An Implementation of Face Emotion Identification System using Active Contour Model and PCA

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Abstract— Facial expression recognition system has turn into a most emphasizing research area since it plays a most important part in human-computer-interaction. The facial expression recognition system finds foremost application in areas like social interaction and social intelligence like in diverse surveillance systems, defense systems, substantiation or verification of individual like criminals etc... The face can articulate emotion sooner than people verbalize or even understand their posture. Thus there is apparent need of unfailing recognition and identification of facial expressions. In this paper we have formulated improvement in the Face expression recognition technique at different phases using PCA (Principle Component Analysis) and active contour model based segmentation.
Key words: Component, Formatting, Style, Styling, Insert

I. INTRODUCTION

Human communication has two main aspects; verbal (auditory) and non-verbal (visual). Facial expressions are an important component of interpersonal communication. Despite their non-verbal nature, they convey a lot of information about the person and the person’s affective state, intention and personality. Particularly for the recognition of the affective state, humans rely heavily on analyzing facial expressions [10, 18]. Facial expressions also support verbal communication due to their complementary nature to the acoustic side of the spoken words. Unlike humans, current computer systems can hardly recognize the affective state of a human user. The last decade has witnessed a trend towards an increasingly ubiquitous computing environment, where powerful and low-cost computing systems are being integrated into mobile phones, cars, medical instruments and almost every aspect of our lives. This has created an enormous interest in automatic processing of digital images and videos in a number of applications, including biometric authentication, surveillance, human-computer interaction, and multimedia management. Research and development in automatic face recognition follows naturally. Face recognition is a visual pattern recognition problem where a three-dimensional object is to be identified based on its two-dimensional image. in recent years, significant progress has been made in this area; owing to better face models and more powerful computers, face recognition system can achieve good results under constrained situations. However because face images are influenced by several factors: illumination, head pose, expression and so on, in general conditions, face recognition is still challenging. From a computer vision point of view, among all these “noises" facial expression maybe the toughest one in the sense that expressions actually change the three-dimensional object while other factors, such as illumination and position, only affect imaging parameters. To get rid of expression noise", one first needs to estimate the expression of an image, this is called Facial Expression Recognition". Another, maybe more important motivation of facial expression recognition is that expression itself is an efficient way of communication: it's natural, non-intrusive, and [12] has shown that, surprisingly, expression conveys more information than spoken words and voice tone. To build a friendlier Human Computer Interface, expression recognition is essential. The importance of facial expression system is widely recognized in social interaction and social intelligence. The system analysis has been an active research topic since 19th century. The facial expression recognition system was introduced in 1978 by Suwa et. al. The main issue of building a facial expression recognition system is face detection and alignment, image normalization, feature extraction, and classification. There are number of techniques which we use for recognizing the facial expression. Some of the researchers [1] introduced the system can recognize the different human gesture in color image. In this paper Viola and Jones describe the face detection technique using Add Boost Haar classifier. After performing the pre-processing operation the recognition is performed, the simplicity and robustness of the system is significant. Depending on threshold value the researchers system can recognize the facial expression. The approach of this system can be adapted to real time and it briefly describes the schemes of capturing the image and to recognize the gestures. Robert Axelrod has also shown the ability to recognize that they have met before and distinguish them from strangers is one of the bases for humans to form cooperation [3].

II. LITERATURE SURVEY

M. Pantic and L.J.M. Rothkrantz focused on a threefold. Modelling the facial motion and its intensity (i.e. dealing with face image sequences and AU intensity) will increase the overall performance of the system. Developing a Fuzzy Expert System for face action tracking and face action emotional classification will increase the quality of the system by allowing it to reason about the involved face actions according to the accuracy of the performed facial feature tracking. Designing and developing a learning facility, which will allow the user to define his/her own interpretation categories, will yield a broader and more realistic classification of the encountered expressions.

