NEI Face Emotions: Standardization and Its Aspects

Priya Saha[1], Rupayan Debnath[1], Aniruddha Nath Sarma[1], Mrinal Kanti Bhowmik[1] and Debotosh Bhattacharjee[2]

[1]*Department of Computer Science & Engineering, Tripura University (A Central University), Suryamaninagar 799 022, Tripura, India.*
[2]*Department of Computer Science & Engineering, Jadavpur University, Kolkata 700 032, West Bengal, India.*
e-mail: mkb_cse@yahoo.co.in

Abstract. Facial expressions are essential means to express one's emotion. In recent years, several facial expression databases have been developed, and researches on face emotions are being made in different areas like forensic sciences, medical sciences, and engineering sciences. In this paper, we have briefly discussed the investigations done by various researchers on facial expressions and listed out a number of observations from them. This paper also presents facial expression analysis of North-East Indian (NEI) visual face images. The analysis illustrates different facial feature changes occurred during facial expressions. Most of the expressions meet with the standard facial feature changes.

Keywords: facial expressions, facial feature changes, NEI face database, visual face image.

1. Introduction

A face is a non verbal communication medium that helps easily to express one's feeling. Facial emotions are fundamental form of nonverbal communication for conveying feelings. In 1872, Darwin introduced the idea of basic emotions, which are principally inborn emotions derived from similar habits [1]. He ascertained that familiar modes of expression like happiness, sadness, fear, disgust, surprise and anger are almost universal. Emotions are basic research topics used in cognitive science [2], neuroscience [3], social psychology [4] etc. According to psychology, there are two theories of emotions: categorical theory and dimensional theory. The categorical theory is all about six basic emotions: happy, anger, sadness, surprise, disgust and fear [5]. The dimensional theory proposes two fundamental dimensions that form emotional spaces. The two dimensions are known as arousal and valence. Arousal ranges from calm to excited and valence ranges from negative to positive. Russell [6] proposed a circular configuration that depicts emotions in dimensional respect. This configuration is known as Circumflex of Affect which is shown in Figure 1. Facial expressions of emotion are the effect of the facial muscle movements [7]. The muscle movements help the external observer to identify the emotion. Different facial features are associated with these different facial appearances. The main facial features are eye corners, lip corners, inner and outer eyebrow.

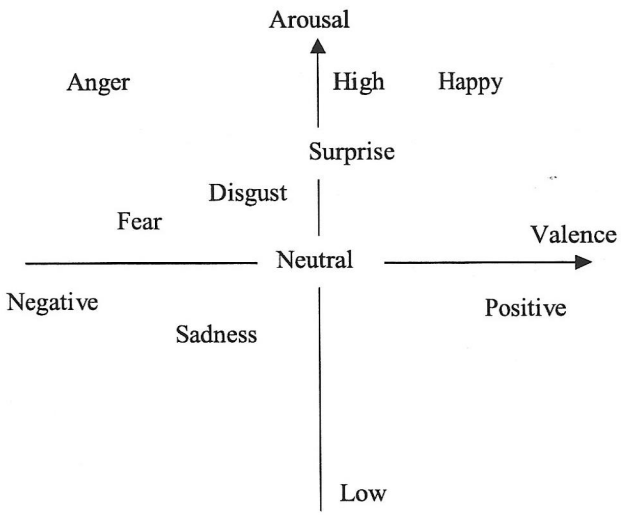

Figure 1. Distribution of the seven emotions [8].

In this paper, the facial feature movements during different expressions are being analyzed. The expressions are taken mainly from North-East Indian (NEI) face database which is still under development. This paper illustrates the creation of North-East face database briefly and also discusses the previous works done by other researchers on facial expressions. In the next section, a survey on previous works is described. The rest of the paper is discussed as follows: section 3 contains categories of facial expressions with their corresponding feature movements; section 4 discusses the NEI face database creation; section 5 depicts the aspects of facial expression database; the standardization of the facial expression capturing is discussed in section 6 and finally conclusions and future works are drawn in section 7.

