Advantage & Issues of Various Techniques of Facial Expression: A Survey

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***Abstract*—**As peoples use a huge amount of their time familiar with computers of one kind or a different way. In contrast, computers are expressively unsighted and uninterested to the emotional circumstances of their customers. Human communicate with computer which does not think emotions take no notice of a whole control of existing information.

Faces contain a huge component of our expressively meaningful behavior. We make use of facial expressions to demonstrate our emotional circumstances and to agreement with our communications. In addition, we state and understand sentiments in faces naturally. Alternatively, automatic recognizing of facial expressions is an extremely complicated job computationally, particularly in the attendance of extremely inconsistent masquerade, appearance and explanation.

***Index Terms*—** Facial Expressions, Emotion, Classification, Human-computer interaction (HCI).

I. Introduction

Computers are quickly becoming a ubiquitous measurement of our lives. We spend an enormous understanding of required instance familiar with computers of one type or another. At the moment the devices we use are indifferent to our affective states. They are emotionally blind. However, unbeaten human-human contact relies on the capability to understand affective and emotional signals. Human-computer interaction (HCI) which does not consider the emotional circumstances of its users loses a large part of the information available in the interaction. Human emotions are becoming an essential measurement of quick products and services that can show the way to a step forward in domains such as healthcare, marketing, security, education, and entertainment [1].

Recently, sentimental computing former widely studied and there is a developing belief that providing computers with the capability to learning the affective circumstances of their consumers would be beneficial [2]. It is believed that with the purpose of make future development in HCI it is necessary to recognize users' affect. This is informed by the consequence of emotion in our daily exists [3]. Affective computing tries to connection the space among the emotionally communicative human and the emotionally incomplete computer [4]. Consistent automated recognition of human emotions is crucial before the expansion of affect sensitive systems is possible. Humans show emotional performance that is multi-modal, restrained and difficult. People are proficient at communicating themselves and understanding others through the exploit of non-verbal cues for ex. facial expressions, eye look, a variety of hand gestures, head motion and posture.

We can look at facial expressions and head gestures from two main perspectives - message and sign judgment. Message judgment approaches facial expressions in expressions of meaning (emotion, intention, etc.), whereas sign judgment looks at the underlying anatomical structure and does not interpret the message. With the intention of achieve message judgments we need to be able to read the signs. To derive information about the interpersonal relations in the crew, we analyzed the correlations between facial expressions of different crew members. To study [5] the relation between the facial expressions of different crew members in additional feature corresponding to two different crew members. There are various application areas that could benefit from the capability to become aware of affect. These range from interfaces that do not interrupt their users when they are stressed, online learning systems that adapt the teaching if the student is confused, and video games that adapt their difficulty based on the player engagement. Further applications include: assisted living environments that can monitor the users' state and report to medical professionals if the patient is feeling pain; assistive technologies for diagnosing and systems that monitor drivers. We aimed to find a method for interpreting the observed temporal history of facial expressions in the circumstance of the occasions that caused the expressed emotions.

II. Theoretical Background

Wherever in the area of human-robot interaction, generally interactive machines are frequently prepared with the capability to become aware of the emotional circumstances of users, the capability to communicate emotions through the exploit of artificial facial expressions, speech and textual content, and the ability for imitating and social learning. ancient times work on generating machines that can create persuasive emotional expressions has think on the value of those expressions and on reviewing people's capability to be familiar with them. Earlier recognition studies offered the facial expressions of the

robots in neutral circumstances, with no any well-built emotional valence (e.g., emotionally valenced music or video). It is for that reason significance empirically investigates whether observers'judgments of the facial indications of a robot would be concerned by a surrounding emotional context. This study discusses different characteristics of facial expressions, including their connections to talk, emotions, and the regulation of interaction and larger social structures. Although psychologists have explored the emotion understanding abilities of the elderly [6]; only a relatively small amount of research has shown in elderly faces are decoded and responded to in conditions of empathy.

III. Facial Expressions of Emotion

The face is one of the the largest part significant channels of non-verbal communication. Facial expressions figure significantly in research on approximately every characteristic of emotion [7]. Facial expressions can have non-emotional information associated as indicative of definite medical circumstances, for example pain or depression. Unsurprisingly, this multi-faceted tool for expression and communication has interested researchers for centuries. There are two most important moves towards to the measurement of facial expressions. The first one is message judgment which assumes that the face is a read out of emotion, or some other social signal, and thus it should be interpreted as that by the observer. The second type of measurement is sign judgment, which assumes nothing about the semantics of the expressions and leaves inferences to higher order decision making [3]. I am more interested in sign judgment as it has broader applicability to various disciplines, including affective computing, psychology, and expression synthesis.

