Lucy - The Visualizer

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***Abstract*- In today's hyper-connected world of smart devices and appliances our technology has lots of Intelligence Quotient, but no Emotional Quotient and lots of cognitive intelligence but no emotional intelligence. "The average application uses 10% of the human's emotion. Imagine what they could do with 100%". This tagline was the inspiration for the project. So, we thought of taking a step ahead in the evolution of applications. The main goal of this project is to make the application to understand the human's emotions and respond to it by using AdaBoost algorithm and OpenCV library. AdaBoost is a machine learning algorithms which if formed from a sequence of weak classifier. Each of weak classifier forms a cascade and contributes a strong classifier in this project as face detector.**

***Index Terms*- Emotion recognition, Face detection, Responding to Emotions, AdaBoost.**

I. INTRODUCTION

In today's world, there are two types of interaction found among people. They are human-to-computer interaction and human-to-human interaction. The later type of interaction is easy as humans know how to respond to certain stimuli whereas machine which have more intelligent quotient does not have emotional quotient. **What if technology could understand our emotions? What if our devices knew when to shut up and let us be, and when to tread gently and support us?** In today's scenario, the applications use 10% of human's emotion when capturing a photo, it auto detects a smile and snaps a photo. So, this project aims at responding to universal emotions. Joy. Sadness. Surprise. Fear. Disgust. Anger. These are all universal emotions, according to the theories of Psychologist Paul Ekman.

This paper presents brief introduction of Emotional analysis in section I. Section II describes six universal facial expressions and features. Section III gives a study of related works. Section IV includes phases of Lucy-The visualizer. Section V consists of a brief explanation of AdaBoost algorithm. Section VI includes future enhancements.

II. CATEGORIZING FACIAL EXPRESSIONS AND IT'S FEATURES

Although humans are filled with various emotions, modern psychology defines six basic facial expressions: Happiness, Sadness, Surprise, Fear, Disgust, and Anger as universal emotions. The movements of facial muscles help to identify human emotions. Eyebrow, mouth, nose & eyes are basic facial features that is used to detect facial expressions.

Emotion	**Definition**	**Motion of facial part**
Anger	Anger is associated with unpleasant, irritating, or frustrating situations. This emotion may be harmful so, humans are trying to avoid this emotion. Secondary emotions of anger are irritation, annoyance, frustration, hate and dislike.	Eyebrows are squeezed together to form a crease, and eyelids are tight and straight. The head is often slightly lowered as the eyes look through a lowered brow.
Disgust	Disgust is a feeling of dislike. Human may feel disgust from any taste, smell, sound or tough.	Lip corner depressor, nose wrinkle, lower lip depressor, Eyebrows pulled down.

Fear	Fear, like surprise, is closely rooted to instinct and indicates a desire to avoid or escape something.	Widened eyes and eyebrows slanted upward. The mouth is usually open to some degree as well.
Happiness	Happiness is most desired expression by human. Secondary emotions are cheerfulness, pride, relief, hope, pleasure, and thrill.	Indicated by a smile and crescent-shaped eye, this face is even innate in infants.
Sadness	Sadness is coupled with feelings of loss and helplessness. It is an indication of defeat as well, a sense of giving up or a lack of attempt to engage with others.	Sad expressions usually display upwardly slanted eyebrows and a frown.
Surprise	This emotion comes when unexpected things happens. Secondary emotions of surprise are amazement, astonishment.	A look of surprise is easily identified by its widened eyes and gaping mouth.

Table -1: Universal Emotion Identification

III. RELATED WORK

Emotion recognition consists of separate phases like face detection, feature extraction and emotional analysis. The papers which provided insights on these modules are:

A. Facial Expression Recognition using Decision Trees [1]

The contribution from this paper is that majority of studies in this field are focused on the geometric approach; where only some regions of the face are used to define an emotion (example eyes, eyebrows, mouth). In this paper, the general process of emotion recognition is introduced, and a new combination of parameters are given for classification of facial expressions based on distances computed between four parts on the face: eyebrow, eyes, nose, and mouth. The challenges in face detection process includes when an existing structural feature must be found, even when the pose, the view or the lighting condition changes. The future enhancement of this paper is introducing other parameters such as pose of the face.

