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REAL-TIME FACIAL EXPRESSION RECOGNITION USING CONVOLUTIONAL NEURAL NETWORK

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Abstract: The paper presents a real-time facial emotion recognition system using Convolutional Neural Networks (CNNs) and OpenCV. The system processes video frames in real-time to detect faces and recognize emotions from the facial expressions. The CNN model is trained on a large dataset of facial images and emotions, and the results demonstrate accurate and fast emotion recognition performance. The integration of OpenCV with the CNN model enables real-time processing of video frames, making the system suitable for various practical applications.One use of machine learning is the identification of facial expressions of emotion.That were extracted from an image based on the features,it assigns a face emotion image to one of the facial emotion classes. Among the classification techniques, convolutional neural network (cnn) also pulls patterns from a picture. In this study we used the CNN model to recognize the facial expressions.To increase the precision of facial emotion detection, the wavelet transform is then used. There are seven different face emotions represented in the facial emotion image dataset that was gathered from Kaggle. The accuracy of the experimental facial emotion recognition utilising the CNN and wavelet transform increases.

Index Terms - Computer Vision, Emotion Recognition, Face Recognition, Feature Extraction, Image Sequences,

Convolutional neural network, Facial Expressions, wavelet transform.

I. INTRODUCTION

1.Intelligence System:

Intelligent systems are emerging more and more in people's lives and often have to be identified when using intelligent systems. Traditional identification methods primarily identify persons with certain personal characteristics, such as identity documents, such as keys and documents.They are easily forgotten, lost and tampered with.If you use some of the personal characteristics to recognize the effect will be very good, such as: facial recognition, fingerprinting and so on.There are sharing parameters between the convolution layer and the CNN convolution layer in terms of algorithms.

This has the benefit of reducing both the amount of memory needed and the number of parameters that must be trained. As a result, the algorithm's performance is enhanced. In contrast, other machine learning algorithms require us to perform feature extraction or pre-processing on the images. However, when using CNN for image processing, we hardly ever need to perform these operations. This is something other machine learning algorithms cannot do. Deep learning has some drawbacks as well.

One of them is that building a depth model needs a lot of samples, which restricts where this algorithm can be used.Since face recognition and licence plate character recognition have made significant strides in recent years, this topic will conduct some basic research on CNN-based face recognition technology.

2. Algorithm for Convolutional Neural Networks

2.1 Introduction of Convolutional Neural Network:

Convolutional neural networks have advanced, and as a result of their improved performance in competitions, they have become the subject of research. Reducing the number of learning parameters is a successful strategy for enhancing the forward BP algorithm's training performance. Convolution of the neural network's spatial relationship can be used to achieve this. The proposed network structure, the convolutional neural network, minimises the pre-treatment of the input data. Each layer in the structure of a convolution neural network has a convolution kernel to obtain the most important data characteristics. The input data is input from the initial input layer, processed through each layer, and then into the other hierarchy. There fore mentioned clear characteristics, such as translation, rotation, and and the like can be obtained by this method.

2.2. Convolution neural network basic structure :

Artificial and biological neural networks are the two different types of neural networks that can be distinguished. Specifically, artificial neural networks are introduced here. An artificial neural network is a data model that processes information and resembles the synaptic connections in the brain in terms of its physical makeup. A neural network is made up of many different neurons, and the output of one neuron can serve as the input for another.The formula:

$$h_{W,b}(x)=f\left(W^{T}x\right)=f\left(\sum_{i-1}^{3}W_{i}x_{i}+b\right)$$

The name of this component is also logistic regression model. The structure is now referred to as a neural network model when numerous neurons are connected to one another and when they were layered. A neural network with hidden layers can be seen in Figure1.1:

1.1 NEURAL NETWORKS

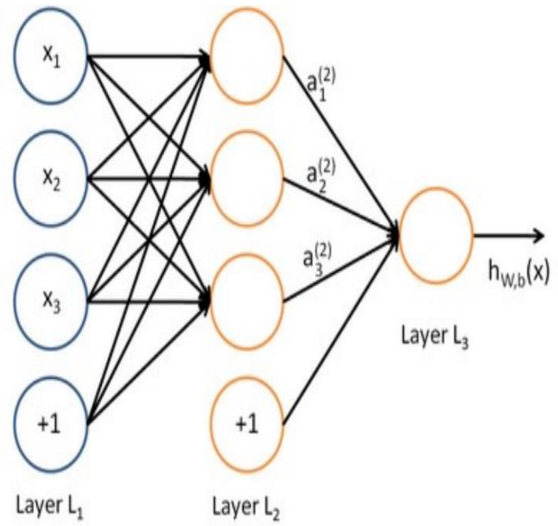

Fig1: Neural Networks

The input of this neural network is made up of X1, X2, and X3. The offset node, also called the intercept term, is at position +1. The input layer of the neural network is located in the left-most column of this neural network model, and the output layer is located in the right-most column. A hidden layer that is completely connected to both the input layer and the output layer makes up the network model's middle layer. The training sample set does not reveal the values of every node in the network model.

We can see from this neural network model that it has a total of three input units, three hidden units, and one output unit.The first layer can be expressed as Ll, followed by the neural network's L1 output layer, whose output layer is Lnl. This neural network has the following parameters:

$$(\mathrm{W},b)=\left(W^{1},b^{1},W^{2},b^{2}\right)$$

is the connection parameter between the jth cell of layer 1 and the I th cell of layer l+1, and bi l is the offset of the I th cell of layer 1+1. Set ai (l) to represent the output value of the first few cells in this layer in the neural network model. Let l represent this layer and I represent its first few cells. IOP Publishing IOP Conf. Series: Earth and Environmental Science 170 (2018) 032110 doi:10.1088/1755-1315/170/3/032110 3 1234567890 ''"" 2nd International Symposium on Resource Exploration and Environmental Science We can use the formula hw,b(x) to determine this neural network's output given the set of parameters W and b.

Equation illustrates how forward propagation is calculated (3). Due to the multi-layered neural network and the necessity of gradient descent + chain derivation rule, neural network training methods and the logistic regression model are similar. 3. CNN Model Building and Instruction CNN model, 3. LeNet5, AlexNet, ZF Net, GooLeNet, and VGGNet are currently the categories into which the typical neural network architecture is divided. The following will provide a detailed analysis of the LeNet5 architecture. LeNet5 is a long-gone CNN classic structure that is primarily used in the identification of handwritten fonts. It has a total of seven layers of structure; aside from the input layer, each of the other layers contains multiple training parameters.

II. OBJECTIVE AND SCOPE

To achieve with the primary aim of developing wavelet transform, opencv, emotion recognition, image based and video based dataset, convolutional neural network model, pre-processing techniques and seven facial expressions, the work consists of following objectives:

✓ In our proposed work, Facial emotion with wavelet transforming, OpenCV also recognize the facial expression analysis of video and we are applying here.