Philipp Michel and Rana El Kaliouby states that in their implementation correctly recognized expressions in 78% of trials, with subsequent improvements including selection of a kernel function customized to the training data boosting recognition accuracy up to 87.9%, as illustrated in Table 1. Incorporating further possible enhancements such as adjusting data to account for head motion or performing automatic SVM model selection is likely to yield even better performance and further increase the suitability of SVM-based expression recognition approaches in building affective and socially intelligent human-computer interfaces

Pushpaja V. Saudagare, D.S. Chaudhari told that automatic facial expression recognition systems are overviewed. The neural network approach is based on face recognition, feature extraction and categorization. The aproach of facial expression recognition method involve the optical flow method, active shape model technique, principle componenet analysis algorithm (PCA) and neural network technique. The approach does provide a practical solution to the problem of facial expression recognition and it can work well in constrained environment.

Akshat Garg, Vishakha Choudhary states that Principal Components Analysis is a method that reduces data dimensionality by performing a covariance analysis between factors. Thus Facial expression recognition or cognitive assessment can be done by comparing the principal components of default image or slice with the new/any respective subject.

Victor-emil neagoe, Adrian-dumitru ciotec had dedicated to the challenging computer vision task of subject-independent emotion recognition from facial expressions. The original key idea of the proposed model is the increasing of the neural classifier training set size by adding virtual samples generated with a system of Concurrent Self-Organizing Maps (CSOM). The model consists of the following main processing cascade: (a) Gabor Wavelet Filtering (GVF); (b) dimensionality reduction using Principal Component Analysis (PCA); (c) Radial Basis Function (RBF) neural classifier trained with virtual samples generated by CSOM system (VSG-CSOM).

Alex Graves, J¨urgen Schmidhuber, Christoph Mayer, Matthias Wimmer, Bernd Radig had presents a complete system for automatic facial expression recognition. The Candide-3 face model is used in conjunction with a learned objective function for face model fitting. The resulting sequence of model parameters is then presented to a recurrent neural network for classification. The advantage of using a recurrent network is that the temporal dependencies present in the image sequences can be taken into account during the classification. Since the entire process is automatic, and the recurrent networks can be used to make online predictions, the system would be ideal for real-time recognition. This would make it suitable for the CoTeSys 'coffee break' scenario, where guests must be recognized and served by robot waiters. Promising experimental results are presented on the Cohn-Kanade database.

Ashutosh Saxena, Ankit Anand, Prof. Amitabha Mukerjee explained an efficient, local image-based approach for extraction of intransient facial features and recognition of four facial expressions from 2D image sequences is presented. The algorithm uses edge projection analysis for feature extraction and creates a dynamic spatio-temporal representation of the face, followed by classification through a feed-forward net with one hidden layer. A novel transform for extracting lip region for color face images based on Gaussian modeling of skin and lip color is proposed. The proposed lip transform for colored images results in better extraction of lip region in the feature extraction stage. The algorithm achieves an accuracy of 90.0% for facial expression recognition from grayscale image sequences.

III. COMPARISON

Reference	Pre-processing	Feature Extraction	Expression Classification	Recognition Performance
Bourel et al.	Using a point tracker	Scalar quantisation of facial dynamics	rank-weighted k-nearest Neighbor classifier.	Relatively little degradation in recognition under partial face occlusion or tracker noise.
Pantic and Rothkrant	Multiple detectors (e.g. snakes, neural networks, …).	Extraction of static geometric measurements	rule-based expert system	91% recognition of basic expression prototypes.
Essa and Pentland	Viewbased and Modular Eigenspace methods	(i) peak activation of each muscle. (ii) motion estimates	(i) maximum correlation with muscle activation template, (ii) minimum distance to motion energy template.	92% recognition of facial expressions.
Tian et al.	Gaussian mixture model , Lucas-Kanade tracking algorithm	Continuous and discrete representation of magnitude and direction for motion of face	multi-layer perceptron for upper-face and lower-face	96.7% recognition o f lower-face AUs, and neutral expression.
Alex Graves	Multitude of features with a multi-stage fitting approach	Feature-point tracking by optical flow discriminates	Recurrent Neural Networks	85.4% AU recognition
Philipp Michel	Automatic Facial Feature Tracker	vector of displacements is calculated	Support Vector Machine	87.9% AU recognition
L Sirovich	-	Low-Dimensional Procedure for Characterization of Human Faces	Principal Component Analysis	Recognition rate is low

