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Review on Facial Emotion Recognition

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Abstract: *Expression recognition is closely related to face recognition where a lot of researches been done and a vast array of algorithms have been introduced. FER can also be considered as a special case of a pattern recognition problem and many techniques are available. So, this paper will discuss the main problems existing in recognition of facial expression recognition system and various methods of facial emotion recognition.*

Keywords: *Expression recognition, Facial Emotion, biometric authentication.*

1. Introduction

The community of computer vision has attracted the attention of facial emotion recognition over the last decade A vast amount of work has been done and is in progress to make life easy for the disabled (e.g. blind, dumb) and aged people by the help of improving all aspects of interaction between computers and human beings. In the area of HCI, there is practical usage based emphasis for automating recognition of a particular facial expression out of a pre-defined list. Facial expressions have been extensively studied in psychology [1]-[3]. Research by A.

Mehrabian [6] shows that 7% of human communication done by language, 38% by paralanguage and 55% through expression of face. Hence, recognition by face expression is an important way in interaction between human and computer. Mathematical model of facial expression has been done by extracting the features from face. Many researchers have been proposed to analyze facial expression [4], [5].

It has been concluded that the sources of facial expressions [7] includes:

a) Mental states (e.g. felt emotions, conviction and cogitation)
b) Verbal communication that are communicated via illustrators, regulators and responses of listeners.
c) Non-verbal communication that are communicated by not only emblems and social winks but also unfelt emotions.
d) Physiological activities such as via manipulators, or other means as pain and tiredness.

To conclude the factors that influence facial expressions into social, emotional and physiological factors, together with expression personality, the diagrammatic form is shown in Fig.1.

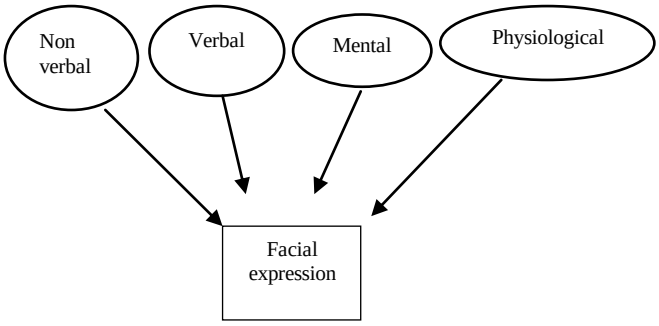

Fig. 1. Factors for Facial Expression

2. MOTIVATION

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.

3. MEASUREMENTS FOR FACIAL EXPRESSION

1. Record video

It may sound very simple, but recording video and playing it back enables more detailed analysis of facial expressions. When only annotating events and facial expressions live without recording it on video, it is likely the annotator may miss essential information. When making video recordings, it can still be difficult to record the face. For example, [8] recorded infants as their mothers fed them green beans in order to objectively quantify infants' facial expressions by manually coding Action Units.

In this study 16 mother-infant dyads had to be excluded because the infant's face was partially or fully occluded during the feeding session. Fortunately, the researchers had a final sample of 92 dyads, which was sufficient to finish their study.

2. Use a stationary microphone and chair

[9] proposed a great idea on how to keep a participant from moving/ shaking/ turning his or her head. They placed a voice-recording instrument in front of the participant and asked the participant to speak in the direction of the device. The researchers explained that this limited the participant from turning to face the interviewer. He/she only turned to the interviewer to exchange information and these parts were irrelevant for the study and therefore later excluded.
Furthermore, one can easily imagine what happens when a participant sits on an office chair. Therefore, Platt et al. fixed the chair and table so that no turning was possible. In short, this study was aimed at identifying whether individuals with a fear of being laughed at (gelotophobia) respond with less facially displayed joy generally towards enjoyable emotions or only those eliciting laughter.

3. Good illumination of the participant's face

Whether working in a laboratory or on-site, adequate illumination is of great importance. This is especially true when using software such as Face Reader to recognize facial expressions because good lighting can increase the reliability of your results. For example, Danner et al. used Face Reader software to automatically analyze facial expressions of participants drinking fruit juice. Their set up provided sufficiently accurate data to detect significant differences in facial expressions elicited by different orange juice samples [10] .A set up can be optimized by using photo lamps. This results in diffused frontal lighting on the test participant. Strong reflections or shadows (for example caused by lights from the ceiling) should be avoided.

4. Lower frame rate

When using the software to analyze videos, make sure to select a frame rate that suits your research needs. A lower frame rate will allow for a faster analysis while still providing the results you need. [11] used Face Reader software to analyze every third frame of the video. They explain that they chose this frame rate in order to reduce the computational time needed for the generation of the data describing facial expressions in a quantitative way, and the computational time required for the analysis of these data. In this particular case facial expressions were measured in the Mars-500 isolation experiment. In his dissertation, Gorbunov explains that the chosen frame rate still enabled them to get smooth dependencies describing the facial expressions.

5. Record context

Now you know how to measure facial expressions, it is important to look at the context of behavior. You can choose to include more measurements in your study, such as eye tracking, physiological measurements, and screen capture technology. Answer for example this question: at what user interface is the test participant looking or which events occurred in the room while the facial expressions recognized as 'happy' were recorded? Taking the context into account can complement the strengths of facial expression analysis by revealing the environmental cues and context that shape facial expressions and emotions.