2. Previous Works

Several researchers explored different approaches to recognize facial expressions automatically. Before going to the details of their works, we are giving the overview of some of the systems in a tabular format. Table 1 summarizes the features of these systems proposed recently.

Datcu and Rothkrantz (2007) compared the performance of still image and video sequence-oriented facial expression recognition. Facial Characteristic Point (FCP) extractor method based on Active Appearance Model (AAM) was used to extract significant information regarding the shapes of the faces. The FCP model can handle certain degree of rotation, scaling and translation by using some parameters for both left and right sides of the face. During the training of AAM, the texture data of the face samples were scaled to lessen the effect of illumination. Partially occluded face images were taken for testing purpose as AAM is capable to handle the influence of occlusion. Investigation revealed that performance was higher in video sequences than still images.

In the paper of P. Wang et al. (2008), Active Appearance Model (AAM) was used to represent the face shape by a set of landmarks and face texture by image intensity or colour of the whole region. AAM face model combined the principal components from the facial texture and shape and applied

Table 1. Survey on Facial Expression Recognition.

Author	Method	Dataset	Actions/Facial Expressions	No. of images taken	Observations	Accuracy
Datcu and Rothkrantz, 2007 [9]	FCP extractor model based on AAM and classification of emotional temporal patterns using SVM	Cohn-Kanade Database	6 prototypic expressions (fear, surprise, sadness, anger, disgust)	Fear-84, Surprise-105, Sadness-92, Anger-30, Disgust-56, Happy-107	1. More information is employed to distinguish between emotion classes for video analysis 2. FCP model can handle certain degree of rotation, scaling and translation.	Static Image-84.70% (Fear) Image Sequence-88.67% (Surprise)
P. Wang et al., 2008 [10]	Automatic classification using adaBoost algorithm with Haar features	Professional actor Database and Private Database	Neutral and 4 expressions (happy, sad, fear, anger)	10,000–20,000 frames	1. The framework provides probabilistic composition of each frame of the sequence which highlights slight differences as well as the possibility of a blend of emotions. 2. This automatic framework helps to process lengthy video sequences.	88% (Happiness)
Tian et al., 2003 [11]	Head detection using smoothed silhouette of the foreground object and extracted facial features are classified using NN based back propagation 3 layer network	Cohn-kanade Database and PETS 2003 Database	Neutral, smile, angry, surprise and others	1088 image sequences	1. The method is beneficial in expression recognition as it uses sequential information instead of using each frame	–
Shan et al., 2009 [12]	Local Binary Pattern is used for feature extraction and template matching, SVM, LDA, linear programming and boosted LBP are examined to recognize	Cohn-Kanade Database, PETS 2003	Neutral and 6 expressions	320 image sequences	1. LBP is useful for facial expression recognition with a significant low computation advantage. 2. The experiment investigates the validity of LBP features in real-world compressed video inputs.	95.2% (disgust, joy, surprise)

PCA to reduce the dimension. The framework was limited to detect only frontal view face images, and participants were instructed to control head movements during data capture. Geometric features were extracted using Adaboost algorithm with Haar features and trained using support vector machine. They employed the video segments of healthy people and Schizophrenia and Asperger patients in experiments. Results showed that facial expressions of healthy people were more reliable, and intensity of expression was higher than patients. Sadness was confused with anger expression because both expressions shared similar facial movements. As a result, recognition accuracy of sadness expression was not as good as other expressions.

Tian et al. (2003) detected the head instead of detecting the face in video sequences. The head detection used smoothed silhouette of the foreground object. The captured face images were in low resolution and real environments with low expression intensity. Detailed facial features such as eye corners, upper or lower eyelids were not available, due to this fact. They extracted 2 types of facial features: location features and shape features. Input to the 3 layered neural network was 5 location features and 12 zone components of shape features of the mouth. Five different expressions were generated as outputs.

