Automatic Emotion Recognition Using Facial Expression: A Review

Monika Dubey[1], Prof. Lokesh Singh[2]

[1]Department of Computer Science & Engineering, Technocrats Institute of Technology, Bhopal, India
[2]Asst.Professor, Department of Computer Science & Engineering, Technocrats Institute of Technology,Bhopal, India

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Abstract - *This paper objective is to introduce needs and applications of facial expression recognition. Between Verbal & Non-Verbal form of communication facial expression is form of non-verbal communication but it plays pivotal role. It express human perspective or filling & his or her mental situation. A big research has been addressed to enhance Human Computer Interaction (HCI) over two decades. This paper includes introduction of facial emotion recognition system, Application, comparative study of popular face expression recognition techniques & phases of automatic facial expression recognition system.*

Key Words: **Emotion recognition, Facial expression, Image processing, Human Machine Interface.**

1. INTRODUCTION

Emotional aspects have huge impact on Social intelligence like communication understanding, decision making and also helps in understanding behavioral aspect of human. Emotion play pivotal role during communication. Emotion recognition is carried out in diverse way, it may be verbal or non-verbal .Voice (Audible) is verbal form of communication & Facial expression, action, body postures and gesture is non-verbal form of communication. [1] While communicating only 7% effect of message is contributes by verbal part as a whole, 38% by vocal part and 55% effect of the speaker's message is contributed by facial expression. For that reason automated & real time facial expression would play important role in human and machine interaction. Facial expression recognition would be useful from human facilities to clinical practices. Analysis of facial expression plays fundamental roles for applications which are based on emotion recognition like Human Computer Interaction (HCI), Social Robot, Animation, Alert System & Pain monitoring for patients.

This paper presents brief introduction of facial expression in section I. Section II describes six universal facial expressions and features. Section III gives brief detail on comparative study of popular techniques proposed earlier for Automatic Facial Emotion Recognition System. Section IV includes phases of Automatic Facial Emotion Recognition System. Section V includes Applications of Facial Emotion Recognition System.

2. CATEGORIZING FACIAL EXPRESSIONS & IT'S FEATURES:

Facial expression presents key mechanism to describe human emotion. From starting to end of the day human changes plenty of emotions, it may be because of their mental or physical circumstances. Although humans are filled with various emotions, modern psychology defines six basic facial expressions: **Happiness, Sadness, Surprise, Fear, Disgust, and Anger** as universal emotions [2]. Facial muscles movements help to identify human emotions. Basic facial features are eyebrow, mouth, nose & eyes.

Table -1: Universal Emotion Identification

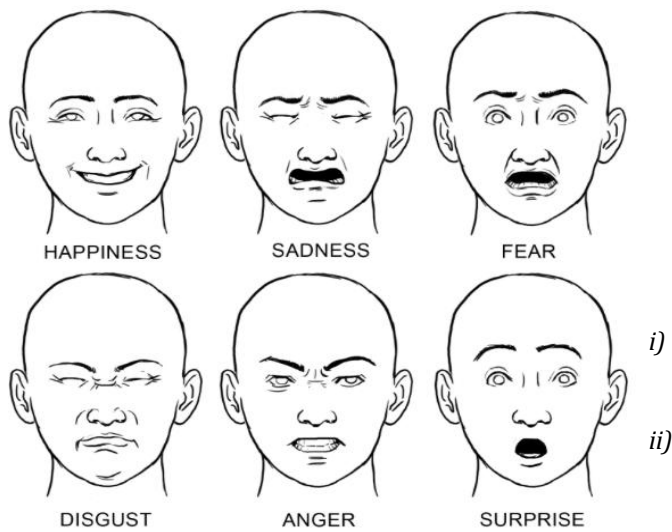| Universal Emotion Identification		
Emotion	**Definition**	**Motion of facial part**
Anger	Anger is one of the most dangerous emotions. This emotion may be harmful so, humans are trying to avoid this emotion. Secondary emotions of anger are irritation, annoyance, frustration, hate and dislike.	Eyebrows pulled down, Open eye, teeth shut and lips tightened, upper and lower lids pulled up.
Fear	Fear is the emotion of danger. It may be because of danger of physical or psychological harm. Secondary emotions of fear are Horror, nervousness, panic, worry and dread.	Outer eyebrow down, inner eyebrow up, mouth open, jaw dropped
Happiness	Happiness is most desired expression by human. Secondary emotions are cheerfulness, pride, relief, hope, pleasure, and thrill.	Open Eyes, mouth edge up, open mouth, lip corner pulled up, cheeks raised, and wrinkles around eyes.
Sadness	Sadness is opposite emotion of Happiness. Secondary emotions are suffering, hurt, despair, pitty and hopelessness.	Outer eyebrow down, inner corner of eyebrows raised, mouth edge down, closed eye, lip corner pulled down.
Surprise	This emotion comes when unexpected things happens. Secondary emotions of surprise are amazement, astonishment.	Eyebrows up, open eye, mouth open, jaw dropped
Disgust	Disgust is a feeling of dislike. Human may feel disgust from any taste, smell, sound or tough.	Lip corner depressor, nose wrinkle ,lower lip depressor, Eyebrows pulled down

