Facial Emotion Detection Using Cubic Bezier Curve

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***Abstract*—** *The facial expression recognition has been increasingly popular research in recent years. Human facial expression plays significant role in interpersonal relations, because human can demonstrate and convey a lot of evident information visually rather than verbally. Extracting and understanding of emotion is of high importance for the interaction among human and machine communication system. Recognition of human emotions using facial expressions without any effort or delay but reliable facial expression recognition by computer interface is still challenge. One of the means of showing emotion is through changes in facial expression. In this paper a Bezier curve algorithm is used which identify the person's emotional state through facial expression such as happy, sad and surprise. The result indicates the good Performance improvements due to the consideration of facial element and muscle movements.*

***Keywords*— facial expression, Bezier curve, emotion recognition, features selection.**

I. INTRODUCTION

Facial expression detection plays a vital role in pattern recognition, computer vision, and human computer interaction, is broadly used in personalized healthcare, video games, surveillance systems, humanoid service robots, and multimedia [1]. Facial Emotion Recognition has attracted significant amount of research interest over the last couple of years as it can make current products and solutions more user context aware many supervised approaches [2]. Facial expressions are a way to express human emotions and also provide gestures during social interactions. Facial emotion recognition is the method of extraction and classification about facial expression information by computer. Human face varies from one person to another person due to physical characteristics therefore the detection of face is more challenging task [3]. Affect and emotion play an important role in humans and are a necessary part of human interaction. Humans afford their communication partner with cues, giving information about their intention, demand and affective state [4]. Facial expression is a fundamental mode of communicating human emotions; effective expression analysis depends upon the accurate representation of facial expression.

This paper proposes the framework which adopts the feature based approach. Although humans are filled with various emotions as the facial muscles movements help to identify human emotions, basics facial features are eyes, nose and lips. There are various approaches are present for the feature extraction in emotion detection and they are powerful for describing local appearances but this method needs only the pixel values of local features of the face, hence the Bezier curve is used to extract the feature points from face. The framework considers the feature points of eye and the lip.

II. BACKGROUND

The method proposed in [1] that is to identifying the most significant discriminative characteristics for each emotion category, in an attempt to address the above challenges. It integrate the spiral search performance of the moths, attractiveness search events of the fireflies, and Simulated Annealing (SA) embedded with the Levy flights to increase local exploitation and global exploration and, at the same time mitigate the early convergence problem of the Levy-flight firefly algorithm (LFA) and the moth-flame optimization (MFO) algorithm. The system is composed of three key steps, Firstly, a novel texture descriptor is proposed, which incorporates the use of Local Binary Patterns (LBP), Local Gabor Binary Patterns (LGBP), and LBP variance (LBPV) to capture local spatial patterns and contrast measures of local texture to recover an initial discriminative facial representation. Secondly, the proposed variant of the firefly optimization algorithm is used to recognize the most significant and discriminative features of each emotion category. Thirdly, single and ensemble classifiers are use for recognizing seven expressions (happiness, fear, disgust, surprise, sadness, anger, and neutral) based on the resulting optimal feature subsets. The proposed method is Efficient in solving optimization problems.

A personalized model is constructed in [2] by learning neutral appearance of the user online using a set of reference neutral frames, thereby overcoming the problems caused by facial biases, lighting conditions, etc., as both learning and testing happens on the same user. Emotion based reference model using emotion frames is difficult to generate and it also may not generalize, as it requires many different kinds of emotion frames from a user for model construction, thereby also increases computational complexity. Moreover, the system would require a user interface that will guide the user to give all kinds of emotions before generating the reference model using all such frames. Hence, neutral frames are the preferred choice for reference model building.

The method proposed in [3] computer detects the emotion of the user based on three elements or factors. That is: addict style of typing, text content analysis and the distinction in the heart rate.

Cognitive systems with the ability to identify changes in the user's affect during HCI in order to respond adequately. Due to the emotions predominantly expressed during HCI the importance of negative affects in HCI and the detectability of negative emotions. Speech as a modality provides rich information on both material and Meta level, allowing the identification of clear-text messages and giving cues on the speakers' inner state [4].

