Capstone Project-5 Submission

Facial Emotion Detection

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Abstract

The Human facial expressions are important for visually expressing a lot more information. Facial expression recognition is essential in the field of human-machine interaction. Automated facial recognition systems have many applications, including understanding of human behavior, diagnosing mental disorders, and synthetic human

expression. Identifying facial expressions through computers with high detection rates is still a challenging task.

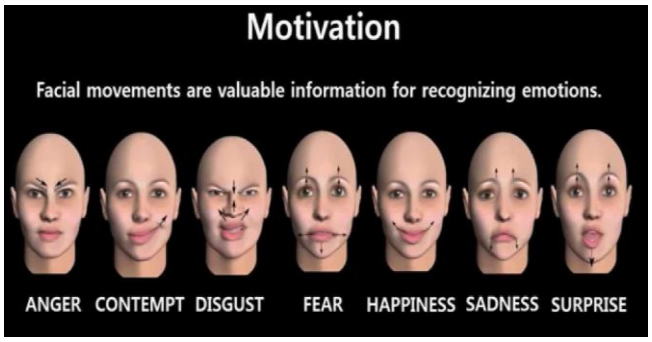
Two of the most popular methods used in the literature for automated FER systems are

geometry and appearance. Facial expression recognition is usually performed in four steps, including

preprocessing, face detection, feature extraction, and expression classification.

In this project, we have used a variety of intensive deeep learning techniques (convolutional neural networks) to identify the main seven human emotions: anger, hate, fear, joy, sadness, surprise, and neutrality.

I. Neutral II. Angry III. Disgust IV. Fear V. Happy VI. Sadness VII. Surprise



1.Introduction

Human facial expressions are categorized into 7 universal emotions: happy, sad, surprised, terrified, angry, ugly, and neutral. Our facial emotions are expressed through the activation of specific sets of facial muscles. These are sometimes subtle and complex signs of expression that contain abundant information about the state of our mind. Through this, we can measure impacts and measurements on audiences / customers with ease and cost.

For example

- Retailers can use these metrics to assess customer interest.
- Healthcare providers can provide better services by using additional information about patients' mood during treatment.
- Entertainment producers can continually monitor audience engagement at events to create the desired content.

The Humans are well-trained to read the feelings of others, in fact, at just 14 months of age, children can already tell the difference between happy and sad. Computers work better than us in getting to the mood of humans. Therefore, we have designed/created an intensive deep learning neural network that gives machines the ability to communicate about our emotional states. In other words, we give eyes to the system for what we can see.

2. Problem Statement

The hands on building this project of Facial Expression Recognition is divided into following tasks/steps:-

Task 1: Introduction

- Introduction to the dataset
- Import essential modules and helper functions from NumPy, Matplotlib, and Keras.

Task 2: Exploring the Dataset

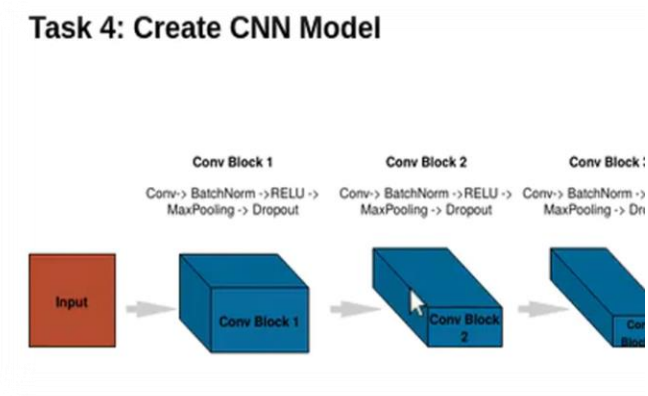
- Display some images from every expression type in the Emotion FER dataset.

Task 3: Generating Training and Validation Batches

- Generate batches of tensor image data with real-time data augmentation.
- Specify paths to training and validation image directories and generates batches of augmented data.