Martin et al. 2008	-	Using AAM based model	AAM classifier set instead of MLP and SVM based classifier.	Anger emotion with average accuracy of 94.9% but other emotions are low between 10 to 30%
Vretos et al. 2009	Appearance based	Model vertices are determined using PCA	SVM based classifier	Classification accuracy achieved up to 90%

Table 1: Comparison

IV. PROPOSED METHODOLOGY

Face recognition system can be formulated as following phases:

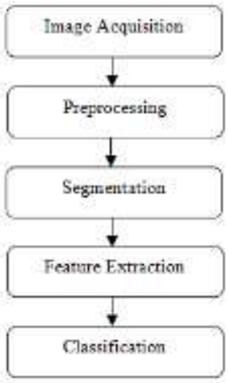

Fig. 1: Face Expression Recognition System

Facial expression plays a principal role in human interaction and communication since it contains critical and necessary information regarding emotion. The task of automatically recognizing different facial expressions in human-computer environment is significant and challenging. As we have seen image preprocessing and segmentation is primary step for recognition hence it is vital to put some efficient technique for the same. Henceforth we are using active contour model for segmentation and PCA based preprocessing and Feature Extraction. After extracting the features the eigenvectors will be generated this will be further fed used for face expression classification.

To improve the efficiency of system we need a efficient segmentation technique. Efficient preprocessing technique so that classification can be performed in efficient manner. If we increase the efficiency of each phase system performance will increase.

