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Emotion Recognition from Facial Expressions: A Brief Review

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ABSTRACT

Human emotion recognition (HER) is an important research topic in the fields of computer vision and machine learning. A facial expression is a form of non-verbal communication. It plays an essential role in human emotion recognition. It expresses human perception or feelings & his or her mental state. This research article focuses on studies that exclusively use facial expressions since facial expressions are one of the significant ways to identify human emotions. This article provides a brief review of researches in the field of HER conducted over the past years. First, conventional HER approaches are described along with a summary and their main algorithms. This review also focuses on up-to-date information about features and classifiers used for human emotions using facial expressions. A brief review of publicly available evaluation metrics is given in the later part of this paper, and a comparison with benchmark results, which are a standard for a quantitative comparison of FER researches, is described. This review can be utilised as brief information to newcomers in the field of HER, providing basic knowledge and a general understanding of the latest up to date studies, as well as to experienced researchers looking for use directions for future work.

Keyword: - Human emotion recognition(HER), Facial expression, Image processing, long short term memory; facial action coding system, facial action unit

1. INTRODUCTION

Emotions play a vital role in the day to day life. It has an enormous impact on Social intelligence, like communication, understanding, decision making. It helps in understanding the behavioural aspects of a human being. Emotion recognition is system is classified based on verbal or non-verbal communication. Voice (Audible), is a verbal form of communication whereas Facial expression, action, body postures and gesture ECG, EEG are a non-verbal form of communication. [1] While the speaker is communicating, only 7% effect of message is contributed by verbal part as a whole, 38% by vocal part and 55% effect of the speaker's message is contributed by facial expression.

Due to this reason, automated & real-time facial expression would play an essential role in human and computer interaction. Facial expression recognition would be useful in a variety of applications such as from human facilities to clinical practices. Analysis of facial expression plays a vital role for applications which are based on emotion recognition like Human-Computer Interaction (HCI), Patient monitoring system, Social Robot applications, intelligent school systems etc.

Section 1 presents a brief introduction of facial expression. Section 2 describes six universal facial expressions and features associated with them for which research work has been carried out. Section 3 gives brief detail on the comparative study of different techniques used earlier for Human Emotion Recognition System using facial expressions. Section 4 includes different aspects of Human Emotion Recognition System. Section 5 gives a summary of applications of Human Emotion Recognition System.

2. BASIC EMOTIONS

Human emotions using Facial expression presents a pivotal mechanism to describe human behaviour in the social environment. Due to mental or physical situation, human imparts reaction to it called as emotion. Though there are a variety of emotions, psychology defines six basic emotions: Happy, Sad, Surprise, Fear, Disgust, and Anger as universal emotions [2]. Facial muscular movements are helpful for identification of human emotions. Based on geometry, facial features are eyebrow, mouth, nose, chick & eyes.

Table -1: Basic Emotions with definition and changes on the face

Emotion Class	Definition	changes on face
Anger	**Anger** is the intense emotion that you feel when you think that someone has behaved in an unfair, cruel, or unacceptable way. Secondary emotions in this class are irritation, annoyance, frustration, hate and dislike.	Eyebrows pulldown, change in colour of the eye, lips tightened, upper and lower lids pulled up.
Fear	**Fear** is the unpleasant feeling you have when you think that you are in danger. Fear is a thought that something unpleasant might happen or might have happened. Secondary emotions of fear are Horror, nervousness, panic, worry and dread.	Outer eyebrow down, inner eyebrow up, chick and nose movement, jaw dropped
Happiness	**Happiness** is the Feelings of pleasure, usually because something beautiful has happened. 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	**Sad** you feel unhappy, usually because something has happened that you do not like. 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	**A surprise** is an unexpected event, fact, or piece of news. Secondary emotions of surprise are amazement, astonishment.	Eyebrows up, open eye, mouth open, jaw dropped
Disgust	**Disgust** is a feeling of very strong dislike or disapproval. The human may feel disgusted from any taste, smell, sound or robust.	Lip corner depressor, nose wrinkle, lower lip depressor, Eyebrows pulled down

3 BACKGROUND ANALYSIS

To recognise emotions from facial expressions is a challenging task. Using various techniques, this can be achieved. The details of these techniques are as follows:

3.1 Deformable 3-D Facial Expression Model for Dynamic Human Emotional State Recognition[2]

Due to the lack of 3-D feature and dynamic analysis, the functional aspect of affective computing is insufficient for natural interaction. The author presents an automatic emotion recognition approach from video sequences based on a fiducial point controlled 3-D facial model.