In interaction, emotional displays are thus used for managing, moment-by-moment, the situational involvement and social relationship of participants within a particular (constantly changing) social action or activity sequence. As the ongoing action continuously changes during the unfolding interaction, so the situational cognitive-emotional connection between the participants must also be constantly modified with the purpose of render it appropriate to the action at hand, which in turn, effects on the conditional relationship. The conversational analytic studies on emotions in interaction discussed above deal with emotions as public displays that are produced during social action. Thus, emotions are socially constructed and serve the purposes of communication and relationship (intimacy, social bonding etc.). Therefore, public emotions serve interpersonal communication that is closely tied to the regulation of unfolding interaction.

IV. Facial Expression Classification

Classification is performed in the last stage of an automatic facial expression investigation system. The classification methods could be classified in various ways, in this section; we categorize the mechanism of classification into the following three categories: 1) template based methods; 2) neural network based methods; 3) statistical classification methods. Template based methods are the firstly proposed methods in decades ago, currently most researchers focus on using neural network based methods and statistical classification methods. We discuss the representing work using these three different methods respectively.

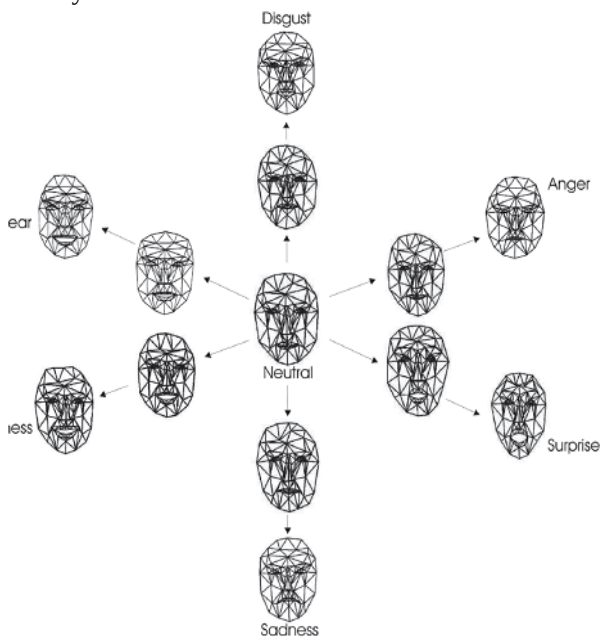

Figure 2.8: Grids on the face with different expressions.

- **Template Based Methods**

The template-based techniques are simple face representation and classification methods. They just compare the new images with the learned template which normally is the average of the pictures in the similar category. These techniques have limited recognition capabilities, because the averaging process always causes smoothing of some important individual facial details, and misalignment of the faces also impacts the template. The additional significant difficulty is there be presents the large inter-personal expression differences. For template based methods, Essa and Pentland [8] used the spatial-temporal motion-energy representation of facial motion for an observed expression. By precisely labeled the training images, 2D motion were extracted to generate the spatial-temporal templates for six different expressions, two facial actions (smile and raised eyebrows) and four emotional expressions (surprise, sadness, anger, and disgust). The Euclidean standard of the motion energy dissimilarity between the pattern and the examined image is used as a metric for measuring similarity. Although they got 98% recognition rate on 52 frontal-view image sequences from eight subjects with six different expressions, but this method still could not be utilized in real system appropriate to the misalignment problem and the large variations between the subjects. Kimura [9] proposed a Potential Net on each frame of the labeled facial image sequence. The pattern of the distorted net is evaluated to the pattern removed from a neutral face, and the discrepancy in the place of the net nodes is used for further processing. However, the proposed method could not work well on the image

sequences of unknown subjects due to the limitation of a very small number of training patterns and an insufficient variety of the subjects.

In summary, template based methods are the pioneer works on facial expression analysis, but they cannot describe the variance among different subjects and are not robust to misalignment problem.

