HUMAN FACIAL EXPRESSION DETECTION

J Component Final Report

for

SOFT COMPUTING (SWE1011)

in

M.Tech (Integrated) Software Engineering

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ABSTRACT

One of the applications of object recognition is it can be used to recognize face of a human with its features, hence, it also can be developed to recognize a human facial expression that convey non-verbal communication cues that play an important role in interpersonal relations.

The 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 human behaviour understanding, detection of mental disorders, and synthetic human expressions. Recognition of facial expression by computer with high recognition rate is still a challenging task.

Facial Expression Recognition is usually performed in four-stages consisting of pre-processing, face detection, feature extraction, and expression classification. In this project we applied back propagation method, which increase the efficiency of model, to identify the key six human emotions: anger, disgust, fear, happiness, sadness and surprise. We focus to tackle the recognition of subtle spontaneous facial expressions.

INTRODUCTION

Facial emotions are important factors in human communication that help us understand the intentions of others. In general, people infer the emotional states of other people, such as joy, sadness, and anger, using facial expressions and vocal tone.

According to different surveys verbal components convey one-third of human communication, and nonverbal components convey two-thirds.

Among several nonverbal components, by carrying emotional meaning, facial expressions are one of the main information channels in interpersonal communication.

Computer animated agents and robots bring new dimension in human computer interaction which makes it vital as how computers can affect our social life in day-to-day activities. Face to face communication is a real-time process operating at a time scale in the order of milliseconds. The level of uncertainty at this time scale is considerable, making it necessary for humans and machines to rely on sensory rich perceptual primitives rather than slow processes. In this project we are presenting the real time facial expression recognition of seven most basic human expressions: ANGER, DISGUST, FEAR, HAPPY, NEUTRAL, SAD, SURPRISE.

Our objective is to predict the expression of human face in real time as fast as accurate as possible.

CONSTRAINTS

1. Latency: Given an image, the system should be able to predict the expression immediately and transfer the result. Hence, there is a low latency requirement.

2. Interpretability: Interpretability is important for still images but not in real time. For still images, probability of predicted expressions can be given.

3. Accuracy: Our goal is to predict the expression of a face in the image as accurate as possible. Higher the test accuracy, the better our model will perform in real world.

HISTORY

Current research and public interest in facial expression recognition stems from a rich history. Scientific study and understanding of emotion is thought to have begun in the 19th century with Charles Darwin's The Expression of the Emotions in Man and Animals (originally published in 1872) and G.G. Duchenne de Bologne's The Mechanism of Human Facial Expression (originally published in 1862) (Mayne & Bonanno, 2001). These early works focused on the important role of facial displays in emotional life and introduced the theory that emotions may be understood as biologically-based reflex behaviours serving adaptive functions. The Darwinian Theory, that emotions serve to aid in survival and that facial expressions and other physiological responses serve to communicate intentions, was firmly rooted in the view of emotions as catalysts for physiological action. More recent theorists "have begun to systematically link specific emotions to social functions" (Keltner & Haidt, 2001, p. 193). For example, Lazarus' (1991) theory of emotion emphasized the role of individual appraisal (such as how the impact of an event is evaluated in terms of self-concept and relationships) on the experience of emotion. How emotions are differentiated has been a "prominent recurrent question" (Frijda, 2004, p. 64). Izard's (1977, 1991) differential emotions theory posits that emotions have distinct neural substrates and facial configurations. Facial expression recognition has been the topic of some special issues in academic journals (Happe, 2004), including Behavior Modification (Singh & Ellis, 1998). In this issue, Singh and Ellis presented several articles that provided research data on the FER ability of individuals with different clinical conditions. According to Singh and Ellis, Understanding why some people have difficulty correctly recognizing the six basic facial expressions of emotion at a socially acceptable level is vital to helping them learn to interpret facial expressions accurately. The ultimate goal, being, of course, that we not only treat the underlying clinical disorders but also improve

the quality of people's lives by enhancing their ability to engage fully in the human experience (p. 126). Ekman (1992, 1993), known for decades of facial expression and emotion research, has made a case for the existence of basic emotions (e.g., fear, joy, sadness, anger, disgust, and surprise), which are recognizable in facial expressions. A popular television series, Lie to Me: The Truth is Written All Over our Faces is based on Ekman's scientific study of human facial expressions (www.fox.com/lietome). This TV hit focuses on and follows a scientist who studies facial expressions to uncover lies and truth in difficult legal cases. As well, Ekman's work has received attention from other media sources such as Time Magazine and he has several mainstream books in publication. Thus, the growing interest in the structural and functional properties of facial expressions as well as individuals' ability to recognize facial expressions is being demonstrated in mainstream popular culture and seems to paralle l research interests in the topic.

REAL WORLD PROBLEM

For criminal interrogation, it is possible to analyse the psychological state of an interro- gated person by monitoring his or her facial expressions, and determine whether he or she is lying or concealing the truth. For telemedicine, in the process of communication between patients and doctors, doctors can obtain the changes of patients' mental state through a facial expression analysis system, which can help doctors determine a better treatment plan. It can also be collaterally leveraged to supervise doctor's attitude towards patients in the process of diagnosis, which is conducive to improve patients' medical experience. For driving fatigue detection, in terms of traffic safety, it can identify the state of the driver, making timely judgments and issue warnings, and effectively reducing the occurrence of fatigue driving and other situations. For intelligent robots, such as hospital lobbies, hotel lobbies, government office lobbies, tourist attractions, and

other places, intelligent robots can capture users' facial expressions and respond to users' emotions accordingly. For example, when they respond to users' emotions, happy or unhappy, by the corresponding measures.