The human emotion recognition by means of the analysis of the heart rate variability (HRV) with varying spectral bands based on respiratory frequency (RF). Three specific emotional states are compared equivalent to calm-neutral state (Relax), positive elicitation (Joy) and negative elicitation (Fear) [5].

This paper presents the brief introduction of facial expression in section I. Section II discusses background. Section III discusses previous work. Section IV discusses existing methodologies. Section V describes proposed methodology. Section VI discusses analysis and discussion. Section VII discusses the possible outcomes and result. Finally section VIII concludes this paper.

III. Previous Work Done

Zhang et al. (2016) [1] proposed facial expression recognition system with a variant of evolutionary fire-fly algorithm for feature optimization which includes a new LBP descriptor for feature extraction, a new M-LFA algorithm for feature optimization, as well as single and collection of classifiers for facial emotion detection. The proposed M-LFA feature selection algorithm benefits from local exploitation of moths and attractiveness behaviors of fireflies simultaneously to identify local and global optimal solutions. It employs spiral search of the moths to increase local exploitation of LFA and the attractiveness search actions of the fireflies to cause sudden optimal movement of the fireflies and their attached moths to in- crease global exploration of MFO. SA-embedded Levy flights search diversification has also been used to increase exploitation of the current global best solution.

Chiranjeevi et al. (2015) [2] proposed that a light-weight neutral versus emotion classification engine acts as a pre-processer to the traditional supervised emotion classification approaches. It dynamically learns neutral appearance at key emotion (KE) points the proposed method is made robust to various types of user head motions by accounting for affine distortions based on a statistical texture model.

Anil Kumar K M et al. (2015) [3] proposed that a multimodal approach to detect emotions by analysing elements like the dynamics of the user's keystroke, semantics of the text and variations of the heart rate.

Hartmann et al. (2013) [4] present a justifiable feature selection for emotion detection from speech which is based on the "PAD emotional state model" and show how to relate measurable features to emotions and provides cognitive systems with the ability to identify changes in the user's affect during HCI in order to respond adequately.

Valderas et al. (2015) [5] proposed human emotion recognition by means of the analysis of the heart rate variability (HRV) with unreliable spectral bands based on respiratory frequency (RF). Three specific emotional states are compared corresponding to calm-neutral state (Relax), positive elicitation (Joy) and negative elicitation (Fear).

IV. Existing Methodology

A. Facial Expression Recognition System Using Fire- Fly Algorithm:

The facial expression recognition system which includes a new LBP descriptor for feature extraction, a new M-LFA algorithm for feature optimization, as well as single and collection of classifiers for facial emotion recognition. A LFA variant, known as M-LFA, is proposed for feature optimization. It searches the spiral search behaviour of the moths and attractiveness search performance of the fireflies to mitigate the early convergence problem of the conventional LFA and MFO models. MFO employs a logarithmic spiral function to update the position of a moth.

$$S(M_i, F_j) = D_i.e^{bt}.\cos(2\pi t) + F_j$$

In comparison with the flames in MFO, the fireflies not only represent the best solutions recognized by the moths, but also proceed the search agents guided by the attractiveness function to cause sudden movements of the fireflies and associated moths to enlarge global exploration. Therefore, it increases local utilization of LFA and global exploration of MFO to guide the search process towards global optima [1].

B. A Personalized Pre-Processing Method:

A fast online pre-processing method is proposed in a light-weight neutral vs. emotion classification engine that acts as a pre-processer to the traditional supervised emotion classification approaches to detect neutral vs. any other emotion using personalized appearance models in order to take care of accuracy and speed limitations of traditional supervised methods. It dynamically learns neutral appearance at key emotion (KE) points the proposed method is made robust to various types of user head motions by accounting for affine distortions based on a statistical texture model [2].