Fig -1: Six basic Facial Expressions

3. BACKGROUND ANALYSIS:

Human can recognize emotions without any significant delay and effort but recognition of facial expression by machine is a big challenge. Some of the vital facial expression recognition techniques are:

3.1 Statistical movement based:

This paper proposed noise and rotation invariant facial expression recognition which is based of Statistical movement that is Zernike moments [3]. Extracted feature form Zernike moments are given as input to Navie Bayesian classifier for emotion recognition.

Pros:

i) The rotation invariance is achieved with the help of Zernike moments.

ii) Recognition time less than 2 seconds for frontal face image.

Cons:

i) Emotion recognition system got affected because of rotation of facial images.

3.2 Auto-Illumination correction based:

In this paper, facial expressions are determined using localization of points called Action Unit (AU's) without labelling them [4]. Face is recognized by using the skin & Chrominance of the extracted image. By using mapping technique extracted eyes and mouth are mapped together. Skin and non-skin pixels are separated to separate face from the background by using Haar-Cascaded method. This paper is based on multiple face image recognition.

Pros:

i) Single and multiple face detection system.

ii) Limitation of illumination is removed and automatically corrected using colour consistency algorithm.

Cons:

i) 60% recognition rate achieved while detecting multiple face images. So, it is required to achieve more accuracy.

ii) This system suffers under very poor lighting system.

3.3 Identification-driven Emotion recognition system for a   Social Robot:

In order to provide personalized emotion recognition, this paper includes identification step prior to emotion classification [5]. For finding facial configuration hybrid approach used which includes Active Space models and Active appearance models. Face tracker is used for face detection. Texture information consists of as set of vectors to describe the face of 3D model.

Pros:

i) Identification of subject and prior knowledge about the subject enhance the performance recognition in term of quality and speed of classification.

ii) 82% recognition rate when facial image taken in a social robot working environment that includes various lighting conditions and different positions and orientations of subject face.

Cons:

i) Required training before using it as application of social robot emotion recognition system.

ii) Required appropriate template in the tracking data to cover the whole 5features space for emotion recognition.

3.4 E-learning based emotion recognition system:

This paper proposed E-learning based emotion recognition system [6]. SVM (Support Vector Machine) classifier based Adoost algorithm used to locate human face. Ad boost algorithm compares the classifier by extracting features with week classifier to strong classifier. This is iterative weight updating process.

Pros:

i) This paper presents application for the emotion in network teaching system.

ii) Wearing glasses on the face area has no effect on   emotion recognition.

Cons:

i) Distance between the camera and face will have an impact on an area of face recognition.

ii) Regional impact of the human face effect the performance of emotion recognition like- Hear, Sitting postures, Light strength.

