A Review on Facial Expression Recognition

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Abstract- *Facial expression is significant for face-to-face communication since it is one of our body language that increases data information during the communication and it have the ability to communicate emotion and regulate interpersonal behaviour. Over the past 30 years, scientists have developed human-observer based methods that can be used to classify and correlate facial expression with human emotion. This paper reviews the past efforts in recognizing these expressions from facial images as the region of interest. Such regions cover eyes and nose, eyes with eyebrows, mouth etc., The aim of this paper is to analyse the key ideas, merits and demerits of some recognition methods. These methods include two phases: feature extraction of facial points using methods like Automated Facial Expression Recognition System (AFERS), SUSAN edge detection, Feed forward back propagation, Euclidean distance, and algorithm to recognize the expressions predicted with that obtained points using Multilayer-perceptrons, learning algorithms. It summarizes the relevant findings in facial expression recognition and discussing the performance metrics for each method and is compared.*

Keywords- Automated Facial Expression Recognition System, SUSAN edge detection, Feed forward back propagation, Multilayer-perceptrons.

I. INTRODUCTION

Due to technological advancements; there is an arousal of that world where human being and intelligent robots live together. Area of Human Computer interaction (HCI) plays an important role in resolving the absences of neural sympathy in interaction between human being and machine (computer). HCI will be much more effective and useful if computer can predict about emotional state of human being and hence mood of a person from, supplied images on the basis of facial expressions.

Nowadays, facial expression recognition becomes interested topic for researcher because it is one of human body language to increase understanding in interaction between human and human, or human and computer as the psychologist Mehrabian said “The facial expression sends the 55% information during the process of human communications while language sends only 7%”.

The facial expression can be adapted to many applications, e.g., animation, robotics, security, Human-Computer-Interaction (HCI), driver safety, and health care system. Most of research in facial expression recognition attempt to classify six basic emotion states – Surprise, Sad, Happy, Disgust, Fear and Anger.

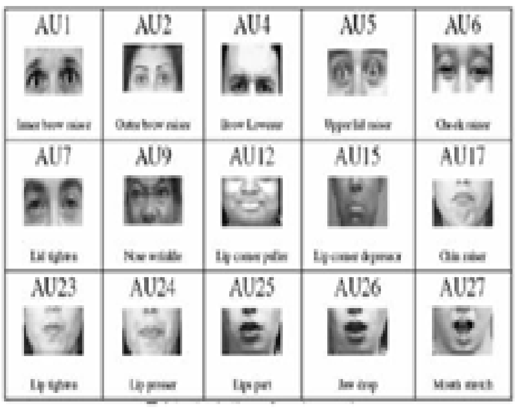
Therefore facial expressions are the most important information for emotions perception in face to face communication. For classifying facial expressions into different categories, it is necessary to extract important facial features which contribute in identifying proper and particular expressions. Recognition and classification of human facial expression by computer is an important issue to develop automatic facial expression recognition system in vision community.

Recent advances in facial image processing technology have facilitated the introduction of advanced applications that extend beyond facial recognition techniques. Then comes the introduction of an Automated Facial Expression Recognition System (AFERS): A near real-time, next generation interrogation tool that has the ability to automate the Facial Action Coding System (FACS) process for the purposes of expression recognition. The AFERS system will analyse and report on a subject’s facial behaviour, classifying facial expressions with one of the seven universal expressions of emotion. Then further methods are get emerged.

II. REVIEW OF EXISTING METHODS

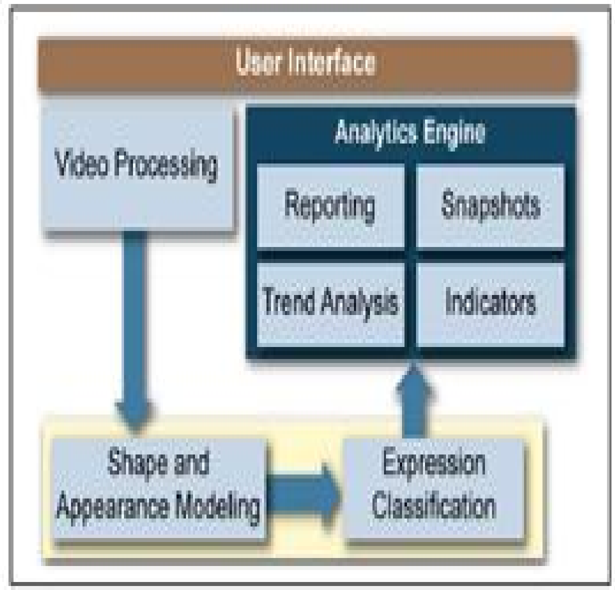
A. FACIAL ACTION CODING SYSTEM

In behavioural psychology, research into systems and processes that can recognize and classify a subject’s facial expressions have allowed scientists to more accurately assess and diagnose underlying emotional state. This practice has since opened the door to new breakthroughs in areas such as pain analysis and depression treatment. In 1978, Paul Ekman and Wallace V. Friesen published the Facial Action Coding System (FACS), which, 30 years later, is still the most widely used method available. Through observational and electromyography study of facial behaviour, they determined how the contraction of each facial muscle, both singly and in unison with other muscles, changes the appearance of the face.



