Facial Expression Recognition - A Review

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Abstract---This electronic document presents a brief review on Facial Expression Recognition. There are basic six facial expressions: Happy, Sad, Ander, Disgust, Surprise, Sad. This is a two step process, In first the facial feature is extracted from image and then it is classified into six category. Facial Expression is the only way to convey feelings more efficiently.

Keywords:Facial Expression, HCI

I. INTRODUCTION

The community of computer vision has attracted the attention of facial emotion recognition over the last decade A vast amount of work has been done and is in progress to make life easy for the disabled (e.g. blind, dumb) and aged people by the help of improving all aspects of interaction between computers and human beings. In the area of HCI, there is practical usage based emphasis for automating recognition of a particular facial expression out of a pre-defined list. Facial expressions have been extensively studied in psychology [1][2].

A Mehrabian [3] shows that 7% of human communication done by language, 38% by paralanguage and 55% through expression of face. So, recognition of Facial Expression is very crucial in human computer interaction.

Fig.1: Facial Expression of 2 persons from JAFFE Database

Research has shown that from a behavioral cognition point of view intrinsic emotions and facial expression have a strong relationship [4]. So recognition of facial expression is very much useful in science and technology like anti-terrorist activity, security, behavioral study, robotics,

psychological study, human computer interaction (HCI). Ekman et al. categorized facial expressions into six basic expressions namely sadness, happiness, fear, anger, disgust, and surprise. These are called universal expressions [5].

II. FACIAL EXPRESSION RECOGNITION PROCESS

Facial Expression Recognition process is further divided into three steps. First preprocessing is done on row images if it is required. Then in second step facial feature extraction is done and after that expression classification is done.
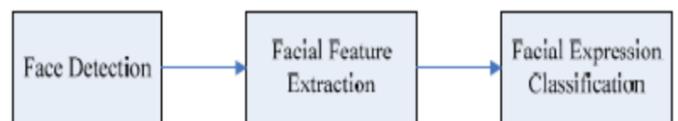

Fig. 2: Facial Expression Recognition System [6]

Turning Head and changes in Illumination are the most important factors affecting the recognition performance. Using Gabor Filter we can reduce the Illumination changes. Sometimes the images are reshaped or resized for batter results.
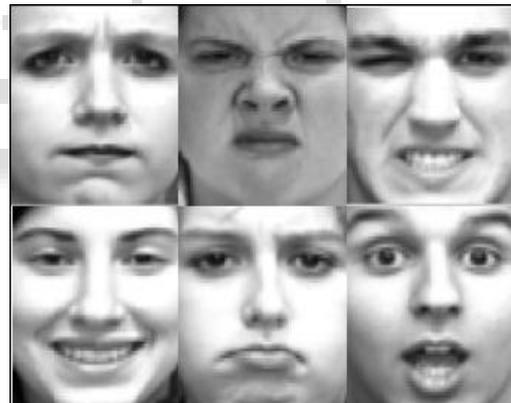

Fig. 3: Facial Expression Images after Preprocessing [7].

The facial feature extraction algorithms can be classified into two main categories. 1) Image (feature) based methods 2) Model based methods. In image based method the input is the set of images and output is the corresponding expression. Image based methods are less accurate compare to model based methods but they require less time for feature extraction and they also reduces the high dimensional features [8] .

Some image based algorithms are 1) FER using Gabor filter, 2) FER using target oriented approach. While in the model based methods the input is model and output is the corresponding expression. Model based methods require more time for feature extraction but they are more accurate compare to image based methods. Some of the model based algorithms are 1) FER using 3D feature distances 2) FER using Active Appearance Model (AAM)[9].

The next task is to recognize the expression using any one of the known classifier. System is trained in such a way that when any unknown image is given as an input it will

automatically identify the corresponding facial expression. Some known classifiers are 1) neural network, 2) support vector machine 3) Linear Discriminate Analysis (LDA) 4) Hidden Markov Model (HMM)[9]

III. METHODOLOGY

A. Facial Feature Extraction Techniques

1) GABOR FILTER

Gabor filter is a useful tool to extract local features in both spatial and frequency domain and seems to be a good approximation to the sensitivity profiles of neurons found in visual cortex of higher vertebrates. A Gabor filter can be represented by the following equation:

$$\psi(\chi,\gamma,\varpi,\theta) = \frac{1}{2\pi\delta^2}\ e^{-(\frac{\chi'^2+\gamma'^2}{2\delta^2})}e^{i\varpi\chi'} \tag{1}$$

Where (x, y) is the pixel position in the spatial domain, ω is the central frequency of a sinusoidal plane wave, θ is the orientation of a Gabor filter and σ is the standard deviation along the both of χ and γ directions. The parameters χ' and γ' are given as the following equations[7]:

$$\chi' = \chi\cos\theta + \gamma\sin\theta\ ,\ \gamma' = -\chi\sin\theta + \gamma\cos\theta \tag{2}$$

(Fig. 4 Gabor Image of a person)

2) PCA (Principal Component Analysis)

It is very much useful technique for finding patterns in data of high dimension. It is also very much useful in compression of large amount of data.

(a)

(b)

(c)

Fig. 4: (a) Normal (b)Gabor (c) PCA image of same person from JAFFE Database.

