# A
# Project Report
# On
# "Facial Expression Recognition"


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# CERTIFICATE

This is to certify that the report entitled "**Facial Expression Recognition**" is a bonafied work carried out by **Mr. Harsh Patel (18DCS068)** under the guidance and supervision of **Assistant Prof. Shraddha Vyas** for the subject **CS348-Software Group Project-III** (CSE) of 5thSemester of Bachelor of Technology in **DEPSTAR** at Faculty of Technology & Engineering – CHARUSAT, Gujarat.

To the best of my knowledge and belief, this work embodies the work of candidate himself, has duly been completed, and fulfills the requirement of the ordinance relating to the B.Tech. Degree of the University and is up to the standard in respect of content, presentation and language for being referred to the examiner.

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# ABSTRACT

These Human facial expressions convey a lot of information visually rather than articulately. Facial expression recognition plays a crucial role in the area of human-machine interaction. Automatic facial expression recognition system has many applications including, but not limited to, human behavior understanding, detection of mental disorders, and synthetic human expressions. Recognition of facial expression by computer with high recognition rate is still a challenging task.

Two popular methods utilized mostly in the literature for the automatic FER systems are based on geometry and appearance. Facial Expression Recognition usually performed in four-stages consisting of pre-processing, face detection, feature extraction, and expression classification.

In this project we applied various deep learning methods (convolution neural networks) to identify the key seven human emotions: anger, disgust, fear, happiness, sadness, surprise and neutrality.

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# CHAPTER-1: INTRODUCTION

With the advent of modern technology our desires went high and it binds no bounds. In the present era a huge research work is going on in the field of digital image and image processing. The way of progression has been exponential and it is ever increasing. Image Processing is a vast area of research in present day world and its applications are very widespread.

Image processing is the field of signal processing where both the input and output signals are images. One of the most important applications of Image processing is Facial expression recognition. Our emotion is revealed by the expressions in our face. Facial Expressions plays an important role in interpersonal communication. Facial expression is a non verbal scientific gesture which gets expressed in our face as per our emotions. Automatic recognition of facial expression plays an important role in artificial intelligence and robotics and thus it is a need of the generation. Some application related to this includes Personal identification and Access control, Videophone and Teleconferencing, Forensic application, Human-Computer Interaction, Automated Surveillance, Cosmetology and soon.

The objective of this project is to develop Automatic Facial Expression Recognition System which can take human facial images containing some expression as input and recognize and classify it into seven different expression classes such as:

1. **Neutral**
2. **Angry**
3. **Disgust**
4. **Fear**
5. **Happy**
6. **Sadness**
7. **Surprise**


**Fig. 1.1 Different Expressions**

# CHAPTER-2: PROBLEM DEFINATION

Human facial expressions can be easily classified into 7 basic emotions: happy, sad, surprise, fear, anger, disgust, and neutral. Our facial emotions are expressed through activation of specific sets of facial muscles.

Through facial emotion recognition, we are able to measure the effects that content and services have on the audience/users through an easy and low-cost procedure. For example, retailers may use these metrics to evaluate customer interest. Healthcare providers can provide better service by using additional information about patients' emotional state during treatment. Entertainment producers can monitor audience engagement in events to consistently create desired content.

Humans are well-trained in reading the emotions of others, in fact, at just 14 months old, babies can already tell the difference between happy and sad. But can computers do a better job than us in accessing emotional states? To answer the question, we designed a deep learning neural network that gives machines the ability to make inferences about our emotional states. In other words, we give them eyes to see what we can see.

Facial expression recognition is a process performed by humans or computers, which consist of:

i. Locating faces in the scene (e.g., in an image; this step is also referred to as face detection).

ii. Extracting facial features from the detected face region (e.g., detecting the shape of facial components or describing the texture of the skin in a facial area; this step is referred to as facial feature extraction).

iii. Analyzing the motion of facial features and the changes in the appearance of facial features and classifying this information into some facial-expression- interpretative categories such as facial muscle activations like smile or frown, emotion (affect)categories like happiness or anger, attitude categories like, disliking or ambivalence, etc.(this step is also referred to as facial expression interpretation).