✓ To develop Convolutional Neural Network algorithm, with Mobilenet and wavelet transform. Here emotion image dataset is used.

✓ By using CNN algorithm we identify/ classified facial emotion and usage of feb 2018 dataset.csv

✓ We explore the presentation order of the samples during training and apply some pre-processing techniques to extract only expression-specific features from a face image in order to solve the issue.

III. PROPESED SYSTEM AND METHODOLOGY

a. Proposed system :

The input of this neural network is made up of X1, X2, and X3. The offset node, also called the intercept term, is at position +1. The input layer of the neural network is located in the left-most column of this neural network model, and the output layer is located in the right-most column. A hidden layer that is completely connected to both the input layer and the output layer makes up the network model's middle layer.

The training sample set does not reveal the values of every node in the network model. We can see from this neural network model that it has a total of three input units, three hidden units, and one output unit. Using nl to represent the number of layers in the neural network, we can see that this neural network has three layers. The first layer can be expressed as Ll, followed by the neural network's L1 output layer, whose output layer is Lnl.

This neural network has the following parameters is the connection parameter between the jth cell of layer 1 and the I th cell of layer l+1, and bi l is the offset of the I th cell of layer 1+1. Set ai (l) to represent the output value of the first few cells in this layer in the neural network model. Let l represent this layer and I represent its first few cells. IOP Publishing IOP Conf. Series: Earth and Environmental Science 170 (2018) 032110 doi:10.1088/1755-1315/170/3/032110 3 1234567890 """ 2nd International Symposium on Resource Exploration and Environmental Science

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The following will provide a detailed analysis of the LeNet5 architecture. LeNet5 is a long-gone CNN classic structure that is primarily used in the identification of handwritten fonts. It has a total of seven layers of structure; aside from the input layer, each of the other layers contains multiple training parameters is following..

$$\left(W,b\right)=\left(W^{1},b^{1},W^{2},b^{2}\right)$$

b. Block Diagram of the system :

The research work can be described by the block diagram shown in fig.1

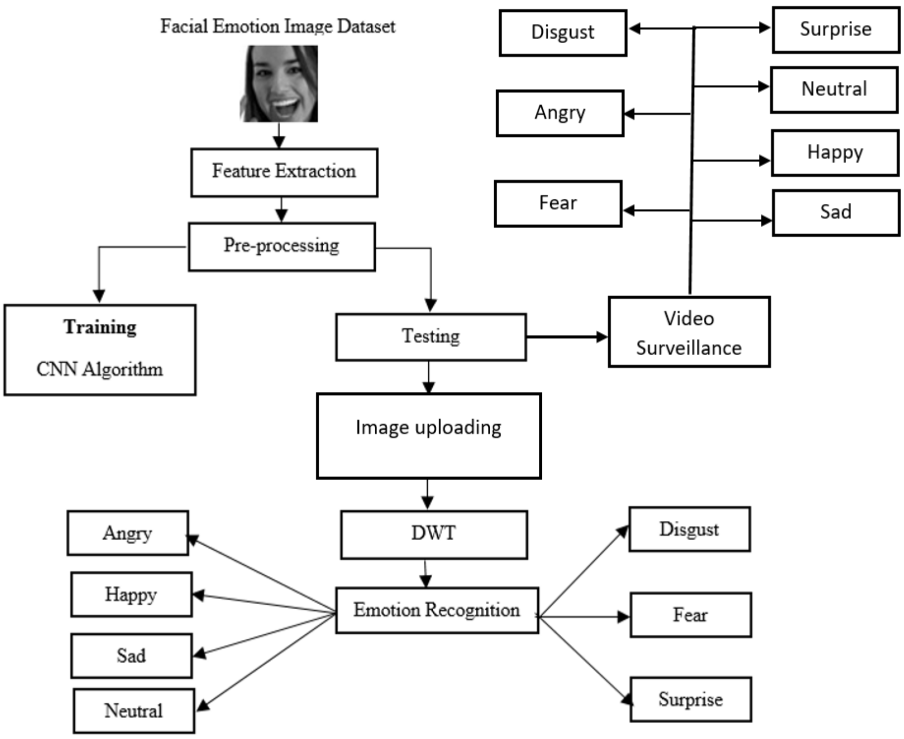


Fig2: ***Block Diagram of the system***

c. Architecture :

