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Detection of Facial Expression using Fisher, Multi-SVM and Pattern Network and Comparison

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Abstract

Expression of face is very remarkable posture underneath the derma of the face. Expression of faces is one of the ways of human communication, which deliver so many things without talking verbally. The main purpose of this project is to develop a system for detecting facial expression of a given image among the seven basic human emotion expressions such as Angry, Sad, Happy, Contempt, Surprise, Disgust and Fear. This is performed using three different methods. The first method used is based on Eigen faces and Fisher face, using this method the obtained accuracy is 95.81%. The second method used here is HOG feature extraction and using these features to train the multi-SVM, and obtain the expression of test image. Using multi-SVM the obtained accuracy is 99.58%. The third method used is pattern neural network for emotion recognition of face image, for this also HOG features are used for training the network, and the accuracy obtained using pattern neural network is 90.79%.

Keywords: *Face expression, Fisher LDA, PCA, multi-SVM, Pattern Network*

INTRODUCTION

Expression of face is very remarkable posture underneath the derma of the face. Expression of faces is one of the ways of human communication, which deliver so many things without talking verbally. Facial expressions play a very influential aspect or part in interpersonal relations. Interpersonal interaction is many a time convoluted, and its realization is predicated upon some factors. The factors generally can include range widely, such as mood of a person, the context, interaction timing and also participant's expectations. For a person to be lucrative or successful, he/she must grasp or recognize a counterpart's disposition or mood as the interaction between them progresses and so alter accordingly. For humans luckily this ability is hugely ingrained according to individual mastery. Humans can instantly assess multitude of indicators, so to say – word choices, inflections of voice, and also body language perceive others sentiments. This analytical talent likely stems from the matter that humans usually share universal fundamental emotions. Naturally these emotions or sentiments are exhibited over expressions of faces that are persistently correspondent. Facial expressions can help to communicate regardless of cultural barriers and languages. Fundamentally basic facial expressions casually people appraise and communicate are seven according to some extensive research. Those elemental emotions are – contempt, happiness, fear, disgust, surprise, anger. A computer can exploit an act for emotion mirror making, user be aware of own emotions and so can contingent upon him with more extra power to establish whether user likes to feel the same emotion or he would want to overcome that emotion. People may sense irritated because of lengthy waiting in traffic and normally transfer their indignation to others unknowingly. Being acquainted

they might calm down. A person attentive of his emotions is capable to be alert to it. For example, a reviewer of the conference this is essential to be a fair person in his/her evaluation. Being in dreadful mood, he/she may judge stricter than needed.

A computer can exploit an act of emotional mediator, accomplishing other people informed of someone's emotion. Whenever the social help for overcoming emotion is needed. For example, a depressed person may in need of talk with friends, who encourage him or make him remind regarding something good of his life. Yet the person may be shy to ask directly the help. A computer by itself can exploit an act of user's friend for the pseudo-social psychological help. Considering example producing or displaying funny image at the right juncture or producing a relevant wise citation.

Image processing is one of the methods for performing some operations on image/s. The purpose of processing an image is to enhance or intensify an image or to excerpt some effective or informative information from it. Image processing is a type of signal processing, where input will be given an image and output may contain an image or associated characteristics or features with that image. Image processing involves basically three steps. Those are:

- Image import using image acquisition tools.
- Analyze and manipulate the image.
- Output the result which can be an altered image or report based on image processing and analyzing.

Machine learning is a technological field which provides the systems the capability to learn on its own or automatically and improve or enhance from its experience or data without being programmed explicitly. The focus of machine learning is on development of computer programs which can access the data and make use of it to learn themselves. There are two types of machine learning such as Supervised and Unsupervised machine learning. In this project supervised learning is used.