The 26 fiducial points are then located on the facial region and tracked through the video sequences by multiple particle filters. Discriminative Isomap-based classification is used to embed the deformation feature into a low dimensional manifold that spans in an expression space with one neutral and six emotion class centres. The final decision is made by computing the nearest class centre of the feature space. The author found that the significant features to distinguish one single emotion from the other emotions were different. Some of the features selected in a global scenario were redundant, while some of the other features might contribute to the classification of a specific emotion. Another finding is that there was not a single feature which was significant for all the classes.

The merits of this paper are:

1) Facial expressions were detected and tracked automatically in the video sequences, which can alleviate a common problem in conventional detection and tracking methods, namely, an inconsistent performance due to sensitivity to variation in illuminations such as local shadowing, noise, and occlusion.

2) Author modelled the face as an elastic body and exhibited different elastic characteristics dependent on different facial expressions. Based on the continuity condition, the elastic property of each facial expression was found, and a complete wireframe facial model can be generated under the availability of some limited feature point positions. An adaptive partition of polygons was embedded in EBS according to the surface curvature through the characteristic feature points. The subtle structural information can be expressed without giving complicated facial features.

3) The generic 3-D facial model was established so that the functional parameters of EBS can be used for emotion recognition, e.g., the appropriate physical characteristics for face deformations, control points, and so on.

4) The author proposed the use of D-Isomap for emotion recognition. It can compact the data points from the same emotion class on a high-dimension manifold to make them closer in the low-dimension space, and made the data points from the different clusters farther as well. It resulted in a high recognition rate when compared with other Isomap methods.

3.2 Multi-view Facial Expression Recognition Based on Group Sparse Reduced-rank Regression[5]

A novel multi-view facial expression recognition method is presented. In the facial feature extraction, the author uses the grids with multi-scale sizes to partition each facial image into a set of sub-regions and carry out the feature extraction in each sub-region. To deal with the prediction of expressions, the author proposes a novel group sparse reduced-rank regression (GSRRR) model to describe the relationship between the multi-view facial feature vectors and the corresponding expression class label vectors. Finally, the author conducts extensive experiments on both BU-3DFE and Multi-PIE facial expression databases to evaluate the recognition performance of the proposed method.

The recognition of facial expressions from multi-view facial images is investigated in this paper, where the author develops a novel regression model, called GSRRR, to this goal. The experimental results on both databases showed that the proposed method achieves competitive recognition performance compared with the state of the art methods under the same experimental settings and same facial feature. The first one may attribute to the use of a multi-view facial feature fusion strategy in the proposed expression recognition method. The second factor may attribute to the optimal region selection ability of GSRRR.

3.3 Learning Multiscale Active Facial Patches for Expression Analysis[4]

In this paper, the author presents a new idea to analyse facial expression by exploring some general and specific information among different expressions. Inspired by the observation that only a few facial parts are active in expression disclosure (e.g., around the mouth, eye), the author tried to discover the common and specific patches which are essential to discriminate all the expressions and only a particular expression, respectively.

A two-stage multitask sparse learning (MTSL) framework is proposed to efficiently locate those discriminative patches. In the first stage MTSL, expression recognition tasks are combined to located characteristic patches. Each of the tasks aims to find dominant patches for each expression. Secondly, two related tasks, facial expression recognition and face verification tasks, are coupled to learn specific facial patches for individual expression. The two-stage patch learning is performed on patches sampled by multiscale strategy. Extensive experiments validate the existence and significance of common and specific patches. Utilising these learned patches, the author achieves superior performances on expression recognition compared to the state-of-the-art.

A two-stage sparse learning model is proposed to learn the locations of these patches based on the prior knowledge of facial muscles and AUs. A multiscale face division strategy is employed to obtain facial patches with different coverage area and eliminate the side effects from fixed patch size. Extensive experiments show that characteristic patches can generally discriminate all the expressions, and the recognition performance can be further improved by integrating specific patches.

