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SURVEY ARTICLE

Survey on Human Face Expression Recognition

Atul Chinchamalatpure[1], Prof. Anurag Jain[2]

[1]Department of Computer Science & Engineering, REC, Bhopal, India

[2]Department of Computer Science & Engineering, REC, Bhopal, India

Abstract— Facial expression recognition plays an important and effective role in the interaction in Human. There are seven basic facial expressions namely fear, surprise, happy, sad, disgust, Neutral and anger. Facial Expression Recognition is process performed by computers which consist of detect the face in the image and pre-process the face region, extracting facial expression features from image by analyzing the motion of facial features or change in the appearance of facial features and classifying this information into facial expression categories. Face Expression Recognition techniques have always been a very challenging task in real life applications because of the variations in the illumination, pose and occlusion. This paper presents a methodology for face expression recognition.

Keywords— Face Detection, Facial Expression Recognition (FER), Feature Extraction, Face Action Coding System, Action Units (AU)

I. INTRODUCTION

Human face is a very useful and powerful source of communicative information about human behavior. It provides information about human personality, emotions and thoughts. Facial expression provides sensitive cues about emotional response and plays a major role in human interaction and nonverbal communications [1]. It can complement verbal communication, or can convey complete thoughts by itself. Facial expression analysis has been attracted considerable attention in the advancement of human machine interface since it provides natural and efficient way to communicate between humans [2]. Some application area related to face and its expression includes personal identification and access control, video phone and teleconferencing, forensic application, human computer application [5]. Facial expression analysis has been attracted considerable attention in the advancement of human machine interface since it provides natural and efficient way to communicate between humans [2]. Some application area related to face and its expression includes personal identification and access control, video phone and teleconferencing, forensic application, human computer application [5].

Most of the facial expression recognition methods reported to date or focus on expression category like happy, sad, fear, anger etc Human face is a very useful and powerful source of communicative information about human behaviour. It provides information about human personality, emotions and thoughts. Facial expression provides sensitive cues about emotional response and plays a major role in human interaction and nonverbal communications [2]. It can complement verbal communication, or can convey complete thoughts by itself. A system that can recognize AUs in real time without human intervention is more desirable for various application fields including automated tools for behavioural research, videoconference, affective computing, perceptual human-machine interfaces, 3D face reconstruction and animation, and others[8].

II. LITERAURE REVIEW

There are several approaches taken in the literature for learning classifiers for emotion recognition [6]. From the feature extraction point of view, the techniques aiming the recognition of face expression can be categorized into methods that use appearance features and methods that use geometric features, although some hybrid-based approaches are also possible. The face images are processed by an image filter or filter banks on the whole face or some specific regions of the face to extract changes in facial appearance. Typically, the entire facial images or some specific facial regions are convolved with some filters, e.g. Gabor wavelets, and the extracted filter responses at the fiducial points (manually selected, most of the times) form vectors that are further used for facial expression classification. In the geometric feature extraction system, the shape, distances, angles or the coordinates of the fiducial points form a feature vector that represents facial geometry. It seems that the highest recognition rates have been obtained when both the responses methods were combined [6]. From the temporal perspective, facial expression recognition techniques are represented by static (typically using still images) and dynamic (image sequences) approaches. Other categories are the global techniques - which analyze the texture of the whole face without having explicit knowledge about the location of single facial features - versus local approaches - which try to extract local features of the face or to fit any holistic face model containing a set of feature points to the face.

Description of Approaches

The facial action coding system (FACS) developed by Ekman [13] is a source of inspiration for many research papers. In the first paper that has been analysed present a method for recognizing the emotions through facial expressions presented in a video sequence is discussed. The novelty of this work consists in introducing the Tree-Augmented-Naive Bayes (TAN) classifier which incorporates the dependencies between features. This is in opposition to the Naïve Bayes (NB) assumption in which features are considered to be independent as in work of Sebe et al. [9].