- **Neural Network Based Methods**

An artificial neural network (ANN), typically called neural network (NN), is a mathematical representation or computational model that is motivated by the arrangement and functional characteristics of biological neural networks. A neural network consists of an interrelated group of artificial neurons, and it methods information by means of a connectionist move toward to calculation. In most cases an ANN is an adaptive method that alters its formation based on exterior or domestic data that streams through the network during the learning stage. They are frequently utilized to representation difficult associations between inputs and outputs or to discover models in information. Generally, neural network could be looked as one black box which greedily maximize or minimize the object function. Because this advantage, neural networks were often used for facial expression classification in lots of works. Neural networks were directly applied on face images, and also combined with facial features extraction and representation methods such as PCA independent component analysis (ICA) or Gabor wavelet filters.

- **Statistical Model Based Methods**

In modern years, machine learning technologies are broadly used in all kinds of areas, also in computer vision area. For classification methods on facial expression analysis, the statistical classification methods are dominated. The most admired techniques are support vector machine, boosting method and other sequence based methods such as hidden Markov models. We will survey these three methods on facial expression analysis separately.

Support Vector Machines Based Methods: Support vector machines (SVMs) are a position of shared supervised learning techniques that examine information and distinguish prototypes, utilized for categorization and regression study. More formally, a SVM builds a hyper-plane or placed of hyper-plane in a high or infinite dimensional space, which can be utilized for classification, regression, or other tasks. As a classifier, SVM is trained on a position of training examples which are spotted as be in the right placing to one of two groups, SVM training algorithm makes a representation that calculates whether a novel example falls into one category or the other. As a powerful general classification method, SVM is also used in lots of works [10-11] on expression analysis.

Boosting Based Methods: Normally, the dimension of features extracted from face image is very high, and it is almost not viable to directly use the high dimension features to train classifier. Therefore, feature selection and dimension deduction must be done as the preprocessing. When Boosting builds the physically powerful classifier through combining the weak classifiers, it can do feature selection at the same time because the weak classifier is directly relative to the corresponding feature. Littlewort [12] used boosting to do feature selection on the extracted Gabor features, and then sent the selected feature into SVM to further train the model. But Littlewort's work just focused on the static images.

For spatial-temporal approaches, Hidden Markov models (HMM) are commonly used for facial expression analysis as they allow modeling the dynamics off facial actions.

The Facial Action Coding System (FACS) [13] is probably the most known study on facial activity. FACS is designed for human observers to detect independent subtle changes in facial appearance caused by the facial muscles contractions. In a form of laws, FACS makes available a linguistic explanation of all potential, visually measurable facial transforms in expressions of 44 so-called Action Units (AUs). Even though the number of atomic action components is little, more than 7,000 arrangements of accomplishment components have been examined. Fig. 2.3 shows the definitions of 7 individual upper face AUs and 5 combinations involving these action units. Using these rules, a trained human FACS coder decomposes a shown expression into the specific Aus that describe the expression.

Automating FACS would make it widely accessible as a research tool in the performance science, which is furthermore the theoretical basis of multimedia user interfaces. This triggered researchers of computer vision field to take different approaches in tackling the problem. Bartlett [14], [15] reported extensive experiments on upper and lower AU recognition and evaluate unstructured expression. Whitehill [16] examined the correlation between different AUs and showed that this correlation can impact recognition rate significantly because high correlation of some AUs happens naturally in prototypical expressions. Several other emotions and many arrangements of emotions have been calculated but continue indefinite as commonly noticeable. While the human mechanisms for facial expression interpretation are very strong, it is frequently very complicated for machine to decide the precise nature of the expression on a person's face. Independent of the used classification categories, the mechanism of classification applied by a particular surveyed expression analyzer is either a template-based- or a neural-network-based- or a rule-based- or statistical classification methods.

V. Facial Expression Data Extraction

The face participate a fundamental responsibility in interpersonal contact. It helps to synchronize discussion and to exchange a few words emotions and other significant psychological, communal, and physiological signs. It indicated that whether the listener liked or disliked a message depends only 7% on the spoken word, 38% on vocal utterances, while facial expressions determine 55% of this feeling. This involve that the facial expressions form the major channel in human interpersonal communication.

Over the previous ago, automatic facial expression investigation has turn out to be a dynamic research region that discovers possible requests in HCI, graphics and animation, talking agents, teleconferencing and human emotion interpretation. An automatic facial expression analyzer should have the ability of bringing facial expressions into man-machine communication as a novel modality and making the interaction stretchered and additional efficient. Humans detect faces and interpret facial expressions in a prospect with small or no effort, but automatic analysis and classification of facial expressions is a very difficult task. We still require extracting facial expression data for correct classification of facial expressions supported on the facial characteristic finding results.