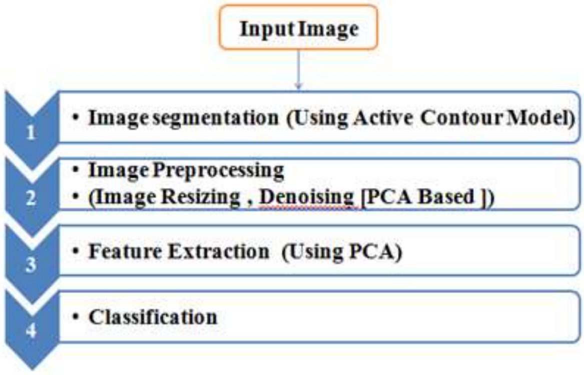

Fig. 2: Proposed Layout

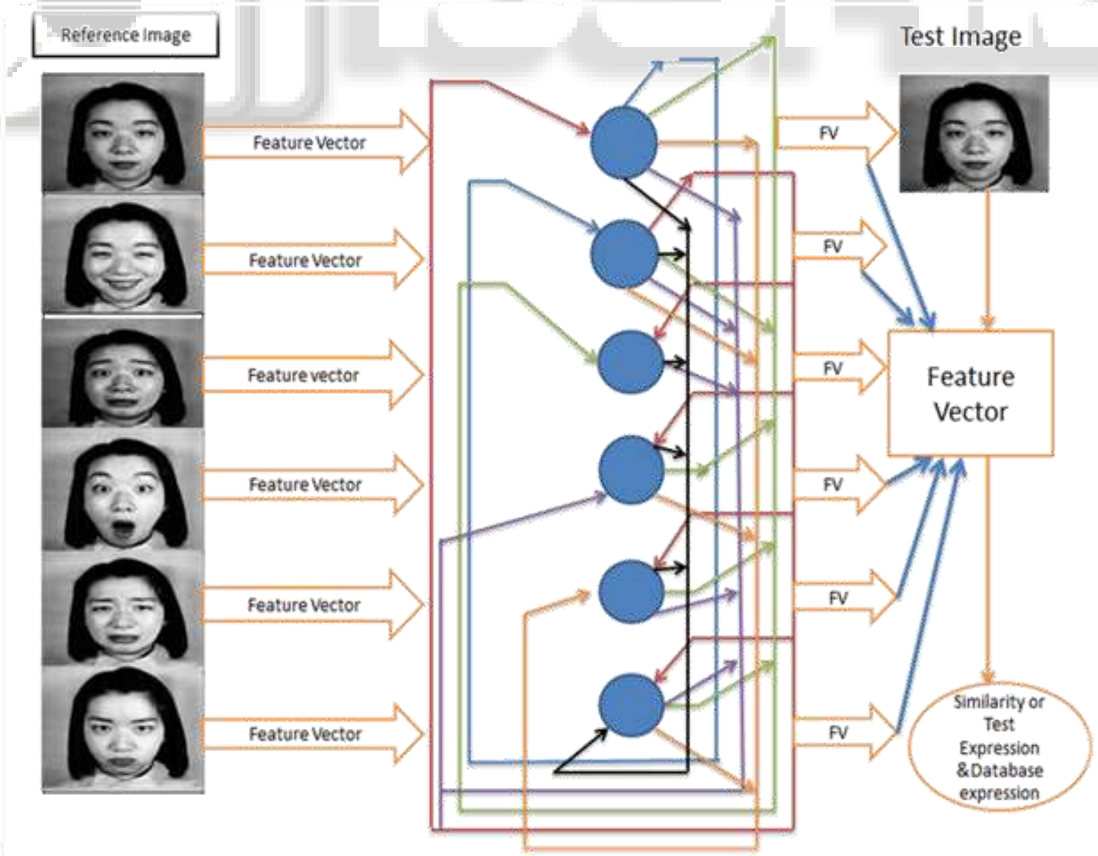

Fig. 3: Classification

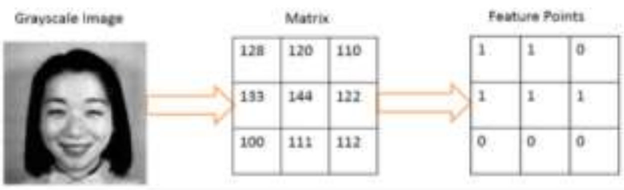

Fig. 4: Calculating Feature Vector (FV)

For calculating feature vector, An N*N matrix is said to have the feature values x_i and corresponding the feature vector is

$$F_v = \begin{cases} 1 & xi < xthresold \\ 0 & otherwise \end{cases}$$

Note: $X_{thresold}$ can be taken from the user.

V. EXPERIMENTAL EVALUATION

A. Preprocessing:

In image preprocessing step we have used PCA based image de-noising. In which the image local features can be well preserved after coefficient shrinkage in the PCA domain to remove the noise.

Input Image	**De-Noised Image**
	

Fig. 5: Preprocessing

B. Segmentation:

We have used Active Contour based segmentation of face. Active contour model represents an object boundary or some other salient image feature as a parametric curve and energy functional E is associated with the curve. The problem of finding object boundary is cast as an energy minimization problem.

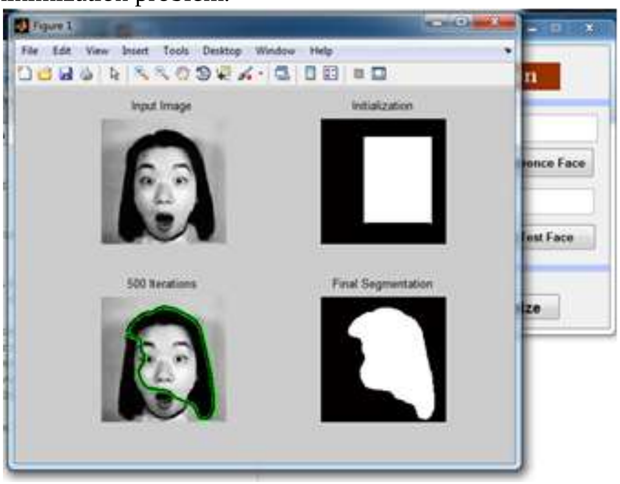

Fig. 6: Segmentation

C. Feature Extraction:

The PCA algorithm will generate the Eigen faces for each of the image and through these Eigen faces; the system will generate the Eigenvectors. These Eigen vectors will be sent into next module.

