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Emotion Detection System Using Image Processing Techniques: A Case Study

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Abstract

When we investigate the last 10 years from a technological point of view, one thing becomes very apparent; technology has infiltrated all parts of human lives in every way imaginable to us, the number of devices in a person's home exceed the number of people itself, the time has come we can no longer ignore the presence of such devices since they hold immense computational power. In this project we want to bring about a very frequently discussed topic of automatically being able to detect human emotions. The project is developed as an android application. The proposed system is being developed using latest technologies such as OpenCV, Haar features, Android Studio, the project aims at face detection as well as emotion detection efficiently, quickly and in minimum amount of steps. The project can detect a wide range of emotions and the unique feature would be that it can detect the person's level and percentage of different emotions he/she is experiencing.

***Keywords:** Android, Emotion Detection, Face Detection, Haar Features, Human emotion, OpenCV*

INTRODUCTION

One of the singularities of human beings that have contributed enormously to the development and growth of mankind is the ability to communicate precisely with rich and powerful spoken (and later in history, also written) languages. Having said that, a significant percentage of what is communicated does not circulate through those languages, but through nonverbal cues. These cues can be in the form of gestures performed, for example, with the hands; or also facial expressions that convey information about what is inside but not necessarily spoken. Given how relevant facial expressions have been to human interactions, it is not surprising that they have been researched for centuries. In it is described how studies on facial expressions were already performed in the Aristotelian era —4th century BC. It can also be read how the foundations of current research were written in the 17th century. Then, in the 19th century Charles Darwin developed one of the important works on facial expression analysis that is more helpful for the science of automatic recognition performed by machines. His work classifies different expressions in groups by similarities, as well as the facial deformations associated to each of these groups. Then, in the 1970s the psychologist Paul Ekman and his associates developed essential work that has been referenced and used by the majority of posterior researchers on the topic of expression recognition.

With the development of computers and the rapid advancement of the capabilities of these machines, the research on facial expressions shifted from psychologists to computer vision scientists, and a myriad of papers and work have been developed to automatically recognize expressions, especially since the 1990s[3, 4].

Researchers trying to build automatic systems have dived into the topic from different approaches. Some have built systems that evaluate pictures and others have built systems that process videos, even in real time. In some cases the information provided by time is taken into account, with models that have memory, and in others the previous samples are ignored.

Researchers have also worked with occlusions of portions of the face, mostly the mouth or the eyes; some to discover what organs or regions convey more information and others to develop an algorithm capable of functioning without all the information available[2], [6, 7]. Different illumination conditions are tested, as well as camera angles —frontal face, profile, etc. and much more. Most of these approaches mentioned are based on a similar structure, where a first stage detectsand potentially tracksthe faces on the image, by means of multiple systems that involve an entire and very active branch of computer vision. Then the most relevant information of the face image extracted is processed and generally condensed so that it is easy to work with than the entirety of the pixels; but this is done in a huge amount of different methods. Finally, a classifier decides the emotion that considers most likely, and again, several different classifiers have been tested and trained in multiple ways [5].

Accompanying all the research that has been undertaken, there are several applications for automatic recognition of emotions. One of the most straightforward applications is for interaction between human beings and machines [6]. First, with the growth of robotics and the fact that an important part of human interactions are done through nonverbal communications, a necessary attribute of robots is the understanding of human emotions. And maybe with less priority but also important, if humanoid robots are build producing facial expressions similar to human beings will probably be desired, too.

In the project we have implemented emotion detection through the android platform, through the flow of this paper we shall be discussing the methodology and techniques that have been employed to develop this project.

LITERATURE SURVEY

Facial emotion recognition in real-time and static images

Abstract: The paper under consideration deals with emotion detection in two scenarios one being real time and the other bean still images otherwise also called as static images. The project that they have undertaken mainly used to databases one is the CK database and the extended CK database, this database is primarily consist of static images in the resolution 640 X 400 pixels. In the case of dynamic images they are using the help of a web camera. The primary goal and methodology employed to detect the emotions of the human face is by using HAAR filters from open CV.