CLASSIFYING THE EXPRESSION OF FACE INTO SIX BASIC HUMAN EXPRESSIONS FROM THE IMAGE:

This model can be used for prediction of expressions of both still images and real time video. However, in both the cases we have to provide image to the model. In case of real time video the image should be taken at any frame in time and feed it to the model for prediction of expression. The system automatically detects the face using HAAR cascade then its crops it and resize the image to a specific size and give it to the model for prediction.

The model will generate seven probability values corresponding to seven expressions. The highest probability value to the corresponding expression will be the predicted expression for that image. Facial expression recognition software is a technology which uses biometric markers to detect emotions in human faces.

- More precisely, this technology is a sentiment analysis tool and is able to automatically detect the six basic or universal expressions: happiness, sadness, anger, and neutral, surprise, fear, and disgust.
- Facial expressions and other gestures convey nonverbal communication cues that play an important role in interpersonal relations.
- Therefore, facial expression recognition, because it extracts and analyses information from an image or video feed, it is able to deliver unfiltered, unbiased emotional responses as data.

METHODOLOGY

- **Face Detection** - Locating faces in the scene, in an image or video footage.
- **Facial Landmark Detection** - Extracting information about facial features from the detected faces.
- **Facial Expression And Emotion Classification** - Classifying the obtained information into expression interpretative categories such as smile or frown or emotion categories such as happy, anger, disgust etc.

Data Cleaning:

After importing the images, the images were resized to 420 × 240 because some of the images in the dataset did not have 1280 × 960 as their size, despite the submission format.

Data Pre-processing:

- The images were then converted into grayscale to remove the third dimension and to make the implementation easier.
- Then the images were then flattened (except for CNN) and for Neural Network we have applied PCA to reduce image's dimensions.
- Histogram of oriented gradients was used to extract faces from entire images.
- Then the dataset was divided into two parts 90% of the dataset was used for training and rest 10% was used for testing.

Learning Algorithms:

- Neural network approach
- Back propagation Neural Network (with 15 features and 2 layers)
- Convolutional Neural Network (3 convolutional layers and 2 fully connected layers with pooling layers)

DATASET

https://www.dropbox.com/s/nilt43hyl1dx82k/dataset.zip?dl=0

As our project is about facial emotion recognition, we take the photos as the input and change it into gray scale.so the photos above can be used as the input for our project.

LITERATURE SURVEY

Reference paper 1

Source:
https://www.researchgate.net/publication/8231628_Facial_Expression_Recognition_Using_Constructive_Feedforward_Neural_Networks

Title: FACIAL EXPRESSION RECOGNIZATION USING CONSTRUCTIVE FEED FORWARD NEURAL NETWORK

The main objective is to find out the facial expression using constructive neural network. A feedforward neural network is an artificial neural network wherein connections between the nodes do not form a cycle. As such, it is different from its descendant: recurrent neural networks. The feedforward neural network was the first and simplest type of artificial neural network devised.

The main limitations of this neural network are

1) There will be a lot of parameters to optimize when go deep.
2) There will be a loss of neighbourhood information
3) It is not translation variance.

And coming to the experimental analysis, A group of 120 people are in a room and categorized into smile,anger,sad,neutral and surprise.The results are noted during this experiment,In that the analysis are like this;-

1) One hidden layer(trained) With pruning technique ,the mean success ratio is 99.375% and without pruning is 100%

2) One hidden layer(untrained)-With pruning technique,the mean success ratio is 92.50% and without pruning is 93.75%

3) The mean average of all the success ratios is 93.75%.So it is declared as the best method for the facial expression recognition.

So the conclusion of this experiment is to recognize the facial expression using the constructive feed forward neural network and this article was published in June, 2004

Reference paper 2

Source: https://biomedical-engineering online.biomedcentral.com/articles/10.1186/1475-925X-8-16

Title: Facial expression (mood) recognition from facial images using committee neural networks

The purpose of the present study was to develop an intelligent system for facial image based expression classification using committee neural networks. Method: Several facial parameters were extracted from a facial image and were used to train several generalized and specialized neural networks.

Real valued parameters are eyebrow raise distance, inter eyebrow distance, upper eyelid, top lip thickness, lower lip thickness, mouth width, mouth opening. Binary

parameters are upper teeth visible, lower teeth visible, forehead lines, eyebrow lines, nose lines, chin lines, nasolabial lines.

Based on initial testing, the best performing generalized and specialized neural networks were recruited into decision making committees which formed an integrated committee neural network system. The integrated committee neural network system was then evaluated using data obtained from subjects not used in training or in initial testing. Result and conclusion

The system correctly identified the correct facial expression in 255 of the 282 images (90.43% of the cases), from 62 subjects not used in training or in initial testing. Committee neural networks offer a potential tool for image based mood detection.

Real valued and binary parameters were extracted from the facial images from 97 subjects (467 images). The integrated committee classification system correctly identified 255 out of 282 different expressions from sixty two different subjects. There were 27 incorrect classification. The incorrect classifications were either misclassifications, ambiguous classification or no-classification cases. A misclassification occurred when an expression was not accurately categorized. An ambiguous classification occurred when two or more expressions were identified for a classification output. A no-classification occurred when there was an all zero output and no expression was classified.

Reference paper 3

Source: https://research.ijcaonline.org/volume77/number5/pxc3891019.pdf

Title: Facial Expression Recognition using Neural Network with Regularized Back- propagation Algorithm

This article mainly based on the Kohn-Kanade database because that database containing the people with exact facial expressions are in this database. The Backpropagation algorithm is a supervised learning method for multilayer feed-forward networks from the field of Artificial Neural Networks. It is an algorithm used to calculate derivatives quickly. The main thing that we are using this algorithm is Kohn-Kanade database.

The advantages of backpropagation algorithm is

1) It is fast, simple and easy to program.

2) It has no parameters to tune apart from the numbers of input.

3) It is a flexible method as it does not require prior knowledge about the network.

Some of the applications are Speech recognition, character recognition, signature verification, human-face recognition are some of the interesting applications of neural networks.

