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Facial Expression Recognition: Issues and Challenges

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Abstract: Facial expressions have an important role in human communications. Cognition of human emotions is usually performed through recognition of facial expression. Over the last decade, facial expression analysis has become an active research area that finds potential applications in area such as human– computer interfaces, talking heads, image retrieval and human emotion analysis. Facial expression analysis and recognition is a complex task because faces vary from one individual to another quite considerably. This paper discusses basic tasks to be performed for recognition. The issues and challenges, which can be faced while recognition, are also discussed.

Keywords: **Human computer interaction, facial expressions, emotions classification.**

1. INTRODUCTION

With Recent advances in image analysis and pattern recognition open up the possibility of automatic detection and classification of emotional and conversational facial expressions. Automatic facial expression analysis and recognition could bring facial expressions into man-machine interaction as a new modality and make the interaction tighter and more efficient[10].

Research says that the verbal part or spoken words of a message contributes only for 7 percent to the effect of the message as a whole, the vocal part contributes 38 percent, while facial expression of the speaker contributes for 55 percent to the effect of the spoken message. This implies that the facial expressions form the major modality in human communication.

Facial expressions have an important role in human communications. Cognition of human emotions is usually performed through recognition of facial expression. Analysis of facial expressions has numerous potential applications in areas such as psychological studies, synthetic face animation, image understanding, robotics, crowd surveillance, entrance security etc.

In a human – computer interface if the computer can sense and understand the user's intentions from their facial expressions, it might be possible for the system to assist them by giving suggestion and proposals according to sensed situation [2][5][9].

Facial expression recognition should not be confused with human emotion recognition as is often done in the computer vision community. While facial expression recognition deals with the classification of facial motion and facial feature deformation into abstract classes that are purely based on visual information, human emotions are a result of many different factors and their state might or might not be revealed through a number of channels such as emotional voice, pose, gestures, gaze direction and facial expressions.

This paper gives an overview of the methodology to be followed for facial expression recognition. The challenges faced by expression recognition system are also discussed with possible options for mitigation.

The rest of this paper is organized as follows. Section 2 describes the facial expression recognition methodology with necessary steps to be followed. In Section 3, the challenges, which make the task of recognition complex, are discussed. Section 4 summarizes the overall study.

2. FACIAL EXPRESSION RECOGNITION

Three basic subtasks related to facial expression analysis and recognition are: face detection in an image, extraction of the facial expression information and classification of the expression in emotion categories. The block schematic of facial expression recognition system is given in Figure: 1. Test Image is acquired and pre processed for uniform

dimension as well as to compensate varying effect of illumination/pose. Then Features are extracted in Feature Extraction unit and given to Classifie unit for identification with features extracted from knowledge database. Finally recognized expression is given as output.

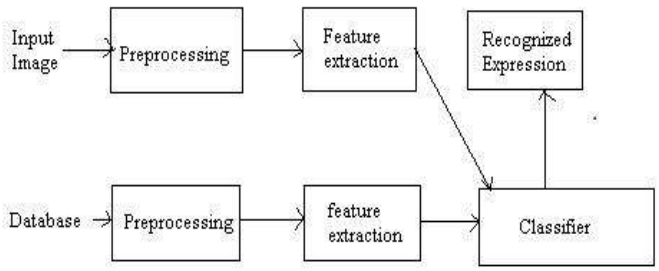

Fig. 1: Block Diagram of Facial Expression Recognition Methodology

Facial expressions are generated by contractions of facial muscles, which results in temporally deformed facial features such as eye lids, eye brows, nose, lips and skin texture, often revealed by wrinkles and bulges.

In the case of static images, the process of extracting the facial expression information is referred to as localizing the face and its features in the scene. In the case of facial image sequences, this process is referred to as tracking the face and its features in the scene. At this point, a clear distinction should be made between two terms, namely, facial features and face model features. The facial features are the prominent features of the face, like, eyebrows, eyes, nose, mouth, and chin. The face model features are the features used to represent (model) the face.

2.1 Face detection in an image

Fig. 2: Face Detection from an image

For every facial expression analysis and recognition system, very first task is to detect face in given image as shown in Figure 2. The task of detecting face is also not easy because scale and the orientation of the face can vary from image to image. If the shots are taken with a fixed camera, faces can occur in images at various sizes and angles due to the movements of the observed person. Thus, it is difficult to search for a fixed pattern in the image. The presence of noise and occlusion makes the problem more difficult. There are two predominant approaches to the face detection problem: Feature based and View based. Many different methods are invented for the said purpose which includes Principle Component Analysis, Linear Discriminant Analysis, and Independent Component Analysis etc[3] . The face can be detected by detecting some important facial features like irises and nostrils. The location of the features in correspondence with each other determines the overall location of the face. Edge detection can also be used to obtain a rough estimate of the face location in the image[1].Lip detection can also help in detecting face in image.

