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RESEARCH ARTICLE

Facial Expression Recognition

Apeksha Nachone, Prof. Karuna G. Bagde

Master of Engineering, Department of Computer Science and Information Technology, H.V.P.M's COET, Amravati, Maharashtra, India

apekshanachone@gmail.com; karunabagde@rediffmail.com

Abstract— Facial expressions convey non-verbal cues, which play an important role in interpersonal relations. Automatic recognition of facial expressions can be an important component of natural human-machine interfaces; it may also be used in behavioural science and in clinical practice. A facial expression is one or more motions or positions of the muscles beneath the skin of the face. These movements convey the emotional state of an individual to observers. Facial expressions are a form of nonverbal communication. Humans can adopt a facial expression voluntarily or involuntarily, and the neural mechanisms responsible for controlling the expression differ in each case. Humans can adopt a facial expression voluntarily or involuntarily, and the neural mechanisms responsible for controlling the expression differ in each case. This paper presents a high-level overview of automatic expression recognition; it highlights the main system components.

Index Terms: ***Recognition, Expression, Emotion, muscles, Nonverbal***

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1. INTRODUCTION

Facial expression is one of the most powerful, natural and immediate means for human beings to communicate their emotions and intensions. Automatic facial expression analysis is an interesting and challenging problem, and impacts important applications in many areas such as human–computer interaction and data-driven animation. Due to its wide range of applications, automatic facial expression recognition has attracted much attention in recent years. Though much progress has been made, recognizing facial expression with a high accuracy remains difficult due to the subtlety, complexity and variability of facial expressions.

A facial expression is a visible manifestation of the affective state, cognitive activity, intention, personality, and psychopathology of a person , it plays a communicative role in interpersonal relations. Facial expressions, and other gestures, convey non-verbal communication cues in face-to-face interactions. These cues may also complement speech by helping the listener to elicit the intended meaning of spoken words. As cited in Mehrabian reported that facial expressions have a considerable effect on a listening interlocutor; the facial expression of a speaker accounts for about 55 percent of the effect, 38 percent of the latter is conveyed by voice intonation and 7 percent by the spoken words.

As a consequence of the information that they carry, facial expressions can play an important role wherever humans interact with machines. Automatic recognition of facial expressions may act as a component of natural human machine interfaces (some variants of which are called perceptual interfaces or conversational interfaces). Such interfaces would enable the automated provision of services that require a good appreciation of the emotional state of the service user, as would be the case in transactions that involve negotiation, for example. Some robots can also benefit from the ability to recognise expressions. Automated analysis of facial expressions for behavioural science or medicine is another possible application domain .Automatic systems for facial expression recognition usually take the form of a sequential configuration of processing blocks, which adheres to a classical pattern recognition model. The main blocks are: image acquisition, pre-processing, feature extraction, classification, and post-processing. Automatic facial expression recognition has attracted much attention from behavioral scientists since the work of Darwin in 1872, Suwa et al made the first attempt to automatically analyze facial expressions from image sequences in 1978. Here the briefly review of some previous work in order to put our work in context. Facial representation

Automatic facial expression recognition involves two vital aspects: facial representation and classifier design. Facial representation is to derive a set of features from original face images to effectively represent faces. The optimal features should minimize within-class variations of expressions while maximize between class variations. If inadequate features are used, even the best classifier could fail to achieve accurate recognition. In some existing work, optical flow analysis has been used to model muscles activities or estimate the displacements of feature points .However, flow estimates are easily disturbed by the non-rigid motion and varying lighting, and are sensitive to the inaccuracy of image registration and motion discontinuities. Facial geometry analysis has been widely exploited in facial representation where shapes and locations of facial components are extracted to represent the face geometry. Another kind of method to represent faces is to model the appearance changes of faces. Holistic spatial analysis including Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA) and Gabor wavelet analysis have been applied to either the whole-face or specific face regions to extract the facial appearance changes.

Facial expression recognition

Different techniques have been proposed to classify facial expressions, such as Neural Network, Support Vector Machine (SVM), Bayesian Network (BN) and rule-based classifiers. To exploit the temporal behaviors of facial expressions, different techniques were presented for facial expression recognition in image sequences. There have been several attempts to track and recognize facial expressions over time based on optical flow analysis.