# CHAPTER-3: MOTIVATION

Significant debate has risen in past regarding the emotions portrayed in the world famousmasterpieceofMonaLisa.BritishWeeklyNewScientisthasstatedthatshe is in fact a blend of many different emotions, 83%happy, 9% disgusted, 6% fearful, 2%angry.

**Fig. 3.1 Mona Lisa Portrait**

We have also been motivated observing the benefits of physically handicapped people like deaf and dumb. But if any normal human being or an automated system can understand their needs by observing their facial expression then it becomes a lot easier for them to make the fellow human or automated system understand their needs.

# CHAPTER-4: SYSTEM DESIGN

## 4.1FLOW OF SYSTEM

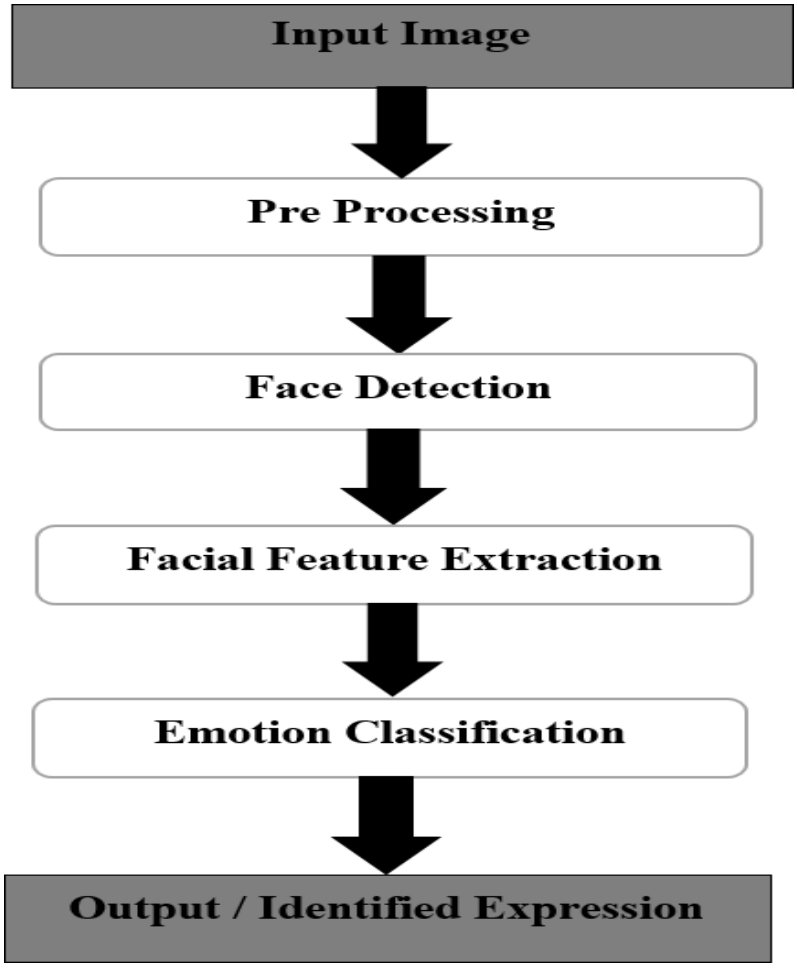


**Fig. 4.1 Flow Chart**

## 4.2BASICS STEPS TO BE PERFORMED

As per various literature surveys it is found that for implementing this project four basic steps are required to be performed.

i. Preprocessing
ii. Faceregistration
iii. Facial featureextraction
iv. Emotionclassification

**1) Preprocessing:**

- Preprocessing is a common name for operations with images at the lowest level of abstraction both input and output are intensity images. Most preprocessing steps that are implemented are

  a. Reduce thenoise

  b. Convert The Image ToBinary/Grayscale.

  c. Pixel BrightnessTransformation.

  d. GeometricTransformation.