EMOSIC- An Emotion Based Music Player For Android

Abstract:-The project aimed to develop an advanced technology by face of user. Playing the music playlist based on current emotions of the user or behavior of user. They had dataset consists of 50 voice samples to check the user feeling, emotions and mood. This was best way but slow and less accurate because it needs high computational, time, and cost. The method used is feature extraction, regression, valence arousal plane, tempo analysis. The problem statement is the music plays is very important role in an individual's life and it has been designed, classified and implemented hence, this

application consist of suggested songs and played according to the mood the user is feeling for their satisfaction.

A Novel Emotion Recognition based Mind and Soul-relaxing system

Abstract:-The project aims to enhance the ability of Computing Technology. In this proposal, for Human-Computer efficient interaction, Computer is programmed to understand human emotions like gesture, facial expression, speech, pose etc., by using Real Time Embedded System followed by playing an audio corresponding to the user emotionsHere, image is captured with webcam and algorithm like Viola-Jones is used for Real time Object Detection. OpenCV librabry, Local Binary Pattern and SVM classifier is used for feature extraction and classification.

Preliminary Research into Control System using Quantified Human Emotions

Abstract:-The preliminary research into how quantified human emotions can be read by a camera and integrated into the systems of machines/robots was conducted to improve their entertainment value. Generally, this degree of value and the success of the events which use such machines are evaluated by the number of attendees, the repeating rate of customers, the result of questionnaires, and so on.

Evaluating Effectiveness of Smartphone Typing as an Indicator of User Emotion

Abstract:-In computing, speech, facial expressions, physiological properties, Smartphone usage patterns and their combinations these different modalities are applied to detect the affective states of users. They analysis the keystrokes and study the typing behavior in desktop. The works efficacy of smart phone typing to detect multiple affective states by conducting experimental approach to answer the questions, by survey among120 participants to understand the typing habits in smart phone and collect feedback by multiple measurements.

Creation of a Facial Expression Corpus from EEG Signals for Learning Centered Emotions

Abstract:-This paper will mainly focus on facial expression using image learning using EEG signals techniques. In order to achieve facial expression recognition necessity parameters are image classification processing, EEG signal processing. The different categories of emotional such as boredom, engagement, interesting, excitement focused and relaxed. Two main variation of subdivisions is been created. And two different classifier algorithms will be used. Finally a validation of facial recognition will be performed to gain accurate results.

Emotional States Recognition by Interpreting Facial Features

Abstract:-In this evolving world of computers and humans are finding a way to interact with computers and computers intern interacting with people. To achieve human computer intelligent interaction, this must be a neutral emotion, which interprets users emotional status and adapt to the behavior appropriately. This paper aims to provide a software application which positions the shape of the face mouth nose and the face line in order to identify and recognize the facial expression. We use OpenCV an open source computer version and machine learning software lab.

Computer Vision for detection of body expressions of children with cerebral palsy

Abstract:-The main objective is to improve the communication with the patient in order for their better care. This article is about an investigation to improve the communication of computer with individual suffering from cerebral palsy

using Computer Vision. Cerebral palsy is cause of disability in children which prevents the development of movement and posture. The technology help by building a process that support people with special needs to improve their lifestyle.

TECHNOLOGIES USED

Andriod Studio

Android Studio is application software used to build android apps, which is operated in various android enabled devices. Written in Java, kotlin and C++.It was built on JetBrains' IntelliJ IDEA software by Google and available for download on Windows, macOS and Linux based Operating systems.

Android studio has wide range of user templets which lets the user to select among the templets depending on the requirement of the GUI. The User Interface for an Android app is build using below hierarchy of layout i.e., View Group objects, whose containers controls the child views position on the screen, and Widgets (View objects), which are UI components like buttons and text boxes.

An activity is component in the application that provides a screen with which user interacts to do any kind of thing, for example, take a photo, call to someone, play a game etc. Each activity has a window for UI.