The method presented by Ma and Khorasani [10] is based on a combination of a two-dimensional discrete cosine transform (2D-DCT) and constructive one-hidden-layer feedforward neural network. The novelty of the approach comes from the proposed pruning technique which substantially reduces the size of the neural network while improving the generalization capability and the recognition rate. A novel low-computation discriminative feature space is introduced in [11] by Shan et al. It is based on Local Binary Patterns (LBP) features which could be extracted faster. Moreover, it is shown that LBP features are robust to low resolution. As possible solutions for the classification stage, template matching and Support Vector Machine (SVM) were considered and compared. Also, a comparison with the previous mentioned work of Cohen et al. [8] (geometric features +TAN) proved the superiority of the proposed technique. Since the year 2006, little work has been done in 3D based face expression recognition.

One of the first attempts is represented by the work of Zeng et al. [12] who employed a 3D face tracker for feature extraction. In the same year, in the approach proposed by Wang et al. [13], the classification of the prototypic facial expressions is performed by extracting primitive 3D facial expression features, and by calculating the feature distribution. Other innovative 3D solutions are the two approaches of Dornaika et al. [14] and Kotsia & Pitas [15] which use AUs together with a 3D face model named Candide, initially proposed by Ahlberg [16].

Some of the most important advantages of these techniques are the texture independence, the view independent (since the used tracker simultaneously provides the 3D head pose and the facial actions) and a simple learning phase which only need to fit second-order auto-regressive models to sequences of facial actions. For an excellent 3D facial expression survey please consult the work [15]. One of the most interesting approaches is presented by Panning in [11]. The authors propose a novel approach from multiple perspectives e.g., it use facial feature detection in color image sequences and the feature extraction is initialized without manual input. For expression classification a three layer feed forward artificial neural network is employed. In the next work, Buciu et al. [11] present a comparison of ICA approaches whereas the classification stage is implemented using either a Cosine Similarity Measure (CSM) or a SVM classifier.

III. BASIC METHODOLOGY

In this paper we are describing the basic methods of human face expression recognition are as follows.

A. Face Detection and Tracking

The first step in facial expression analysis is to detect the face in the given image or frame and then following it across different frames of a video. Locating theface within an image is termed as face detection and locating and tracking it across multiple frames is termed as face tracking. Face detection and tracking algorithms originates from the basis of feature extraction algorithms which looks for a certain representation within an image. One of the methods developed and perhaps one of the most popular one to detect and track faces is the Kanade- Lucas-Tomasi tracker[15]. In earlier studies Kanade and Lucas developed a fea- ture extraction algorithm[10] which matches two images for stereo

matching and assumed that the second frame in a continuous frame of images is a translation of the first one because of the small inter-frame motion. Their implementation can successfully determine the distance to the object from camera and also can calculate brightness, contrast and five other camera parameters. In the presence of human supervision, the system worked really well, but their procedure also conjures errors and Tomasi and Kanade updated and developed[15] the feature extraction algorithm on their own which iterates a few iterations over the basic solution that converges to a fast and simple solution. They define a feature as good, based on how well they can track that feature. Since by construction, their good feature selection criteria has become the optimal one. They represented a feature as a function of three variables x, y and t, where x, y are the space co- ordinate variables and t defines the time. They experimented with a stream of 100 frames that shows surface of different objects for example, furry puppets, mugs etc and found that the results from surface markings are very accurate and typically within one tenth of a pixel or better. As a result this technique is well suited for motion and shape determination.

Skin color plays a vital role in differentiating human and non-human faces. From the study it is observe that skin color pixels have a decimal value in the range of 120 to 140. In this project, we are going to increase skin color pixels decimal value in the range of 120 to 180. It gives the more accuracy than previous one. We used a trial and error method to locate skin color and non skin color pixels. But many of the times, system fails to detect whether an image contains human face or not (i.e. for those images where there is a skin color background) an image is segmented into skin color and non-skin color pixels.

