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Active Shape Model Based Recognition Of Facial Expression

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Abstract:
The tracking and recognition of facial activities from image or video is useful in many applications such as animation and human machine interaction. The facial activities are described in three levels. In the bottom level, the facial components are detected. In the middle level, movements in the facial components can be identified. The top level represents the facial muscle movement and human emotion. Eigenfaces algorithm is used to detect face from the image. Hough Transform is used to extract the features. Naive Bayes Classifier and Active Shape Model are used to classify the features. The DBN is introduced between the Hough Transform and the classifier.
Keywords: Eigenfaces, Hough Transform, Naive Bayes Classifier, Active Shape Model, DBN.

I.INTRODUCTION

Face plays an essential role in human communication. Nowadays many computer vision techniques have been developed to track and recognize the facial activities. The detailed face shape information can be captured through tracking facial feature points. The facial expression recognition system can recognize six basic expressions.

Accurate tracking of facial feature points are important in the applications such as animation and human computer interaction. The facial feature tracking techniques can be classified into model free and model based approaches. The model based approach focused on the face shape information. So that, model based face tracking approach can be applied in many applications.

The facial expression recognition system can recognize six prototypical expressions or its corresponding action units. The feature tracking can be used in the feature extraction stage.The facial feature tracking is based on the local search, whereas expression recognition depends on the global feature.After detecting the face from image, the features can be extracted using the Hough Transform.

Naive Bayes Classifier is an algorithm applied to the extracted face image to collect and classify the features of the face present in the image. Active Shape Model is also used for the purpose of feature classification.The comparison between these two classifiers used to identify the better one. The classifier output and the training set of data are interacted using DBN to provide the facial expression.Dynamic Bayesian Network(DBN) is used to keep the relationship between the extracted features and the training data that contains information about expressions and their corresponding features.

First the input video is converted into image sequence. The image sequence may contain many similar frames. So that, the image sequence should be clustered to reduce the number of frames. Before applying Eigenfaces algorithm, the lighting compensation should be applied to the image. The face in the image can be detected using skin color.After detecting the face, the features of the face should be extracted using Hough Transform.

Hough Transform can be applied to the detected face to calculate the standard deviation of the features. Based on the value, the facial expressions can be classified using two classifiers. Dynamic Bayesian Network is used to capture the facial interactions at different levels. Using training data and observed data, the facial activity model can be constructed. DBN is used to maintain the relationship between facial features and expressions. It will provide a complete facial action model. Other than this technique, the facial expression recognition system can be constructed using different methods. The facial recognition system can be used in different applications. It can also recognize face from images or from videos.

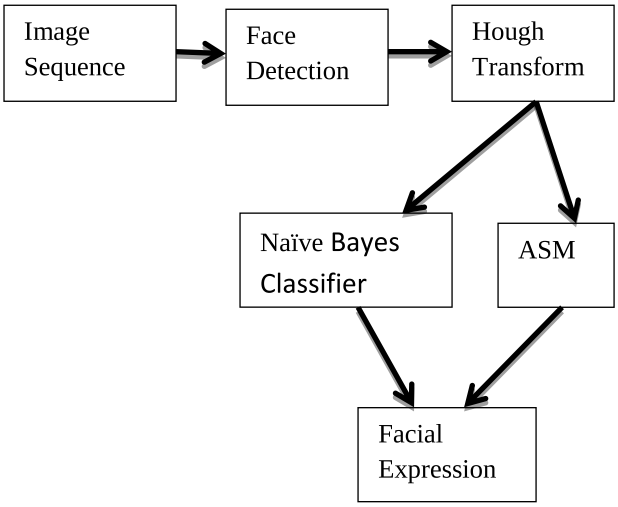

Fig.1. Flowchart of facial expression recognition system

II. RELATED WORKS

In the existing systems, there are several methods such as Simple Thresholding, Red Eye Effect and K-mean clustering. These all are having some difficulties to find only the face because they are detecting the face from image using pixel value. If there is no face in the image, it may detect any other object or something in the image.

Gabor wavelet is used for feature extraction. But it has more computational complexity and it is a basic filter so it requires more improvement in the extraction process. The extracted measurements are not very accurate due to noise of the image and the limitation of the computer vision technique itself. If the feature point movement between two consecutive frames is large than 8 pixel, the tracking error will increase significantly.

There are several classification techniques used to recognize facial expressions from the image. They are AdaBoost classifier, SVM classifier and Neural network based classifier. They have low performance while comparing the performance of the Naïve Bayes Classifier.

III. PROPOSEDSYSTEM

A. Face Detection

The Eigenfaces algorithm is used to detect face from the image. For that, first the input video is converted into sequence of images. Then the required image should be selected from the sequence. Noise in the image can be removed by using the bilateral filter. The face color will be varied for different people. In Eigenfaces algorithm face can be identified based on the skin color.

In the pre-processing stage, the light variation in the image should be compensated and noise in the image should be removed. After removing noise, the face part in the image can be detected based on the skin color. Face part can be highlighted using a filter. For expression recognition system the facial components such as eyes, nose and mouth are necessary and that should be segmented from the image. Then the remaining part in the image will be discarded.

The skin color in the image can be identified using a function, called boundingbox function. The face region can be calculated by setting the height and width of the face in normal. The value of height divided by width should not greater than 1.75 and less than 0.75. If it is, it should be discarded.There are three criteria used to check the image which contains face or not. First one is the height to width ratio; second, existence and location of mouth; third, existence and location of eyes.

