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Sentiment Analysis using Deep Learning

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Abstract: *"Sentiment analysis is a process that involves identifying and analyzing human emotions, including joy, love, surprise, sadness, fear, and anger. These emotions play a vital role in our daily activities, including decision-making, learning, inspiration, and thinking. With the use of sentiment analysis, machines can understand human behavior, which can be utilized to improve business requirements and customer satisfaction. This study proposes a sentiment analyzer system that utilizes facial landmark detection and feature extraction to capture real-time facial images and analyze the emotions expressed in the images. Facial landmark detection is a critical step in the proposed system as it accurately identifies specific regions of the face, including the eyes, nose, and mouth, which are essential in analyzing facial expressions. The proposed system was evaluated using a dataset of facial images with labeled emotions, and the experimental results demonstrated that the system achieved high accuracy in identifying human emotions from facial images. The system's performance was compared to several state-of-the-art methods, and it outperformed these methods in terms of accuracy and efficiency. The proposed sentiment analyzer system has broad applications in various fields, including marketing, healthcare, education, and social media analysis. This study provides insights into how facial landmark detection and feature extraction can be utilized to analyze human emotions, which can ultimately improve customer satisfaction and enhance business decision-making.".*

Keywords: Sentiment analysis, Emotion detection, Facial landmark detection, Feature extraction, Human behavior, Decision-making, Machine learning, Artificial intelligence, Facial expressions, Marketing, Healthcare, Education, Social media analysis, Accuracy, deep learning, Raspberry pi..

I. INTRODUCTION

Human sentiment detection is implemented in many areas requiring additional security or information about the person. It can be seen as a second step to face detection where we may be required to set up a second layer of security, where along with the face, the emotion is also detected. This can be useful to verify that the person standing in front of the camera is not just a 2-dimensional representation.

Another important domain where we see the importance of emotion detection is for business promotions. Most of the businesses thrive on customer responses to all their products and offers. If an artificial intelligent system can capture and identify real time emotions based on user image or video, they can decide on whether the customer liked or disliked the product or offer. We have seen that security is the main reason for identifying any person. It can be based on finger-print matching, voice recognition, passwords, retina detection etc. Identifying the intent of the person can also be important to avert threats. This can be helpful in vulnerable areas like airports, concerts and major public gatherings which have seen many breaches in recent years.

- Sentiment analyzer is the study of recognizing six universal expressions which are anger, joy, fear, happiness, sadness, and surprise.
- Our aim is to work in real time in which we detect the sentiments from the images that has been captured by the live cam or webcam.
- By capturing the images, we can get the real feedback about our product or services directly from the consumers even without asking them through their facial expressions.
- This way a business model can be improved through constant feedback. Our project is a prototype of an RASBERRYPI BASED sentiment detection system that uses pi camera along with a facial recognition system that helps us to detect facial expression and thereby improve services.

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II. PROBLEM STATEMENT

In present day technology human-machine interaction is growing in demand and machine needs to understand human gestures and emotions. If a machine can identify human emotions, it can understand human behavior better, thus improving the task efficiency.

Sentiment analysis in the field of business

Emotion recognition is already widely used by different companies to gauge consumer mood towards their products, brands, marketing efforts, staff, or in-location experiences. Understanding customer emotions is vital to ensure business growth and enhance experiences, however the opportunities brought by this technology goes further than market research and digital advertising.

Elections and sentiment analysis:

During elections also we can apply emotion recognition technology, when the speaker will complete his/her speech after that using our system a report will be generated which will provide the feedback of all listeners sentiments, this report will show the average percentage of each six sentiment. In this way, a party can make several decisions on the basis of the report and plan their future action in that particular area to get most benefit.

Emotion analysis for online education:

Anonymous emotion detection for online education is an ideal way to analyze the online student journey and improve it where necessary. Assess schools course materials, teaching styles, structure and layout by way of emotional feedback as student's go through each module in real-time. Use true facial responses and engagement levels to find points of interest or course stumbling blocks and make optimizations.