C. Multimodal Approach For Emotion Detection:

Emotion is a feeling, a behavior, a state of mind of a person that is caused due to internal or external factors. Emotions are detected predominantly using analysis of textual contents even though there are other means such as analysis of speech, facial expressions etc. In this multimodal approach the Keystroke dynamics the process of analyzing the way a user types on a keyboard and identify him based on his habitual typing rhythm. In text based detection two processes are undertaken namely Data collection and Analysis of textual documents from JAWS and NLTK approach and In heart rate variation determination of emotion based on heart rate relies on the fact that the amount of light being absorbed depends on the volume of blood present in the region of interest to detect user's emotions [3].

D. Emotion Detection From Speech:

The method provides cognitive systems with the ability to identify changes in the user's affect during HCI in order to respond adequately. Based on the "PAD emotional state model" is describe and measure emotions. The PAD model uses a dimensional approach to describe emotions, opposing to using categorical models. In the PAD space emotions are expressed in terms of quantities of pleasure (P-axis), arousal (A-axis) and dominance (D-axis).The axes may be continuous, although it is more common to partition the axis in discrete values corresponding to labels such as "high", "low" or "medium". The common use of categorical axes labels for the dimensional model is due to a lack of continuous input [4].

E. Emotion Detection Using Heart Rate Variability:

Heart rate variability (HRV) with varying spectral bands based on respiratory frequency (RF). Three specific emotional states are evaluated corresponding to calm-neutral state (Relax), positive elicitation (Joy) and negative elicitation (Fear). Standard HRV analysis in time and regularity field is performed. In order to improved characterize the HRV component connected to respiratory sinus arrhythmia; the high frequency (HF) band is centered on RF [5].

V. Analysis And Discussion

A variety of emotion detection methods are described and categorized and these varies according to different academic theories. The facial expression recognition system, which includes a novel LBP descriptor for feature extraction, a novel M-LFA algorithm for feature optimization, as well as single and ensemble classifiers for facial emotion recognition. The proposed algorithm is able to take out spatial patterns and contrast measures of each image region for facial analysis, in order to better deal with enlightenment changes, rotations, and scaling differences. The empirical findings indicate that it out-performs conventional texture descriptors for facial expression recognition. M-LFA is proposed for feature optimization. It searches the spiral search behavior of the moths and attractiveness search performance of the fireflies to mitigate the premature convergence problem of the conventional LFA and MFO models. Specifically, it employs the logarithmic spiral search of the moths to increase local exploitation of the fire-flies. In comparison with the flames in MFO, the fireflies not only represent the best solutions identified by the moths, but also act as the search agents guided by the attractiveness function to cause sudden movements of the fireflies, associated moths to increase global exploration and Efficient in solving optimization problems. Therefore, it increases local utilization of LFA and global exploration of MFO to guide the search process towards global optima but there may be improvement in efficiency for increase the convergence speed [1].

Procrustes Analysis method is used to align each input shape to a common shape. CLM to track *N* facial feature points in each frame. CLM fitted input shape is aligned to a pre-trained mean shape model using procrustes analysis to compensate for affine variations. Then the resultant shape is chosen as the *reference shape* at t=0. Procrustes matrix is calculated using a set of non-emotive points of the tracked facial feature points – nose and eye points (anchor points) - which generally do not have spatial displacement when the user moves from neutral to emotion and vice versa, and are termed as stable CLM points. For the Selection of Key Emotion Points All CLM tracked points are not affected equally by the facial expressions. Lower eye brow CLM points are affected majorly by Inner portion of the brows is raised, Outer portion of the brows is raised and Brows lowered and drawn together. The mouth corner CLM affected by Lip corners are pulled obliquely, the corners of lips are pulled down and the chin boss is pushed upwards. As a result, the probability of error

incurred by the AU classification system is reduced but it may not handle [2].