3.5 Cognitive Face Analysis System for Interactive TV System:

This paper proposed, emotion detection of members watching TV Program [7]. Face expression recognition are employed to identify specific TV viewer and recognize their internal emotional state. Ada-LDA method based recognition. Per second over 15 frames can operated.

Pros:

i) This paper introduced a novel architecture of the future interactive TV.

ii) Proposed technique is based on real time emotion recognition system.

iii) It can operate at over 15 frames per second.

Cons:

i) Recognition rate differ with type of facial database used.

ii)Need to improve performance of recognition and timing for real time application.

3.6 Motion detection based facial expression using Optical flow:

In order to localize facial features approximately active Infra-Red (IR) illumination used [8]. Source Vector (SV) used for vector collection which shows motion and deformation due to emotion representation. Emotions are classified according to the estimated similarity between the source vector and execution motion vector and highest degree of similarity could be identified as detected emotion.

Pros:

i) Few number of image frames (three frames) are sufficient to detect facial expression.

ii)Not necessary to determine exact facial feature locations, only the approximate values are sufficient.

Cons:

i) Recognition rate of emotion "Fear" is less than other emotions.

Table -2: Comparative Study

Comparative Study				
Title	Technique	Database	Performance (%)	Remarks
Statistical Moments based Facial expression Analysis	**Feature Extraction:** Zernike moments **Classification**: Naive Bayesian classifier	JAFFE (Japanese Female Facial expression) database 60 images used for experiment.	Average accuracy for six emotions is 81.66% in time less than 2 seconds.	Emotion accuracy graph shows highest recognition rate of happiness and lowest recognition rate of sadness.
Facial expression recognition with Auto-Illumination correction	Expressions on the face are determined with Action Units (AU's)	Single and Multiple face image	60% recognition rate for multiple face image	Illumination on image plays vital role.
Identification-driven Emotion recognition system for a Social Robot	Hybrid approach used for personalized emotion recognition,	MUG facial expression database used. More than 50 people frontal face database used aged between 20-25 years.	82% performance achieved with KNN Classifiers.	3D model facial image used.KNN classifier gives good performance for emotion recognition.
The application study of learner's face detection and location in the teaching network system based on emotion	SVM(Support Vector Machine) classifier based Adaboost algorithm used	PIE face image database used	Detection and Correction rate 95% or more.	Presents application of face emotion recognition with of E-learning system.

recognition				
Cognitive Face Analysis System for Future Interactive TV	Ada-LDA learning algorithm and MspLBP features used for effective multi-class pattern classifier	JAFFE and MIT+CMU database	Recognition rate of over 15 frames per second	Real time performance with high recognition rate
An Efficient Algorithm for Motion Detection Based Facial Expression Recognition using Optical Flow	Infra-Red(IR) illumination used for facial feature approximately localization. Source Vector (SV) used for vector collection and identification of emotion is based on highest degree of similarity between source vector and execution motion vector	Approximately 1000 images sequences of Cohn-Kanada Facial Expression Database with 65% female facial image used for experiment	94% recognition rate	Only three frames are sufficient to detect facial expression.

4. INTEGRATED FACIAL EXPRESSION RECOGNITION SYSTEM:

The system which performs recognition of facial expression is called facial recognition system. Image processing is used for Facial expression recognition. With the help of image processing useful information from image can get extracted. Image processing converts image into digital form and perform some operations on it to extract useful information from image.

Facial expression recognition system consists of following steps:

4.1 Image Acquisition:

Static image or image sequences are used for facial expression recognition.2-D gray scale facial image is most popular for facial image recognition although color images can convey more information about emotion such as blushing. In future color images will prefer for the same because of low cost availability of color image equipments. For image acquisition Camera, Cell Phone or other digital devices are used.

