Facial Expression Recognition using Analytical Hierarchy Process

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Abstract- *Face Expression Recognition and Analysis is an actively researched topic since early nineties due to its significant contribution in Human-Computer Interaction which has paved the way for Affect-Sensitive Computing, also called Human Centered Computing. There have been several advances in terms of face detection and tracking, feature extraction methods and the techniques adopted for expression classification. But most face expression analysis systems utilize low-level visual features to recognize face expressions, while the user perception of facial expression recognition often varies with each individual. Low level visual features suffer a high degree of variability due to a number of factors and are unstable due to the variation of imaging conditions. So it is very important to introduce the semantic knowledge into the automatic recognition process in order to improve the recognition rate. In this paper, a semantic-based facial expression recognition model is proposed that incorporate both, the low-level feature and the human semantics using a multi-criteria decision making model, called Analytical Hierarchy Process (AHP). Experimental results show that the recognition rate is improved with this approach.*

Keywords: Analytical Hierarchy Process, Facial Expression Recognition, High-Level Semantic Knowledge, Low-Level Visual Feature.

1. INTRODUCTION

Accurate recognition of facial expression can benefit in the field of human-centered computing, human-computer interaction and finds applications in several interesting areas. Automatic Recognition of a student's facial expression can be used for automated feedback in teaching and for Intelligent Tutoring Systems (ITS). Another application can be prediction of behavioral aspect of people with respect to consumer research, security surveillance, or clinical observation.

2. RELATED WORK

By tracking facial features and measuring the amount of facial movements, we can categorize different facial expressions..

2.1. *Facial Expression Recognition method*

Facial Recognition methods are similar to Pattern Recognition in the sense that, they first extract some features from image or video, then these features are used as inputs into a classification system, and the outcomes is one of the preselected emotion categories. They differ mainly in the features extraction approaches and in the classifiers used to classify an input face image. Recognition of Face expression is done by a classifier, which consists of models of pattern distribution, coupled to a decision algorithm. In general, human emotions cannot be sufficiently represented using the low-level visual features only due to inherent inconsistency between the machine and human perception to the image. This semantic gap between low-level visual features and high-level features needs to be bridged in a proper way in order to construct an efficient automatic facial expression system which satisfies the user perception. For this purpose, AHP is used to provide a systematic way to assess the fitness of a semantic description for analysis of the emotion from a face image.

2.2. *An Overview of AHP technique*

The AHP developed by Thomas Saaty is a multi-criteria decision making technique which decomposes a complex problem into a hierarchy and also it is a qualitative technique which rely on the judgement and experience of decision makers to prioritize information for better decisions. In decomposition stage a hierarchical network is constructed to represent a decision problem, where the topmost level represents the overall goal and the lower levels represent criteria, sub-criteria, and alternatives. With comparative judgments, users are required to set up a comparison matrix at each hierarchy level by comparing sets of criteria or sub-criteria. A scale of value ranging from 1 to 9 is used to express the users' preference, where 1 denotes equal preference and 9 denotes extreme preference. Final stage is the synthesis of priority stage, where each comparison matrix is solved by an eigenvector method for determining the prime criteria from the alternatives.

3. Proposed Work

In this paper, two kinds of features are extracted -low-level features and high-level semantic features. The low-level visual features are defined and extracted as the feature point distances between a target input

image and a predefined neutral face image for eyebrows, eyes and mouth. For the high-level feature extraction, criteria hierarchy using AHP is defined which includes six kinds of facial expressions -neutral face, happy, angry, sad, surprise, and fear. According to the concept hierarchy, a semantic vector is used to represent the semantic content of the image, which consists of the fitness value of semantic-based facial expression of a given image. Based on the semantic vector calculation, the training sample images are clustered. For each semantic cluster, the weighting adaptation is calculated by analyzing the homogeneity of the class. In this way, the values of weighting adaptation to the low-level features are different for the different semantic clusters. □

