Emotion Recognition using Open CV

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Abstract*: *The human face plays a pivotal role in identifying emotions, regardless of subject-independent features. For human-computer interaction, facial expressions form a platform for non-verbal communication. In this regard, a system which detects and analyses facial expressions, needs to be robust enough to account for human faces having multiple variability such as color, orientation, posture and so on. Our paper focuses on the technicalities which makes the system capable of addressing the variability associated with facial expressions. This is achieved using concepts of machine learning, deep learning and artificial intelligence. The focus extends to making human-machine interaction not only an interactive process, but also a user friendly one. The implementation makes use of a Haar Cascade Classifier, Tensorflow and openCv.

Index Terms*: *Facial Expressions, Haar Cascade Classifier, machine learning, non-verbal communication, OpenCV, Tensorflow

I. INTRODUCTION

In communication, there are three basic elements – Words (7%), Voice Tone (38%) and Non-verbal Behavior (55%), according to a study conducted by Albert Mehrabian [1]. We've come to observe that non-verbal behavior, such as facial expressions and body language, account for the biggest part of detecting emotions. According to psychological theory, the most classisc type of emotions include surprise, fear, disgust, anger, happiness and sadness [9]. Facial movement and tone likewise assume a major job in communicating these feelings. The muscles of the face can be changed and the tone and vitality during discourse can be purposefully altered to impart diverse emotions. As we all know, humans are very capable of detecting emotions based on facial expressions, but the same cannot be said for machines. A significant amount of processing is required in order to account for various features, such as color, orientation, posture and so on. Our project focuses on creating a software which is capable of not only detecting human faces, but also the emotions present on them. Recognizing the present emotional state of a person can have various applications, such as determining fatigue when driving and alerting in advance, observing facial expressions and changing the presentation style during e-learning and observing the patient's comfort level during healthcare.
The two classifiers being used are Haar Cascades and Local Binary Pattern (LBP) Cascades. While the Haar Cascades produces more accurate results, it places a heavier load on the system, as it uses floats to calculate the results. The decrease in speed however, is a worthwhile trade-off as the detection can work in the 95%+ accuracy range. The LBP Cascades on the other hand can be trained to perform similarly to the Haar Cascades, but there is an accuracy drop of around 10-20%. However, this places a much smaller load on the system as it uses integer values to perform the required calculations.

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II. RELATED WORK

A. Facial Feature Detection Using Haar Classifiers

A strategy was designed to precisely and quickly distinguish faces inside a picture. This strategy can be adjusted to precisely identify facial highlights. Be that as it may, the zone of the picture being broke down for a facial component should be mapped to the area with the most elevated probability of having the element. By localizing the recognition region, false positives are wiped out, and the speed of identification is expanded because of the decrease of the zone analyzed [2]. The results involving Human and computer Interaction can be made more accurate by considering attributes like posture, feeling which demands for the identification of the facial element and its course. Face identification has different frameworks which includes contours, flesh tones along with mathematical,to take a level higher,it also includes frameworks involving templates and neural network. The major hindrance with these kind of framework is that they are computationally not economical. An image is simply a collection of light intensity and/or color values. Breaking down these pixels for facial identification is tedious and hard to achieve in view of the wide varieties of shape and pigmentation inside a human face. Pixels frequently require reanalysis for scaling and exactness. Viola and Jones formulated an algorithm, called Haar Classifiers, to quickly recognize any article, including human faces, utilizing AdaBoost classifier cascades that depend on Haar-like highlights and not pixels. The methodology to detect faces in color images is discussed in [3].