Android uses xml to declare layouts of the page and each element and java to provide logic. Android studio also uses XML to declare UI elements in XML [4]. Java is the interactions between the app, elements and its core objects. XML in Android Studio is for designing the application and Java in Android Studio is for putting life to application.

We have chosen this particular project to be built it in Android, because At present, Almost everyone carry a smartphone, in which most have android OS, which is whythe project will become compatible in almost 90% devices.

The android studiolibraries have more than 2500 optimized algorithm which assist in classifications and functions. One of the libraries we have made use of is OpenCV which has haar classifier (consists of face detection algorithm). OpenCV consist of C++, Python and java interfaces and is platform independent which means it can work on any given platform [5].

OpenCV

Open source computer vision library (open CV) deals with open source and machine learning libraries. For training a cascade classifiers we need a set some positive images and negative images:Negative samples are taken from arbitrary images, which will not contain objects that you want to detect [3][7]. The samples are generated by negative images and should be listed in a special negative image file containing one image path per lines. The negative samples which are non-facial images are also called background images.

Using open CV samples application the positive samples are created. Thus it helps identify the object the algorithm is looking for. The application supports two ways of generating a positive sample dataset:

- From a single positive object images you can generate a bunch of positives.
- Or OpenCV lets you feed all the positive inputs yourself and cut out the negative images using the tool.

METHODOLOGY

Face Detection

Haar cascade mainly works with face detection. The algorithm requires a lot of training datasets the image which contain faces as positive dataset and images without faces as negative datasets. The next process will be extracting features from these images. For this, haar features

shown in Fig.1 are used. Each rectangle represents bright and dark spots of the image.These rectangles represent a single value obtained by subtracting dark spot with the bright spots [5, 6].

Consider Fig.1, the first row images shows nearly perfect images of classifier model. The region of eyes is darker then the bridge of nose and eye region is considered as black rectangle and vice-versa.

Each input image will undergo instance classification of determining if the input image contains a face or not. But for sure there will be miscalculations or misclassifications.
Furthermore the images with comparatively low error rate are considered and weighted sum of these week classifiers is computed. Week classifier because they cannot classify the image independently. The classifier dataset is well classified into face and non-face images.

Classifiers are more efficient and time saving while applying then applying each frame one–by-one. This way the classification is more accurate.

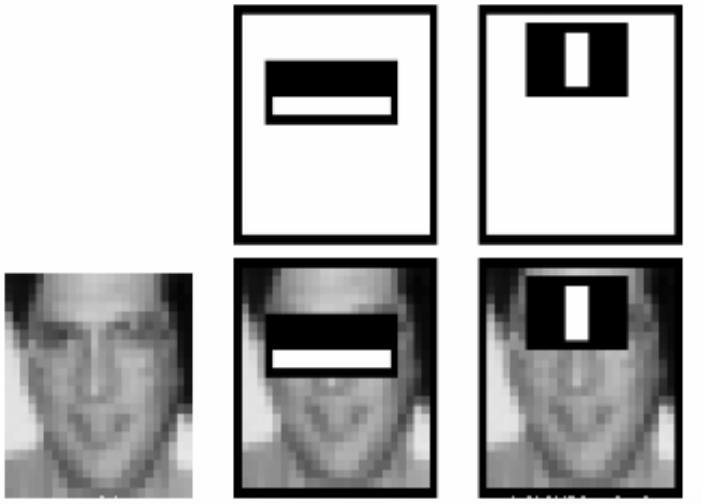

Figure 1: *Haar classifier.*

Feature Extraction

Feature extraction, in pattern recognition and in image processing, starts from measured dataset and building corresponding values which are intended to be informative and facilitating the learningand carry out steps to better human interpretations. Feature extraction involves reducing thenumber of assets used to represent huge amount of data. While performing complex calculations, large number of variables is likely to cause errors in the end result. Henceforth to overcome this problem we use a general method of combining variables and computing the problem [4] [5].