Several techniques have been proposed in the literature in recent years. Some surveys [17, 18] gave a detailed review of existing methods on facial expression analysis. The first step for an entirely repeated facial expression analyzer is to extract the information about the encountered facial expression in an automatic way. Both the category of input information and the demonstration of visual information have an effect on the alternative of the approach to facial expression data extraction. The input information can be fixed images or image sequences. There are three kinds of face representation: holistic, analytic and hybrid. The holistic approaches fit a template face model to the participation image or track it in the participation image sequence. The analytic approaches localize the features of an analytic face model in the input picture or track them in the input sequences. The hybrid approaches combine the above two methods to some amount.

It is a more difficult task to extract facial expression data from a video sequence because we encounter the 3-D head movement simultaneously. Characteristic points are more prone to drift without geometry constraints in extensive video sequences. Generally holistic approaches can achieve a better global result.

VI. Literature Survey

For the most part essential involvement of this paper [5] is the expansion of a model that, on the starting point of the available technology, opens possibilities for interpreting emotional facial expressions in the circumstance of the happenings that caused these affects. The emotional events depicted during collaborative gaming could be of unusual intensities and types. Our model assumes that the current facial expression can be characterized as a mathematical function of the subsequent three arguments: 1) the intensity and type of the event; 2) time division between the current moment and the moment when the event happened; and 3) the facial expression at the instant of the event. The approach is applicable in the circumstance of the interpersonal relations and continuing outcomes of isolation.

We have also enlarged a computational process that can facilitate recognize the situations of the emotional events with their categories and intensities supported on the observed sequence of the facial expressions. This procedure is also utilized to find out the method in which the dynamics of the facial expressions are manipulated by the emotional events. The technique is advancement in analyzing the affective appearances in the structure of appraisal theory, which is best supported by a multidisciplinary community of researchers. Additionally, the occurrences are represented for the duration of the interpersonal interaction; therefore, the experimental design, as well as the model supports analyzing social and emotional performance in the circumstance of interpersonal announcement. The developed method for analysis of social behavior during interaction can contribute to investigate in the multidisciplinary study of behavior from the so-called second-person perspective, i.e., the perception of a personality in communication with another person, which beat variances from the well-created primary person viewpoint in science, where the area under discussion reports on his experiences, and from the third-person perspective, when there is an observer who is not participating in the experiment.

In this paper [19] author has proposed a model for generation of unusual categories of facial expressions. Psychologists classified facial expressions according to meaning, role, and appearance. Facial expressions do not always match up to feel emotions: they can be counterfeit i.e. demonstrating an expression of an unfelt emotion, masqueraded i.e. masquerading a feel passion by an unfelt feeling, superposed i.e. showing a combined of felt emotions, restrained i.e. masking the manifestation of emotion with the impartial expression), contained (de-intensifying the appearance of an emotion), or amplified (intensifying the look of an emotion). We call composite facial appearances the expressions that are different from the spontaneous facial displays of simple emotional states (e.g. display of anger or sadness). They can be shows of several arrangements of emotions with appearances of emotions, which are modified according to some social rules. We form difficult facial expressions using a features screening move toward. It means that unusual emotions are communicated on unusual regions of the face. Additional exactly, each facial expression is described by a position of eight facial regions.

Here [20] author emphasize on facial expression administration. They aspire at determining factors that influence the facial behavior in interpersonal relations and at building the model of the facial activities administration for an ECA. Depending on some parameters those define interpersonal relations and the expressive conditions of the mediator our algorithm alters agent's default i.e. unstructured facial performance. It denotes that in definite social contexts our mediator will use various composite facial appearances instead of simple ones. Thus we need to find rules between factors that influence the facial behavior in interpersonal relations and the occurrence of particular type of complex facial expressions. Our rules of facial behavior management are mostly supported on the effects of the annotation of a video-corpus we have made for this purpose.

According to Breazeal et al. [21], with the purpose of be proficient to contribute efficiently in emotion based interactions, robots must be equipped with abilities to

recognize and interpret affective signals from humans, acquire their individual inner representations of emotions frequently motivated by psychological theories and be proficient to communicate this affective state to others. These inner representations of emotion are of serious meaning when interacting socially with humans as the robot‘s computational model of emotion determines the robot‘s emotional responses according to its interactions with the outdoor background and its own internal cognitive-affective state [21]. Therefore, after communally interactive automatons are given rich facial features, the insights from the psychology of emotion and its expression are often taken to design their computational representations of emotion. Actually, seemingly conflicting hypothesis of emotion have been adapted to design computational representations of emotion for some emotional robots.