Shan et al. (2009) presented an investigation on the validity of Local Binary Pattern (LBP) features in the real world compressed video inputs. They conducted template matching method, SVM, LDA+ NN, boosted LBP, linear programming for facial expression recognition. Among these 5 different methods, boosted LBP was the highest performer for its robustness against illumination changes. Like P. Wang et al., they also stated that sad was easiest confused expression with low recognition rate. Their method was not accurate enough in other datasets.

3. Categories of Facial Expressions

Facial expression with an emotion entails the categories of human emotions into which expressions can be allotted.

a) Sadness

Sad expressions convey messages related to failure, loss, anxiety, hurt, helplessness etc. Sad expression is associated with following facial feature movements.

- Corners of lips pulled down
- Raised cheeks
- Inner corners of eyebrows raised and brought together
- Upper eyelids drop
- Lower lip may push up in a pout

b) Surprise

Surprise is a momentary expression which converts into other expressions. They are complex to detect in real time. Unexpected, sudden, novel or shocking emotions are related to surprise expression. Following facial feature movements are associated with surprise expression

- The upper eyelids and brows rise
- The jaw drops

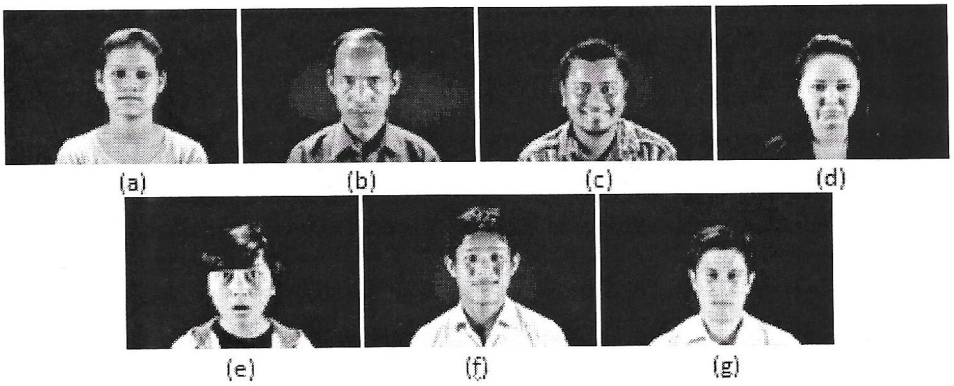

Figure 2. Facial expressions (a) Neutral, (b) Anger, (c) Happy, (d) Sad, (e) Surprise, (f) Fear, (g) Disgust.

- Eyes staring straight ahead
- The skin below the eyebrows stretch and horizontal wrinkles can be seen around the forehead
- Head is tilted in 2 ways. If the head tilts forward, it specifies disbelief, and if head pulls back, it signifies fear.

c) Happy

Joy or happy expressions interpret enjoyment, pleasure, positive outlook and friendliness. Joy expression associates following facial feature movements.

- The corners of the mouth lift
- Eyelids tighten
- Cheeks rise
- Outside corners of the brows pull down

d) Fear

This expression conveys information of forthcoming hazard, a nearby threat, a disposition of escape etc. Fearful face associates following facial feature movements.

- Eyes widen
- Upper lids rise, but brows draw together
- Lips stretch horizontally

e) Disgust

Disgust expression associates the emotions of unclear, infectious, inedible etc. The disgusted face associates following facial feature movements.

- Nose wrinkles
- Upper lip rises, lower lip protrudes
- Lower eyebrows

f) Anger

This is primary related to interpersonal hostility, opposition and potential attack. The following features are changed accordingly in aggressive mode of expression.