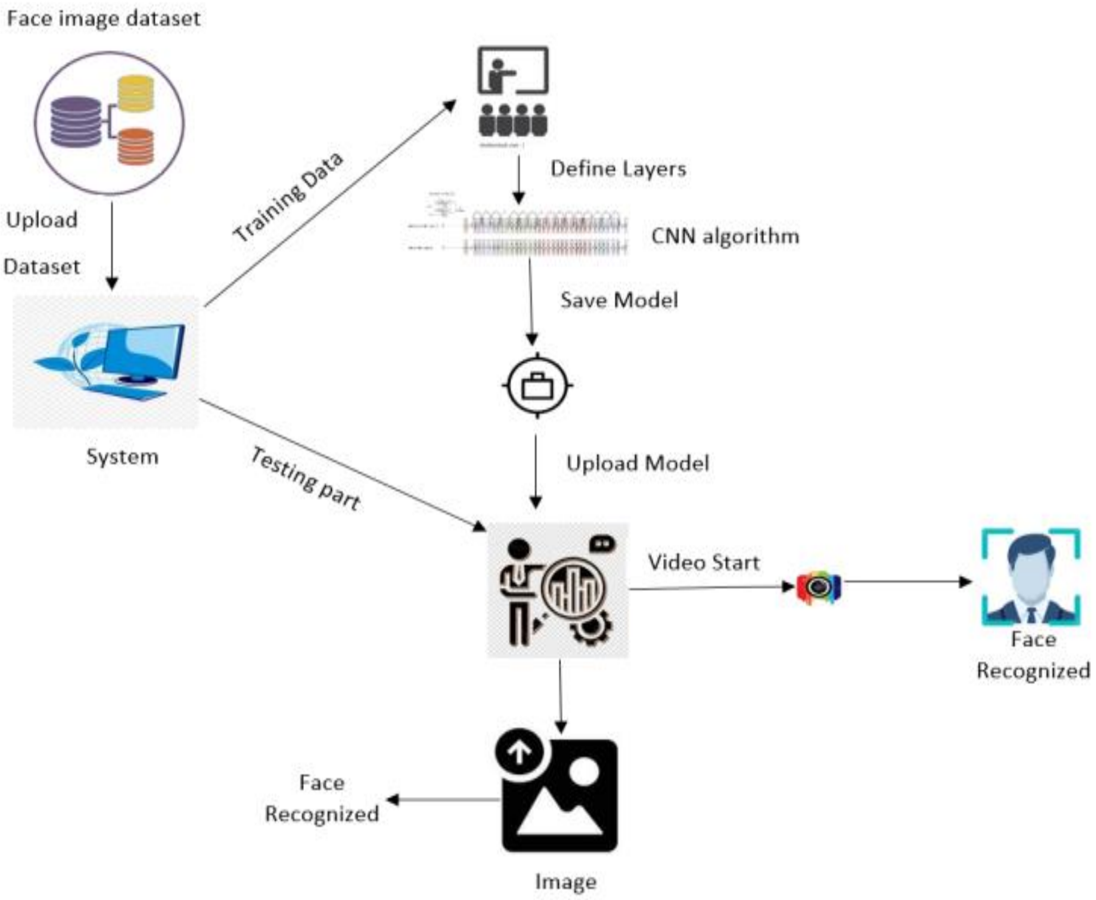


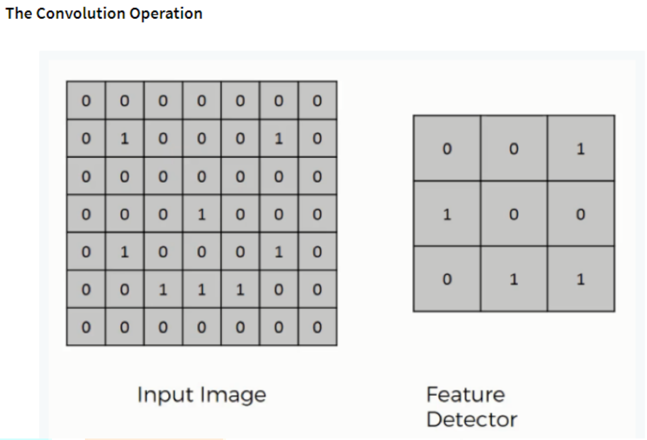
Fig3: CNN Architecture

d. Methodology and Algorithms :

Convolutional Nueral Network

First step(1): a convolutional operation

Convolution operation serves as the foundation of our strategy. This step will briefly discuss feature detectors, which are essentially the filters for the neural network. Additionally, we'll talk about feature maps, their parameters, how patterns are found, how to map out the results, and how layers of detection work.



The Convolution Operation

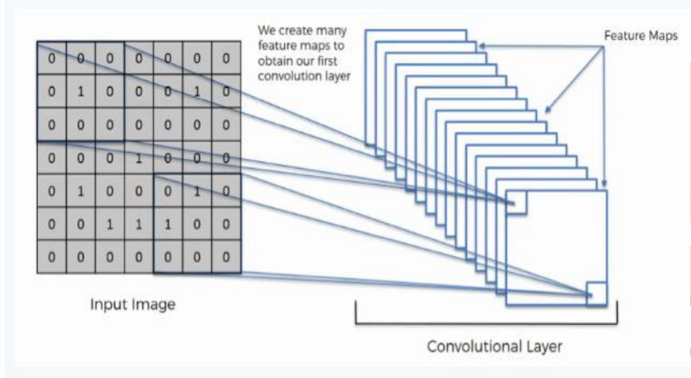
0	0	0	0	0	0	0
0	1	0	0	0	1	0
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	1	0
0	0	1	1	1	0	0
0	0	0	0	0	0	0

Input Image

0	0	1
1	0	0
0	1	1

Feature Detector

Fig4: Convolution Operation



0	0	0	0	0	0	0
0	1	0	0	0	1	0
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	1	0
0	0	1	1	1	0	0
0	0	0	0	0	0	0

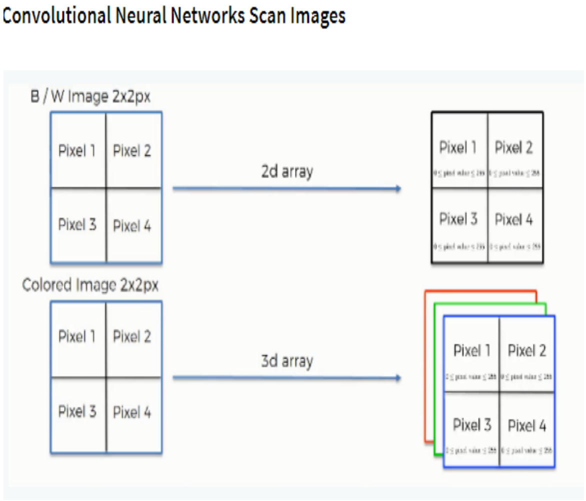
We create many feature maps to obtain our first convolution layer
Feature Maps
Input Image
Convolutional Layer

Fig5: Convolutional layer

First step(1b):Relu Layer:

This step's second component, the Rectified Linear Unit or Relook, is involved. We'll discuss Relook layers and look at how linearity works in relation to convolutional neural networks.

It's not necessary to understand CNN's, but it wouldn't hurt to take a quick lesson to sharpen your skills.



Convolutional Neural Networks Scan Images

Fig6: Convolutional Neural Networks Scan Images

Second step(2): Pooling Layer

We'll discuss pooling in this section and learn exactly how it typically operates. But max pooling will be the central concept in this situation. However, we'll discuss a variety of strategies, including mean (or sum) pooling. This section will conclude with an interactive visual demonstration that will undoubtedly clarify the entire idea for you.

Third step(3):Flattering Layer

Here is a brief explanation of the flattening procedure and how, when using convolutional neural networks, we go from pooled to flattened layers.

Fourth step(4): Full Correction Layer

Everything we discussed in the previous section will be combined in this section. By understanding this, you'll be able to picture how Convolutional Neural Networks work more clearly and how the "neurons" that are ultimately created discover how to classify images.

VI. SYSTEM DESIGN

A. Input Design:

Data that is processed to create output is considered input in an information system. Developers must take into account input devices like PCs, MICR, OMR, and others when designing input.

Consequently, the system output's quality is determined by the input's quality. It should effectively serve a specific purpose, such as storing, recording, and retrieving the information, among other characteristics of well-designed input forms and screens.

- ✓ It guarantees accurate, correct completion.
- ✓ It must be simple and easy to complete.
- ✓ The attention, consistency, and simplicity of the user should be its main priorities.
- ✓ Knowing the fundamental design principles relating to what the system's input requirements are allows us to achieve all of these goals.
- ✓ What elements of forms and screens elicit the most responses from users.

Objectives for Input Design:

The goals of input design are to:

- ✓ Create efficient data entry and input processes.
- ✓ Decrease the volume of input.
- ✓ Create source documents for data capture or develop alternative data capture techniques.
- ✓ Create input data records, data entry screens, user interface screens, etc.
- ✓ Employ validation checks; and Create input controls that are both efficient and reliable.