The appraisal hypothesis of emotion provides a suitable framework for the expansion of affective recognition (or interpretation) systems in which the affective expression must be associated to the causing event. In addition, it can connect to the categorical framework of recognition of affect and respectively utilize the available systems for automatic acknowledgment of facial affect that are developed according to the definite scheme. The representing of a motivation, established by a particular human in a particular circumstance and at a particular instant of occasion, leads to elicitation and differentiation of emotions [22].

Facial Expression Recognition is fast becoming area of importance in human computer interface. This paper shows [23] the methodology for a well-organized facial expression investigation and classification. The most communicative way of demonstrating the sentiments by human is all the way through the facial expressions. Here author shows a acknowledgment of facial expression is researched with the help of numerous properties join together with the face itself. As facial expression transforms then the curvatures on the expression and belongings of the objects such as, eyebrows, nose, lips and mouth area are also transforms. In the similar technique for concentration of corresponding pixels of images also changes. Here author have used some statistical parameters to calculate these transforms and calculated consequences changes are confirmation as feature vectors. Artificial neural network is used to categorize these characteristics in to six worldwide appearances for instance anger, disgust, fear, happy, sad and surprise. This appearance analysis is done [23] on the source of statistical parameters such as entropy, skewness and kurtosis. Features are extracted from difference images and these features are classified using the two layer feed forward neural network. For training this neural network Scaled Conjugate Gradient Back propagation algorithm is used. Experimental analysis shows that these methods are good on the basis of statistical parameters.

Here they present [24] automated, concurrent representations construct with machine learning algorithms which utilize videotapes of subject’s faces in combination with physiological amounts to forecast timed emotion. Input consisted of videotapes of 41 subjects observing expressively evocative films along with evaluates of their cardiovascular movement, somatic activity, and electrodermal responding. So the author try to find with the help of algorithms based on extracted points from the subject’s faces with their physiological answers. Strengths of the existing come within reach of are (1) we are evaluating real performance of area under discussions observing emotional videos as an alternative of actors making facial masquerades, (2) the training data permit us to forecast both emotion type i.e. interested in opposition to unhappiness as well as the intensity level of each feeling, (3) we provide a direct evaluation between person-specific, gender-specific, and wide-ranging models. Consequences shows good fits for the models in general, with enhanced presentation for emotion grouping than for emotion intensity, for laughter ratings than unhappiness ratings, for a full model using both physiological calculates and facial trailing than for moreover indication unaccompanied, and for person-specific models than for gender-specific or general models.

In this paper [25], author has proposed a hierarchical structure based on Dynamic Bayesian Network for concurrent facial characteristic following and facial expression recognition in contrast to the typical move towards, we put together a probabilistic model supported on the Dynamic Bayesian Network (DBN) to capture the facial communications at different stages. Consequently, in this proposed model the flow of information’s two-way, not only bottom-up, but also top-down by steadily characterizing and modeling put in the ground relationships among different stages of facial behavior, besides the temporal evolution information, not only the facial characteristic patching can add to the expression/AUs recognition, but also the expression/AU recognition helps to additional get better the facial feature tracking presentation.

In this paper [26] author has investigation the modern progress in 3D and 4D facial expression recognition. Here author try to find the new research expansions in 3D facial data acquisition and tracking, and author in attendance at this occasion accessible 3D/4D face databases appropriate for 3D/4D facial expressions examination besides the subsisting facial expression recognition systems that make use of either 3D or 4D data in aspect. As a final point, confronts that have to be concentrate on if 3D facial expression recognition systems are to become a part of prospect requests is comprehensively conversed. Finally of all exceeding expression analysis arrangements will necessitate to become more forceful and be able to become accustomed to impulsive expressions and additional composite situations.

VII. Conclusion

Facial expressions make available susceptible signs about emotional answers and contribute a most important responsibility in the learning of psychological phenomenon and it may standardize social performance, signal communicative objective and are shared to speech production. As accurate and robust facial expression analysis could improve the performance of facial recognition systems that are used widely

in security or surveillance systems. Automatic facial expression analysis is capable of provide as an efficient tool for scientist in other fields. A robust automatic facial expression system can help to make all these potential applications into reality.

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