Some of the disadvantages are

1) It relies on input to perform on a specific problem. Sensitive to complex/noisy data.

2) It needs the derivatives of activation functions for the network design time.

Take a 100 people face expressions from the dataset, the deep learning model arrives to is actually the mess that was caused by all the nodes accumulated into one number. Therefore, we need to find out which node is responsible for most of the loss in every layer, so that we can penalize it in a sense by giving it a smaller weight value and thus lessening the total loss of the model. The accuracy given by this model in test data set is 91.95% and in the train data set is 99.32%.

So by using this dataset and algorithm we can able to get the facial expression. This article was published in the year 2013.

Reference paper 4

Source: https://www.sciencedirect.com/science/article/pii/S1877050917305264

Title: Emotion recognition using facial expressions

They conducted an experiment where some subjects are asked to mimic some facial experiemnts.in total they received a dataset of 252 facial expressions. They conducted the experiments using K-NN and MLP classifiers. Here they have used two ways to recognize the emotions.1-subject-dependent for each user separately, 2-subject – independent for all users together.in both the above mentioned cases, using the 3NN classifier they divided the data randomly for teaching(training) and testing part. For teaching they have 70%of the data and for the testing they have used 30% of the data. For the subject dependent classification the data was divided into 6 subsets, which is 2 sessions x 3 trails. With 7 different facial expressions. Five subsets were used for training and one is used for the testing. For subject independent classification data was divided into 12 subsets.11 subsets were used for the training and one for testing, and the highest classification accuracy was 73% archived for MLP neural network. They have obtained classification accuracy of emotions of 96% (3-NN), 90% (MLP) for random division of data. For “natural” division of data the classification accuracy was 73% (for MLP classifier). In the same case, for the 3-NN classifier we obtained a classification accuracy of 10% worse. Certainly, the classification accuracy was influenced by the way users play specific facial expressions. In real conditions the classification accuracy can be affected by many additional factors. When you feel real emotions, facial expressions can vary greatly - may be exposed to a greater or lesser extent.

Reference paper 5

Source: https://eudl.eu/doi/10.4108/eai.23-4-2018.2277588

Title: Face Expression Recognition Using Artificial Neural Network (ANN) Model Back Propagation

As we know that humans can detect the face expression but computer or machines cant detect that, So we are using some methods like “Artificial neural Networks” is which we used here.Basically ANN is used for modelling non-linear problems and to predict the output values for given input parameters from their training values.

The disadvantages of this ANN is

1) Hardware Dependence

2) Unexplained Behaviour of network

3) The duration of the network is not shown.

By using the “Viola- Jonus” Method we can able to extract the the facial objects like eyes,mouth and nose majorly for 60 people.And also PCA is used for the image analysis that is to reshaping the image into 2-dimensional compressed image. And that compressed image is shown in the output.

Some of the advantages of using the ANN is;

1) Can able to work with incomplete knowledge.

2) Having a distributed memory.

3) Parallel processing capability. Process to find a face using ANN is

1) Calculating the output of each processing element through the outer layer.

2) Calculating the error on the outer layer

3. Transform the error to the appropriate error on the input side

4. Propagation of these errors on the output of each processing element to the error Contained in the input.

4) Repeat this process until input is reached.

By doing this experiment we can able to get the 81.67% accuracy so this is chosen as the best model

So by this process we can detect the face expression of a person and this article is published in the year April 2018.

Reference paper 6

Source: https://ieeexplore.ieee.org/document/9438728

Title: Facial emotion recognition using deep learning: review and insights

Their data set consists of 2000 images of 200 subjects. About 600 images are used. The tests performed are person dependent tests. The variation in the images of testing and training is more in the database. The performance of the system is measured by varying the number of images of each expression in training and testing. Following table shows the performance of the proposed method along with the other methods. It is found that the PCA with emotional back propagation neural network is yielding the better results even the training samples are less. The performance plot was shown against various algorithms, number of training images and their performances. Experimental results here shows that the proposed architecture improves the performance of the facial expressions. Based on the results they concluded that the proposed emotional back propagation neural network with principal component analysis is best in both cases of minimization of training time of neural network and performance as well. The optimal value for learning rate is 0.02, which produces the best performance for facial expression. The work can be extended to clustering techniques like

segmentation for the lower training times and higher performance. Since the training data is still images, there is more dependency on the image data like lighting, illumination conditions, poses of the faces, variations in expression and gender of the person also. The recognition performance increases as the number of training samples increases. The lower the number of training samples the lesser the recognition rate. It is found that the PCA with emotional back propagation neural network is yielding the better results even the training samples are less.

The performance plot was shown against various algorithms, number of training images and Their performances. The confusion matrix is created for each of the test. The test is performed on five subjects.

Reference paper 7

Source: https://downloads.hindawi.com/journals/complexity/2020/4065207.pdf

Title: Emotion Recognition of Students Based on Facial Expressions in Online Education Based on the Perspective of Computer Simulation

Our main objective is to create a framework that enables real-time monitoring of students' emotions in online courses and ensures that the feedback expressed by facial expression can be provided to teachers timely, so that they can flexibly adjust the teaching programs and ultimately improve the quality and efficiency of online education and this can be done using, Emotion AI, is a technology that is capable of reading, imitating, interpreting, and responding to human facial expressions and emotions

The main advantages of this Facial Expression Recognition model are

1. Helps figuring out if a student is stressed and depressed
2. Helps make more effective timetables and programmes

3. Make Online Education more effective

Limitations

1. it's not necessary that student keeps their camera "ON"

2. If full face is not visible system won't be able to process it

3. There are high chances that students' expressions may not fully represent their emotions due to some subjective factors

4. We still have no way to ensure if student is paying full attention to class or not By using this model we found that out of 27 faces 25 faces were successfully recognised, hence the accuracy of the model is 92.6%.