Objective

- To accomplish an interaction between human sentiments and machines.
- To get real time data of crowds at the same time with analysis.
- Get reviews of people on products.
- To improve business model through constant true feedbacks.

II. LITERATURE SURVEY

A Standalone Vision Device to Recognize Facial Landmarks and Smile in Real Time Using Raspberry Pi and Sensor by Navjot Rathour, Anita Gehlot, Rajesh Singh

In current scenario of technological advancement, human-machine association is becoming sought after and machine needs to comprehend human emotions and feelings. The productivity of an exercise can be improved to a considerable extent, if a machine can distinguish human feelings by understanding the human conduct. Feelings can comprehend by content, vocal, verbal and outward appearances. The major deciding factor in the identification of human emotions is Facial expression. Working with facial images and emotion is real time is a big task. It is also found that confined amount of work has been done in this field. In this paper, we propose a technique for facial landmark detection and feature extraction which is the most crucial prerequisite for emotion recognition system by capturing the facial images in real time. The proposed system is divided into three tightly coupled stages of face detection, landmark detection and feature extraction. This is done by HOG and Linear SVM-based face detector using dlib and OpenCV. The curiosity of our proposed strategy lies in the execution stage. Raspberry Pi III, B+ and a normal exactness of 99.9% is accomplished at ongoing. This paper can be proved as the basis of real time emotion recognition in majority of applications.

Arduino Stress Detector from EE122B, Introduction to Biomedical Electronics, by M.N Clooney Stress detector, is a system that measures stress level of a human being who is known to be under stress. This method has the potential to be precise and smoother. Stress brings negative consequences such as decreases in level of concentration, mental health issues such as anxiety and depression as well as ineffective ways of coping, such as substance abuse. In the market, there are smart phone's apps where people can hold a finger to the camera, which will then detect slight changes in

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color related to blood flow. If a person is able to recognize when they get stress and what they get stress from, it will be helpful for them to find ways to relieve it. It is our intention to address these gaps in the market and create a system that will be beneficial to a great many patients and health care practitioners by better assisting them by taking control of an elevated physiological response that has many negative health consequences. Through this project we aim to understand the various conditions that lead to stress, find suitable parameters to measure and detect it using arduino and then immediately present it to the user through an android app. This project describes our efforts and results in answering these questions. The most popular physiological markers of stress are as follows: Galvanic skin response (GSR); Electromyogram (EMG); Skin temperature; ECG; HRV.

"Real-time emotion recognition from facial images using Raspberry" by Suchitra, Suja P. and S. Tripathi

In present day technology human-machine interaction is growing in demand and machine needs to understand human gestures and emotions. If a machine can identify human emotions, it can understand human behavior better, thus improving the task efficiency. Emotions can understand by text, vocal, verbal and facial expressions. Facial expressions play big role in judging emotions of a person. It is found that limited work is done in field of real time emotion E &TC, SCOE 14 recognition using facial images. In this paper, we propose a method for real time emotion recognition from facial image. In the proposed method we use three steps face detection using Haar cascade, features extraction using Active shape Model(ASM), (26 facial points extracted) and Adaboost classifier for classification of five emotions anger, disgust, happiness, neutral and surprise. The novelty of our proposed method lies in the implementation of emotion recognition at real time on Raspberry Pi II and an average accuracy of 94% is achieved at real time. The Raspberry Pi II when mounted on a mobile robot can recognize emotions dynamically in real time under social/service environments where emotion recognition plays a major role