Objectives for Output Design:

B. Output Design:

The most crucial task for any system is the design of the output. Developers choose the appropriate output types, take into account the required output controls, and create prototype report layouts during output design.

Objectives for Output Design:

The goals of input design are to:

- ✓ To create output designs that fulfil their intended functions and stop the creation of unwanted output.
- ✓ To create an output design that satisfies the needs of the final user.
- ✓ To produce the necessary amount of output.
- ✓ To organise the output properly and send it to the proper recipient.
- ✓ To deliver the output on time so that you can make wise decisions.

B.Modules:

Dataset collection:

Video based:

Here we are collecting the data by capturing of video for one person we take 200 frames as image dataset.

Image based:

Here we collect the one image of one person.

Training:

We are training our model with the CNN algorithm using the pre-processed training dataset.

Four layers make up the CNN algorithm: the input layer, the convolution layer, the pooling layer, the flatten layer, and the dense layer.

We consider images to be input in the input layer.

We convert the image into matrices in the convolution layer.

The numerical values will be stored in the pooling layer. Utilizing the machine learning algorithm Softmax, we convert the numerical data to binary data (supervised learning algorithm). We will convert the numerical data to binary in the Softmax layer.

The classes of the entire dataset, which will be in binary data format, are stored in flatten layer and dense.
We save the data as.yml files using the fit generator method. See exampleLabeling:
Here we will split the images from the directory where we are saved images. After splitting will collect the label part and save as pickle format.

Testing:

Image Based:

Here we will upload the image for testing that which will be recognized.

Video Based:

Here we test the data using of computer vision.

V. UML DIAGRAMS

Unified Modelling Language is known as UML. A general-purpose modelling language with standards, UML is used in the field of object-oriented software engineering. The Object Management Group oversees and developed the standard.

The objective is for UML to establish itself as a standard language for modelling object-oriented computer programmes. UML currently consists of a meta-model and a notation as its two main parts. In the future, UML might also be associated with or added to in the form of a method or process.

The Unified Modelling Language is a standard language used for business modelling, non-software systems, and specifying, visualising, building, and documenting the artefacts of software systems.

The UML is an amalgam of best engineering practises that have been effective in simulating large, complex systems.

The UML is a crucial component of the software development process and the creation of objects-oriented software. The UML primarily employs graphical notations to convey software project design.

GOALS:

The following are the UML's primary design objectives:

- ✓ Provide users with an expressive, ready-to-use visual modelling language so they can create and trade meaningful models.
- ✓ Provide mechanisms for specialisation and extendibility of the fundamental concepts.
- ✓ Be independent of specific development methodologies and programming languages.
- ✓ Offer a formal framework for comprehending the modelling language.
- ✓ Encourage the market for OO tools to expand.
- ✓ Support more advanced development ideas like frameworks, components, patterns, and collaborations.
- ✓ Integrate industry standards.

CASE DIAGRAM IN USE:

In the Unified Modeling Language (UML), a use case diagram is a specific kind of behavioural diagram that is defined by and produced by a use-case analysis.
Its goal is to provide a graphical overview of a system's functionality in terms of actors, their objectives (represented as use cases), and any dependencies between those use cases.
A use case diagram's primary function is to display which system functions are carried out for which actor. The system's actors can be represented by their roles.

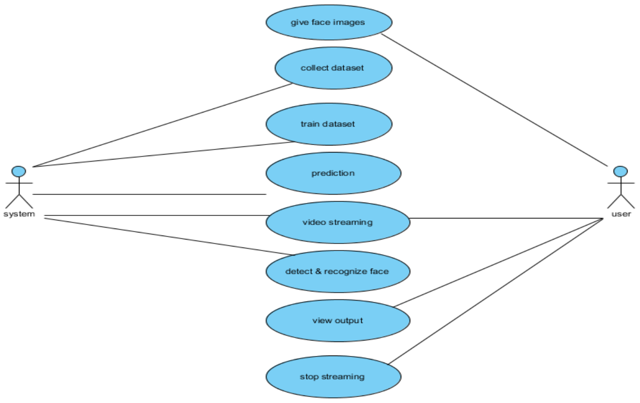


Fig7: Use case Diagram

DIAGRAM OF CLASS

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that depicts the classes, their attributes, operations (or methods), and relationships among the classes to describe the structure of a system. It clarifies which class has information.

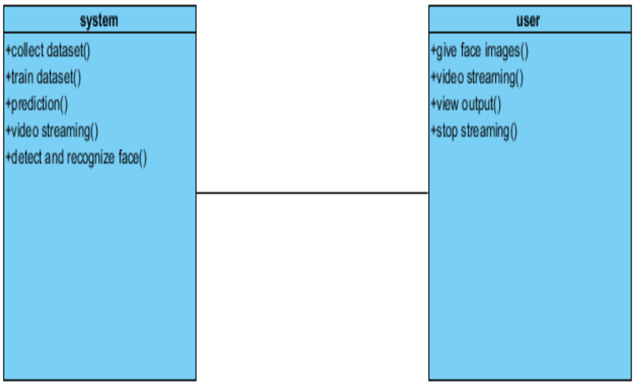


Fig8: Class Diagram

SEQUENCE DIAGRAM

In the Unified Modeling Language (UML), a sequence diagram is a type of interaction diagram that demonstrates how and in what order processes interact with one another.

It is a Message Sequence Chart construct. Event diagrams, event scenarios, and timing diagrams are other names for sequence diagrams.

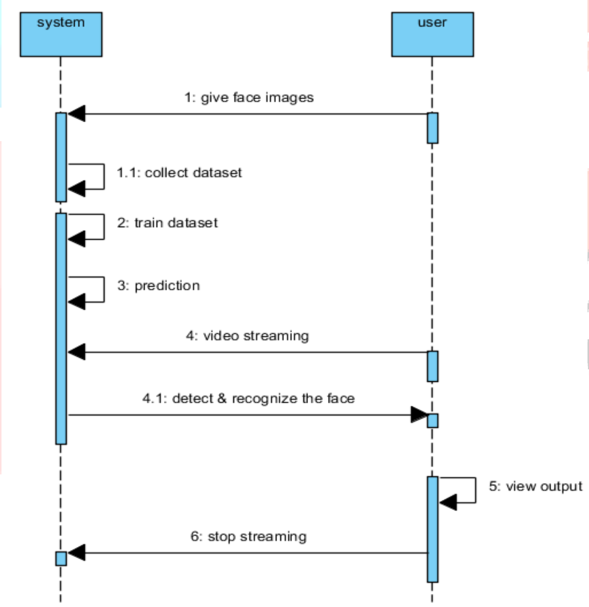


Fig9: Sequence Diagram

COLLABORATION DIAGRAM:

The following collaboration diagram uses a numbering technique to show the order in which the methods are called. The number designates the order in which the methods are called. The collaboration diagram is described using the same order management system. Similar to a sequence diagram, the method calls are also similar. Nevertheless, the collaboration diagram illustrates the object organisation, whereas the sequence diagram only describes it.