Reference paper 8

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Reference paper 9

Source: https://downloads.hindawi.com/journals/cin/2021/5570870.pdf

Title: FACIAL EXPRESSION MOOD RECOGNIZATION FROM FACIAL IMAGES USING COMMITTEE NEURAL NETWORK

Facial expressions are important in facilitating human communication and interactions. Also, they are used as an important tool in behavioural studies and in medical rehabilitation. Facial image based mood detection techniques may provide a fast and practical approach for non- invasive mood detection. The purpose of the present study was to develop an intelligent system for facial image based expression classification using committee neural networks.

Points to be noted:-

1) Our study investigated the emotion recognition accuracy and the perception of arousal and valence ratings of facial expressions among preadolescents.

2) Recognition accuracy varies according to emotions and the observer's age.

3) Moreover, our results highlight that the affective ratings in response to emotional facial expressions are also subjected to a developmental process during this stage of life.

In this author takes the dataset containg the 282 images and in that 255 images are showing the correct output.So the steps are taken to achieve is first taking the dataset and after that train the dataset and we are going to get the accuracy and in that the best thing is to be taken as the bestfit model.

So the accuracy for the above model 90.4% for the given dataset. Then we can get this by using committee neural network.

Reference paper 10

Source: https://www.sciencedirect.com/science/article/pii/S1877050920318019

Title: Real time facial recognition using edge computing.

In this experiment they have used an edge device NVIDIA Jetson TX22, uses the detection method of facial motion unit. AI Model is partially deployed at the backend cloud servers. Here they have extracted AU's with prominent facial features, the identification features mainly uses grayscale feature, motion features and frequency features. They have used convolution expert's constrained local model (CECLM) for pinning markers on the face.

They have used PCA method to reduce the dimension of HOG eigenvector. After the processing of the input the output response map is a non-negative and non-linear combination of neurons in the ME-layer that are activated used the S-shapes. Regarding the data set, It is composed of image sequence of eight expressions of video recorded by 118 subjects. The images in the database vary widely in age, gender and ethnicity, head posture, lighting conditions, occlusion

(e.g., glasses, facial hair, scarves), and post-processing operations (e.g., various filters and effects). The RAF-DB dataset we used in the experiment contains 2920 facial images. They first run the code on the server with Intel Xeon CPU E5-2630 v4@2.2GHz, 64G of memory, and NVIDIA GeForce GTX 1080Ti 16G, and compared it with the facial expression recognition methods of recent years in terms of model parameters, accuracy, run-time, and CPU memory occupation. Their method has achieved a test accuracy of 3.45%less than the method with the highest accuracy. At the same time, our run time is only 66 seconds and the number of parameters is only 0.5 million. Their proposed method has not only achieved competitive accuracy but is computationally efficient as well. Based on their observations of image recognition and all other affiliated services, in addition to the time required to establish an initial connection, image/streaming data transferring takes hundreds of milliseconds. Therefore, the true value of edge computing is that it can integrate every component connected to the local network into a more complex and complete entity, thereby creating a meta-system that can do more magical things. The data processed by edge computing is relatively small and does not require much computing resources. When the data processing speed is faster, the network transmission pressure is less, and the cost of the Raspberry Pi we use is much lower than the cost of servers, notebooks, etc., it can greatly save costs without changing the accuracy of the algorithm.

SOFTWARE REQUIREMENTS SPECIFICATION:

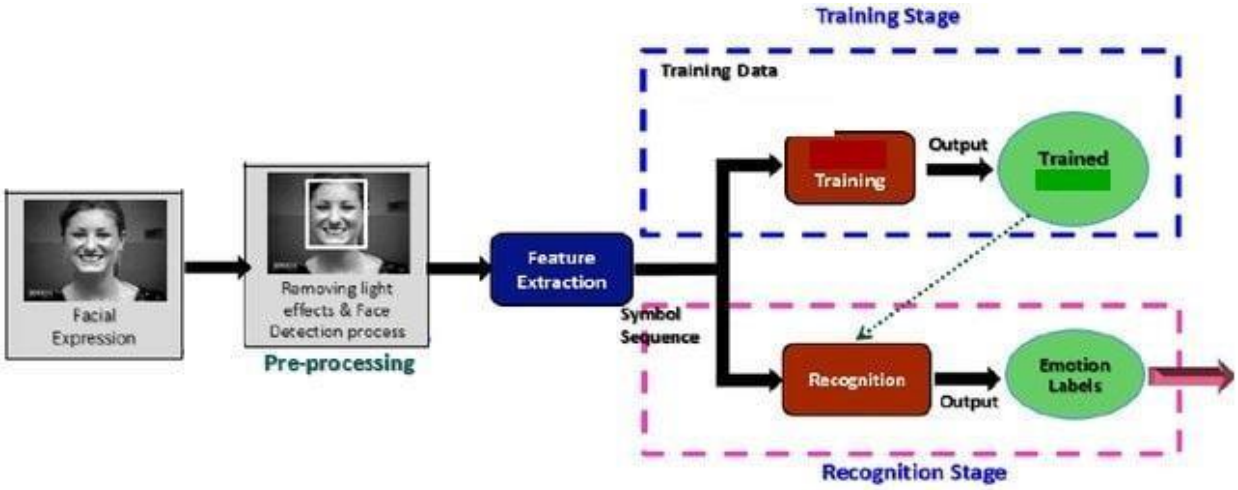
Language : python

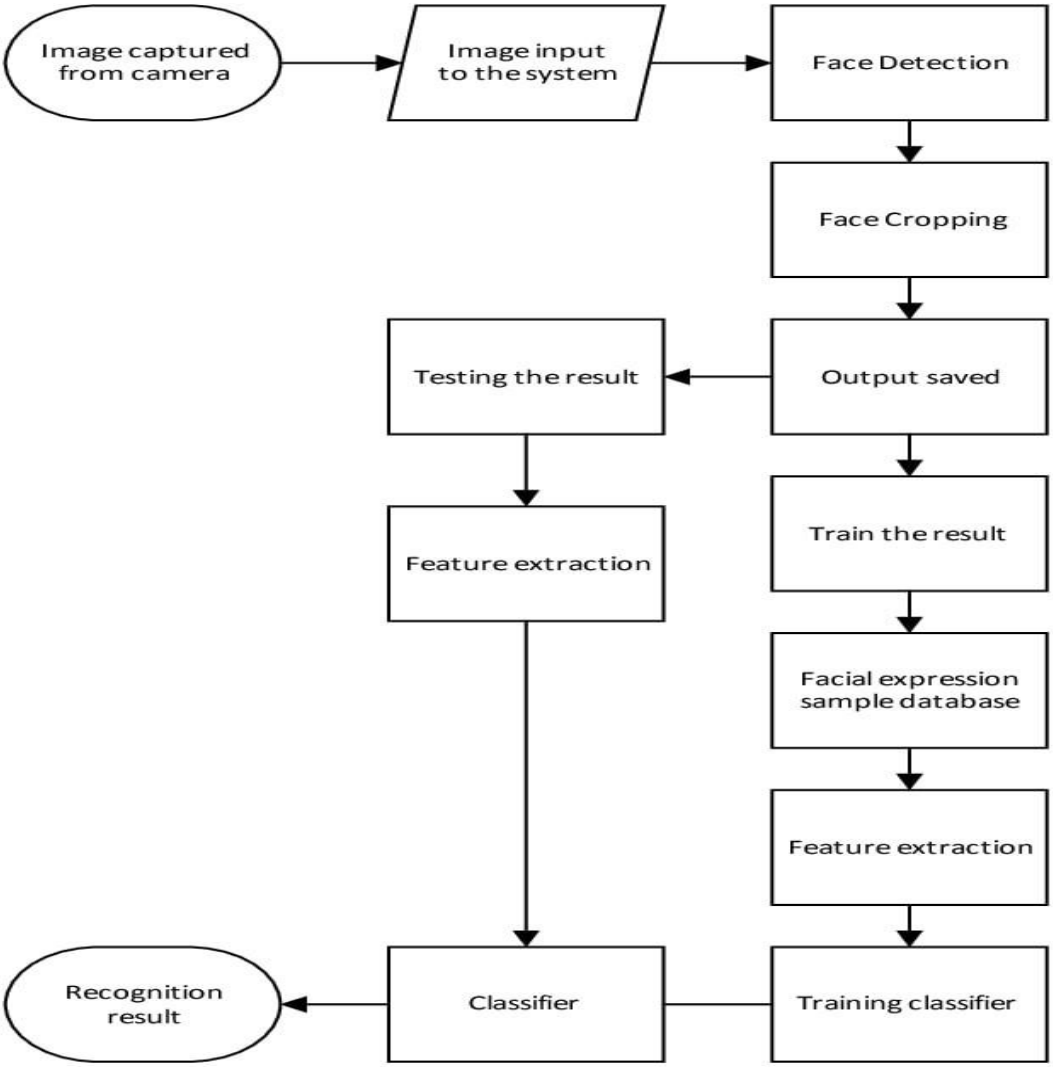
Dataset : Kaggle

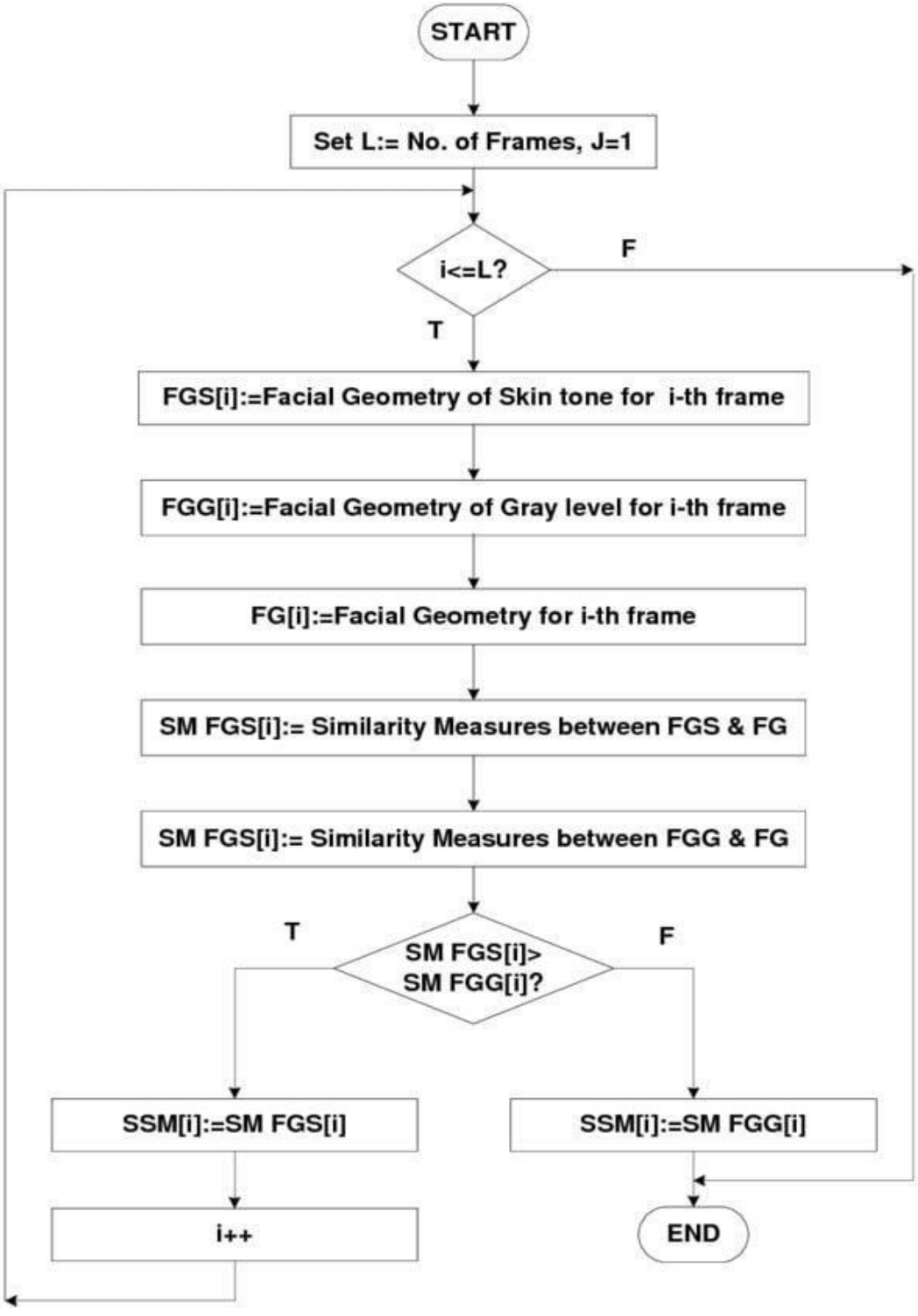
Compiler: Google collab

SYSTEM DESIGN

DETAILED ARCHITECTURE

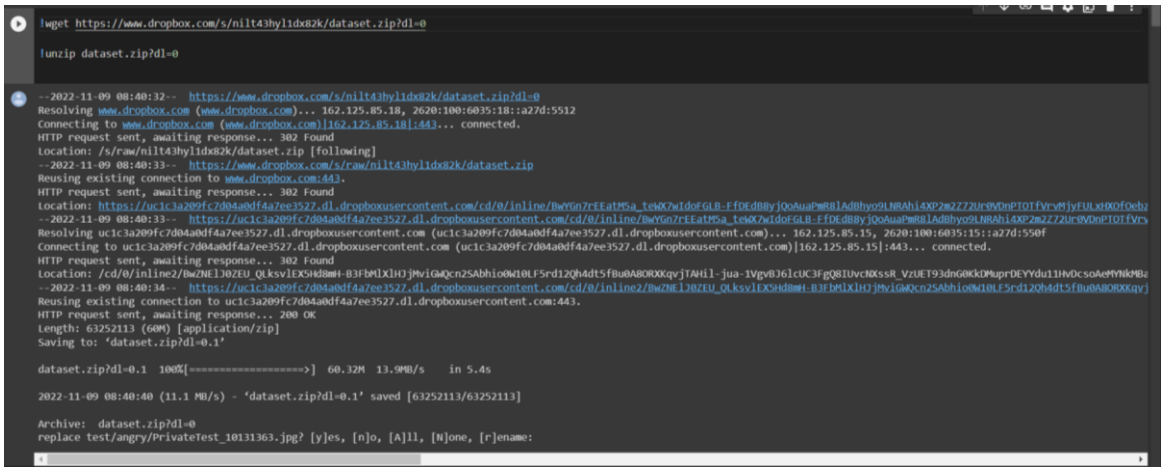





START
Set L:= No. of Frames, J=1
i<=L?
F
T
FGS[i]:=Facial Geometry of Skin tone for i-th frame
FGG[i]:=Facial Geometry of Gray level for i-th frame
FG[i]:=Facial Geometry for i-th frame
SM FGS[i]:= Similarity Measures between FGS & FG
SM FGS[i]:= Similarity Measures between FGG & FG
T
SM FGS[i]>
SM FGG[i]?
F
SSM[i]:=SM FGS[i]
SSM[i]:=SM FGG[i]
i++
END

IMPLEMENTATION

Importing dataset from dropbox



Importing necessary libraries and packages.

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

from keras.layers import Flatten, Dense
from keras.models import Model
from keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.utils import img_to_array, load_img
from keras.applications.mobilenet import MobileNet, preprocess_input
from keras.losses import categorical_crossentropy
```

Converting images into array and creating the model using adam optimizer.

```
# Working with pre trained model

base_model = MobileNet( input_shape=(224,224,3), include_top= False )

for layer in base_model.layers:
  layer.trainable = False


x = Flatten()(base_model.output)
x = Dense(units=7 , activation='softmax' )(x)

# creating our model.
model = Model(base_model.input, x)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/mobilenet/mobilenet_1_0_224_tf_no_top.h5
17225924/17225924 [==============================] - 1s 0us/step
```

```
model.compile(optimizer='adam', loss= categorical_crossentropy , metrics=['accuracy']  )
```

Creating a base model to use for cnn and finding the best model out of all epochs done using metrics as accuracy and adam as optimizer and categorical_crossentropy as loss.

Displaying number of folders present and number of images used for training

```
train_datagen = ImageDataGenerator(
      zoom_range = 0.2,
      shear_range = 0.2,
      horizontal_flip=True,
      rescale = 1./255
)

train_data = train_datagen.flow_from_directory(directory= "/content/train",
                                               target_size=(224,224),
                                               batch_size=32,
                                    )