B. Faces and Facial Features Detection in Color Images

According to [2], face identification is essentially about recognizing the area and dimension of each human face in a given picture. Human v/s computer interaction sector has detection of face as a prime factor. Face detection is the fundamental step in application based on detection of expressions, facial feature detection etc. There are numerous procedures utilized in face discovery and each one has its own upper hand as well as drawbacks. The first stage involves applying a skin detection algorithm in order to identify all the areas which have skin. The next phase involves extracting facial features such as the eyes, the nose and the mouth. Lastly, the extracted features are checked and verified as parts of the face [3]. Face identification has pulled in numerous analysts since it has a wide zone of uses. In the ongoing decade, the security frameworks dependent on the data about a client's character, similar to unique finger and sound print, now rely upon facial highlights. The extraction of these highlights from pictures is finished by utilizing face recognition strategies, and systems of the security frameworks would then be able to respond likewise.

C. Human Emotion Recognition System

A system was purposed in order to overcome the drawbacks (expensive, complex and time consuming) of identifying emotions through brain activity [4]. Emotions were identified based on concepts of feature extraction and neural networks. This was one of the inspirations to our approach.

D. Face++ API

Face++ is an API that is available for free, but limits usage and has a shared QPS capacity (1 query/second). In order to overcome this, they've introduced a pre-paid pricing plan which could go up to a 100$ per day. We're attempting to make our product free of cost [5].

E. Google's Cloud Vision

Google's Cloud Vision API is a powerful tool but process the image feed online, hence leading to slower response times. We're trying to increase response by making all calculations local to the system, as internet connectivity isn't reliable in all places across India [6].

F. SkyBiometry

SkyBiometry is a cloud based tool which analyses emotions in photos. Our product analyses a live camera feed and produces results accordingly [7].

G. Project Oxford by Microsoft

There are available archives for artificial intelligence APIs applied in the field of computer vision, language, speech, one such example is Microsoft's Project Oxford. The Microsoft's Project Oxford considers only still photos. Its response of face detection is in JSON and with extremely specific percentages of the 7 core emotions present on the face [10]. We've tried taking this a step further by identifying emotions from a live camera feed, and rather than giving percentages, we provide an accurate overall emotion.

III. METHODOLOGY

A. Training the Models

Haar and LBP cascade classifiers are used to detect the presence of faces. The one being used is the Frontal Face Classifier. The network is then trained to identify emotions using the Tensorflow Image Classifier. For training the network, several directories are created, namely "Happy", "Sad", "Surprised", "Sleepy" and so on. More directories can be added to identify more emotions. Each directory is then loaded with images of their respective emotions.

B. Haar vs LBP

"The algorithm designed by Viola and Jones is the Haar Classifier" [2]. For the identification of a feature which resembles**Haar**, the average of dark region pixel value and the average of light region pixel value are considered for the subtraction operation. The result is compared with the threshold and the feature is said to be present if the result value exceeds the threshold value [11].

Local Binary Patterns (LBP) is an efficient texture operator which uses labelling to identify features. It labels the image pixels by thresholding their neighborhoods with the center value, and stores the result as a binary number, as mentioned in [11]. This places a significantly smaller burden on the system, thus leading to widespread use.

Although, the Haar classifier produces better results, thus leading to our choosing of it.

Algorithm	Advantages	Disadvantages
Haar	1. High detection accuracy 2. Low false positive rate	1. Computationally complex and slow 2. Longer training time 3. Less accurate on black faces 4. Limitations in difficult lightening conditions 5. Less robust to occlusion
LBP	1. Computationally simple and fast 2. Shorter training time 3. Robust to local illumination changes 4. Robust to occlusion	1. Less accurate 2. High false positive rate

Figure 1: Haar vs LBP

C. Workflow of Project

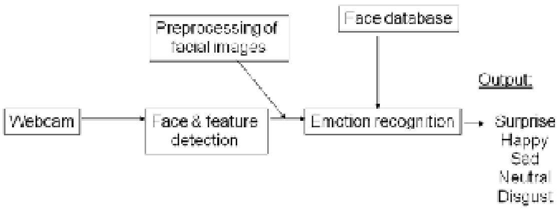

Figure 2: Flowchart of application

IV. RESULTS AND DISCUSSION

A. The Algorithm

Step 1: Start
Step 2: Open the application
Step 3: Begin capturing live feed from the device's camera
Step 4: Pre-process facial images
Step 5: Recognition
Step 6: Output is displayed
Step 7: Go to Step 3 until the application is closed