B. Learning Personalized Models for Facial Expression Analysis and Gesture Recognition [2]

This paper focuses on the approaches for automatic detection of body movements and analyzing emotions from facial features which heavily rely on advanced machine learning algorithms. Transfer learning and personalization approaches for facial expression analysis and accelerometer-based gesture recognition. The proposed method is based on a regression framework which is trained to learn the relation between the unlabeled data distribution of a given person and the parameters of her/his personalized classifier. The future enhancement of this paper is using a pre-trained regression function, its computational cost can be reduced much lower than other domain adaptation algorithms.

C. Face Detection and Facial Feature Extraction Based on a Fusion of Knowledge Based Method and Morphological Image Processing [3]

This paper focuses on facial feature detection techniques which aims to extract specific features such as, pupil, eye corners, nostrils, corners of lips, etc. The face detection methods are divided into three categories. They are Knowledge-based, template matching-based, and appearance feature-based methods. An extensive research has been addressed to enhance Human Computer Interaction (HCI). Facial expression recognition would be useful from human facilities to clinical practices like pain monitoring for patients.

IV. PHASES OF LUCY – THE VISUALIZER

A. User snaps a photo or selects the image from the gallery
B. The image gets loaded in the application
C. The image is sent to OpenCV library

a. The Face Recognizer class is used to detect faces in the image
b. The result of this phase is a boundary which is marked over the face
c. The image is sent to Feature extraction phase

D. Feature Extraction Phase
a. The faces are cropped over the boundary
b. The face recognizer class uses feature extraction method to mark the features over the image
c. The feature is marked over eyes, nose and mouth endpoints

E. Emotion Detection Phase
a. The feature extracted image is sent to Face database
b. The Face database uses AdaBoost algorithm to define emotions
c. The confidence level is associated with the face emotion

F. Gender and age prediction
a. The Fisher faces algorithm is used to predict gender and age
b. The predicted age and gender is sent back to application

G. Responding to emotions
a. The application analyses the emotion and plays a media file corresponding to the emotion

V. ADABOOST ALGORITHM

AdaBoost is a short form of Adaptive Boosting. AdaBoost is machine learning algorithms and is proposed by Yoav Freund and Robert Schapire in 1995. It is to pick up a few thousand features and assign weights to each one based on a set of training images. The aim of AdaBoost is assign each weak classifier with best combining weights. More results were proved that it works in generalization performance. It consists of numerous of weak classifier to construct a strong classifier. Weak classifier just handle a slightly features, however, numerous of weak classifier can be used to increase overall performance. One strong classifier can't be computed a large input features in real time.

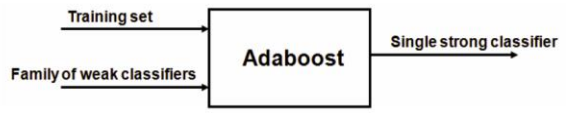

Figure 5.1: Basic idea of Adaboost

A. Why AdaBoost is used in this project?

AdaBoost algorithm is core methods in this project, the following are the advantages:

1. Simple to implementation: As you know, AdaBoost is a machine learning algorithm which only input two set of data. One is training dataset, other is a sequence of weak classifier. System is no need to concern about the facial structure.
2. Adaptive algorithm: AdaBoost is a short name of adaptive boosting, which means each of weak classifier will be adjusted their own weight when import positive and negative samples in learning stage of each iteration.
3. Theoretical training error index can tend to 0: Freund and Schapire in are proposed, given a numerous of positive and negative samples, the training error can reach to 0 value in numerous of iterations.
4. Fast Detection methods: In other research, AdaBoost got 15 frames per second of face detection with the size of resolution is 384x288 pixels which ran on PIII 700MHz computer.

VI. FUTURE WORK

The future enhancement that can be done to this project is do a live video streaming and analyze the emotions at the run time. The application can respond according to the emotion in the run time by playing some music in the background to ease the emotion.

VII. CONCLUSION

The project takes a step forward in solving the question "What if our devices knew when to shut up and let us be, and when to tread gently and support us". Thus, this project is responsible for detecting human faces in digital images effectively, no matter what person's ethnic, pose. Input image may be varied with face size, complex of background and

illumination condition. It is also responsible for detecting human's emotion and responding according to it.

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