train_data.class_indices
```

```
Found 28709 images belonging to 7 classes.
{'angry': 0,
 'disgust': 1,
 'fear': 2,
 'happy': 3,
 'neutral': 4,
 'sad': 5,
 'surprise': 6}
```

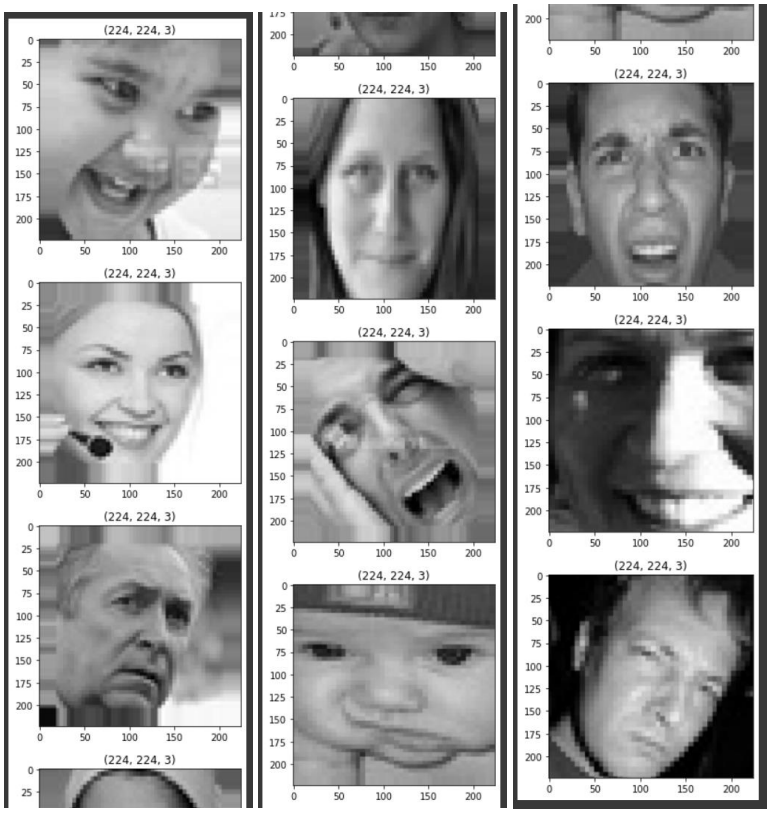
Displaying the testing images.

```
val_datagen = ImageDataGenerator(rescale = 1./255 )

val_data = val_datagen.flow_from_directory(directory= "/content/test",
                                           target_size=(224,224),
                                           batch_size=32,
                                )
```

```
Found 7178 images belonging to 7 classes.
```

Displaying the images using image array.

```
[ ]  # to visualize the images in the traing data denerator

     t_img , label = train_data.next()

     #-----------------------------------------------------------------
     # function when called will prot the images
     def plotImages(img_arr, label):
       """
       input  :- images array
       output :- plots the images
       """
       count = 0
       for im, l in zip(img_arr,label) :
         plt.imshow(im)
         plt.title(im.shape)
         plt.axis = False
         plt.show()

         count += 1
         if count == 10:
           break

     #-----------------------------------------------------------------
     # function call to plot the images
     plotImages(t_img, label)
```



Having early stopping and model check point for training

```
## having early stopping and model check point

from keras.callbacks import ModelCheckpoint, EarlyStopping

# early stopping
es = EarlyStopping(monitor='val_accuracy', min_delta= 0.01 , patience= 5, verbose= 1, mode='auto')

# model check point
mc = ModelCheckpoint(filepath="best_model.h5", monitor= 'val_accuracy', verbose= 1, save_best_only= True, mode = 'auto')

# puting call back in a list
call_back = [es, mc]
```

Training the data with 30 epochs with 10 steps per epoch

```
hist = model.fit_generator(train_data,
                           steps_per_epoch= 10,
                           epochs= 30,
                           validation_data= val_data,
                           validation_steps= 8,
                           callbacks=[es,mc])
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:6: UserWarning: `Model.fit_generator` is deprecated and will be removed i

Epoch 1/30
10/10 [==============================] - ETA: 0s - loss: 18.3190 - accuracy: 0.2219
Epoch 1: val_accuracy improved from -inf to 0.29297, saving model to best_model.h5
10/10 [==============================] - 32s 3s/step - loss: 18.3190 - accuracy: 0.2219 - val_loss: 15.1433 - val_accuracy: 0.2930
Epoch 2/30
10/10 [==============================] - ETA: 0s - loss: 12.5459 - accuracy: 0.3281
Epoch 2: val_accuracy did not improve from 0.29297
10/10 [==============================] - 23s 2s/step - loss: 12.5459 - accuracy: 0.3281 - val_loss: 14.0753 - val_accuracy: 0.2695
Epoch 3/30
10/10 [==============================] - ETA: 0s - loss: 8.5156 - accuracy: 0.3688
Epoch 3: val_accuracy improved from 0.29297 to 0.32812, saving model to best_model.h5
10/10 [==============================] - 23s 2s/step - loss: 8.5156 - accuracy: 0.3688 - val_loss: 9.7008 - val_accuracy: 0.3281
Epoch 4/30
10/10 [==============================] - ETA: 0s - loss: 9.0016 - accuracy: 0.3187
Epoch 4: val_accuracy improved from 0.32812 to 0.38672, saving model to best_model.h5
10/10 [==============================] - 24s 2s/step - loss: 9.0016 - accuracy: 0.3187 - val_loss: 5.3766 - val_accuracy: 0.3867
Epoch 5/30
10/10 [==============================] - ETA: 0s - loss: 5.4031 - accuracy: 0.4563
Epoch 5: val_accuracy improved from 0.38672 to 0.41797, saving model to best_model.h5
10/10 [==============================] - 23s 2s/step - loss: 5.4031 - accuracy: 0.4563 - val_loss: 5.6353 - val_accuracy: 0.4180
Epoch 6/30
10/10 [==============================] - ETA: 0s - loss: 5.3470 - accuracy: 0.4281
Epoch 6: val_accuracy improved from 0.41797 to 0.42969, saving model to best_model.h5
10/10 [==============================] - 26s 3s/step - loss: 5.3470 - accuracy: 0.4281 - val_loss: 5.2062 - val_accuracy: 0.4297
Epoch 7/30
```