TABLE 1: COMPARISON BETWEEN DIFFERENT EMOTION DETECTION TECHNIQUES

Emotion detection technique	Advantages	Disadvantages
M-LFA algorithm for feature optimization	Efficient in solving optimization problems.	Convergence speed is low.
Neutral Face Classification Using Personalized Appearance Models	1) Low complexity. 2) Saves computation cycles of ER system.	1) May not handle talking faces. 2) May not succeed under large and abrupt pose variations.
Multimodal Approach	It is non-intrusive and easy-to-obtain.	Incapability of Recognizing Sentences without Emotional Keywords.
emotion detection from speech	Speech is easy to record even under extreme environmental conditions (temperature, high humidity and bright light) requires cheap, durable and maintenance free sensors.	Depend on age and gender. Angry males show higher levels of energy than angry females. It is found that males express anger with slow speech rate as opposed to females who employ a fast speech rate.
Human emotion detection using heart rate variability	1) A measure of emotional response to certain stimuli. 2) Used in various medical applications.	Anger and Sadness is not implemented.

VI. PROPOSED METHODOLOGY

This paper proposes recognition of facial expression and the emotion using Bezier curve. The most notable application of the Bezier curve includes the interpolation approximation, object representation, and curve fitting. The main aim of the algorithm is to find the points in the middle of two nearby points and repeats this until there is no more iteration. The new values of points results in curve. The Bezier curve is based on four control points and it is used generate counter points considering the global shape information with curve passing through first and last curve points. To categorize facial emotion firstly need to determine the expression from facial movements of facial control points.

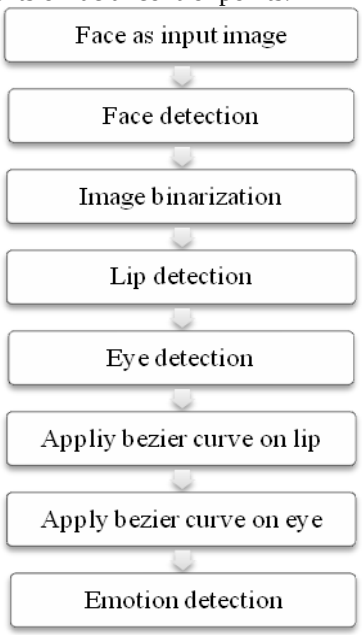

Figure 1: Flow Diagram of Proposed Frame Work

Algorithm:

Step1: Input image.
Step2: recognize face detection.
Step3: convert RGB image to Binary Image
Step4: recognize eyes of binary Image.
Step5: recognize lip curve in Binary Image.
Step6: use Cubic Bezier curves to draw two Bezier curves of the lip, one for upper lip and one for lower lip.
Step7: apply Bezier curve on eyes, remove eyebrow from eye.
Step8: Using Bezier Curves of the Lip and Eye emotions can be detected.

i) Happy
ii) Sad
iii) Surprise

The method proposes recognition of facial expression and the emotion, the detection and analysis of facial area from the original input image. The eyes and lips region appear to be the most vital facial regions to reveal the truth about the expressed emotions. The method locates and recognizes a face in a color image based on the skin color and the region of eye and mouth. For the face detection the RGB image is converted to the binary image. For converting the binary image, the average value of RGB for its pixel is calculated. Then the method estimates a face position and the region of facial location for eye and mouth by using feature map. After the face is detected from the color image then the various parts such as eyes, lips etc. are identified and the feature points are extracted then the Bezier curve is applied on eye and lips then understanding and recognition of facial emotion is performed. By using this framework

the emotions like happy, sad and surprise detected easily.

VII. Possible Outcomes And Result

The expressions happy, sad and surprise are considered in the facial emotion recognition by using this approach. The framework is mainly designed to detect human emotions from face by the input image. The faces with expression are compared with the model face database. All the face images are normalized using some parameter. To categorize the facial emotions firstly need to determine the expression from movements of facial control points. Then understanding and decision of facial emotion is chosen by similarity in faces. By using this approach the emotions expressed by human face can recognize easily.

VIII. Conclusion

This paper presented the simple approach for the recognition of the human facial expression analysis. In this paper propose a framework that automatically detects human emotions on the basis of facial expression. The algorithm extracts the emotions from different colored facial images and focused on many factors such as face detection, lip detection, end eye detection. This recognition system provides the best result for some sets of data and indicates the good performance.

IX. Future Scope

The scope and further improvement includes the system detect the human emotion easily using segmentation methods such as support vector machines to simplify the process and gives result accurately.

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