- Raised upper eyelids
- Possibly tensed lower eyelids
- Tighten up the area around eyes
- Eyebrows lowered and brought together
- Lower jaw can be forward
- If teeth exposed, mouth has rectangular shape
- The lips press together, and lower lip may push up a little

4. NEI Face Database

The North-Eastern face database is a visual face image database, which is still under progress. The database is being created in the Biometrics Laboratory of Computer Science & Engineering Department of Tripura University, Tripura, India, with the face images of the different tribe as well as non-tribe people of the seven North-Eastern states of India. Initially, research team has completed capturing from 5 states. Images in this database are mainly taken under strictly controlled conditions of lighting, pose etc. and are of different resolutions. The cameras are placed and fixed in front of the subject, at 4.5 ft distance from the subject. The five cameras i.e., Cam1, Cam2, Cam3, Cam4, and Cam5 are placed at $+50°$, $+25°$, $0°$, $-25°$, and $-50°$ respectively, with respect to the subject. Heights of the cameras are adjusted according to the subject's head position. The three lights are named as L1, L2 and L3, and are placed above the head, at an angle of $+60°$, and $-60°$ respectively, with respect to the subject. In NEI database, we include total eight different types of expressions including the six basic expressions (i.e. anger, happy, sad, surprise, fear, and disgust). The other two expressions are neutral and closed eye. All these eight expressions are captured in 'full illumination', and 'half illumination' conditions. Only the neutral expression is also captured in 'left light on', 'right light on', and with glasses in 'full illumination'.

5. Applications of Facial Expression Database

Forensic aspects on automatic facial expression analysis

Facial expressions are taken as challenges in forensic applications. The reliability of forensic face recognition is more essential than biometric face recognition. The reliability of the system itself is extremely significant as it will lessen the manual effort and help in standardization of the facial comparison. In order to measure the consistency of forensic face recognition system several factors such as lighting conditions, facial expressions and pose etc should be considered.

Medical aspects on automatic facial expression analysis

Facial expressions can be used in medical diagnosis for identifying particular mental processes (e.g., pain, depression) at the time of its occurrence. Health professionals make use of Facial Expression

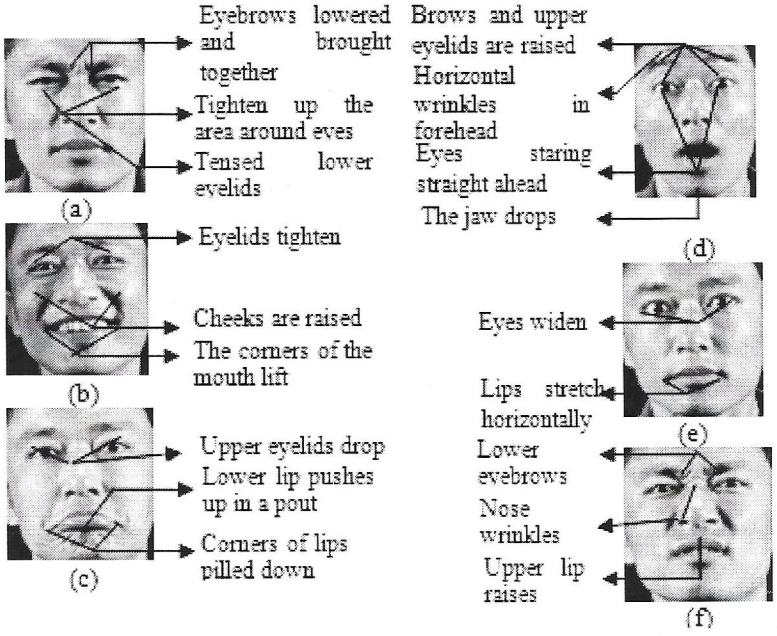

Figure 3. Standard expressions of captured NEI Standard face expressions of (a) Anger, (b) Happy, (c) Sad, (d) Surprise, (e) Fear, (f) Disgust.

Analysis to take a moment change of facial expressions sensitively using FACs training. Patients' pain intensity can be noticed under treatment from an instant change of facial expressions [13].