B. Feature Extraction

To develop any new detection system, the choice of database is very important[2]. If we have a common database used by all researchers, it would be very easy to test the new detection system and compare it against existing systems. So a lot of efforts are put into building the 'perfect' database. After the database is built, researchers used a feature based approach where they tracks the permanent and transient features of the face separately[1]. The permanent features for example eyes can be tracked using eye tracker, lips can be tracked with lip tracker etc while edge detection methods are used for transient feature detection for example wrinkles. But all depends on the availability of a good database.

Human face is made up of eyes; nose, mouth and chine etc. there are differences in shape, size, and structure of these organs. So the faces are differs in thousands way. One of the common methods for face expression recognition is to extract the shape of eyes and mouth and then distinguish the faces by the distance and scale of these organs

C. Expression Classification

After the face detection and feature extraction process the final piece of the puzzle of facial expression system is a good classification module, that will classify the extracted features into particular expressions. We are going to cover some recent researches on different facial expression classifiers Among the static classifiers, the naive bayes classifier assumes all features are conditionally independent. But in real life scenario that is not the case. On the other hand in the tree based classifier, each feature has at most one feature as a parent resulting in a tree based structure. For example, in text after the word "thank", the probability of the word "you" to appear is higher than the other words. But naive bayesian classifiers doesn't account for that. Cohen et al.[5] noted this property is applicable to facial expression recognition system as well. So they found the tree augmented naive bayes classifier performing better. For the structure of the tree, they didn't fix it to any particular structure, rather they developed an algorithm that gives the optimal structure. Their experimental methodology consists of two types of tests person dependent where part of the data for each subject is used as training data and person independent test where all but one subject is used to train the system and the 'left out person' is used for the classification test. Results shows that static classifiers performs poorly when the video feed is person dependent because dynamic classifiers take into account the difference in temporal patterns as well as the change in expression's appearance for different individuals. Finally they integrated these classifiers to build a real time facial expression recognition system.

After the set of features are extracted from the face region are used in classification stage. The set of features are used to describe the facial expression. Classification requires supervised training, so the training set should consist of labeled data. Once the classifier is trained, it can recognize input images by assigning them a particular class label. The most commonly used facial expressions classification is done both in terms of Action Units, proposed in Facial Action Coding System (FACS) [12] and in terms of six universal emotions: happy, sad, anger, surprise, disgust and fear defined by Ekman [13].

***1) Facial Action Coding System (FACS)*:**

Facial Action Coding System (FACS) was developed by Paul Ekman and Wallace Friesen in 1976 is a system for measuring facial expression. FACS is based on the analysis of the relations between muscle contraction and changes in the face appearance. It is a common standard to systematically categorize the physical expression which has been useful to psychologists and to animators. The Face can be divided into Upper Face and Lower Face Action units [13] and the subsequent expressions are also identified. The fig 5 shows some of the combined action units. Contractions of muscles occurred because of some expression are marked as an Action Unit (AU).Action Units are changes in the face caused by one muscle or a combination of muscles. The task of expression analysis with use of FACS is based on decomposing observed expression into the set of Action Units. There are 46 AUs that represent changes in facial expression and 12 AUs connected with eye gaze direction and head orientation. Action Units are highly descriptive in terms of facial movements, however, they do not provide any information about the message they represent. AUs are labeled with the description of the action.

2) Prototypical Facial Expression

Instead of describing the detailed facial features most facial expression recognition system attempt to recognize a small set of prototypical emotional expressions. According to the Ekman's theory [13], there are six basic emotion expressions that are universal for people of different nations and cultures. Those basic emotions are anger, neutral, disgust, fear, happy, sad and surprise There are a lot of different machine learning techniques for classification task, namely: K-Nearest Neighbors [10], Artificial Neural Networks [11], Support Vector Machines [3], Hidden Markov Models [3] and Boosting Techniques like Adaboost classifier [2].

IV. CONCLUSIONS

This paper has briefly overviewed the methodology of facial expression recognition. Human detect and identify faces and facial expressions in a scene with little or no effort. Feature extraction is important stage for expression recognition system because extracted features are used for Classification stage. Feature extraction for expression recognition using geometric features is more difficult because it depends on the shape and sizes of features so appearance based features are easier to extract.

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