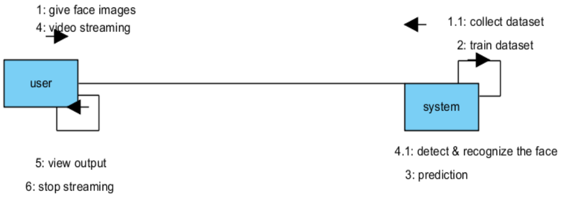


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Fig10: Collaboration diagram

DIAGRAM OF DEPLOYMENT

A deployment diagram shows how a system will be deployed. The component diagram is relevant to this. as a result of the deployment diagrams being used to deploy the components. Nodes make up a deployment diagram. Physical hardware used to deploy the application is what nodes are.

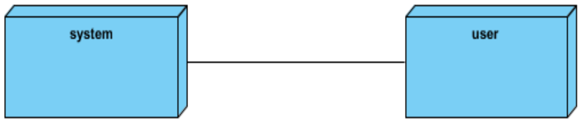


Fig11:Deployment Diagram

ACTIVITY DIAGRAM

With support for choice, iteration, and concurrency, activity diagrams are graphical representations of workflows involving sequential activities and actions. Activity diagrams can be used to describe the operational and business workflows of system components in the Unified Modeling Language. An activity diagram demonstrates the overall control flow.

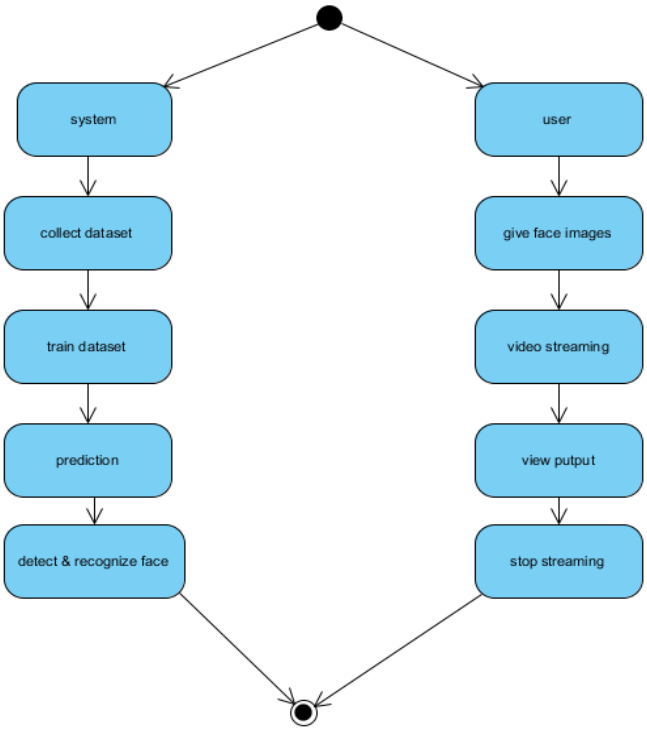


Fig12: Activity Diagram

COMPONENT DIAGRAM

A component diagram, also referred to as a UML component diagram, outlines the arrangement and wiring of the actual physical components in a system. Drawing component diagrams is a common practise for modelling implementation details and verifying that planned development addresses every aspect of the system's necessary function.

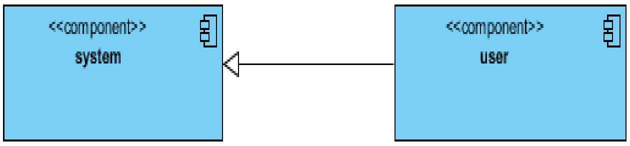


Fig13: Component Diagram

ER DIAGRAM:

An entity-relationship model (ER model) employs a diagram referred to as an entity relationship diagram to explain the organisation of a database (ER Diagram). In the future, a database can be built using a blueprint known as an ER model. The two primary components of the E-R model are the entity set and relationship set.

The relationships between entity sets are shown in an ER diagram. An entity set is a group of connected entities, each of which may have attributes. An entity in a DBMS is a table or an attribute of a table, so the ER diagram demonstrates the relationships between tables and their attributes to show the entire logical structure of a database.To better understand this idea, let's look at a straightforward ER diagram.

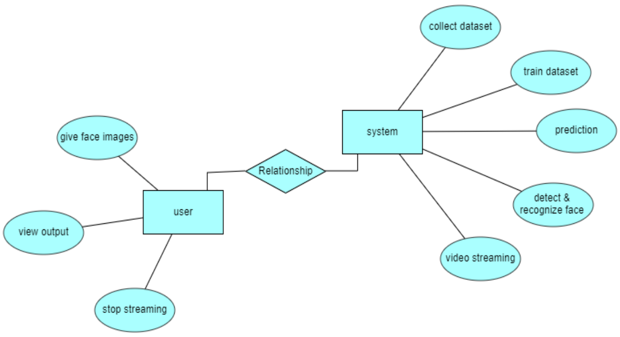


Fig14: ER Diagram

DFD DIAGRAM:

A data flow diagram (DFD) is a common method for illustrating how information moves throughout a system. A good deal of the system requirements can be graphicall depicted in a clean and clear DFD. It may be manual, automated, or a hybrid of the two. It demonstrates how information enters and exits the system, what modifies the information, and where information is stored. A DFD's main function is to outline the scope and bounds of a system as a whole. It may be utilised as a tool for communication between a systems analyst and any individual who plays a component in the system that serves as the foundation for redesigning a system.Context Level Diagram:

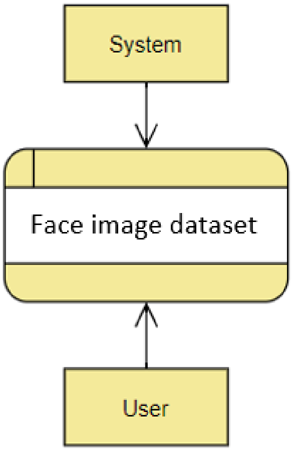


Fig15: Context Level Diagram

Level-1 Diagram:

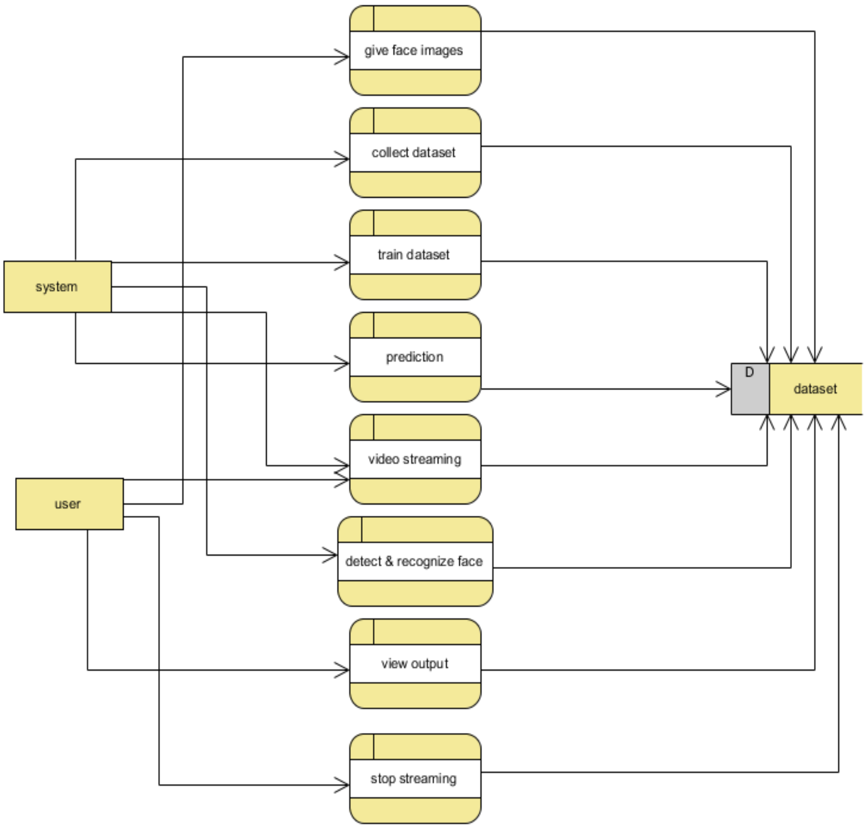


Fig16: Level-1 Diagram

Level-2 Diagram:

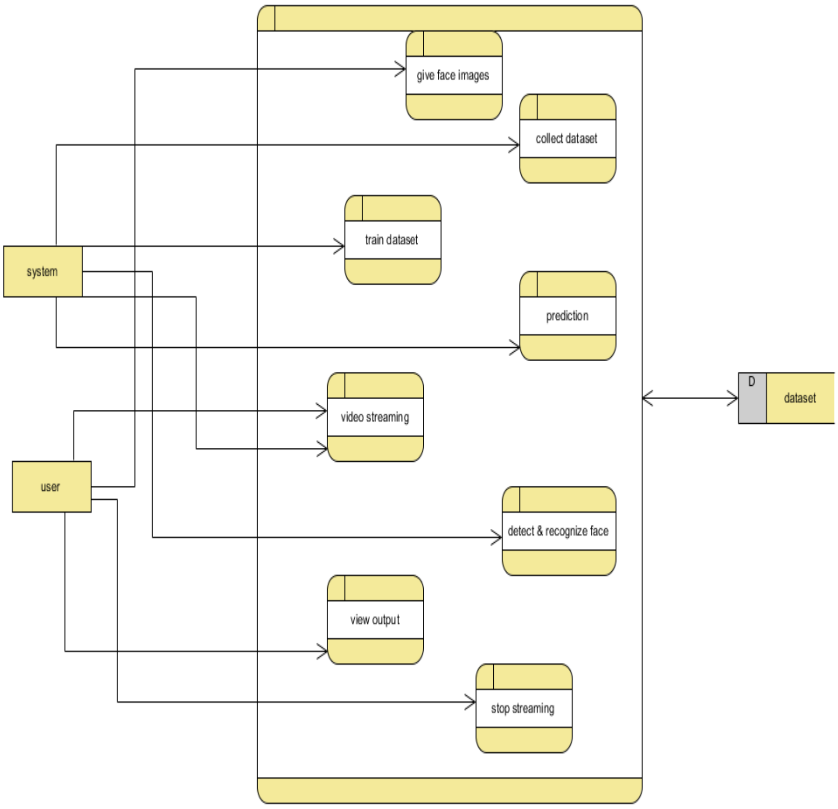


Fig17: Level-2 Diagram

VI.RESULTS AND DISCUSSION

The results and discussion for real-time facial expression recognition using CNN depend on the specific dataset, architecture, hyperparameters, and evaluation metrics used in the experiment. Here are some possible results and discussion points:

1. Dataset: The choice of dataset affects the performance of the facial expression recognition system. Common datasets include FER2013, CK+, and JAFFE. The system's accuracy and generalization ability can be evaluated using metrics such as precision, recall, F1 score, and confusion matrix.

2. CNN architecture: The architecture of the CNN model affects the accuracy, computational efficiency, and real-time performance of the system. Popular architectures include VGGNet, ResNet, and Inception. The number of layers, filter size, and pooling strategies can be tuned to optimize the performance.

3. Hyperparameters: The hyperparameters of the CNN model affect the training process and performance of the system. The learning rate, batch size, and regularization strength can be tuned using techniques such as grid search orrandom search.

4. Real-time performance: The real-time performance of the facial expression recognition system is a critical factor for practical applications. The latency,frames per second, and memory usage can be evaluated to determine the system's efficiency and feasibility.

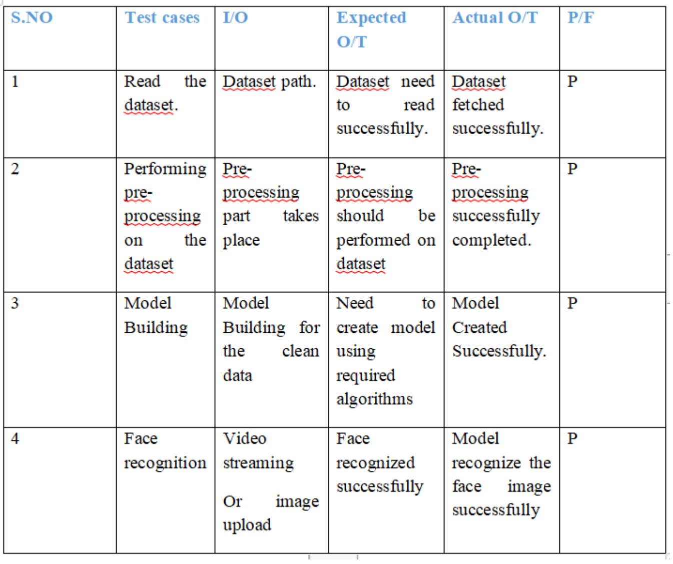
4. Discussion: The discussion of the results should address the strengths, limitations, and potential future directions of the facial expression recognition system. The system's accuracy, real-time performance, and generalization ability can be compared with other state-of-the-art methods. The limitations of the dataset, architecture, and hyperparameters should be acknowledged. Potential future directions include improving the accuracy and efficiency of the system, expanding the dataset to include more diverse facial expressions and conditions, and exploring the use of other deep learning models such as recurrent neural networks and attention mechanisms