```
Epoch 9/30
10/10 [==============================] - ETA: 0s - loss: 5.4186 - accuracy: 0.3938
Epoch 9: val_accuracy did not improve from 0.42969
10/10 [==============================] - 24s 3s/step - loss: 5.4186 - accuracy: 0.3938 - val_loss: 6.3401 - val_accuracy: 0.4258
Epoch 10/30
10/10 [==============================] - ETA: 0s - loss: 5.6751 - accuracy: 0.4375
Epoch 10: val_accuracy did not improve from 0.42969
10/10 [==============================] - 23s 2s/step - loss: 5.6751 - accuracy: 0.4375 - val_loss: 6.3068 - val_accuracy: 0.3711
Epoch 11/30
10/10 [==============================] - ETA: 0s - loss: 6.1669 - accuracy: 0.3938
Epoch 11: val_accuracy improved from 0.42969 to 0.44531, saving model to best_model.h5
10/10 [==============================] - 23s 2s/step - loss: 6.1669 - accuracy: 0.3938 - val_loss: 5.8521 - val_accuracy: 0.4453
Epoch 12/30
10/10 [==============================] - ETA: 0s - loss: 6.5785 - accuracy: 0.4563
Epoch 12: val_accuracy did not improve from 0.44531
10/10 [==============================] - 26s 3s/step - loss: 6.5785 - accuracy: 0.4563 - val_loss: 5.8127 - val_accuracy: 0.4336
Epoch 13/30
10/10 [==============================] - ETA: 0s - loss: 6.0719 - accuracy: 0.4094
Epoch 13: val_accuracy did not improve from 0.44531
10/10 [==============================] - 23s 2s/step - loss: 6.0719 - accuracy: 0.4094 - val_loss: 5.3009 - val_accuracy: 0.4180
Epoch 14/30
10/10 [==============================] - ETA: 0s - loss: 6.8759 - accuracy: 0.4062
Epoch 14: val_accuracy did not improve from 0.44531
10/10 [==============================] - 23s 2s/step - loss: 6.8759 - accuracy: 0.4062 - val_loss: 6.9694 - val_accuracy: 0.4102
Epoch 15/30
10/10 [==============================] - ETA: 0s - loss: 7.6702 - accuracy: 0.3969
Epoch 15: val_accuracy did not improve from 0.44531
10/10 [==============================] - 25s 3s/step - loss: 7.6702 - accuracy: 0.3969 - val_loss: 8.6150 - val_accuracy: 0.4062
Epoch 16/30
10/10 [==============================] - ETA: 0s - loss: 6.7229 - accuracy: 0.3812
Epoch 16: val_accuracy did not improve from 0.44531
10/10 [==============================] - 23s 2s/step - loss: 6.7229 - accuracy: 0.3812 - val_loss: 5.9070 - val_accuracy: 0.4453
Epoch 16: early stopping
```

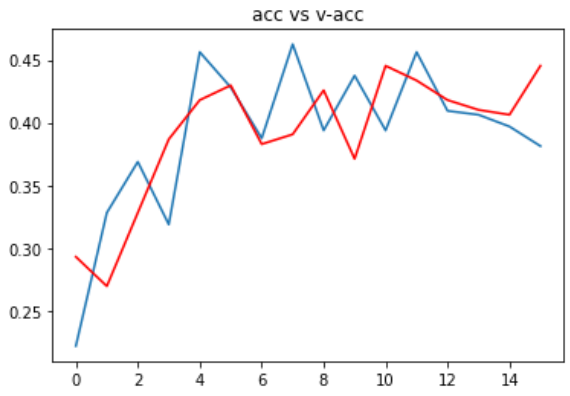
Loading the model to the model

```
[ ]  # Loading the best fit model
     from keras.models import load_model
     model = load_model("/content/best_model.h5")
```

Plotting the graphs

```
plt.plot(h['accuracy'])
plt.plot(h['val_accuracy'] , c = "red")
plt.title("acc vs v-acc")
plt.show()
```

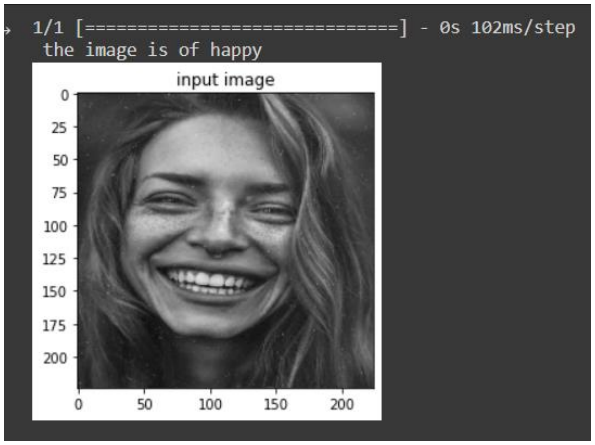
```
[ ]  plt.plot(h['loss'])
     plt.plot(h['val_loss'] , c = "red")
     plt.title("loss vs v-loss")
     plt.show()
```



Predicting the input emotion

```
# path for the image to see if it predics correct class

path = "/content/surprise.jpeg"
img = load_img(path, target_size=(224,224) )

i = img_to_array(img)/255
input_arr = np.array([i])
input_arr.shape

pred = np.argmax(model.predict(input_arr))

print(f" the image is of {op[pred]}")

# to display the image
plt.imshow(input_arr[0])
plt.title("input image")
plt.show()
```

```
# path for the image to see if it predics correct class

path = "/content/happy.jpg"
img = load_img(path, target_size=(224,224) )

i = img_to_array(img)/255
input_arr = np.array([i])
input_arr.shape

pred = np.argmax(model.predict(input_arr))

print(f" the image is of {op[pred]}")

# to display the image
plt.imshow(input_arr[0])
plt.title("input image")
plt.show()
```



Code

https://colab.research.google.com/drive/1k8o-YpI73jAcrQVTFbX1yY6SqZL1j0Nq?usp=sharing

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