One of the important sectors of this application is images processing, in which the application algorithm detects and segregates shapes and points containing features of image or video on grey scale. It plays a vital role in optical object determination.Features are extracted following a step of calculating the pixel code value of a pixel in the metrics of an image. Based on that, the features are extracted particularly from those Grayscale image andthen the output is displayed.In software packages, Predefined interfaces provide for feature extraction and dimension reduction. The algorithms are available publicly.

Emotion Detection

Emotions and expressions are calculated using valance points which will be placed around the face. The distance and angle between these points calculates the category of emotion and gives the percentage (ranges from 0 to 100) of facial expression on the users face. For instance if the input is joy the total percentage is determined by the sum of all the expression and the difference of weighted sum of individual expressions. [2, 3] The respective emotions are displayed if the total exceeds the threshold value.

In addition to valance metric, the points also compute degree of confidence which calculates the probability of true population parameters. Higher the degree of confidence higher wills the accuracy of emotion detection.

As demonstrated in Fig.2, the valance point metric gives the comprehensive feedback of the face expression.The valance points on the user's face corresponds to the array of locations on the face. The value ranges from 0 to 100 specifying a neutral to positive face expression and the values ranging from 0 to -100 specify neutral to negative face expression [7].

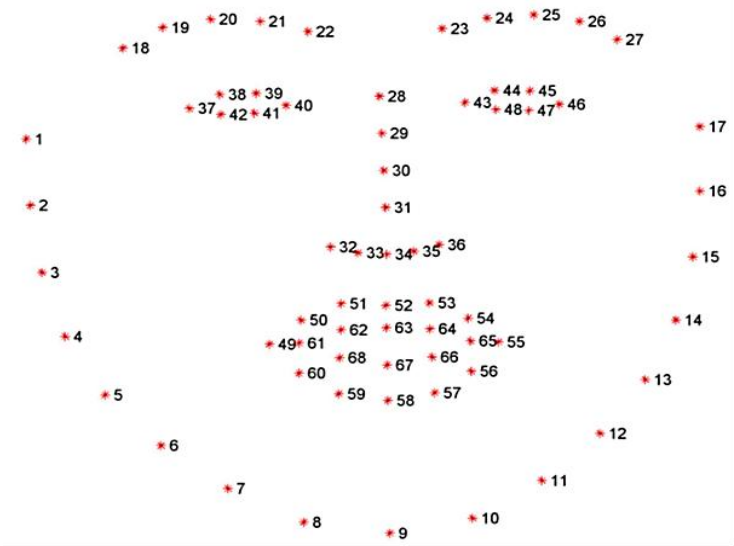

Figure 2: *Valance points detection.*

Block Diagram for Emotion Detection

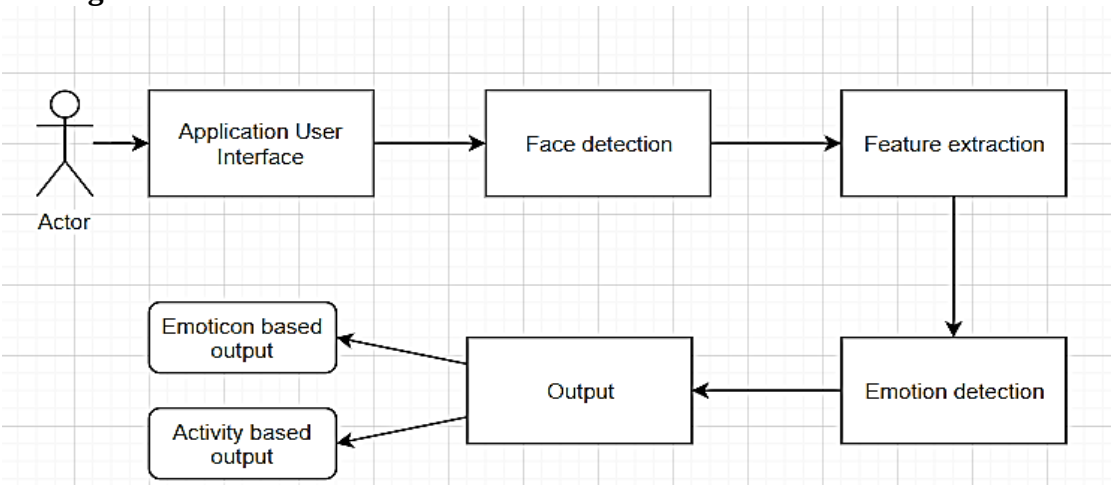

Figure 3: *Block diagram.*

When the user starts the application the app asks for the permissions to access camera, once the permission is granted the face is detected within the square box which is displayed on screen. Now the app identifies the edge points on the face in four primary reasons: Nose, eyebrows, eyes and mouth and the necessary features are extracted. Once features are extracted, emotions are detected and identified.