Rather than using the names of the active muscles, FACS measures these changes in appearance using units called Action Units (AUs). The figure, illustrates some of these Action Units and the appearance changes they describe. The benefits of using AUs are two-fold. First, individually and in combination they provide a way to unambiguously describe nearly all possible facial actions. Second, combinations of AUs refer to emotion-specified facial expressions. Happy, for instance, is distinguished by the combination AU 6 and AU 12. AU 6, orbicularis oculi contraction, raises the cheeks and causes wrinkling lateral to the eyes. AU 12, zygomatic major contraction, pulls the lip corners obliquely into a smile. Seven expressions appear universally in Western- and non-Western, literate, and pre-literate cultures.

AFERS is designed to operate in a platform independent manner allowing it to be hosted on various hardware platforms and to be compatible with most standard video cameras AFERS employs shape and appearance modelling using constrained local models for facial registration and feature extraction and representation, and support vector machines for expression classification. AFERS provides both pre- and post analysis capabilities and includes features such as video playback, snapshot generation, and case management. In addition to the AFERS processing algorithms, the implementation features a plug-in architecture that is capable of accommodating future algorithmic enhancements as well as additional inputs for behaviour analysis.



AFERS is built upon both Java and C++ technologies. The user interface, video processing and analytics engine are built using Java and the expression recognition engine is built using C++. The two technologies are bridged via the Java Native Interface (JNI).

B. FACE PORTION LOCALIZATION AND FEATURE EXTRACTION

Face area and facial feature plays an important role in facial expression recognition**.** Better the feature extraction rate more is the accuracy of facial expression recognition. Precise localization of the face plays an important role in feature extraction, and expression recognition. But in actual application, because of the difference in facial shape and the quality of the image, it is difficult to locate the facial feature precisely. Images from JAFFE database are taken as input. This database contains low contrast images therefore images are first pre-processed using contrast limited adaptive histogram equalization operation and is used for enhancing contrast of an image. Face area is segmented using morphological image processing operations like dilation, erosion reconstruction, complementation, regional max and clear border(to get Region of Interest).

In order to extract facial features, segmented face image (RoI) is then resized to larger size to make facial components more prominent. SUSAN edge detection operator along with noise filtering operation is applied to locate the edges of various face feature segment components. SUSAN operator places a circular mask around the pixel in question. It then calculates the number of pixels within the circular mask which have similar brightness to the nucleus and refers it as

SUSAN and then subtract SUSAN size from geometric threshold to produce edge strength image.

C. FORMATION OF FEATURE VECTOR

Bounding box location of feature segments obtained in the above step are used to calculate the height and width of left eyebrow, height and width of left eye, height and width of right eyebrow, height and width of right eye, height and width of nose and height and width of mouth. Distance between centre of left eye and eyebrow, right eye and eyebrow and mouth and nose is also calculated. Thus,

$$F_v=\{H_1,W_1,H_2,W_2,H_3,W_3,H_4,W_4,H_n,W_n,F_m,W_m,D_1,D_2,D_3\} \quad (1)$$

Where,

H_1=height of left eyebrow, W_1= width of left eyebrow

H_2= height of left eye, W_2= width of left eye

H_3=height of right eyebrow, W_3= width of right eyebrow

H_4= height of right eye, W_4= width of right eye

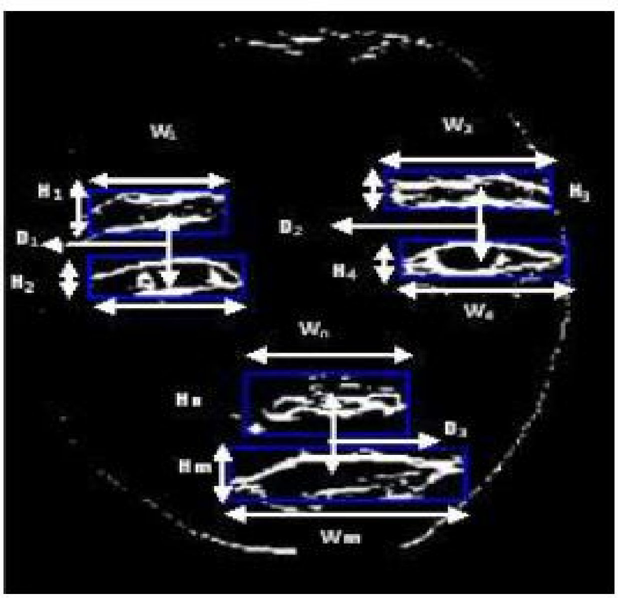
H_n= height of nose, W_n= width of nose,