III. METHODOLOGY

3.1 Block Diagram

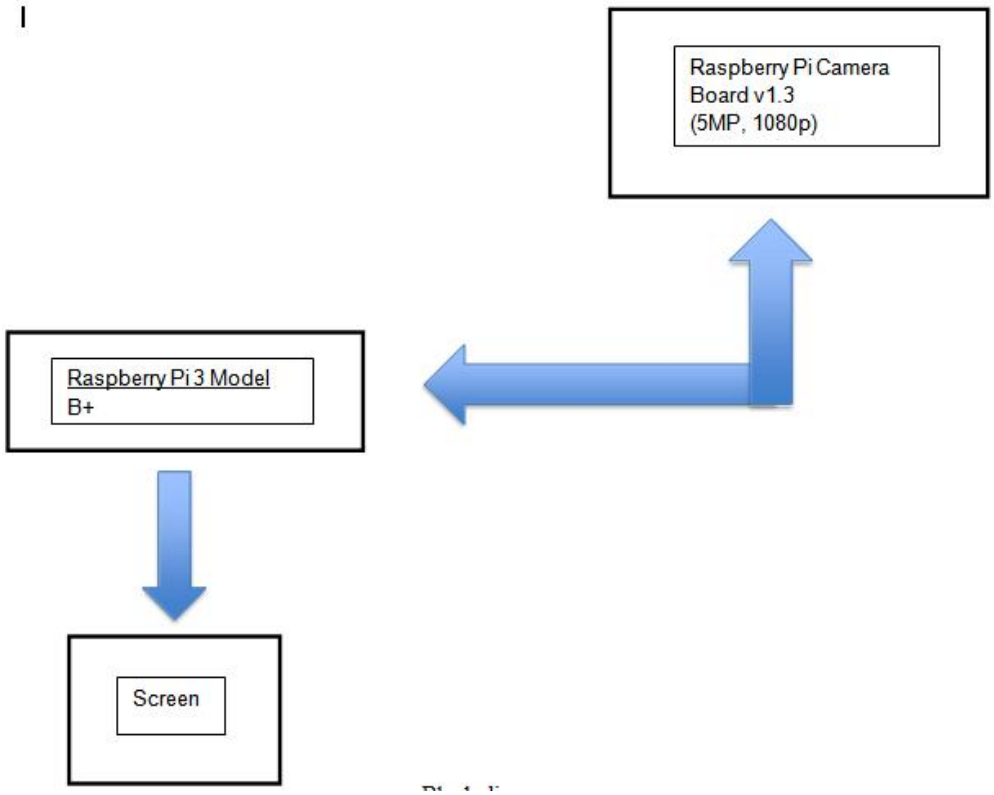

Fig. 3.1 shows the Block Diagram of Stress detector using Face Recognition

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3.2 Description:

Firstly we collect dataset for various sentiments. We made use of Kaggle website for doing the same. Now for making the model recognize sentiments by comparing them to the datasheet we train the model by applying deep learning. Libraries of Keras and Tenserflow are used for the purpose of training the model. Once the model recognizes the sentiments it needs to display it somewhere. So, for this we make use of open CV library. Raspberry Pi Camera Board v1.3 is the camera model which helps scan for faces and detect emotions. It sends data to Raspberry Pi 3 Model B+ which then assess the data to display the output report on the screen. The model firstly scans for a face, the result starts generating once a face is detected. In case of no face detection, no result will be generated. Now, once the face is detected it is then compared with many emotions in the dataset. On analyzing, the result is obtained in the form of a report for you to see on the screen. This is a real time report i.e. it will show data for the time the model detects sentiments. This report can be downloaded and used for further references as per need.

3.3 Circuit Diagram

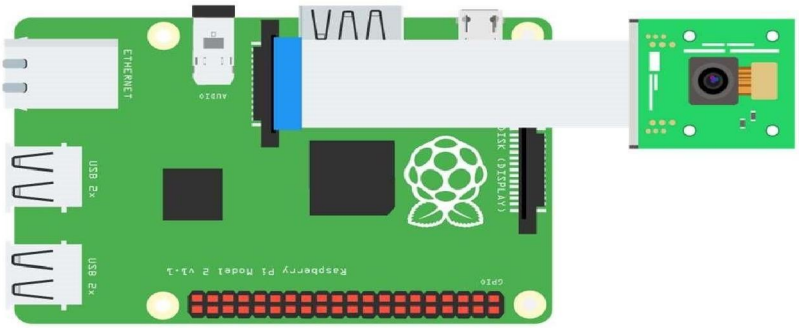

Fig 3.2 Circuit diagram of the System

Hardware and Software Requirements Hardware

Hardware is best described as devices or components that are physically connected to the computer that we can physically see and touch. Hardware will usually contain a circuit board, Integrated Circuits (ICs), microcontroller board and sensors. The hardware requirements of the system are:

- Camera
- Raspberry Pi

Camera

This Raspberry Pi camera module board is a high resolution 5MP camera that can take high-quality images. In addition to taking pictures, it can also record videos, making it perfect for Raspberry Pi projects like drones and CCTV. The Raspberry Pi camera board is suitable and practical to use as a concealed camera or cameras for Pi phones due to its small size and lightweight qualities.