LITERATURE SURVEY

1. Authors Taskeed, Kabir and Oksar described local facial descriptor depending on LDP codes which are used for recognizing facial expressions. Authors used LDP features for dimensionality reduction and SVM classifier for classifying facial expressions and achieved accuracy about 95%.
2. Authors Treves and Franco proposed a system for facial expression recognition based on neural networks, which has used PCA (principal component analysis) for reduction of feature vectors. These features were then fed into a neural network that is feed forward neural network and it is trained using back propagation neural network. The achieved recognition rate reported was 84.5% on the facial expressions database Yale. This achievement is not very encouraging.
3. Authors Kumbar, Ashish and Manasi proposed classification of facial expressions recognition neural network classification based system which performed feature extraction using Gabor and reduction of features by making use of Principal Component Analysis. In this recognition system specified 20 inputs, seven output neural networks feed forward and hidden layers 40- 60. Accuracy obtained using this system was 60 to 70% which is not so encouraging.
4. Authors Tai and Chung proposed an automatic facial expression recognition system by using the neural networks. In experiment they reserved maximum connected component for the reduction of wrinkles and noises. Conducted seven-class classification on database

using Elman network by making use of two hidden layers, where each layer contained fifteen neurons. With this experiment the average accuracy of about 84.7% was achieved.

5. Authors Zhang and Tjondronegoro, extracted the expressive face by making use of the Gabor filters, reduction of features by principal component analysis and classification of expressions by using neural networks. Using this method authors achieved that, an average facial expression recognition rate of 93.4%.
6. Authors Borui Zhang, Liu, Xie proposed classification of expression of faces using SVM, and based on Gabor transform authors used fusion of LQP and LBP for the feature extraction and reducing the dimensions. The accuracy achieved using this method is 98%.
7. The authors Alaa Eleyan and Muzammil proposed an approach for recognizing facial expressions. This approach was based on PCA and LBP algorithms. Experiment was performed on MUFE database and JAFFE data. They used SVM as classifier. In all the experiments for which results were obtained reveal average emotion recognition for JAFFE a rate of 87% and for MUFE a rate of 77%, which is not so encouraging.
8. Authors Ghimire, Jeong, Lee and Hyun proposed a recognition of facial expression system depending on detection of landmarks and local representation then LBP and NCM features of these local regions. SVM for training and classification. Using this approach they have achieved an accuracy of 97.2% for six – class classification and 91.9% for seven-class classification.

PROPOSED SYSTEM

The proposed system is to find out the emotion of a given face as input image or test image. There are basically seven emotion are considered in this project work namely– Angry, Sad, Happy, Contempt, Surprise, Disgust and Fear. In this the system is divided mainly into two phases. Those are

- Training Phase and
- Testing Phase

The face images are taken from cohn - kanade database, which consist of 239 face images including all the seven emotions.

For training fisher, initially images are read from the database then detection of faces is performed and detected faces are cropped to 100 X 100 size. Then for Fisher prediction, mean face of each emotion and total mean face of all emotions is calculated. Then Eigen faces are calculated and top 100 Eigen faces are chosen. Then fisher faces are calculated for each emotion class to distinguish each emotion from other emotions. For training multi-SVM and pattern network, histogram oriented gradients features are used.

For testing fisher, the input or test image is given, then detection of face from this test mage is performed and it is cropped to required size of 100 X 100. Then this test face is projected on the fisher faces for finding the maximum match, for which emotion class the match is found as maximum, that emotion is returned as output predicted emotion. For testing using multi-SVM, the cropped test face HOG features are calculated for eyes and mouth. Depending upon the training HOG features label to an image is given, if it matches to any of the training feature label then that emotion is displayed. Similarly for pattern testing HOG features of test image for eyes and mouth is calculated. Then these are used for testing the using pattern network test.

SYSTEM DESIGN

The following figure shows the Architecture of the proposed system.