**Fig. 4.2.1 Preprocessing**

**2) Face Registration:**

- Face Registration is a computer technology being used in a variety of applications that identifies human faces in digital images. In this face registration step, faces are first located in the image using some set of landmark points called “face localization” or “face detection”. These detected faces are then geometrically normalized to match some template image in a process called “face registration”.

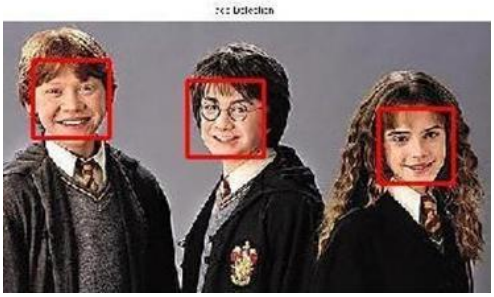

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**Fig. 4.2.2 Face Registration**

### 3) Facial Feature Extraction:

- Facial Features extraction is an important step in face recognition and is defined as the process of locating specific regions, points, landmarks, or curves/contours in a given 2-D image or a 3D range image. In this feature extraction step, a numerical feature vector is generated from the resulting registered image. Common features that can be extracted are-
  a. Lips
  b. Eyes
  c. Eyebrows
  d. Nosetip

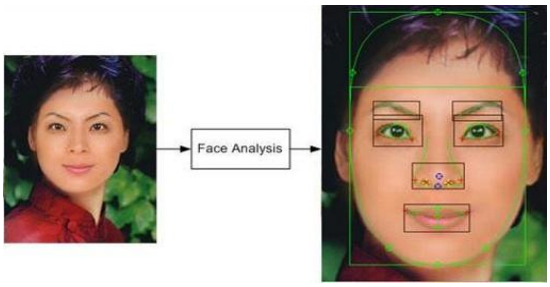



**Fig. 4.2.3 Feature Extraction**

### 4) Emotion Classification:

- In the third step, of classification, the algorithm attempts to classify the given faces portraying one of the seven basic emotions.

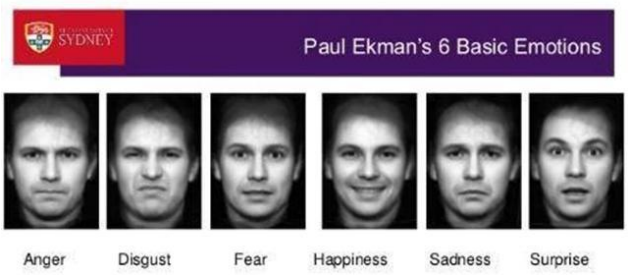



**Fig. 4.2.4 Emotion Classification**

- Paul Ekman (born February 15, 1934) is an American psychologist and professor emeritus at the University of California, San Francisco who is a pioneer in the study of emotions and their relation to facial expressions. He has created an "atlasof emotions" with more than ten thousand facialexpression.

# CHAPTER-5: TOOLS AND TECHNOLOGY

## 5.1SOFTWARE REQUIREMENT

As the project is developed in python, we have used Anaconda for Python 3.6.5 and Visual Studio Code.

**Anaconda**

- It is a free and open source distribution of the Python and R programming languages for data science and machine learning related applications (large-scale data processing, predictive analytics, scientific computing), that aims to simplify package management and deployment.
- Package versions are managed by the package management system conda. The Anaconda distribution is used by over 6 million users, and it includes more than 250 popular data science packages suitable for Windows, Linux, andMacOS.

**Visual Studio Code**

- Visual Studio Code is a free source-code editor made by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git. Users can change the theme, keyboard shortcuts, preferences, and install extensions that add additional functionality.