Fig. 3.3.2 Camera Module

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Specifications:

- Resolution: 5 Mega Pixel 1080p
- Field of view: 160 degree
- Range: 50-60 m

Raspberry Pi:

A single-board computer the size of a credit card called the Raspberry Pi enables users of all educational backgrounds and computing skills to experiment with and learn about computation. It is an improved motherboard that the Raspberry Pi foundation created in the UK and is now generally acknowledged as a component of developing computer technology. Other pieces of peripheral gear, including a keyboard, mouse, and monitor, can be connected to the minicomputer.

Fig. 3.3.3 Raspberry Pi

Specifications:

- OS: Linux Based OS
- RAM: 4GB
- ROM: 16GB SD Card
- Processor: Broadcom BCM2711, quad core cortex- A72 (ARM v8) 64-bit SOC.

3.3.2.(a) Raspberry Pi Camera Board v1.3 (5MP, 1080p) :

Specifications:

- Still Picture Resolution: 2592 x 1944
- Fully Compatible with Both the Model A and Model B Raspberry Pi
- Video: Supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 Recording
- 15-pin MIPI Camera Serial Interface - Plugs Directly into the Raspberry Pi Board
- Size: 20 x 25 x 9mm
- Weight 3g

3.3.2(b) Raspberry Pi 3 Model B+

Raspberry Pi Model B+

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Specifications:

- Processor : Broadcom BCM2837B0, Cortex-A53
- 64-bit SoC @ 1.4GHz
- Memory : 1GB LPDDR2 SDRAM
- Memory : 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE
- Gigabit Ethernet over USB 2.0 (maximum throughput
- 300Mbps)× USB 2.0 ports
- Input power : 5V/2.5A DC via micro USB connector
- 5V DC via GPIO header
- Power over Ethernet (PoE)–enabled (requires separate PoE HAT)

Software:

A software requirement specification is a description of a future software system. Since it is an IoT/ Embedded project, we can use below specified software's to program the functionalities of the hardware components. The software requirements of the system are:

Raspberry Pi OS:

Raspberry Pi OS is a popular operating system designed for use on platforms that support Raspberry Pi. It is a flexible system that is on the basis of Debian. Raspberry Pi OS comes for about 35,000 packages and are compiled by a software It is in a format that is easy for installation. Raspberry Pi OS is an important system that is under progression having focus on improving the ability and performance for Debian packages. It is similar to many desktop OSs with GUI similar to that of Windows and Mac OS with mouse controls. It has a terminal window
where all required commands are executed

Python:

Python is an interpreted high level programming language used in Raspberry Pi to control the status and voltage level of the pins and also perform ML based algorithms on input images to detect and identify animals. Python is a powerful language as it contains a wide variety of libraries and frameworks that helps in quicker execution of quotes with a smaller number of programming lines. In this project python is helpful in acting as an embedded language for GPIO configuration to control voltage levels and statuses of the raspberry pi pins. Also, the backend framework is responsible for training this CV to identify the animals from the image. The weights are used to train the cv2 accordingly to encircle the animal in the output image with a rectangle indicating the boundary.

OpenCV:

OpenCV is an open-source computer vision machine learning software library built to provide a common infrastructure of computer vision applications to accelerate the use of perception among the commercial products.
It has 2500 optimized algorithms including a comprehensive set of classic and state-of-art CVs. The majority of these are used to identify objects, classify human actions, detect vehicles, extract 3D models, extract stereo camera images, and many other things. It is also used in enhancing upscaling, downscaling interpolation and other image processing applications in a simple and effective manner. It has C++, Java and MATLAB interfaces and supports multi-paradigm programming for higher level project synthesis. In this project cv2 is trained with weights to identify the region of interest in an image and extract if an animal is found. Since CV support libraries are strong enough, multiple presence of animals can be detected and identified.