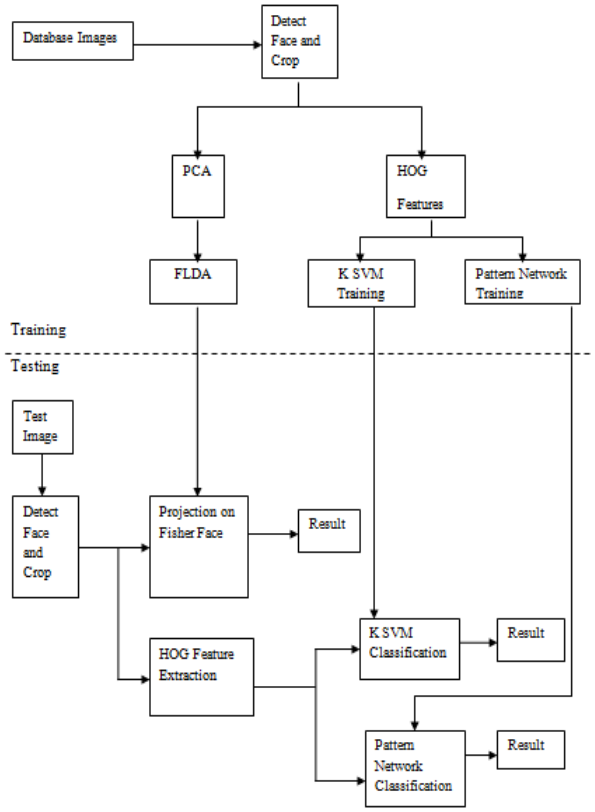

Fig 1: *System Architecture*

Algorithm Steps for Proposed System

1. Read the images from database, and then detect faces from the image and crop only faces.
2. Perform training of fisher data to obtain the fisher faces for each of the emotion category.
3. For the cropped faces, identify eyes and mouth to get HOG features, and then save along with class differentiation for each emotion.
4. Organize data in step 3 suitable for SVM training.
5. Organize data in step 3 suitable for NEURAL training, and obtain the specifications for pattern network.
6. For testing read an input or query image.
7. Identify face and crop it to required size.
8. Find HOG features for mouth and eyes.
9. Find the projection of this face from step 7 on the fisher face of emotion from step 2, the maximum match gives the result.
10. Train the data from step 4 for K SVM, and classify the given query obtained from step 8.
11. Give the features from step 8 as input to the network specification obtained at step 5 and get the class output which is the maximum of array output.
12. To check accuracy replace the inputs at step 9, 10, 11 with the training data and check the correct outputs, and calculate percentages.

IMPLEMENTATION

In this the description of the functions and technologies used in the project are described.

Detect Face and Crop

MATLAB involves the function for detecting objects in the vision toolbox. The statement that is used is as follows: face Detector = vision. Cascade Object

Detector ('Frontal Face CART', 'Marge Threshold', 5);. This object detector is used to detect face in a given image. Here the Classification Model used is Frontal Face CART, which performs detection of faces which are forward facing and upright

Principle Component (PCA) and Fisher LDA

PCA analysis is used for reducing dimensionality. This can be performed as, after detecting and cropping the face images, from each emotion class, perform the subtraction of totalmeanface from each image. This is called the co-variance matrix.

Imsub = Im – Total Mean Face

Then Eigen values and Eigen vectors are calculated. MATLAB contains the built-in function "eig()" which finds out the Eigen values and Eigen vectors. Choose the top 100 Eigen faces which have maximum values. Fisher LDA, here the output/result of PCA is used for Fisher LDA analysis. This is one versus other method, here the process is carried out by keeping one emotion at a particular time and remaining as other emotion. Fisher LDA minimizes or reduces the within class variance and maximizes the between class variance. To obtain fisher-face of a class, find the projection of each expression class at a time on Eigen faces {Emotion Reduce}. Find projection of all other emotions{Other Emotion Reduce}. Find within and between class differences. Find Eigen vectors of ratio between/within projections.

Then calculate fisher-face for each class, then normalize the values. For testing, read the test image, detect face and crop, subtract mean face obtained in training from the test image then finally find the projection of test face on fisher faces and find the maximum match. The maximum match gives the emotion the face contains.

Extracting Histogram Oriented Features

Before obtaining the histogram oriented features, segmentation of eyes and mouth from the face image is performed using the same function which is used for face detection. The difference here is the arguments that are used to detect face and mouth are different from.

SVM –Support Vector Machine

It is a discriminatory classifier. Defined by using a separating hyper plane. Provided supervised learning or training labeled data, the SVM algorithm outputs a hyper plane which is optimal and categorizes given new test or query examples. In the two –dimensional space, this hyper plane will be a line which is segregating a plane into two parts, where each of the class present in either subsidiary of the plane.

SVM is mainly developed for binary classification. How to plot a separating line between two classes is what the SVM performs. It adequately separates two classes. At any point which is left side of the line belongs to one class and right side of the line belongs to another class.

In this project multi-class SVM is used. There are seven classes of emotions are considered in this project. Each emotion is labeled separately from 0 to 6. For each emotion HOG features are extracted separately and stored along with class label. For the test image also HOG features are extracted. For multi-svm the arguments passed are HOG features of all training images, face labels and HOG features of test image. For classifying multi-svm depending on binary svm, it considers the emotion of first label as one class and remaining labels as another class. If the features match for this label then it outputs that as detected emotion class otherwise, it considers the second label faces and its features as one class and remaining labels as another class, and it repeats the process

until it finds the matching class and outputs the corresponding label and detects the class of emotion for which the test image belongs to.