## 5.2HARDWARE REQUIREMENT

- **Processor:** Intel CORE i5 processor with minimum 2.9 GHz speed.
- **RAM:** Minimum 4GB.
- **Hard Disk :** Minimum 500GB

# CHAPTER-6: IMPLEMENTATION

## 6.1ALGORITHM

**Step 1:** Collection of a data set of images. (In this case we are using VGGFace 2 database of 35887 pre-cropped, 48-by-48-pixel grayscale images of faces each labeled with one of the 7 emotion classes: anger, happiness, sadness, surprise, and neutral.

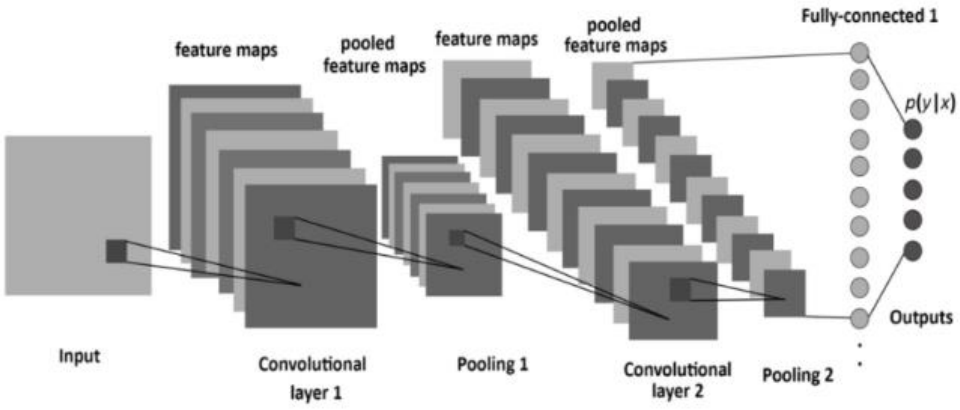
**Step 2:** Pre-processing of images using Image Data Generator . Example, rescalling, rotation shear zppm width shift , height shift and horizontal flip.

**Step 3:** Detection of a face from each image.

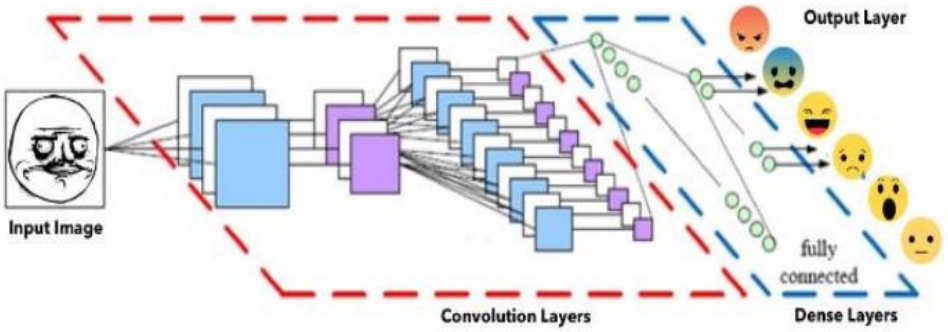
**Step 4:** The cropped face is converted into grayscale images.

**Step 5:** The pipeline ensures every image can be fed into the input layer as a (1, 48, 48) numpy array.

**Step 6:** The numpy array gets passed into the blocks of Convolution2D layer.




### 6.1.1 Convolution 2D layer (1)




### 6.1.2 Convolution 2D layer (2)

**Step 7:** Convolution generates feature maps.

**Step 8:** Pooling method called MaxPooling2D that uses (2, 2) windows across the feature map only keeping the maximum pixel value.

**Step 9:** During training, Neural network Forward propagation and Backward propagation performed on the pixel values.

**Step 10:** The Softmax function presents itself as a probability for each emotion class. The model is able to show the detail probability composition of the emotions in the face.