B. Design Flow of Face Detection

1. Input: Webcam feed
2. Haar features are identified
3. Integral images are formed
4. Feature Extraction
5. Adaboost
6. Face is detected and tracked

To begin running our application, we open the command prompt and begin the execution of our python program. This program makes use of openCv libraries to open the device's camera. Once the live feed starts, images are captured based on the given time frame and compared with the trained data. The identified emotions are displayed beside the detected face box, as shown in the following images.

C. Outputs

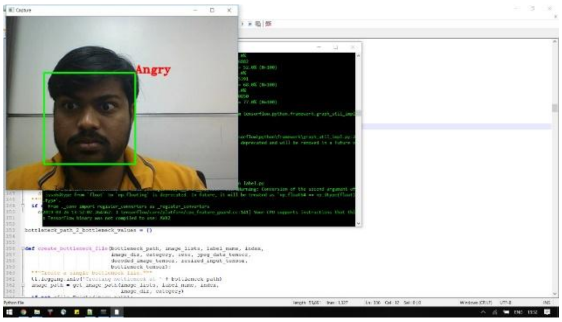

Figure 3: Angry

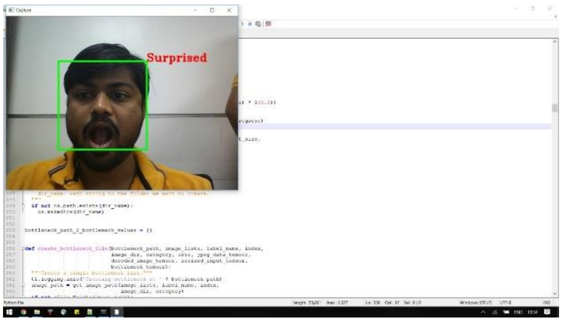

Figure 4: Surprised

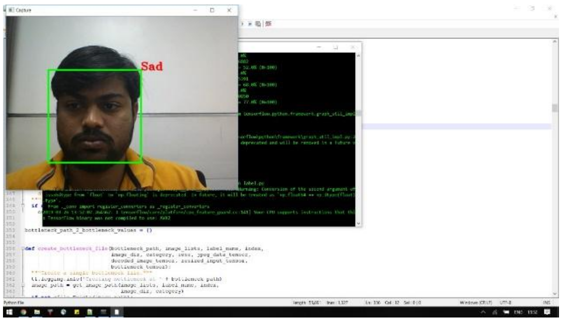

Figure 5: Sad

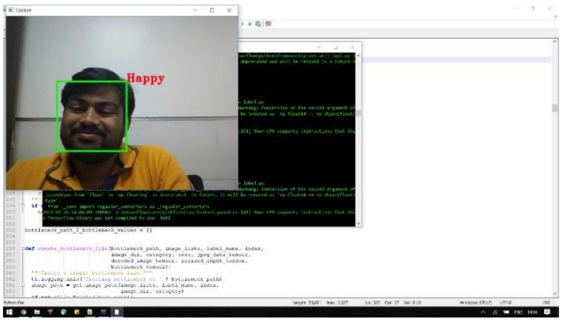

Figure 6: Happy

V. CONCLUSION AND FUTURE SCOPE

Our project forms the basis for better human-machine interaction. In its present state, the communication between humans and machines is very monotone, mainly consisting of speech-to-text conversion. By bringing human emotion into the picture, it's possible to make the responses of the machine better.

In the future, we would like to add an alarm system that would go off if the application detects that the individual's present emotional state is fatigued/sleepy, thus preventing potential accidents on the road. An interactive response system can also be added, thus making interactions feel closer to those made with other human beings.

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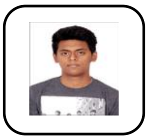

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