4.2 Pre-processing:

Pre-Processing plays a key role in overall process. Pre-Processing stage enhances the quality of input image and locates data of interest by removing noise and smoothing the image. It removes redundancy from image without the image detail. Pre-Processing also includes filtering and normalization of image which produces uniform size and rotated image.

4.3 Segmentation:

Segmentation separates image into meaningful reasons. Segmentation of an image is a method of dividing the image into homogenous, self consistent regions corresponding to different objects in the image on the bases of texture, edge and intensity.

4.4 Feature Extraction:

Feature extraction can be considered as "interest" part in image. It includes information of shape, motion, color, texture of facial image. It extracts the meaningful information form image. As compared to original image feature extraction significantly reduces the information of image, which gives advantage in storage.

4.5 Classification:

Classification stage follows the output of feature extraction stage. Classification stage identifies the facial image and grouped them according to certain classes and help in their proficient recognition. Classification is a complex process because it may get affected by many factors. Classification stage can also called feature selection stage, deals with extracted information and group them according to certain parameters.
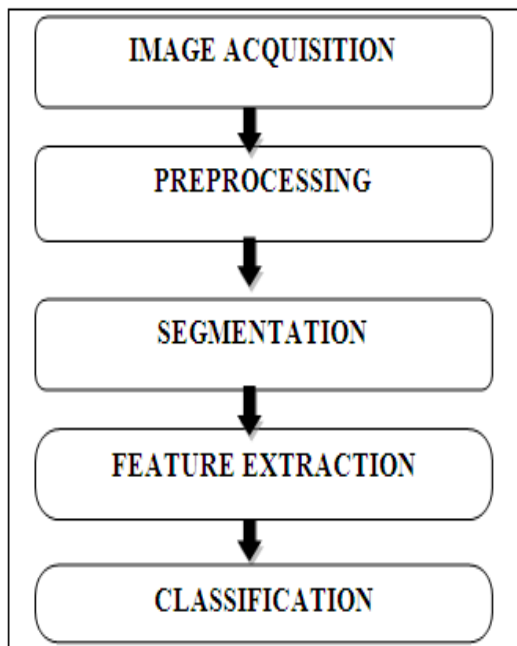

Fig -2 Facial expression Recognition System

5. APPLICATION AREA:

With the rapid development of technologies it is required to build an intelligent system that can understand human emotion. Facial emotion recognition is an active area of research with several fields of applications. Some of the significant applications are:

i)   Alert system for driving.
ii) Social Robot emotion recognition system.
iii) Medical Practices.
iv) Feedback system for e-learning.
v)   The interactive TV applications enable the customer to actively give feedback on TV Program.
vi) Mental state identification.
vii) Automatic counseling system.
viii) Face expression synthesis.
ix) Music as per mood.
x)   In research related to psychology.
xi) In understanding human behavior.
xii) In interview.

6. CONCLUSION

Extensive efforts have been made over the past two decades in academia, industry, and government to discover more robust methods of assessing truthfulness, deception, and credibility during human interactions. Efforts have been made to catch human expressions of anyone. Emotions are due to any activity in brain and it is known through face, as face has maximum sense organs. Hence human facial activity is considered. The objective of this research paper is to give brief introduction towards techniques, application and challenges of automatic emotion recognition system.

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BIOGRAPHIES

Monika Dubey received her B.E degree in Computer Science from Lakhmi Chand Institute of Technology (LCIT), Bilaspur, Chhattisgarh, 2012. Technocrats Institute of Technology, Bhopal, Madhya Pradesh, where she is moving toward M.Tech degree in Computer Science. Her current interests include image processing, Computer Vision.

Lokesh Singh received his B.E degree in Computer Science from MIT,Ujjain,Madhya Pradesh.M.E degree in Computer Science from Institute of Engineering and Technology(IET), Indore, Madhya Pradesh. Currently, he is working as Asst. Professor in Technocrats Institute of Technology, Bhopal, Madhya Pradesh. His current interests include image processing, Computer Vision, Human Computer Interaction.