TEST CASES

Input	Output	Result
Input image	Model recognize the face successfully	Success

TABLE 1: TEST CASES

TEST CASES MODEL BUILDING



S.NO	Test cases	I/O	Expected O/T	Actual O/T	P/F
1	Read the dataset.	Dataset path.	Dataset need to read successfully.	Dataset fetched successfully.	P
2	Performing pre-processing on the dataset	Pre-processing part takes place	Pre-processing should be performed on dataset	Pre-processing successfully completed.	P
3	Model Building	Model Building for the clean data	Need to create model using required algorithms	Model Created Successfully.	P
4	Face recognition	Video streaming Or image upload	Face recognized successfully	Model recognize the face image successfully	P

TABLE 2: TEST CASES MODEL BUILDING

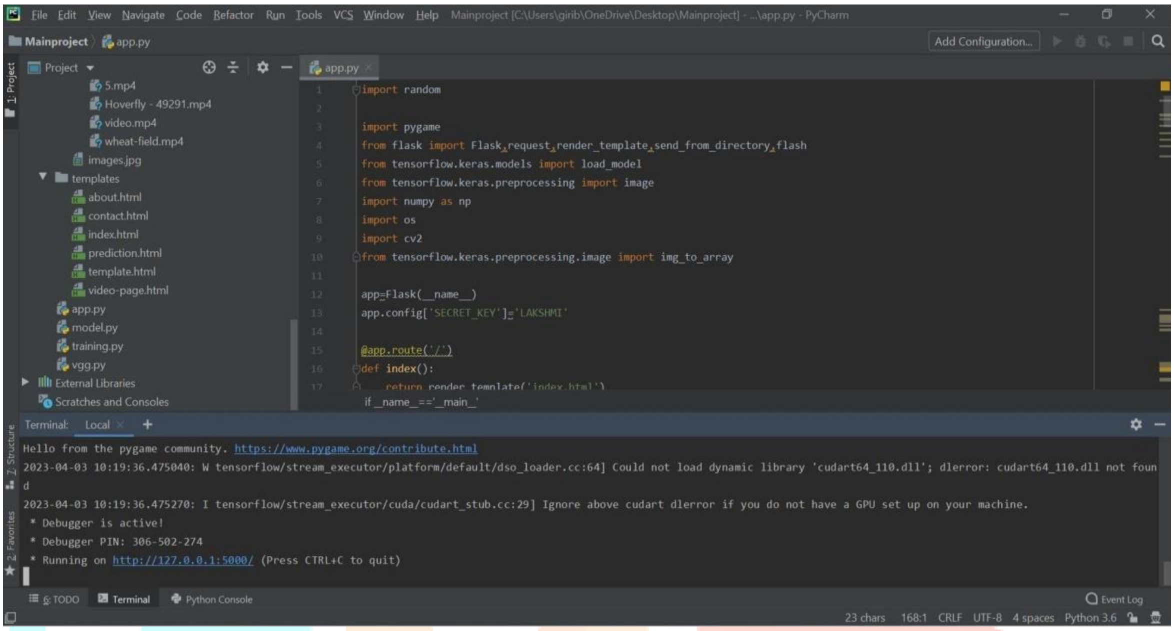
In general, the results and discussion for real-time facial expression recognition using CNN should demonstrate the effectiveness and feasibility of the system for practical applications. The system should achieve high accuracy, real-time performance, and generalization ability while addressing the limitations and potential future directions of the field. In this Project, By using PyCharm we developed the code for the Real-Time Facial Expression Recognition using CNN successfully.

We developed a web page to upload images and Live prediction by using Flask Application.

Finally, we successfully predicted the images and Live prediction including audio by using Mobilenet Model, RestNet50 and VGG16 Model.

In this Proposed system we are getting 85% accuracy for image based and live prediction.

Step1: Run the Code

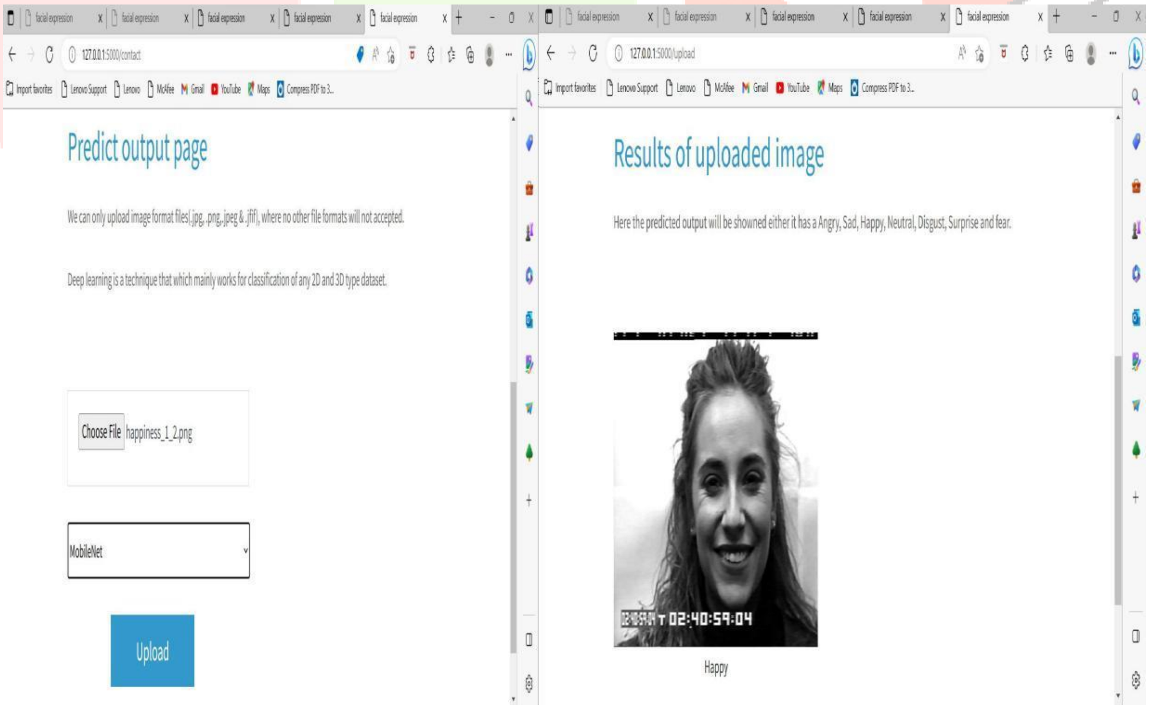


```
import random

import pygame
from flask import Flask,request,render_template,send_from_directory,flash
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
import numpy as np
import os
import cv2
from tensorflow.keras.preprocessing.image import img_to_array

app=Flask(__name__)
app.config['SECRET_KEY']='LAKSHMI'

@app.route('/')
def index():
    return render_template('index.html')
```

```
Hello from the pygame community. https://www.pygame.org/contribute.html
2023-04-03 10:19:36.475040: W tensorflow/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'cudart64_110.dll'; dlerror: cudart64_110.dll not foun
d
2023-04-03 10:19:36.475270: I tensorflow/stream_executor/cuda/cudart_stub.cc:29] Ignore above cudart dlerror if you do not have a GPU set up on your machine.
 * Debugger is active!
 * Debugger PIN: 306-502-274
 * Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
```