4. Proposed Facial Expression Recognition Algorithm

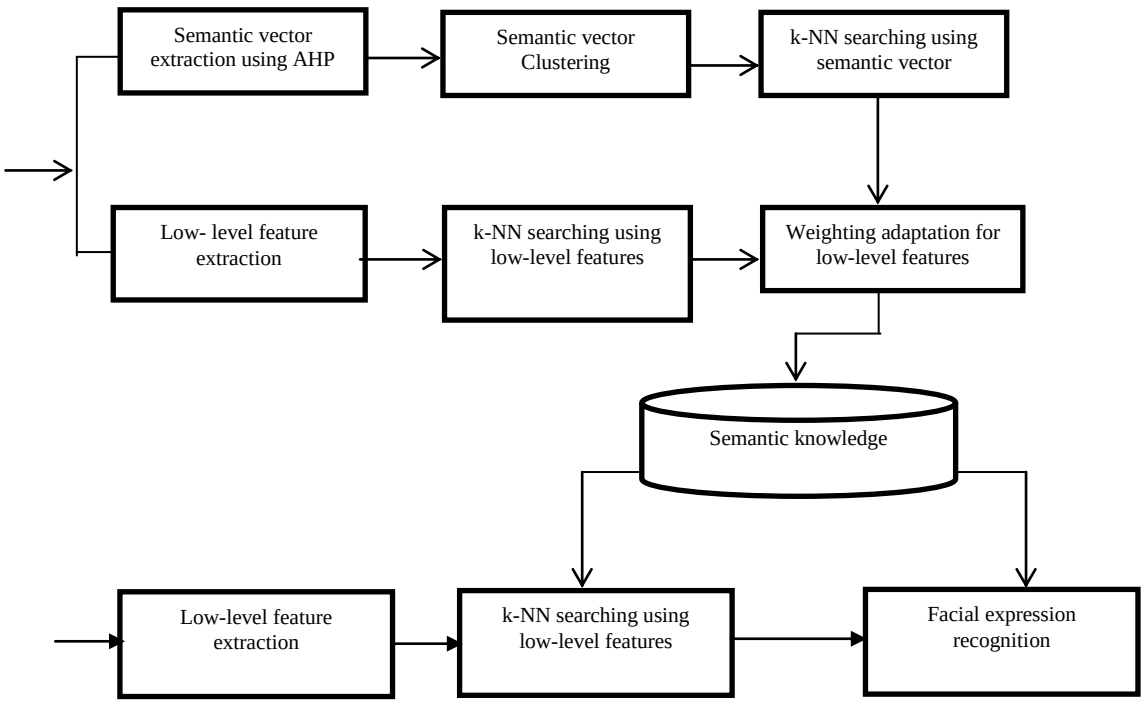
Algorithm: The proposed recognition strategy
Input: A training database TD and an input face image q
Output: The expression category of the input image
Method: The semantic knowledge vector of the unknown facial expression image q is calculated, the steps are briefly described as follows:

(1) The low-level visual features of the unknown facial expression image q are extracted.
(2) The k-NN algorithm is used to find the top k similar images in the training database and form a candidate set A.
(3)The semantic knowledge vector of the unknown facial expression image q was calculated according to the following equation:

$$S = (s_1, s_2, \ldots, s_n), \sum_{i=1}^{n} s_i = 1 \qquad \text{eq. (1)}$$

The semantic knowledge vector of the unknown facial expression image is calculated and formed as
$S = (\rho_{ha}, \rho_{an}, \rho_{sa}, \rho_{su}, \rho_{fe}, \rho_{di})$,
The semantic knowledge vector is composed of the probability of each category. Given an input face image, we can classify the input image into the facial expression category of the largest probability value according to its semantic vector.

Fig. 1. Block diagram of the proposed semantic-based facial expression recognition system



5. Experimental Result after using AHP

In order to test the efficiency of AHP in analyzing the facial expression, a comparison is done. For each image in the training database, the semantic vectors calculated from the proposed methodology are compared with the annotations provided by the JAFFE database. This is shown in the confusion matrix in table1. As shown, labeling results in both the methods are much similar to each other. Also it is observed that including the weighting adaptation in this semantic approach plays an important role in improving the recognition performance.

Table 1: Confusion matrix for actual label by JAFFE and labeling face image using AHP

	Neutral	Happiness	Anger	Sadness	Surprise
Neutral	**29/30**	**0**	**0**	**1**	**0**
Happiness	**1**	**32/34**	**0**	**0**	**1**
Anger	**0**	**0**	**26/30**	**3**	**1**
Sadness	**2**	**2**	**1**	**27/32**	**0**
Surprise	**0**	**1**	**1**	**0**	**28/30**

6. Conclusion

Experimental observations display that this approach is effective in bridging the gap between low level visual features and high level user perception by adaptively tuning the weights of low level visual features. Hence semantic knowledge based recognition methods shows improves recognition rate than traditional methods of facial expression recognition

REFERENCES

[1] B. Fasel and J. Luttin, "Automatic Facial Expression Analysis: a survey," Pattern Recognition, vol. 36, no. 1, pp. 259-275, 2003.

[2] T. Kanade, J. Cohn, and Y. Tian, "Comprehensive Database for Facial Expression Analysis," Proc. IEEE Int'l Conf. Face and Gesture Recognition (AFGR '00),pp. 46-53, 2000.

[3] K. Anderson and P.W. McOwan, "A Real-Time Automated System for Recognition of Human Facial Expressions," IEEE Trans. Systems, Man, and Cybernetics Part B,vol. 36, no. 1, pp. 96-105, 2006.

[4] https://en.wikipedia.org/wiki/Confusion_matrix

[5] Cheng Shyi-Chyi, Chen Ming-Yao, Chou T C, et al. Semantic-based facial expression recognition using analytical hierarchy process[J],Expert Systems with Applications, 2007,33 (1): 86-95.

[6] Hao Tang, Thomas S. Huang.3D facial expression recognition based on automatically selected features[C].IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops,2008,6:1-8.