Eigenfaces is the name given to a set of Eigen vectors, when they are used in the computer vision problem of human face recognition. The Eigen faces themselves form a set of all images used to construct the covariance matrix. This produces the dimension reduction by allowing smaller set of basic images to represent the original training images. A set of Eigenfaces can be generated by performing a mathematical process called Principal Component Analysis.

B.Feature Extraction

Feature extraction involves simplifying the amount of resource required to describe the large set of data accurately. Analysis with large set of data requires complex computation and large memory. The Hough transform is a feature extraction technique used in computer vision and image analysis. The purpose of this technique is to find imperfect instances of objects by a voting procedure.

Two parameters, r and θ are used in the Hough transform. The parameter r represents the algebraic distance between the line and the origin, while θ is the angle of the vector from the origin to its closest point. Using this parameterization, the equation of the line can be written as eqn (1)

$$y = \left(-\frac{cos\theta}{sin\theta}\right)x + \left(\frac{r}{sin\theta}\right) \qquad (1)$$

which can be rearranged to $r = x\, cos\theta + y\, sin\theta$. It is possible to associate with each line of the image. The (r,θ) plane is sometimes referred to as Hough space for the set straight lines in two dimensions.

The linear Hough transform algorithm uses the two dimensional array, called an accumulator. The dimension of the accumulator equals the number of unknown parameters. For each pixel at (x,y) and its neighborhood, the Hough transform algorithm determines if there is enough evidence of a straight line at that pixel. By finding the bins with the highest values, the most likely lines can be extracted.

A kernel based Hough transform can be applied to the maximum image size of 1280x960. Before applying this technique, the image should be clustered into groups. For each cluster, votes are using an oriented elliptical Gaussian kernel with the best fitting line with respect to the corresponding cluster. This approach not only improves the performance of the voting scheme, but also produces the cleaner accumulator.

C.Classification

Classification is the process of identifying a new observation belongs to which category, on the basis of a training set of data. The individual observations are analyzed into a set of quantifiable properties, known as features. An algorithm that implements the classification process is known as classifier.Classifier is a mathematical function that maps input data to the category. Classification is considered as an instance of supervised learning.

Naive Bayes classifier is used to classify the extracted features of the image. This classifier is based on the Bayes' theorem with strong independence. This classifier is based on the presence or absence of a particular feature. One of the main advantages is that it requires only small amount of training data to estimate the parameters necessary for classification.

Active Shape Model is a statistical model of objects which iteratively deform to fit an object in a new image. The shapes are constrained by the Point Distribution Model. The ASM aims to match the model with a new image. It works based on the following steps:

- Look in the image around each point for a better position for that point.
- Update the model parameters to best match to the new position.

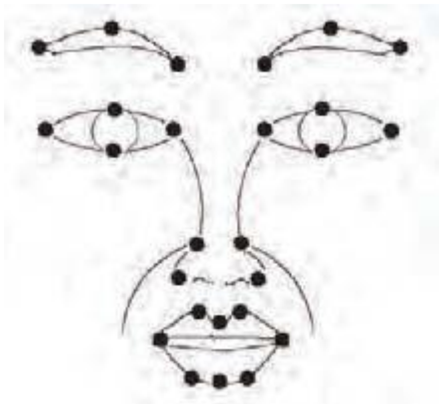

Fig2. Facial feature points in a face

To locate a better position for each point one can look for strong edges or a match to a statistical model of what is expected at that point. This technique has been widely used to analyze face images, mechanical assemblies and medical images. It is closely related to the Active Appearance Model. It is also known as 'Smart snakes' method, since it is an Active Contour Model, it would respect shape constraints.

Two classifiers Naive Bayes Classifier and Active Shape Model are used to perform the classification function. Output of the Hough transform i.e. the extracted features are given to classifier to perform classification.

D. Recognition

Recognition is the process of checking whether the new observation with the training data or not. The classified features are compared with the training data to find the facial expressions. The training data contains classified features and their associated facial expression. It can contain the features for six facial expressions. A new observation can be compared with these training data to recognize the exact human emotion.

This process will be carried out for naïve Bayes classifier and Active Shape Model. Output of both classifierswill be compared to find which one is the best. So that, the better classifier can be identified and used for future recognition processes. Usually a video can contain minimum 30 similar frames, so it is enough to do the above process for a single frame. This will reduce computation and time required for the recognition process.

IV.EXPERIMENTAL RESULT

Parts	Hough Dimension	Eigen Dimension
Eyes(both concate)	100x120	180x160
Nose	100x120	200x158
Nose(compress apply)	100x120	100x220
Lips	100x120	180x64
Average Execution Time	2s	4s

Table1. Facial Expression according to their Standard Deviation of Hough Transform

The values of this table can be calculated from the formula as follows:

$$\rho = x\cos\theta + y\sin\theta \quad (2)$$

In eqn (2),ρ is the standard deviation of Hough transform, x and y are the distance from the origin to the pixels. Based on the values ofstandard deviation of the Hough transform, the classifier will classify the facial features and recognize the humanemotion states.But these values will be varied for different people because each person has different face structure.

V.CONCLUSION

In this facial expression recognition system, it can recognize the frontal view face images. It also gives the comparison between the naive Bayes classifier and the Active Shape Model. Thus the performance of this recognition system will be improved. In the future work, multi view face images can also be recognized.In addition, modeling the temporal phases of each AU, which is important for understanding the spontaneous expression, is another interesting direction to pursue images.

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