Facial expression data

Facial expressions can be described at different levels. A widely used description is Facial Action Coding System (FACS), which is a human-observer-based system developed to capture subtle changes in facial expressions. With FACS, facial expressions are decomposed into one or more Action Units (AUs). AU recognition or detection has attracted much attention recently. Meanwhile, psychophysical studies indicate that basic emotions have corresponding universal facial expressions across all cultures . This is reflected by most current facial expression recognition systems that attempt to recognize a set of prototypic emotional expressions including disgust, fear, joy, surprise, sadness and anger.

Local Binary Patterns (LBP)

The original LBP operator was introduced by Ojala et al and was proved a powerful means of texture description. The operator labels the pixels of an image by thresholding a 3 x 3 neighborhood of each pixel with the center value and considering the results as a binary number and the 256-bin histogram of the LBP labels computed over a region is used as a texture descriptor. The derived binary numbers (called Local Binary Patterns or LBP codes) codify local primitives including different types of curved edges, spots, flat areas. The limitation of the basic LBP operator is its small 3 x 3 neighborhood which cannot capture dominant features with large scale

Facial expression recognition using LBP

Person-independent facial expression can be recognise using LBP features. Different machine learning techniques, including template matching, Support Vector Machines, Linear Discriminant Analysis and the linear programming technique, are used for this purpose. Low-resolution facial expression recognition. In real-world environments such as smart meeting and visual surveillance, only low-resolution video input is available. How to derive a discriminative facial representation from low-resolution images is a critical problem for real-world applications.

Boosting LBP for facial expression recognition

Face images are equally divided into small sub-regions from which LBP histograms are extracted and concatenated into a single feature vector. However, apparently the extracted LBP features depend on the divided sub-regions, so this LBP feature extraction scheme suffers from fixed sub-region size and positions. By shifting and scaling a sub-window over face images, many more sub-regions can be obtained, bringing many more LBP histograms, which yield a more complete description of face images. To minimize a very large number of LBP histograms necessarily introduced by shifting and scaling a sub-window, boosting learning can be used to learn the most effective LBP histograms that containing much discriminative information.

2. COMMUNICATION

Eye contact

A person's face, especially their eyes, creates the most obvious and immediate cues that lead to the formation of impressions. A person's eyes reveal much about how they are feeling, or what they are thinking. Blink rate can reveal how nervous or at ease a person may be. Eye contact is another major aspect of facial communication. Some have hypothesized that this is due to infancy, as humans are one of the few mammals who maintain regular eye contact with their mother while nursing Eye contact serves a variety of purposes. It regulates conversations, shows interest or involvement, and establishes a connection with others. Eye contact regulates conversational turn taking, communicates involvement and interest, manifests warmth, and establishes connections with others, it can command attention, be flirtatious, or seem cold and intimidating and invites conversation. Lack of eye contact is usually perceived to be rude or inattentive.

Micro expressions

Micro expressions are the facial expressions that last less than a second that can help to determine the true feelings or emotions of the sender in communication. The fundamental characteristics of a micro-expression, according to Ekman’s original definition, are involuntary leakage and fast speed. These expressions have been gaining more attention over the years for many reasons.

It is unknown how this tiny demographic has learned such a useful skills and researchers are still trying to determine what qualities people may possess to make them successful. So far, researchers have not been able to find a technology that can accomplish the same lie-detecting skills as people who are natural lie detectors. However, it is possible for anyone with a computer to be formally trained in the art of detecting micro expressions.

Cues that tip off lie-detectors can be through the mouth, eye movements, or even our eyebrows. Micro expressions have become increasingly studied over the years due to the possible help in detecting danger or someone's true, underlying emotions.