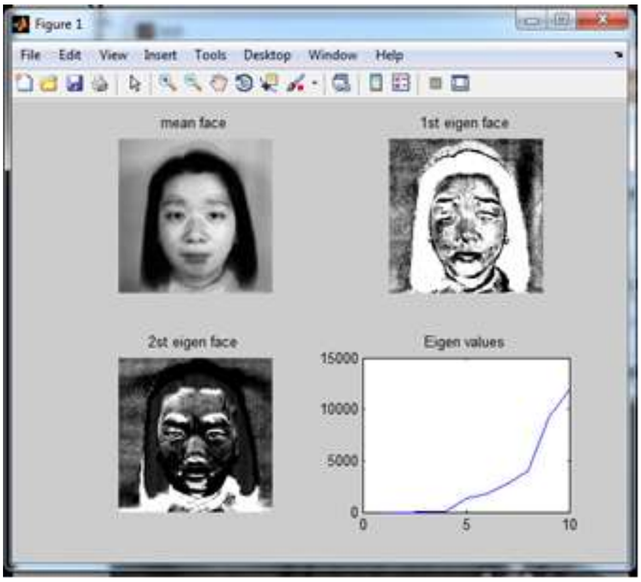

Fig. 7: Feature Extraction

D. Classification:

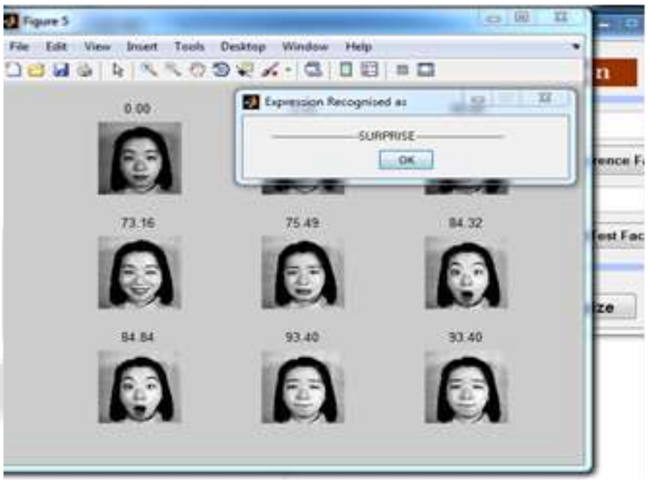

Fig. 8: Classification

We evaluated our system on the JAFFE facial expression recognition database. The task was to classify each of the video sequences into one of the six standard expression classes: happiness, anger, disgust, sadness, fear and surprise. The JAFFE database contains 213 images of 10 Japanese female models. Their images are labeled by emotions: six basic emotions (anger, disgust, fear, joy, happy, sad and surprise) are considered.

The efficiency plots for three sets of images are shown in Figure 4. From the figure, it is shown that there is a slight decrease in the performance of recognizing the expression 'Fear' compared to others. The expression 'Surprise' has better performance of nearly 100%. The performance ratios for surprise and disgust are almost same.

Emotion	Accuracy(in percentage)
Anger	83.1
Disgust	95.3
Fear	78.2
Joy	83.9
Sorrow	89.4
Surprise	98.8
Total Accuracy	86.8

Table 2: Accuracy

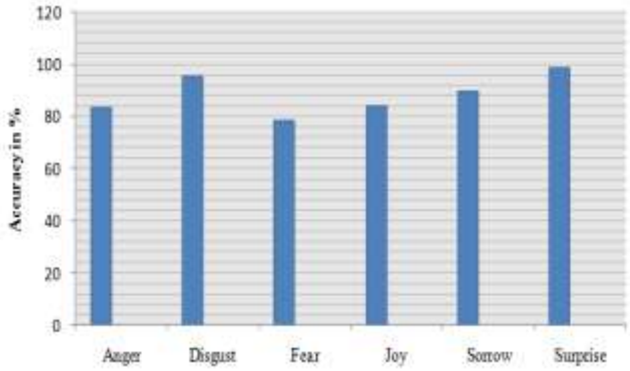

Fig. 9: Efficiency Plot

VI. CONCLUSION

Human beings naturally and intuitively use facial expression as an important and powerful modality to communicate their emotions and to interact socially [13]. There has been continued research interest in enabling computer systems to recognize expressions and to use the emotive information embedded in them in human-machine interfaces.