H_m= height of mouth, W_m= width of mouth

D_1= distance between centre of left eyebrow and left eye,

D_2= distance between centre of right eyebrow and right eye,

D_3= distance between centre of nose and mouth



D. EXPRESSION CLASSIFICATION USING NEURAL NETWORK

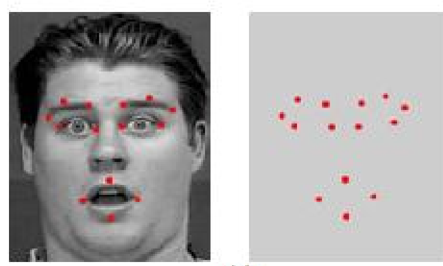
Neural computing has re-emerged as an important programming paradigm that attempts to mimic the functionality of the human brain. Back-Propagation Networks is most widely used neural network algorithm than other algorithms due to its simplicity, together with its universal approximation capacity. The back-propagation algorithm defines a systematic way to update the synaptic weights of multi-layer perceptron (MLP) networks. The supervised learning is based on the gradient descent method, minimizing the global error on the output layer. The learning algorithm is performed in two stages: feed-forward and feed- backward.

E.GRAPH-BASED FEATURE EXTRACTION

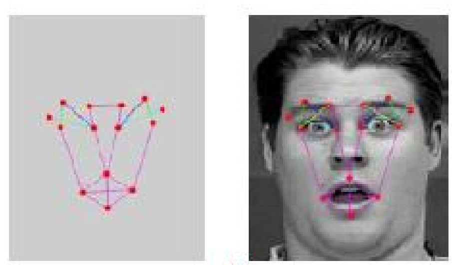
In this subsection, graph-based feature extraction is proposed in two steps: locating points in face mage and constructing feature vector.

1) Locating fourteen points.

From the regions that are influence to six basic expressions consist of eyes, eyebrows, nose and mouth. In addition, nose region can be ignored because of its minimal influence on outlet motions. From this reason, graph construction based on fourteen points location including inner eyebrows of two points, middle eyebrows of two points, outer eyebrows of two points, inner eyes of two points, outer eyes of two points and mouths of four points were manually defined as shown in following figure.



(a)



(b)

2) Constructing feature vector

Next, the Euclidean distances, as in (1), between 14 points were computed, and then the 14x14 distance symmetric matrices were built.

$$D(p,q)=\sqrt{(p_2-p_1)^2+(q_2-q_1)^2} \qquad (1)$$

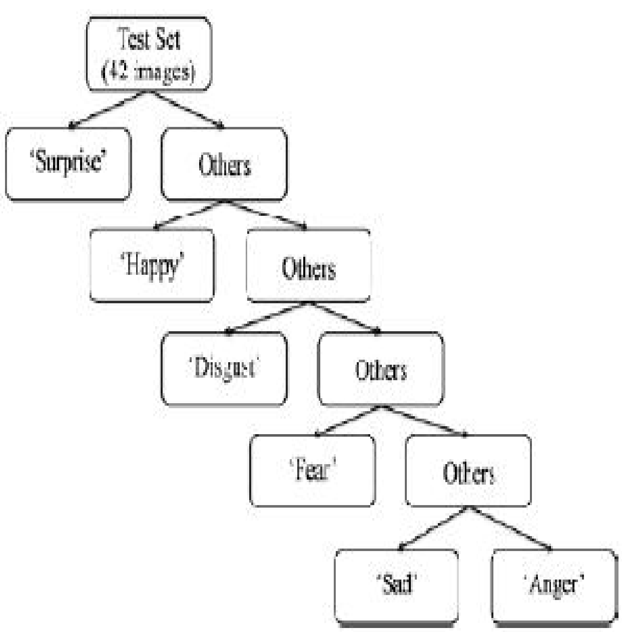
In addition, each feature vector containing all distances were normalized by the distance of diagonal line across the face, as shown in (2) to reduce error caused by image scaling obtained from the distance between face and camera as shown in figure.

$$\hat{D}(p,q)=\frac{D(p,q)}{\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}} \qquad (2)$$

Where Dˆ(p, q) is a normalized distance between p and q calculated from the ratio of D(p,q), original distance, and the distance of diagonal line across the face.

According to recognition architecture, the decision vertices in biclassfication tree are sorted with easiness of classification. For example, ‘Surprise’ is the simplest emotion to distinguish because it is obviously identified from mouth

region covered by complete graph with four points as a shape of large parallelogram. Three next emotions following ‘Surprise’ are ‘Happy’, ‘Disgust’, ‘Fear’, respectively.



II. CONCLUSION

The potential for AFERS exists not just in the criminal investigative arena. The combination of SUSAN edge detector, edge projection analysis and facial geometry distance measure is best combination to locate and extract the facial feature for gray scale images. Proposed combination method does not extract exactly six features parameters properly if there are hairs on face area. Among these methods, graph-based features by constructing five neural networks in a form of binary tree get the high accuracy.

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