Once the face and valence has been determined the emotion are displayed in terms of percentage right above the face. Right beside the users face based on the emotion calculated the respective emoticons are displayed. The user interface also has three additional options to flip the camera, take a screenshot and access the application settings. The process is explained in the block diagram shown in Fig. 3.

EXPERIMENTSAND RESULT

The figures attached below are the real time images captured when the person has used the emotion detection application. The application takes input in real time i.e. dynamic images. The application detects and monitors the face even after it has calculated the percentage value of different emotions hence when the face expression changes the corresponding changes are reflected in the emotion detection which leads to the values of the percentages to change accordingly. Emoticons are displayed right next to the face and they are in accordance with the emotion detected.

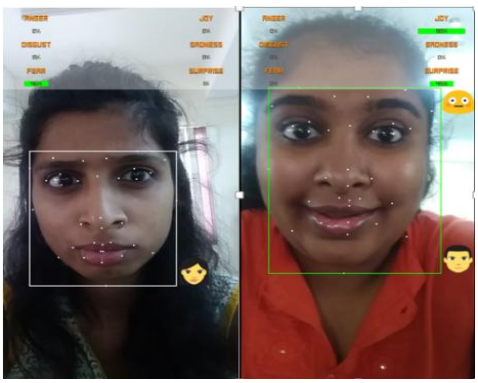

Figure 4: *Experimental result 1.*

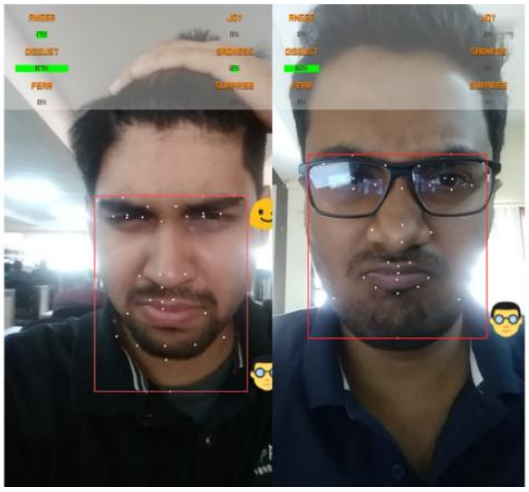

Figure 5: *Experimental result 2.*

CONCLUSION AND FUTURE WORK

We have developed an android based application that enables the user to detect his emotion and have connected his emotion into an output based system, which can either results in the corresponding emoticon, or a suggestion based output which would suggest activities to the user. A unique feature of the developed application is that it calculates the percentages of different emotions that the user is experiencing and the respective emotions are also displayed alongside when the emotion is calculate. Fig. 4 and 5 demonstrate the calculated percentage of emotion. The developed application is simple and user friendly, also the entire process has been developed to work quickly yet give an accurate output.

For the future, this app can be developed so that it is compatible on multiple platforms. The emotion can be used as an input in order to achieve a variety of outputs based on the requirements. The user interface can be enhanced to be more aesthetic and pleasing.

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