B. Facial Expression Classification Techniques

1) Neural Network

Artificial Neural Networks (ANNs) are applied in various majors, e.g. mathematics, statistics, physics engineering, and computer science. ANN can be used in many applications such as time series analysis, signal processing, and pattern recognition with learning ability from input vectors. Multilayer neural network consists of three parts: input layer, at least one hidden layer of computation neurons, and output layer of computation neuron. Multilayer perceptron is widely used to solve some difficult and diverse problems by training them in supervised manner with the error calculated from back propagation algorithm based on error-collection learning rules. Basically, the network consists of two parts in different directions: a forward pass and a backward pass. In forward pass, input vector is applied to the sensory neuron of the networks then output value was produced while, in the backward pass, all of synaptic weights were adjusted with respect to the difference between target and actual output [10]. There are various kind of neural networks are available like: Feed Forward Neural Network, Artificial Neural Network (ANN), Bi-directional Neural Network, Probabilistic Neural Network (PNN) and everyone has its own application.
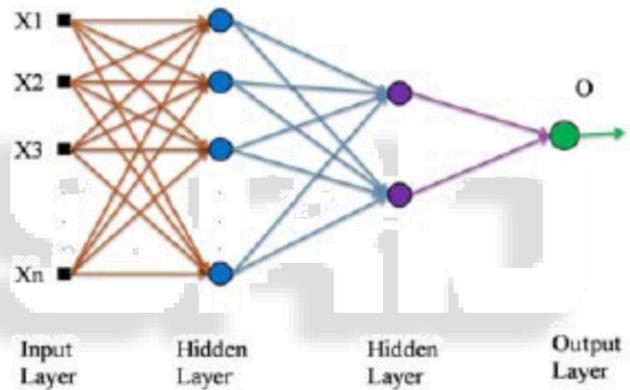

Fig. 5: Neural Network with back propagation [10].

2) Support Vector Machine (SVM)

Support Vector Machine is a valid machine learning method in limited sample, which is used widely since C Cortes and V Vapnik have proposed in 1995 [11]. Bartlett obtained a better result by using Adaboost to extract features and selecting the SVM classifier to classify features. In 2008, Ying et al. propose an algorithm for dimension reduction called support vector discriminant analysis (SVDA), which first looks for the optimal separating Hyperplane by SVM algorithm and then project data in the corresponding normal direction [12]. In multi-class cases, the algorithm has many choices for selecting projecting axis. The algorithm has the intrinsic nice generalization ability of SVM. The algorithm to the feature extraction in facial expression recognition application and compares the results to other algorithms such as PCA, LDA, KPCA and GDA. The results show the effectiveness of the proposed algorithm.

Hidden Markov Model (HMM)

Hidden Markov Model (HMM) commonly used for speech recognition are also used in Facial Expression Recognition. Muller used 3-D Hidden Markov Models (P3DHMMs) for facial expression recognition [13]. Patar and Aggelos presented an automatic multistream HMM facial expression recognition system and analyze its performance [14].This

model is useful when the facial features are extracted using LBP (Local Binary Patterns).

IV. CHALLENGES CURRENT FER TECHNIQUES

- All techniques are used on frontal view of face only.
- Rotation of face and Illumination changes can affect the performance
- Image Occlusion : the same person face is having beard or spectacles can't be easily identified
- Facial Expression are subject to age so aging is the major challenges for these techniques
- Results are dependent on Databases so algorithm should be independent from Databases
- In real life hybrid expressions are possible so the system can be efficient to recognize them.
- FER should be integrate

V. CONCLUSION

Although the facial expression recognition area is most popular in now a days due to HCI (Human Computer Interaction)   many research should be done to come out from the various challenges and this field should be combined with others to serve mankind very nicely.

REFERENCES

[1] P. Ekman and W. V. Friesen, Unmasking the Face. Englewood Cliffs, NJ:Prentice-Hall, 1975.
[2] Z. Zeng, M. Pantic, G. Roisman, and T. S. Huang, "A survey of affect recognition methods: Audio, visual and spontaneous expressions," IEEE Trans. Pattern Anal. Mach. Intell., vol. 31, no. 1, pp. 39–58, Jan. 2009.
[3] Mehrabian A. "Communication without words[J]". Psychology Today. 2(4): 53~56. 1968.
[4] Hosseini, I., Shams, N., Amini, P., Sadri, M.S.: Facial Expression Recognition UsingWavelet-based Salient Points and Subspace Analysis Methods. IEEE (2006)
[5] Ekman, P., Friesen, W.V. : Unmasking the Face. Prentice Hall, New Jersey (1975)
[6] Shuai-Shi Liu,Dong Li :New Research Advances of Facial Expression Recognition IEEE (2009)
[7] Saeid Fazli, High Performance Facial Expression Recognition Using Gabor Filter and Probabilistic Neural Network IEEE (2009)
[8] M.Pantic, J.M.Rothkrantz, "Automatic Analysis of Facial   Expressions: The State of the Art" IEEE transactions on pattern analysis and machine intelligence, vol. 22, no. 12, December 2000.
[9] Jatin B Patel, Automatic Facial Expression Recognition Using Support vector Machine and Neural Network IJCTA 2014
[10] Chaiyasit Tanchotsrinon, Facial Expression Recognition Using Graph Based Features and Artificial Neural Networks IEEE 2011
[11] C Cortes, V Vapnik. "Support vector networks[J]".Machine Learning, 20(3): 273-293. 1995.
[12] Ying Zi-lu,Tang Jing-hai, Li Jing-wen, Zhang You-wei. "Support Vector Discriminant Analysis and Its Application to Facial Expression Recoginition". Acta Electronica Sinica.36(4): 725-730. 2008.
[13] Muller S, Wallhoff F, Hulsken F, et al. "Facial expression   recognition using pseudo 3-D hidden Markov models[A]". In: Proceedings of International Conference on Pattern Recognition[C], Québec City, Canada, 2: 32~35. 2002.
[14] Petar S. Alekeic. Aggelos K. Katsaggelos. "Automatic Facial Expression Recogintion Using Facial Animation Parameters and Multistream HMMs". IEEE Transactions on Information Porensice and Security, Vol. 1, 3-11. 2006.