2.2 Extraction of facial expression information

Fig. 3: Facial Expression Extraction

After the presence of a face detected in an image, the next step is to extract the information about the shown facial expression as shown in Figure 3. The facial expressions under examination are defined as a set of six basic facial expressions: anger, disgust, fear, happiness, sadness and surprise. Combinations of these produce every other complex facial expression [13]. Facial expressions are generated by contractions of facial muscles, which results in deformation of facial features such as eye lids, eye brows, nose, lips, mouth, often revealed by wrinkles and bulges. The experiments suggest that the visual properties of the face, regarding the information about the shown facial expression, could be made clear by describing the movements of points belonging to the facial features as stated above and then by analyzing the relationships between those movements. Few of the approaches to extract features of facial expressions are [2]:

- Focusing on facial features or areas that are prone to change with facial expressions.
- Focusing on a neutral face image or face model in order to extract facial features that are relevant to facial actions.

Feature extraction methods can be categorized according to whether they focus on motion or deformation of faces and facial features. Various approaches used to extract expressions are listed in [2], which include intransient facial features (eyes, eyebrows, mouth etc.), transient facial features (wrinkles, bulges etc.), deformation feature extraction (changes in shape, texture, line endings, edge borders etc.), using eigen vectors [3], using Local Binary Patterns [9] etc.

2.3 Facial expression classification

Fig. 4 Six Universal Expressions

After the face and its appearance have been perceived, the next step is to identify the facial expression conveyed by the face.

A fundamental issue about the facial expression classification is to define a set of categories we want to deal with. A related issue is to devise mechanism of categorization. Facial expressions can be classified in various ways – in terms of facial actions that cause an expression, in terms of some non prototype expressions such as raised eyebrows, wrinkles near eyes etc. or in terms of some prototype expressions such as emotional expressions. Ekman defined six such categories, referred to as the basic emotions: happiness, sadness, surprise, fear, anger, and disgust [13] as shown in Figure 4. He described each basic emotion in terms of a facial expression that uniquely characterizes that emotion.

The Facial Action Coding System (FACS) [12] is probably the most known study on facial activity. It is a system that has been developed to facilitate objective measurement of facial activity for behavioural science investigations of the face. FACS is designed for human observers to detect independent subtle changes in facial appearance caused by contractions of the facial muscles. In a form of rules, FACS provides a linguistic description of all possible, visually detectable, facial changes in terms of 44 so-called Action Units (AUs).

Many methods which can be used for classification include support vector machine [6], K-means algorithm [8], neural network [4] etc.

3. CHALLENGES

Although humans recognize facial expressions virtually without any effort or delay, reliable expression recognition by machine is still a challenge. Automatic facial expression analysis and recognition is a complex task because faces vary

from one individual to another quite considerably due to different age & ethnicity. Even if recognition is done in a constraint of faces specific to some culture, several factors like presence of facial hair, glasses etc. make this task complex. Another challenge to this recognition task is the variation in size and orientation of the face in input images. This disables a search for fixed pattern in the images. Pose of the faces may differ due to angle of the camera. There may be faces which are frontal or non frontal. Faces may be at different angle which may obscure some of the facial features. Some good preprocessing technique is required to apply on input images which have good insensitivity to translation, scaling and rotation of the head. At present, many feature-based methods of facial expression recognition use local spatial analysis or geometrical information as facial features. For these methods, automatic localization of facial points is a key step to categorizing facial expressions robustly.
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However, in many practical applications, such as robotics, the performance of facial point extraction algorithm usually depends on the environmental factors such as lighting conditions heavily. So if the illumination is non-uniform, facial point can be detected inaccurately and hence high recognition rate of facial expression hardly expected. This factor would typically make feature extraction more difficult to perform reliably. To compensate the variation of illumination in an input image, image preprocessing methods like DCT normalization, Histogram Equalization, Rank Normalization can be applied before feature extraction.

4. CONCLUSION

Human detect and interpret faces and facial expressions in a scene with little or no effort. Still, development of an automated system that accomplishes this task is rather difficult. And hence, in recent years, facial expression analysis and recognition has become active research area. Various approaches have been made towards robust facial expression recognition, applying different image acquisition, and feature extraction, analysis and classification methods. This paper has briefly overviewed the methodology of facial expression recognition.

Facial expression recognition rate highly suffers due to many issues like varying lighting conditions, pose variation, presence of glasses and facial hair etc. Various challenges faced by facial expression recognition methods along with possible solutions to overcome those are also highlighted.

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