14% and precision rate of 72.82%.

Debasmita chakrabarti et al [2],proposed Eigen spacesmethods for facial expression recognition. To reduce the dimensionality made use of PCA reconstruction with snapshot method. For all six universal expressions images were divided into six classes then Eigen spaces were computed for each class. Test images were projected into the Eigen spaces of each class followed by Euclidean distance calculation. Based on similarity test image was classified to class. Expressions differ from each human for same expression. To overcome the problem of varying expression subspace was formed for all classes. Therefor each test image will be projected to subspace of each expressions rather than projecting to common subspace. Performed this analysis on JAFFE database and found that anger was recognized best followed by fear. Sad was least recognized as it's most difficult to be posed. Accuracy was lower for disgust happy and surprise due to confusion may be due to open mouth in happy and surprise faces.

Anurag Dea et al [3], proposed a human facial expression recognition model based on Eigen face approach. It used Hue Saturation Value (HSV) color model for detecting face. To reduce dimensionality of Eigen face PCA was used. Test image

was projected onto the Eigen space followed by Euclidean distance calculation between the mean of the Eigen faces of the training dataset and test image for the classification of the facial expression. Used generic dataset and classified five basic emotions sad, shock, fear, anger and happy. From the input image facial area is detected and features are extracted, preprocessed and classifier is used for classification of expression.

Liton Chandra Paul et al [4], proposed face recognition system by using Principal Component Analysis (PCA). The number of variables in face recognition is effectively reduced by using PCA approach. In PCA, each image in the training set is depicted as a linear combination of vectors known as Eigen faces.The weights are determined after selecting a set of most relevant Eigenfaces. Recognition is carried out by projecting a test image onto the subspace spanned by the eigenfaces and then classification is achieved by measuring minimum Euclidean distance. Many experiments were carried out to estimate the performance of the face recognition system. Theyused training database of students of Electronics and Telecommunication Engineering department, Batch-2007, Rajshahi University of Engineering and Technology, Bangladesh.

Ganesh Linge et al [5], proposed a system that utilizestwo methodologies of face recognition, those are the feed forward backpropagation neural network and feature extraction. The feature extraction is done using Principal Component Analysis and classification is done using neural network. Eigenfaces are applied to extract the required information in an image, which are persistent foridentification. The Principal Component Analysis (PCA) algorithm is used along with Eigen face approach for image recognition. In theproposed algorithm the 160 images of Yaleface database are used for testing.

Motion indications for facial expressions are:

Facial Expressions	**Indications**
Happiness	Widen lips
Sadness	Lowering of mouth corner, inner portions of brows raised
Surprise	Eyes open wide where more white is exposed, jaw drops slightly, brows raised
Fear	Mouth opens slightly, eyes open and brows raised
Disgust	Nose bridge wrinkled, upper lip and cheeks raised
Anger	Lips pressed firmly, brows lowered and bulging eyes

3. Working of proposed methodology:

The facial expression recognition system consists of the following four steps:

i) Face detection
ii) Train database creation
iii) Feature extraction
iv) SVM classifier

The Fig. 3.1 shows the schematic diagram for expression recognition system. Initially the user gives the

input image for which the facial expression has to be identified by the system. Then the image is checked whether the face is present in the image or not. Then the new input image is compared with train database images so that the expression is classified. If face is detected then the image is cropped and if there is no face detected in an image then it is not cropped. From the cropped images which will be stored in train database features will be extracted. Expression will be classified based on the knowledge of expression. When the user gives new image then its features are extracted and SVM classifier is used to identify the facial expression. Finally the user gets the recognized facial expression.