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Flow Chart

Fig. 3.4 shows flowchart of sentiment analysis using deep learning

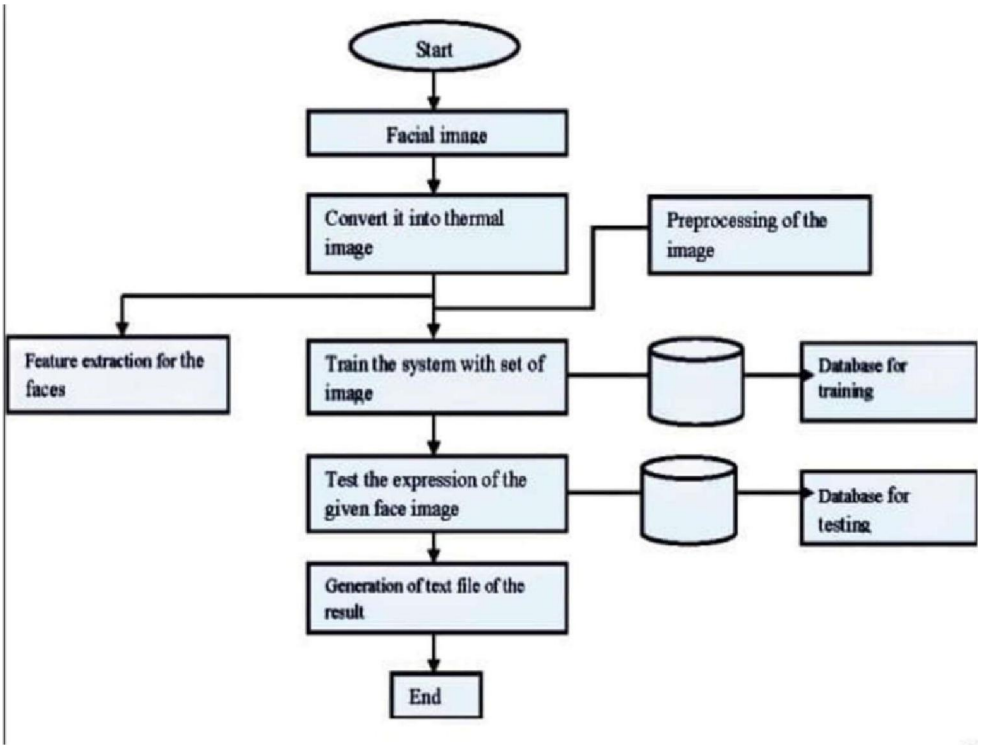
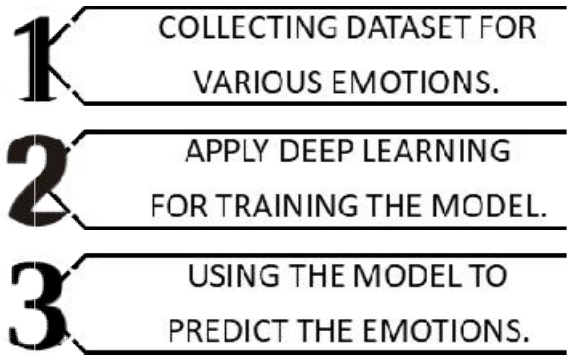


Fig. 3.4 Sentiment analysis using deep learning

Algorithm



- For data collection we will take help of Kaggle website.
- For training our model, we will use Keras and Tenserflow library.
- And at last, we will use Open CV library to see our result.

IV. RESULTS AND DISCUSSION

4.1 Performance Parameters

Performance parameters are metrics that measure the performance and progress of a project against its objective. Our suggested model's performance is based on two types of requirements, which are described below.