Sign languages

Facial expression is used in sign language to convey specific meanings. In American sign language (ASL), for instance, raised eyebrows combined with a slightly forward head tilt indicate that what is being signed is a yes/no question. Lowered eyebrows are used for wh-word questions. Facial expression is also used in sign languages to show adverbs and adjectives such as distance or size: an open mouth, squinted eyes, and tilted back head indicate something far while the mouth pulled to one side and the cheek held toward the shoulder indicate something close, and puffed cheeks mean very large. It can also show the manner in which something is done, such as carelessly or routinely. Some of these expressions, also called non-manual signs, are used similarly in different sign languages while others are different from one language to another. For example, the expression used for 'carelessly' in ASL means 'boring or unpleasant in British Sign Language.

Components of Automatic Expression Recognition System :

The main approaches embedded in the components of an automatic expression recognition system are reviewed below.

Image Acquisition : Images used for facial expression recognition are static images or image sequences. An image sequence contains potentially more information . With respect to the spatial, chromatic, and temporal dimensionality of input images, 2-D monochrome (grey-scale) facial image sequences are the most popular type of pictures used for automatic expression recognition. However, colour images could become prevalent in future, owing to the increasing availability of low-cost colour image acquisition equipment, and the ability of colour images to convey emotional cues such as blushing.

Pre-processing: Image pre-processing often takes the form of signal conditioning (such as noise removal, and normalisation against the variation of pixel position or brightness), together with segmentation, location, or tracking of the face or its parts. Expression representation can be sensitive to translation, scaling, and rotation of the head in an image. To combat the effect of these unwanted transformations, the facial image may be geometrically standardised prior to classification. This normalisation is usually based on references provided by the eyes or nostrils. Segmentation is concerned with the demarcation of image portions conveying relevant facial information. Face segmentation is often anchored on the shape, motion, colour, texture, and spatial configuration of the face or its components . The face location process yields the position and spatial extent of faces in an image; it is typically based on segmentation results. However, robust detection of faces or their constituents is difficult to attain in many real-world settings. Tracking is often implemented as location, of the face or its parts, within an image sequence, whereby previously determined location is typically used for estimating location in subsequent image frames.

Feature Extraction: Feature extraction converts pixel data into a higher-level representation of shape, motion, colour, texture, and spatial configuration of the face or its components. The extracted representation is used for subsequent expression categorisation. Feature extraction generally reduces the dimensionality of the input space. The reduction procedure should (ideally) retain essential information possessing high discrimination power and high stability. Such dimensionality reduction may mitigate the 'curse of dimensionality' . Geometric, kinetic, and statistical- or spectral-transform-based features are often used as alternative representation of the facial expression prior to classification .

Classification: Expression categorisation is performed by a classifier, which often consists of models of pattern distribution, coupled to a decision procedure. A wide range of classifiers, covering parametric as well as non-parametric techniques, has been applied to the automatic expression recognition problem . The two main types of classes used in facial expression recognition are action units (AUs) and the prototypic facial expressions defined by Ekman . The prototypic expressions relate to the emotional states of happiness, sadness, surprise, anger, fear, and disgust .However, it has been noted that the variation in complexity and meaning of expressions covers far more than these six expression categories . Moreover, although many experimental expression recognition systems use prototypic expressions as output categories, such expressions occur infrequently, and fine changes in one or a few discrete face parts communicate emotions and intentions . An AU is one of 46 atomic elements of visible facial movement or its associated deformation; an expression typically results from the agglomeration of several AUs . Sometimes, AU and prototypic expression classes are both used in a hierarchical recognition system . for example, categorisation into AUs can be used as a low-level of expression classification, followed by a high-level classification of AU combinations into basic expression prototypes.

Post-processing: Post-processing aims to improve recognition accuracy, by exploiting domain knowledge to correct classification errors, or by coupling together several levels of a classification hierarchy.

3. CONCLUSION

The paper aims at recognizing the various human facial expressions. Automatic recognition of facial gestures (i.e., facial muscle activity) is rapidly becoming an area of intense interest in the research field of machine vision. As one of the most successful applications of image analysis and understanding, face recognition has recently received significant attention, especially during the past several years. Every countenance is marked by changes in the feature points of the face. These feature points are located in various regions of the face. We observe in our experiments that LBP features perform stably and robustly over a useful range of low resolutions of face images, and yield promising performance in compressed low-resolution video sequences captured in real-world environments.

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