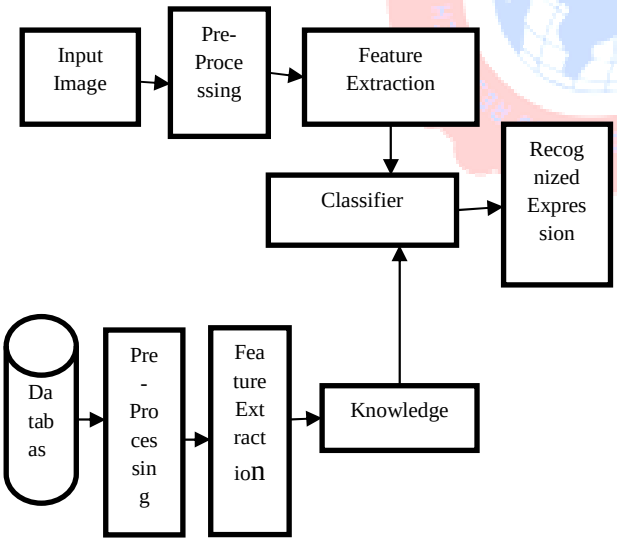

Fig. 3.1 Schematic diagram for expression recognition system

3.1 Face detection

Face detection is the first step carried out in this paper. Only face part is detected so as to minimize the search of locations that has to be done for the recognition of expression in an image. For the detection of frontal face, face-detection algorithm (Viola john's algorithm) is used. Face detection is done for images in database such that only the face is captured in images by ignoring the other details that does not help in identification of expressions. Here background details are not necessary; it is ignored by capturing only face in images. Only face part is concentrated more because it includes eyes, nose, mouth and eyebrows which are main components of facial expressions. Movement and positioning of these parts of face leads to facial expressions.

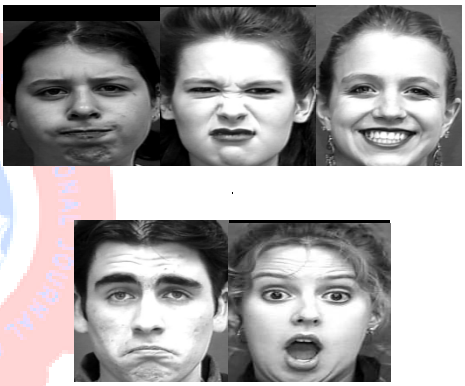

Fig. 3.2 Sample database images

3.2 Train database creation

Initially the system does not know to classify the expressions; hence it has to be trained. Based on the knowledge of expressions training dataset is prepared. Sample images of the database are shown in Fig. 3.2. It consists of totally 250 images. For testing the system for each expression is tested with 34 images. For each expression there are 50 images in the training set. Each image is resized to 200 x 200 pixels, reduce the number of computations. Let an image be of K x L dimension, so that the 200 x 200 images

becomes 40000 column vectors. Images in training set are aligned in an order such that the first 50 images belong to one particular expression 1, next set of 50 images belong to expression 2 and so on. Color to gray image conversion is done to reduce dimensionality of the image. Each 2D image is converted into 1D image column vector. And these column vectors are put in a row to obtain 2D matrix which contains all the images.

3.3 Feature extraction

The feature extracted here is eigenfaces. The set of eigenvectors represent eigenfaces. Eigenfaces represent characteristic features of a face. Eigenfaces are computed by using PCA method for the training dataset images. In this method mean of the images is obtained. Deviation of each image from mean image is computed. Sorted the eigenvalues of the matrix and eigenvalues which are less than threshold value of 1 are eliminated, as it does not contain discriminating Eigen features.

3.4 SVM classifier

A Support Vector Machine (SVM) is a machine learning algorithm. Classification and analysis can be done for data by using learning models such as support vector machines. Multi-SVM classifier takes train database, classes/group and test image as inputs to identify the class of test image belongs to. To train SVM on data taken from two groups svmtrain is used. To classify the group to specific class svmclassify is used. Then the condition is checked for whether class does not belong to 1 and also checked that all 5 classes it is compared with. The extracted features of the train dataset are compared with the features of test image and decision is made for given test image.

4. Results:

On performing test for test database images, got satisfactory result with pass percent of happy (85%), sad (85%), anger (70%), shock (89%) and disgust(80%). The accuracy of the proposed system achieved is 81.8%.the below table 4.1 shows the accuracy achieved for all expressions.

Expression	Accuracy
Happy	85%
Sad	85%
Anger	70%
Shock	89%
Disgust	80%

Table 4.1 Accuracy of Expressions

5. Conclusion:

Facial expression recognition system is an area of research from past few decades as it is a challenging problem in the image processing domain. This paper proposes facial expression recognition system based on PCA approach and classified various facial expressions using SVM classifier. The training database consists of expressions of various people when tested gave satisfactory result. Future work can be considered to improve the accuracy and reduce the recognition time of human facial expressions.

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