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Functional Requirements:

The Functional requirement defines a function of software or its component. Functional Requirements may be calculations, technical details, data manipulation and processing. Functional requirement is a specific functionality that defines what a system is supposed to accomplish. This project is a societal application which emphasizes the present business requirements, various feedback systems and the efforts to improve it. The main functional requirements of the system are:

- Use a camera to capture images of facial expressions of a human.
- Use of Raspberry Pi to transmit control signals to generate a report of percentage of different sentiments involved with high accuracy.
- At last, providing those reports to our clients which will lead to massive improvements in their respective domain.

Non-functional Requirements:

Non-functional requirements are characteristics of a system that define the standards by which the performance of a system may be evaluated rather than particular actions. In general, non-functional requirements describe how a system is intended to be, whereas functional requirements describe what a system is expected to perform. Non-functional requirements are sometimes referred to as system characteristics.

The quality objectives or limitations of a system to be created are known as non-functional requirements. It describes how our solution performs from the end user's perspective once it has been put into practice. The following are the system's non-functional requirements:

User-friendly: If a system can be used and understood with the help of an uncomplicated manual, it is user-friendly.

Reliability: The criteria for how frequently software fails. The parameter is sometimes stated as Mean Time Between Failures (MTBF). Before deployment, the system is rigorously tested for robustness. The module created in this way preserves data consistency.

Accuracy: Being true, correct, or precise is a state or attribute of accuracy. By examining the image that will be acquired by the camera, the system provides an exact count of the number of animals. One parameter for assessing classification models is accuracy. Accuracy is the proportion of forecasts that our model successfully anticipated. Formally, accuracy has the following definition: Accuracy=Number of correct predictions / Total number of predictions. For binary classification, accuracy can also be calculated in terms of positives and negatives as follows:

Accuracy=TP + TN / TP + TN + FP + FN

Where TP = True Positives, TN = True Negatives, FP = False Positives, and FN = False Negatives.

True Positive : A result where the model properly predicted the positive class is referred to as a true positive.

True Negative : A result where the model properly predicted the negative class is referred to as a true negative.

False Positive : A result where the model incorrectly predicted the positive class is referred to as a false positive.

False Negative : A result where the model incorrectly predicted the positive class is referred to as a false negative.

Sensitivity: How well a machine learning model can identify positive examples is measured by its sensitivity. The true positive rate (TPR) or recall are other names for it. Sensitivity helps us to determine how many cases the model was able to accurately recognise, which is why it is utilised to assess model performance.

Sensitivity = (True Positive)/(True Positive + False Negative)

Quality: According to each quality requirement, the system being developed must achieve a specific level of a quality factor or sub-factor that has been established by the quality model. The project was completed on schedule, and the final product meets all requirements.

Usability: Usability is the degree to which software may be used by specific customers to fulfil measurable goals with effectiveness, efficiency, and satisfaction in a quantified context of usage. The requirements for how tough the system would be to learn and run. Because it is automated, the proposed system is simple and straightforward to use; it is used to give warnings to the farmer when animal invasion occurs and, when necessary, steps to be done due to change field circumstances.