This paper presents a high-level overview of automatic expression recognition; it highlights the main system components and some research challenges. This work provided a framework for facial expression recognition that can effectively maximize performance.

REFERENCES

[1] F. Bourel, C.C. Chibelushi, A.A. Low, "Robust Facial Expression Recognition Using a State-Based Model of Spatially-Localised Facial Dynamics", Proc. Fifth IEEE Int. Conf. Automatic Face and Gesture Recognition, pp. 106-111, 2002
[2] F. Bourel, Models of Spatially-Localised Facial Dynamics for Robust Expression Recognition, Ph.D. Thesis, Staffordshire University, 2002
[3] V. Bruce, "What the Human Face Tells the Human Mind: Some Challenges for the Robot-Human Interface", Proc. IEEE Int. Workshop Robot and Human Communication, pp. 44-51, 1992
[4] R. Chellappa, C.L. Wilson, S. Sirohey, "Human and Machine Recognition of Faces: a Survey", Proc. IEEE, Vol. 83, No. 5, pp. 705-741, 1995
[5] C.C. Chibelushi, F. Deravi, J.S.D. Mason, "A Review of Speech-Based Bimodal Recognition", IEEE Trans. Multimedia, Vol. 4, No. 1, pages 23-37, 2002
[6] G. Donato, M.S. Bartlett, J.C. Hager, P. Ekman, T.J. Sejnowski, "Classifying Facial Actions", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 21, No. 10, pp. 974-989, 1999
[7] P. Ekman, W. Friesen, Facial Action Coding System: A Technique for the Measurement of Facial Movement, Consulting Psychologists Press, 1978
[8] P. Ekman, Emotion in the Human Face, Cambridge University Press, 1982
[9] I.A. Essa, A.P. Pentland, "Coding, Analysis, Interpretation, and Recognition of Facial Expressions", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 19, No. 7, pp. 757-763, 1997
[10] A.K. Jain, R.P.W. Duin, J. Mao, "Statistical Pattern Recognition: A Review", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 22, No. 1, pp. 4-37, 2000
[11] T. Kanade, J.F. Cohn and Y. Tian, "Comprehensive Database for Facial Expression Analysis", Proc. 4th IEEE Int. Conf. on Automatic Face and Gesture Recognition , pp. 46–53, 2000
[12] J.J. Lien, T. Kanade, J.F. Cohn, C-C. Li, "Automated Facial Expression Recognition Based on FACS Action Units", Proc. Third IEEE Int. Conf. Automatic Face and Gesture Recognition, pp. 390-395, 1998
[13] Yang Ming-Hsuan, D.J. Kriegman, N. Ahuja, "Detecting Faces in Images: a Survey", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 24, No. 1, pp. 34-58, 2002
[14] M. Pantic, L.J.M. Rothkrantz, "Automatic Analysis of Facial Expressions: the State of the Art", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 22, No. 12, pp. 1424-1445, 2000
[15] M. Pantic, L.J.M. Rothkrantz, "An Expert System for Multiple Emotional Classification of Facial Expressions", Proc. 11th IEEE Int. Conf. on Tools with Artificial Intelligence, pp. 113-120, 1999
[16] A. Pentland, "Looking at People: Sensing for Ubiquitous and Wearable Computing", IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 22, No. 1, pp. 107-119, 2000
[17] [A. Pentland, B. Moghaddam, T. Starner, "View-based and Modular Eigenspaces for Face Recognition", Proc. IEEE Computer Soc. Conf. on Computer Vision and Pattern Recognition, pp. 84-91, 1994
[18] A. Samal, P.A. Iyengar, "Automatic Recognition and Analysis of Human Faces and Facial Expressions: A Survey", Pattern Recognition, Vol. 25, No. 1, pp. 65-77, 1992
[19] Y-L. Tian, T. Kanade, J.F. Cohn, "Recognizing Action Units for Facial Expression Analysis", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 23, No. 2, pp. 97-115, 2001
[20] A. van Dam, "Beyond WIMP", IEEE Computer Graphics and Applications, Vol. 20, No. 1, pp. 50-51, 2000