3.4 Facial Expression Recognition Using Facial Movement Features[3]

Facial expression is an essential channel for human communication and can be applied in many real applications. Current approaches on FER in static images have not fully considered and utilised the features of facial element and muscle movements, which represent static and dynamic, as well as geometric and appearance characteristics of facial expressions. The experimental results demonstrate high correct recognition rate (CRR), significant performance improvements due to the consideration of facial element and muscle movements, promising results under face registration errors, and fast processing time.

This paper explores the issue of facial expression recognition using facial movement features. The experimental results also demonstrate significant performance improvements due to the consideration of facial movement features and promising performance under face registration errors. The results indicate that patch-based Gabor features show a better performance over point-based Gabor features in terms of extracting regional features, keeping the position information, achieving a better recognition performance, and requiring a less number. The JAFFE database requires larger sizes of patches than the CK database to keep useful information.

The proposed approach can be potentially applied to many applications, such as patient state detection, driver fatigue monitoring, and intelligent tutoring system. In the future work, the author told to extend the approach to a video-based FER system by combining patch-based Gabor features with motion information in multi frames.

3.5 Dynamics of Facial Expression: Recognition of Facial Actions and Their Temporal Segments From Face Profile Image Sequences[1]

Automatic analysis of human facial expression is a challenging problem with many applications. Instead of representing another approach to machine analysis of prototypic facial expressions of emotion, the method presented in this paper attempts to handle an extensive range of human facial behaviour by recognising facial muscle actions that produce expressions. Virtually all of the existing vision systems for facial muscle action detection deal only with frontal-view face images and cannot handle temporal dynamics of facial actions. In this paper, the author presents a system for automatic recognition of facial action units (AUs) and their temporal models from long, profile-view face image sequences.

Automating the analysis of facial signals, unusually rapid facial signals (i.e.,AUs), is important to advance studies on human emotion and nonverbal communication, to design multimodal human-machine interfaces, and to boost numerous applications in fields as diverse as security, medicine, and education. In this paper, the author presented a novel method for AU detection based upon changes in the position of the facial points tracked in a video of a near profile view of the face. To wit, the automated systems for AU detection from face video that have been reported so far do not deal with the profile view of the face, cannot handle temporal dynamics of AUs, cannot detect out-of-plane movements such as thrusting the jaw forward (AU29), and, at best, can detect 16 to 18AUs (from in total 44 AUs).

This paper provides a basic understanding of how to achieve automatic detection of AUs and their temporal segments in a face-profile image sequence. Further research on facial expression symmetry, spontaneous vs posed facial expressions, and facial expression recognition from multiple facial views can be based upon it. Based on the validation study presented in Section VI, it has been concluded that the proposed method exhibits an acceptable level of expertise. The achieved results are similar to those reported for other automated FACS coders of face video. This method achieves an average recognition rate of 93.6% AU-wise for the encoding of 27 AUs and their combinations, while their system achieves an average recognition rate of 94.5% AU-wise for the encoding of 18 AUs and their combinations. Except for the profile view, the number of AUs, the difference in AUs, and the temporal dynamics handled, the proposed method has also improved other aspects of automated AU detection compared to previously reported systems. To deal with inaccuracies in facial point tracking, the proposed method employs a memory-based process that takes into account the dynamics of facial expressions (Table IV). Future work on this issue aims at investigating on the use of measures that can express the confidence to facial point tracking and that can facilitate both more robust AU recognition and the assessment of the certainty of the performed AU recognition.

Finally, the proposed method assumes that the input data are near profile- view face image sequences showing facial displays that always begin with a neutral state. Variations in the viewing angle should be expected. Also, human facial behaviour is more complex, and transitions from a facial display to another do not have to involve intermediate neutral states.