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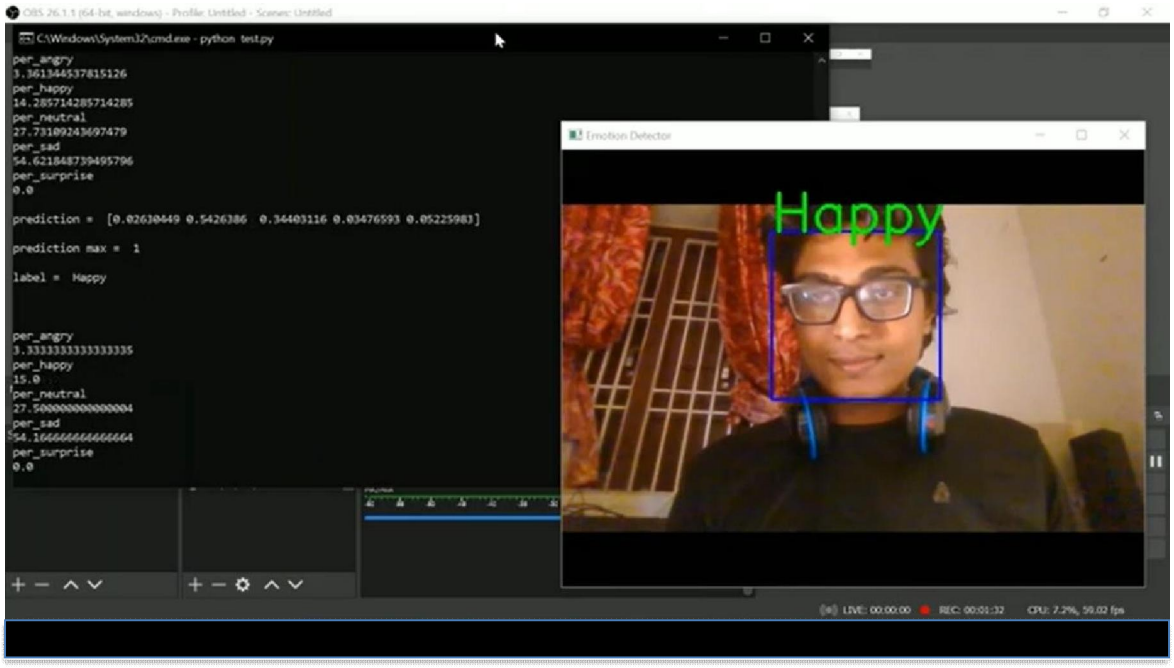
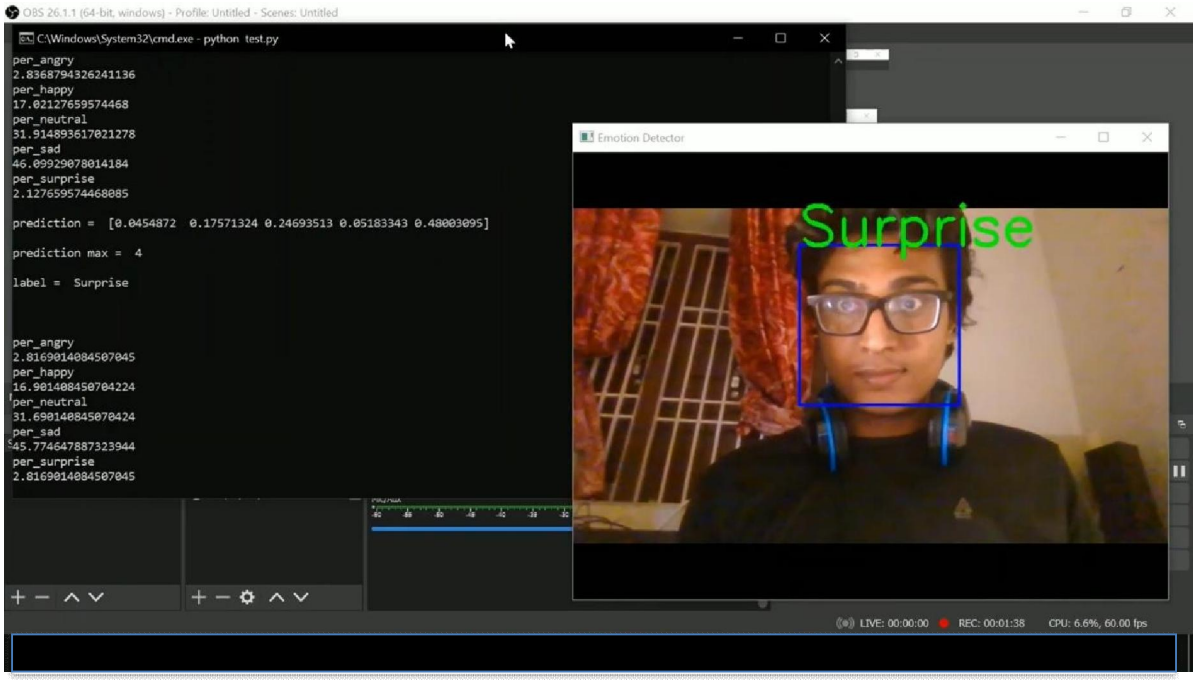
Result and Simulation