4. ARCHITECTURE

The facial expression recognition system consists of four steps. First is face detection phase that detects the face from a still image or video. Second is normalization phase that removes the noise and normalize the face against brightness and pixel position. In third phase features are extracted and irrelevant features are eliminated. In the final step basic expressions are classified into six basic emotions like anger, fear, disgust, sadness, happiness and surprise.

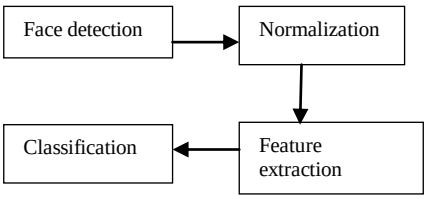

Fig 2. Architecture of facial expression recognition system

Facial expressions show the intention, affective state, cognitive activity, psychopathology and personality of a person [12]. In face-to-face interactions facial expressions convey many important communication cues. These cues help the listener to understand the intended meaning of the spoken words.

Facial expression recognition also helps in human computer interaction (HCI) systems [13]. In some robotic applications facial expressions are also used to detect human emotions [14]. Automatic facial expressions analyses also have applications in behavioral science or medicine [12] [15]. The facial expression recognition also has major application in areas like behavioral science, medicine, social interaction and social intelligence. For automatic facial expression recognition system, representation and categorization of characteristics of facial features deformations is a problem area.

5. PROBLEM FORMULATION

As we know that we can recognize human emotions using facial expressions without any effort or delay but reliable facial expression recognition by computer interface is still a challenge. An ideal emotion detection system should recognize expressions regardless of gender, age, and any ethnicity. Such a system should also be invariant to different distraction like glasses, different hair styles, mustache, facial hairs and different lightening conditions.

It should also be able to construct a whole face if there are some missing parts of the face due to these distractions. It should also perform good facial expression analysis regardless of large changes in viewing condition and rigid movement [16].

Achieving optimal feature extraction and classification is a key challenge in this field because we have a huge variability in the input data [17, 18]. For better recognition rates most current facial expressions recognition methods require some work to control imaging conditions like position and orientation of the face with respect to the camera as it can result in wide variability of image views. More research work is needed for transformation-invariant expression recognition.

6. TECHNIQUES FOR FACIAL EMOTION RECOGNITION

A. *Dynamic Bayesian Network Method*

In [19] author proposed approach to facial emotion recognition lies in the dynamic and probabilistic framework based on Dynamic Bayesian Network (DBN) with Kalman Filter for modeling and understanding the temporal phases of facial expressions in image sequences. By combining AAM and DBN, the proposed method can achieve a higher recognition performance level compare with other facial expression recognition methods.

The advantage of this method is that recognition accuracy of more than 90% for facial emotion reasoning is achieved using the proposed method.

The disadvantage of proposed method is the vulnerability of an AAM such as the necessity for a large number of landmarks and time data.

B. *Using Compact Facial Representation*

In [20] author derives compact facial representations using methods motivated by Principal Component Analysis and speaker face normalization. Moreover, they model emotional facial movements by conditioning on knowledge of speech-related movements (articulation).

The advantage of this method is that dynamic modeling and the use of this information improves recognition accuracy for anger, happiness and sadness, as well as for the overall un-weight performance.

The disadvantage of this technique is that it improves recognition for anger, happiness and neutrality but decreases performance for sadness.

C. *Novel Triangular Facial Method*

In [21] author proposed a method based on feature dimensions. Firstly they construct the face model of target image then genetic algorithm has been applied to extract the features.

The advantage of this method is that this method is robust to noise, and feature rotation cases.

The main disadvantage of this method is that it takes more time in searching of the features.

D. *Multilevel HMM*

In [22] author focuses on automatic facial expression recognition from live video input using temporal cues. Methods for using temporal information have been extensively explored for speech recognition applications using HMM.

The advantage of proposed method is that new methods for emotion recognition from video sequences of facial expression were explored. The experiments on a database of five people showed that the recognition rates for a person-dependent test are very high using both methods. The recognition rates drop dramatically for a Person-independent test. This implied that a larger database is needed for the training.

E. Unsupervised Domain Approach

In [23] author focus on facial expression recognition, which is one of the main modalities in which people express emotions and they show how a user-specific classifier can be built using only unlabeled target data.

The main advantage is that framework achieves the same or even slightly superior experimental results in short time also it is much easier to reproduce.

The disadvantage of this method is that training the generic SVM is more costly than other classifiers.

7. CONCLUSION

Face recognition is taking place in many sectors nowadays because it works well under constrained conditions. But there can be many advances in this direction because there are vast scopes of improvement and development. As considered above, all current face recognition the algorithms fail under the vastly varying condition under which humans need to and able to identify other people. So, future work can be done in the direction that people can recognize the images in "Real-Time" in less constrained condition. Almost all traditional and recent methods of face recognition are facing the problems such as change in illumination, pose variation, and change in expressions, aging factors and alignment. So, one of the promising future in face recognition approach is "Enhancement" so as it will be applicable to even low resolution conditions. From the above literature survey we came to know that SVM classifier is time consuming even if the accuracy rate is high so in the future neural network classification will be recommended with enhanced accuracy rate.

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