Fig.24: Source Code

Step2: Image Prediction Output


facial expression
127.0.0.1:5000/contact
127.0.0.1:5000/upload
Import favorites Lenovo Support Lenovo McAfee Gmail YouTube Maps Compress PDF to 3...
Choose File
Upload
Happy

Predict output page

We can only upload image format files(.jpg, .png, .jpeg & .jfif), where no other file formats will not accepted.

Deep learning is a technique that which mainly works for classification of any 2D and 3D type dataset.

Choose File happiness_1_2.png

MobileNet

Results of uploaded image

Here the predicted output will be showned either it has a Angry, Sad, Happy, Neutral, Disgust, Surprise and fear.

Happy

Fig.25: Results of Image

Step 3: Live Prediction Output

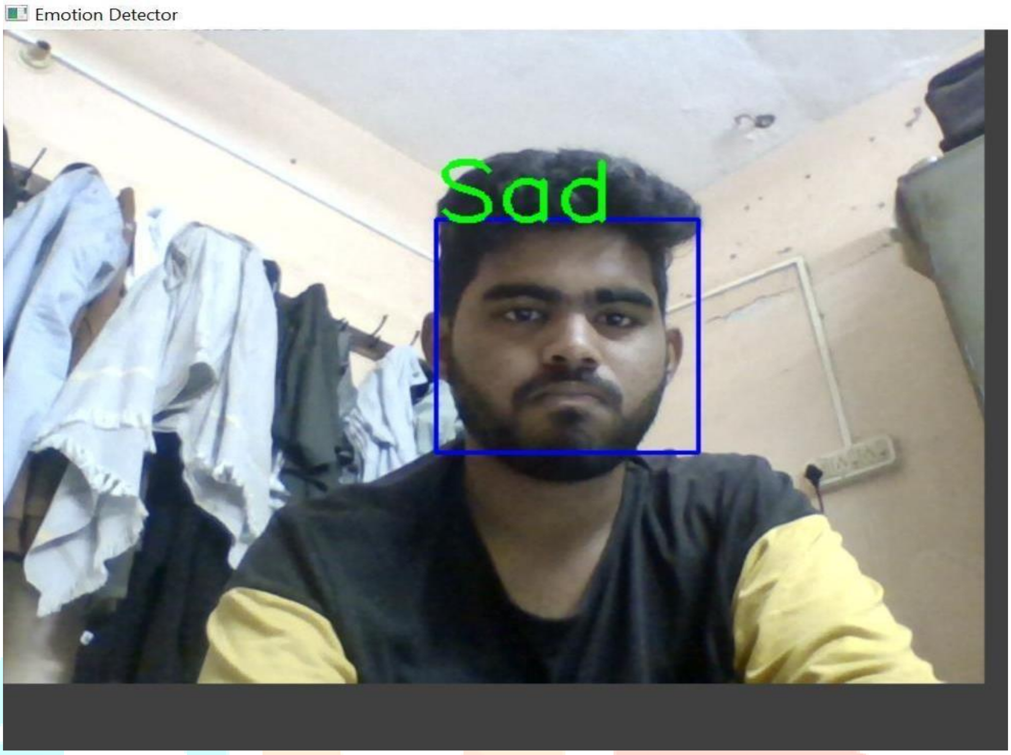


Fig.26: Result of Live Prediction1

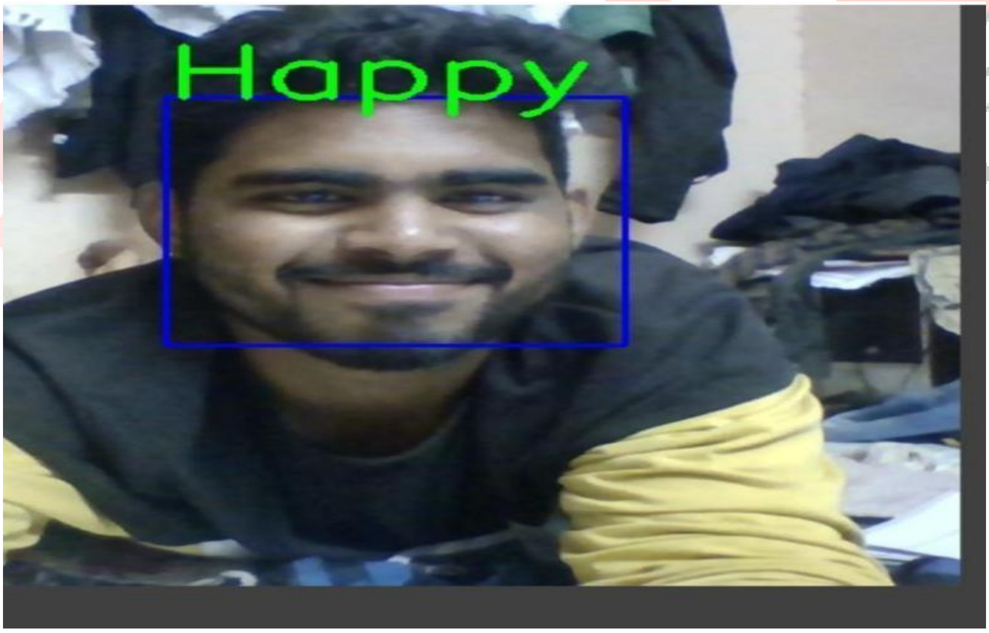


Fig.27: Result of Live Prediction2

VII. FUTURE SCOPE

To improve the model's accuracy and predictability in the future, we should think about training it on a lot of data. The facial expressions can be recognized by machines with the aid of this process.

VIII. CONCLUSION

We have successfully created an application that can detect and recognize faces in this project. Here we developed the two types of methods like image and video based by using CNN algorithm. Once after trained the dataset results were tested by uploading image and also video streaming with face inputs.

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