Facial Expression Recognition Based on Image Feature

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***Abstract*—Facial expression recognition has potential applications in different aspects of day-to-day life not yet realized due to absence of effective expression recognition techniques. This paper discusses the application of Gabor filter based feature extraction in combination feedforward neural networks (classifier) for recognition of seven different facial expressions from still pictures of the human face. The study presented here gives simple method in facial expression recognition. The study presented here gives 60% to 70 % recognition of facial expression for the entire database of JAFEE. In this study the Japanese Female Facial Expression (JAFFE) database used which contains expressers that expressed expressions. The present study proves the feasibility of computer vision based facial expression recognition for practical applications like surveillance and human computer interaction.**

***Index Terms*—PCA, FER, Gabor etc.**

I. Introduction

Facial expressions provide an important behavioral measure for the study of emotions, cognitive processes and social interaction and thus automatic facial expression recognition systems can provide a less intrusive method to apprehend the emotion activity of a person of interest. With the availability of low cost imaging and computational devices, automatic facial recognition systems now have a potential to be useful in several day-to-day application environments like in identifying suspicious persons in airports, railway stations and other places with higher threat of terrorism attacks.

A. How this thing works?

There are two different approaches commonly used in computer vision based facial expression recognition so far: recognition using 2D still images and recognition using image sequences. Approaches using image sequence often apply optical flow analysis to the image sequence and use pattern recognition tools to recognize optical flow patterns associated with particular facial expression. This approach requires acquisition of multiple frames of images to recognize expressions and thus has limitations in real-time performance and robustness. Facial expression recognition using still images often use feature based methods for recognition and thus have fairly fast performance but the challenge in this approach is to develop a feature extraction method that works well regardless of variations in human subjects and environmental conditions.

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B. Need for study

- To avoid difficulties in facial expression recognition (FER) due to the variation of facial expression across the human population.
- To analyze facial expression feature extraction methods.
- To compare the facial expression & classification.

II. Literature Review

This paper introduced a multi-posed face detection and expression identification system which is more robust than the other proposed face detection system and facial expression system. This system is based on hybrid-boost multi-class learning algorithm as well as three decision rules which generates higher detection rate and lower false alarm rate. The experimental results show that the system has better performance than the others using Harr-like feature or Gabor feature [1].

This paper proposed a hybrid facial expression recognition framework in the form of a novel fusion of statistical techniques and the known model of a human visual system. An important component of this framework is the biologically inspired radial grid encoding strategy which is shown to effectively down sample the outputs of a set of local Gabor filters as applied to local patches of input images. Local classifiers are then employed to make the local decisions, which are integrated to form inter- mediate features for representing facial expressions globally. The recognition accuracies obtained on application to standard individual databases have been shown to be significantly better [2].

The methods about how to effectively extract expression features and recognize expression is studied in this paper. Firstly, they segment the face image from each image in the image sequence, and execute the operations of gray and scale normalization, circumrotation revision for the sub-face image. Then a hybrid feature extraction method based on AAM and Gabor wavelet transformation is presented in this paper. Experiments show that there method can recognize the six basic expressions effectively. Especially for the easily confused expressions such as angry, sad, fear, etc [3].

FER by computer is very useful in many applications such as human behavior interpretation and human-computer interface. Comparison of the recognition performance with different types of features shows that Gabor wavelet coefficients are much more powerful than geometric positions [4].

This paper introduced an idea to develop a feature vector which consists of three types of facial variations and is robust against the expressional changes in the human faces

in real environments. Since the training set consists of the facial expressions information of a person, it can recognize the person even under various expressions. A Bayesian Network (BN) classifier is efficient to train and classify. However the benchmarked database consists of only frontal view of faces. This technique is capable of working in real time environment. This system is a constituent of HRI system. It can keep the person identity information even under the presence of facial expressions which could originate under human machine interaction scenarios [5].

Facial feature extraction attempts to find the most appropriate representation of the face images for recognition. There are mainly two approaches: holistic template-matching systems and geometric feature-based systems. In holistic systems, a template can be a pixel image or a feature vector obtained after processing the face image as a whole. In the latter, principal component analysis and multilayer neural networks are extensively used to obtain a low-dimensional representation. In geometric feature-based systems, major face components and/or feature points are detected in the images. The distances between feature points and the relative sizes of the major face components are computed to form a feature vector. The feature points can also form a geometric graph representation of the faces. Feature-based techniques are usually computationally more expensive than template-based techniques, but are more robust to variation in scale, size, head orientation, and location of the face in an image [6].

III. Motivation

The recognition of facial expressions implies finding solutions to three distinct types of problems. The first one relates to detection of faces in the image. Once the face location is known, the second problem is the detection of the salient features within the facial areas. The final analysis consists in using any classification model and the extracted facial features for identifying the correct facial expression. For each of the processing steps described, there have been developed lots of methods to tackle the issues and specific requirements. Depending on the method used, the facial feature detection stage involves global or local analysis. In the case of global analysis, the connection with certain facial expressions is made through features determined by processing the entire face.

IV. Methodology

A. Image preprocessing

A practical facial expression recognition system is shown in Fig.1 below. The Recognition process begins by first acquiring the image using an image acquisition device like a camera. The image acquired then needs to be preprocessed such that environmental and other variations in different images are minimized. Usually, the image preprocessing step comprises of operations like image scaling, image brightness and contrast adjustment and other image enhancement operations. In this study, an existing image database of human facial expressions is used to train and test the performance of the classifier. The images in the database have already been pre-processed and thus there is no need to apply any image pre-processing operation in this study.