3.6 Facial expression recognition system consists of the following steps:

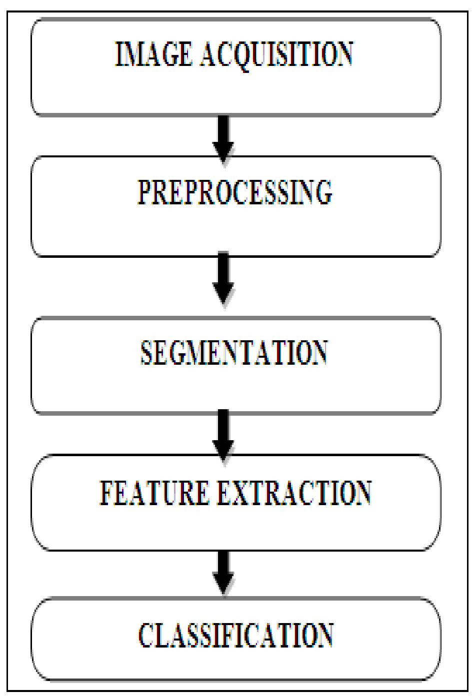

Fig -2 Facial expression Recognition System

3.6.1 Image Acquisition

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

3.6.2 Pre-processing

Pre-Processing plays a crucial role in the 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 an image without the image detail. Pre-Processing also includes filtering and normalisation of the image, which produces uniform size and rotates the image.

3.6.3 Segmentation

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

3.6.4 Feature Extraction

"interest" part in the image is Feature extraction. It includes information of shape, motion, colour, the texture of a facial image. Pattern recognition algorithms extract the significant information form image. As compared to original image feature extraction significantly reduces the information of the image, which gives advantage in storage.

3.6.5 Classification

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

4. APPLICATION AREA

With the sudden 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) Social Robot emotion recognition system.
ii) Medical Practices.
iii) The e-learning feedback system.
iv) The interactive TV applications.
v) Mental state identification.
vi) Computerized counselling system.
vii) Face expression synthesis.
viii) Music as per mood.
ix) Psychology.
x) Understanding human behaviour.
xi) In an interview.

4. CONCLUSIONS

In the last few years researchers are taking large number of efforts in features to deveolp robustness of system. Over the past two decades, extensive efforts have been made 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 the brain, and it is known through face, as the face has maximum sense organs. Hence human facial activity is considered. The main focus and objective of this research paper are to give a brief introduction towards techniques, application and challenges of the automatic emotion recognition system.

6. REFERENCES

[1] M. Pantic. "Dynamics of Facial Expression: Recognition of Facial Actions and Their Temporal Segments From Face Profile Image Sequences", IEEE Transactions on Systems Man and Cybernetics-Part B (Cybernetics), 4/2006

[2] Yun Tie, Ling Guan. "A Deformable 3-D Facial Expression Model for Dynamic Human Emotional State Recognition", IEEE Transactions on Circuits and Systems for Video Technology, 2013

[3] Ligang Zhang, Dian Tjondronegoro. "Facial Expression Recognition Using Facial Movement Features", IEEE Transactions on Affective Computing, 2011

[4] Lin Zhong, Qingshan Liu, Peng Yang, Junzhou Huang, and Dimitris N. Metaxas. "Learning Multiscale Active Facial Patches for Expression Analysis", IEEE Transactions on Cybernetics, 2015.

[5] Wenming Zheng, "Multi-View Facial Expression Recognition Based on Group Sparse Reduced-Rank Regression", IEEE Transactions on Affective Computing, 2014.

[6] Shuai Liu and Wansen Wang "The application study of learner's face detection and location in the teaching network system based on emotion recognition" IEEE, 2010

[7] A.Mehrabian, "Communication without Words" Psychology Today, Vol.2, no.4, pp 53-56, 1968

[8] Bharati A.Dixit and Dr A.N.Gaikwad "Statistical Moments Based Facial Expression Analysis" IEEE International Advance Computing Conference (IACC), 2015

[9] Ekman P, Friesen, WV. Constants across cultures in the face and emotion Journal of personality and social psychology 1971; 17:124

[10] Mateusz Zarkowski, "Identification-driven Emotion Recognition System for a Social Robot" IEEE, 2013

[11] Ahmad R. Naghsh-Nilchi and Mohammad Roshanzamir "An Efficient Algorithm for Motion Detection Based Facial Expression Recognition using Optical Flow" International Scholarly and Scientific Research and Innovations.

[12] Ashok Kumar and K.K.Thyaghrajan "Facial Expression Recognition with Auto-Illumination Correction" International Conference on Green Computing, Communication and Conservation of Energy (ICGCE), 2013

[13] Kwang Ho An and Myung Jin Chung "Cognitive Face Analysis System for Future Interactive TV" IEEE, 2009