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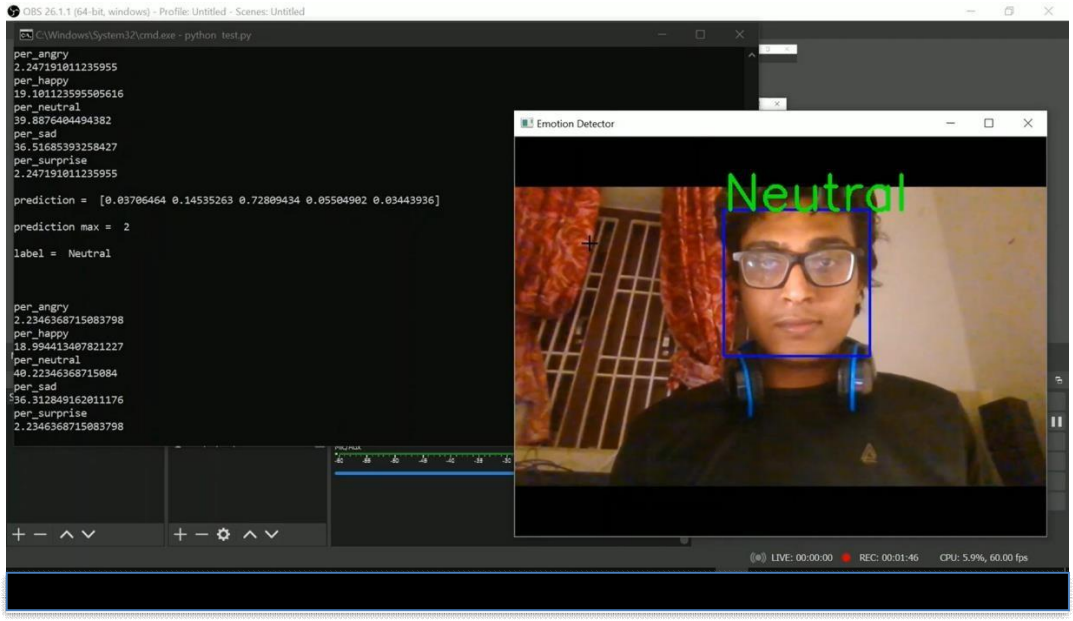

Sentiment of an individual

Sentiment of a person in crowd

V. CONCLUSIONS AND FUTURE SCOPE

5.1 Conclusion

With proper outputs we can monitor the sentiments and keep a right track of feedbacks and thereby improve our product or services. The model is highly effective in the recognition of faces which is essential for users during online classes. This reduces the chances of false negatives and false positives while registering attendance. In distance learning, automating this process would relieve the lecturer of having to worry about attendance

In order to address this issue, we have worked to create a system that will use sensors and cameras to monitor the area, and image processing will be used to identify the sentiments and suitable action by the provider can be taken.

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5.2 Advantages

- We can detect emotions of many people at the same time.
- Get reviews of people on products in the malls etc.
- Movie reviews can be generated without wasting valuable time of people
- Can data about emotional index in a particular area with real time assessment.
- Doesn't require bulky hardware.
- Can be carried anywhere and used at any time.

5.3 Limitations

- As the model is dependent on camera we might get varied results due to improper lightings or connection issues.

5.4 Applications

- Can be installed in horeca to analyze customers feedback
- Sentiment analysis during speech in election rallies
- Can also be installed in theatres

5.5 Future Enhancements

- Future scope involves enhancement by applying the framework in real-time attendance monitoring, which would be computationally expensive and require powerful hardware.
- For more precision and quicker reaction, a more powerful computer can be used in place of the Raspberry Pi.
- The module can be powered by solar panels.
- Creating an android application of the system using BLE module and can add extra features in application as per the consumer and provider requirements.

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