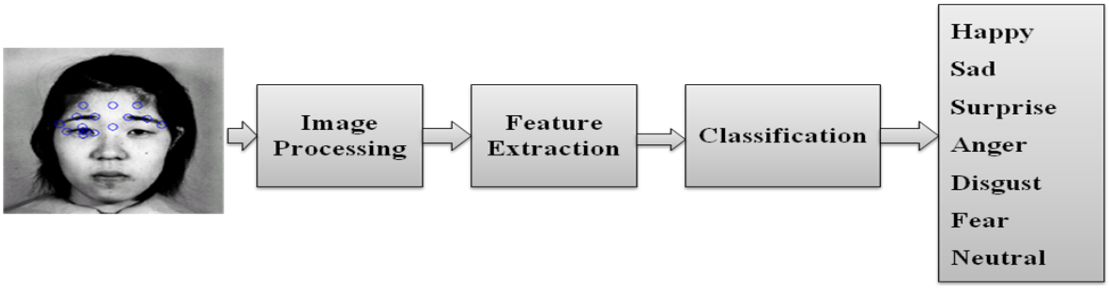

Fig. 1. Facial expression recognition system overview.

A. Feature extraction

In order to recognize facial expressions from frontal images, a set of key parameters that best describe the particular set of facial expression needs to be extracted from the image such that the parameters can be used to discriminate between expressions. This set of parameters is called the feature vector of the image and the amount of information extracted from the image to the feature vector is the single most important aspect of successful feature extraction technique.

B. Two D Gabor function

A 2-D Gabor function is a plane wave with wave-factor k, restricted by a Gaussian envelope function with relative width σ:

$$\Psi(k, x) = k^2/\sigma^2 \ (\exp(-k^2 x^2/2\sigma^2)) [\exp(ik, x) - \exp(-\sigma^2/2)]$$

The value of σ is set to pi for the image of resolution 256x256. A discrete set of Gabor kernels is used that comprises of 3 spatial frequencies (with wave number k=pi/4,pi/8, pi/16) and 6 distinct orientations from 0 to 180^0, differing in 30 steps that makes a filter bank of altogether 18 different Gabor filters. The 18 different Gabor filter kernels obtained as described above. The output of Gabor filter for selected fuditial points are convolved with image for the selected co ordinates of fuditial points. The resulted vector is called as feature vector and length of feature vector will be no. of Gabor filter multiplies no. of fiducial points [7].

C. Principal component analysis

PCA is a technique used to lower the dimensionality of a feature space that takes a set of data points and constructs a lower dimensional linear subspace that best describes the variation of these data points from their mean. PCA is a linear transformation commonly used to simplify a data set by reducing multidimensional data sets to lower dimensions. By using PCA, dimensionality reduction in a data set can be achieved while retaining those characteristics of the data set that contribute most to its variance, keeping lower order principal components and ignoring higher-order ones. PCA has the distinction of being the optimal linear transformation keeping the subspace that has largest variance. Unlike other linear transforms, PCA does not have a fixed set of basis vectors and its basis vectors depend on the data set. In this study, length of feature vector can change from 612 to a desired length. The length of feature vector is variable we can take the length of the feature vector such as 10, 20 up to 612 to improve the recognition rate.

D. Classifier

- Assemble the training data.
- Create the network object.
- Train the network.
- Simulate the network response to new inputs.

By using the feedforward neural networks (20 input, 40 to 60 hidden layers and seven outputs) we can classify the input images such as happy, anger, disgust, neutral, sad, surprised and fear.

V. Working Steps

Face detection and Facial expression recognition is based on the feature extraction. In order to classify facial expressions, we require a reasonable set of descriptive features. We apply two kinds of facial features to represent the face state and face movement global features and local features. The first represent face properties of single images, such as the opening of the mouth or rising of the eye-brows. We combine them with information about movement within the face region to form an invariant feature vector. As our experimental evaluation will prove, these extracted features are efficient for face and facial expressions recognition.

A. Proposed block diagram

Fig. 2 shows that proposed block diagram of facial expression recognition. JAFEE image data base is used for the input purpose. Then the features points will be selected by using the Matlab commands.

The features will be extracted by using the Gabor filter (explained in 4.3) & then PCA (Explained in 4.4) is applied over this to reduce the feature vector length and the resulting data will be considered as image features. These features will apply to the classifier which will give the best result of the facial expression recognition.

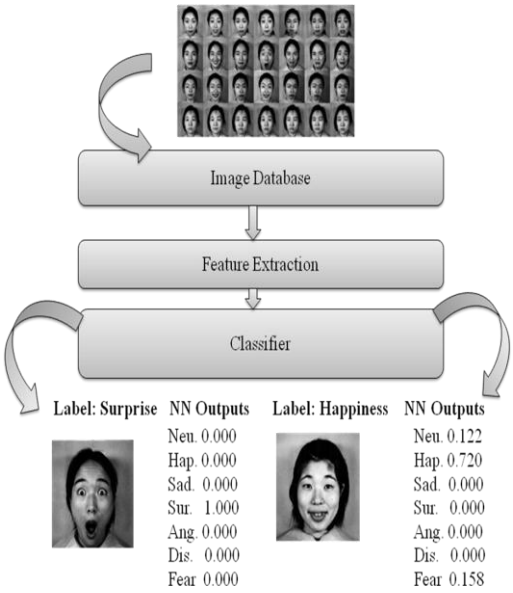

Fig. 2. Block Diagram of Facial Expression Recognition Method.

VI. Summaries

- System avoids difficulties in facial expression recognition (FER) due to the variation of facial expression across the human population.
- System can analyze facial expression feature extraction methods.
- Classifier will compare the facial expression & classify them.

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