**Step 11:** Using CV2 for input, process it and give realtime expression output.

## 6.2SNAPSHOTS

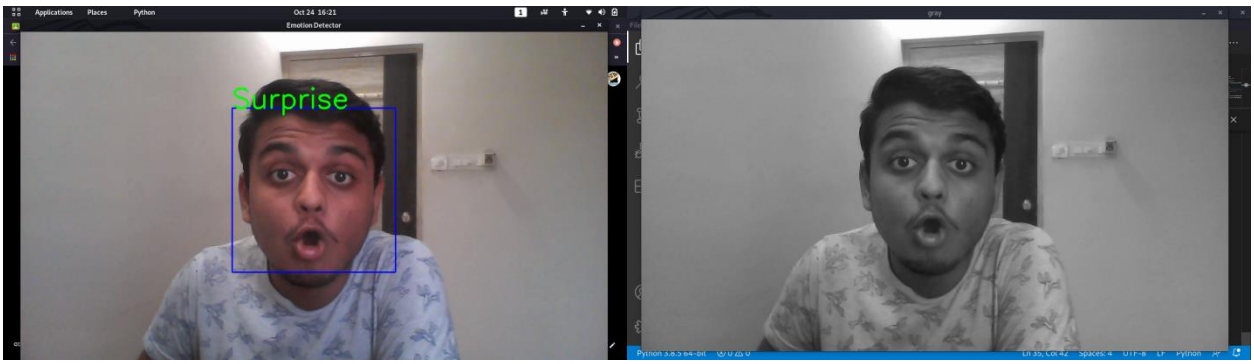



**Fig. 6.2.1 Surprise**

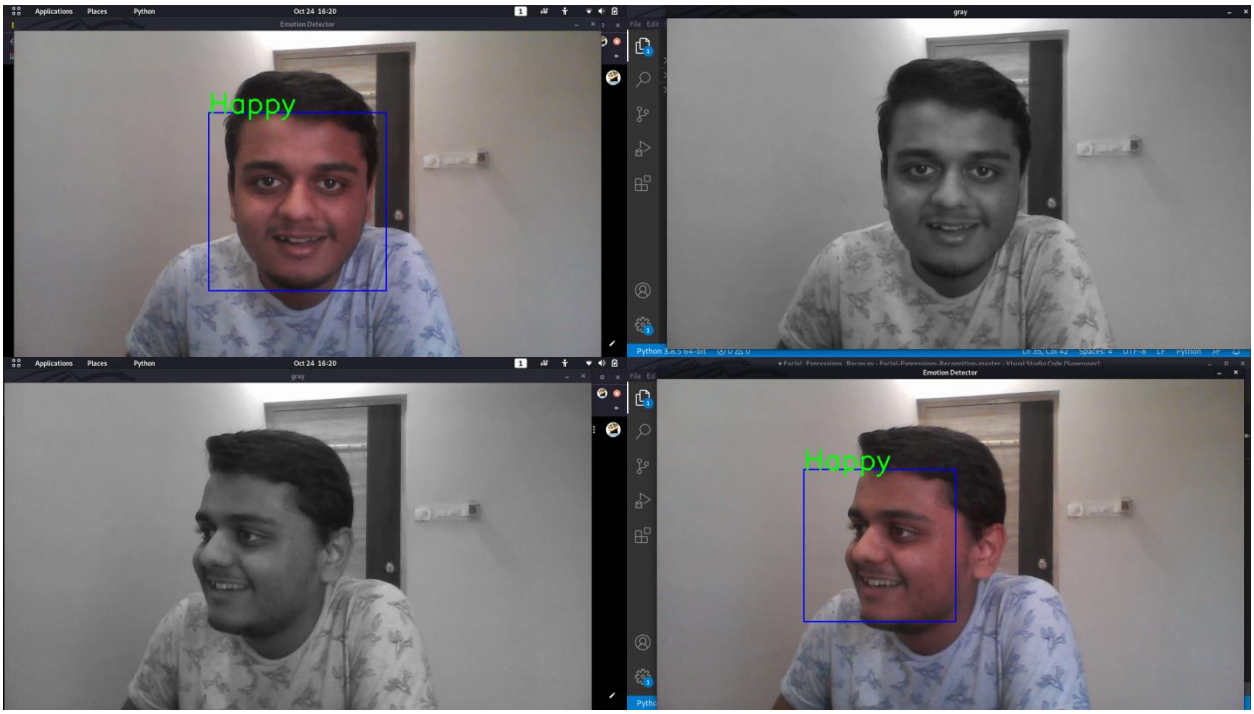



**Fig. 6.2.2 Happy**


**Fig. 6.2.3 Neutral**

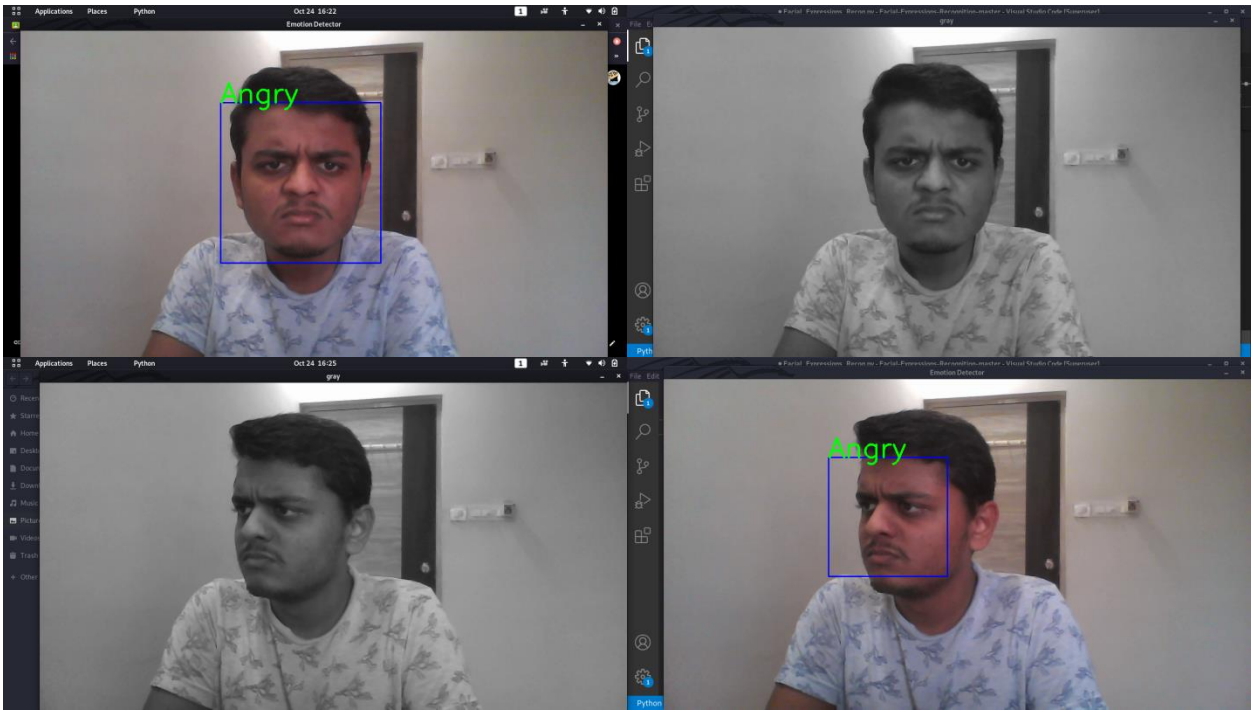



**Fig. 6.2.4 Angry**

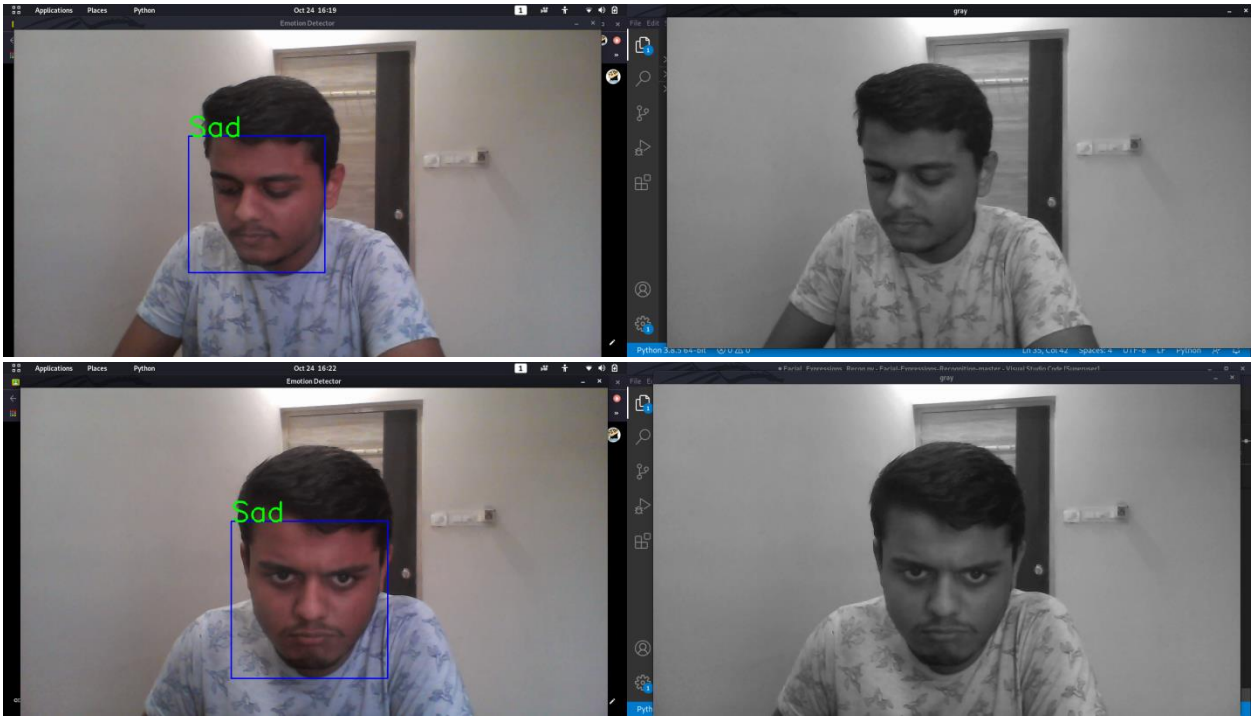



**Fig. 6.2.5 Sad**

# CHAPTER-7: CONSTRAIN AND FUTURE ENHANCEMENT

## 7.1 CONSTRAINS

- Poor Image Quality Limits Facial Recognition's Effectiveness.
- Small Image Sizes Make Facial Recognition More Difficult.
- Different Face Angles Can Throw Off Facial Recognition's Reliability.

## 7.2 FUTURE ENHANCEMENT

In this project we got an accuracy of almost 70% which is not bad at all comparing all the previous models. But we need to improve in specific areas like-

- number and configuration of convolutional layers
- number and configuration of dense layers
- dropout percentage in dense layers

We would also like to train more databases into the system to make the model more and more accurate but again resources becomes a hindrance in the path and we also need to improve in several areas in future to resolve the errors and improve the accuracy.

And we would also like to make an application which can suggest music based on user’s mood using this project.

# CHAPTER-8: CONCLUSION

The facial expression recognition system presented in this research work contributes a resilient face recognition model based on the mapping of behavioral characteristics with the physiological biometric characteristics.

The physiological characteristics of the human face with relevance to various expressions such as happiness, sadness, anger, surprise are associated with geometrical structures which restored as base matching template for the recognition system.

This research work promises a new direction of research in the field of asymmetric biometric cryptosystems which is highly desirable in order to get rid of passwords and smart cards completely.

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