Pattern Networks

Pattern recognition networks these are a kind of feed forward networks. These can be trained for the classification of inputs corresponding to the target or output classes. The target or output data for pattern networks includes all zero value vectors, leaving one element, where that element is the target class that is required to be represented. In this data is fed at the inputs, and is forwarded layer by layer through the network, until that turn up till the outputs. In this project pattern recognition network are used. The implementation for training pattern networks is as follows:

net = pattern net (hidden Layer Size)

Hidden layers considered here are 15. Default it will be 10.

train (net, inputs, targets)

here, net is the row vector of specified hidden layers size that is 15 for this model, inputs is training function which consists of HOG features of eyes and mouth of training images and targets is the labels for each emotion class that is from one to seven. Then simulation of network is performed as represented below:

Sim (net, X)

Here net contains the training data and X contains the HOG features of test image for which classification is to be performed. Then maximum match of the outputs emotion is returned as detected emotion.

EXPERIMENTAL RESULTS

Fig 2: *User interface*

The above figure represents the User Interface containing buttons for loading test image, detect and crop the face only, then detecting eyes and mouth, extracting HOG features for the test image. At the right side Fisher test, multi-SVM and Pattern Network test buttons are programmed.

Fig 3: *Face detected and Cropped*

The above figure shows the face detected and cropped.

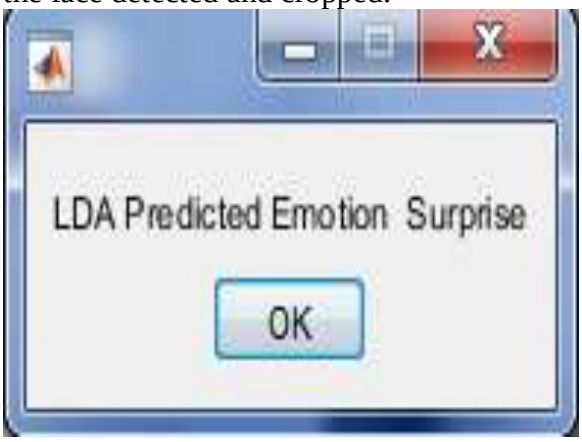

Fig 4: *Results for Fisher LDA*

Fig 5: *Results for SVM*

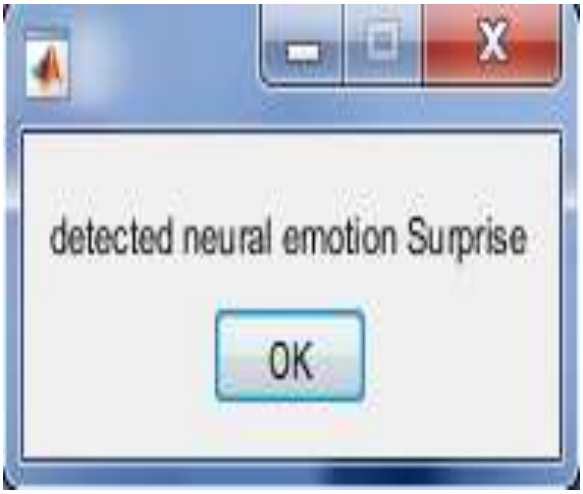

Fig 6: *Results for Pattern Network*

All the above three figures show the detection facial expression of the test images.

CONCLUSION

The proposed system performs the recognition of facial expression of a given input or a query image among the seven emotions such as anger, happy, sad, contempt, surprise, disgust, fear. In this three classification methods are used for this purpose. The first method used is based on Eigen faces and Fisher face, using this method the obtained accuracy is

95.81%. The second method used here is HOG feature extraction and using these features to train the multi-SVM, and obtain the expression of test image. Using multi-SVM the obtained accuracy is 99.58%. The third method uses pattern neural network for emotion recognition of face image, for this also HOG features are used for training the network, and the accuracy obtained using pattern neural network is 90.79%. Since the obtained accuracy is above 90% for all the three methods, it can be concluded that multi-SVM is best compared to other two classifications and machine learning techniques are good for classification with high accuracy.

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