6. Standardization of NEI Facial Expression Images

Here, we present one individual of Nagaland face image database. Basic six facial expressions are compared with the Ekman standard database [14]. Figure 3 shows captured face expressions images of the NEI database. While comparing with the standard given in section 3, we found most of the expressions of NEI face are matched to that of standard expressions. Some changes of muscle movement have been observed. In Anger expression margin of the lips is not rolled in & Lips are loose. Expression may differ from person to person. So it is not possible to get complete uniqueness.

7. Conclusions and Future Work

Face expressions are one of the basic means in order to communicate with other. We have taken six basic expressions of a frontal face to analyze the facial feature movements. During capturing the face images of NEI database, the team has maintained most of the standards specified by the "Indian Face Image Data Standards" of DIT, MCIT, New Delhi, Govt. of India, to maintain the quality of the face images. After the facial expression analysis, automatic facial expression recognition can be made. In future, thermal facial expression analysis will also be taken into consideration.

Acknowledgements

The research has been supported by the grant from DeitY, MCIT, Govt. of India. Vide No. 12(2)/2011-ESD, dated 29/03/2011, undertaken by the Biometrics Laboratory Computer Science & Engineering Department, Tripura University. Authors would like to thank Prof. Phalguni Gupta of IIT Kanpur for his valuable suggestion regarding camera and light setup.

References

[1] Darwin, C. R.: The Expression of the Emotions in Man and Animals. London: John Murray. 1st Edition (1872).
[2] Damassio, A. R.: Descartes' Error: Emotion, Reason, and the Human Brain. G. P. Putnam's Sons, New York (1995).
[3] LeDoux, J. E.: Emotion Circuits in the Brain. Annual Review of Nueroscience, 23, 155–184 (2000).
[4] Adolphs, R.: Regret in Decision Making. Cognitive Neuroscience of Human Social Behaviour, 4(3), 165–178 (2003).
[5] Ekman, P.: Emotion in the Human Face. Cambridge, UK: Cambridge University Press, (1982).
[6] Russell, J. A.: A Circumplex Model of Affect. *Journal of Personality and Social Psychology*, 39, 1161–1178 (1980), doi:10.1037/h0077714.
[7] Duchenne, C.-B.: The Mechanism of Human Facial Expression. Jules Renard, Paris. (Cambridge University Press, 1990) (1862).
[8] Breazeal, C.: Emotion and Sociable Humanoid Robots. *International Journal of Human-Computer Studies*, 59, 119–155 (2003), doi:10.1016/S1071-5819(03)00018-1.
[9] Datcu, D. and Rothkrantz, L.: Facial Expression Recognition in Still Pictures and Videos Using Active Appearance Models. A Comparison Approach. *Proc. International Conference on Computer Systems and Technologies*, 112:1–112:6, Bulgaria (2007).
[10] Wang, P., Barrett, F., Martin, E., Milonova, M., Gur, R. E., Gur, R. C., Kohler, C. and Verma, R.: Automated Video-Based Facial Expression Analysis of Neuropsychiatric Disorders. *J. Neuroscience Methods*, 168, 224–238 (2008).
[11] Tian, Y.-L., Brown, L., Hampapur, A., Pankanti, S., Senior, A. and Bolle, R.: Real World Real-time Automatic Recognition of Facial Expressions. In *Proceedings of IEEE Workshop on Performance Evaluation of Tracking and Surveillance*, Graz, Austria (2003).
[12] Shan, C., Gong, S. and McOwan, P. W.: Facial Expression Recognition Based on Local Binary Patterns: A Comprehensive Study. *J. Image and Vision Computing*, 27, 803–816 (2009).
[13] Matsuoka, Y. and Fukai, K.: Face Scales and Facial Expression Analysis to Assess Clinical Pain Intensity. *J. Health Sciences Health Care*, 8(1) (2008).
[14] Ekman, P.: Darwin, Deception, and Facial Expression. *Annals of the New York Academy of Sciences*, 1000(1), 205–221 (2003).