Task 4: Creating a Convolutional Neural Network (CNN) Model

- Design a convolutional neural network with 4 convolution layers and 2 fully connected layers to predict 7 types of facial expressions.
- Used Adam as the optimizer, categorical crossentropy as the loss function, and accuracy as the evaluation metric.



Task 5: Training and Evaluating Model

- Training the CNN by invoking the **model.fit()** method.
- Used **ModelCheckpoint()** to save the weights associated with the higher validation accuracy.
- Observed live training loss and accuracy plots in Jupyter Notebook for Keras.

Task 6: Saving and Serializing Model as JSON String

- Used **to_json()**, which uses a JSON string, to store the model architecture.

Task 7: Creating a App to Serve Predictions

- We used the open-source code from "Video Streaming with Flask Example" to create a app to serve the model's prediction images directly to a web interface.

Task 8: Creating a Class to Output Model Predictions

- Created a FacialExpressionModel class to load the model from the JSON file, load the trained weights into the model, and predict facial expressions.

Task 9: Used Model to Recognize Facial Expressions at the Real Time using laptops webcam

- We than run the test**.py** script to create the app and serve the model's predictions to a web interface.
- Applied the model for real time recognition of facial expresssions of users using webcam of the Laptop.

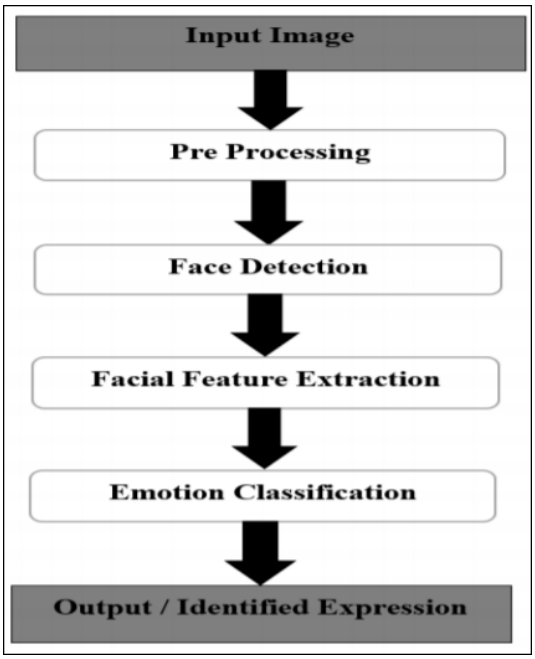
3. Data Description

The dataset used in this project work has been taken from the (https://www.kaggle.com/code/iayushgupta/facial-expression-recognition). The data consists of 48x48 pixel grayscale images of faces. The faces have been automatically registered so that the face is more or less centered and occupies about the same amount of space in each image. The task is to categorize each face based on the emotion shown in the facial expression in to one of seven categories (0=Angry, 1=Disgust, 2=Fear, 3=Happy, 4=Sad, 5=Surprise, 6=Neutral).

train.csv contains two columns, "emotion" and "pixels". The "emotion" column contains a numeric code ranging from 0 to 6, inclusive, for the emotion that is present in the image. The "pixels" column contains a string surrounded in quotes for each image. The contents of this string a space-separated pixel values in row major order. test.csv contains only the "pixels" column and your task is to predict the emotion column.

The training set consists of 28,709 examples. The public test set used for the leaderboard consists of 3,589 examples. The final test set, which was used to determine the winner of the competition, consists of another 3,589 examples.

4. PROJECT STRUCTURE



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

1. **Locating faces in the scene** (e.g., in an image; this step is also referred to as facedetection),
2. **Extracting facial features** from the detected face region (e.g., detecting the shape of facialcomponents or describing the

texture of the skin in a facial area; this step is referred to asfacial feature extraction),

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

5. STEPS FOLLOWED FOR BUILDING THE PROJECT

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

i.) Preprocessing
ii.) Face registration
iii.) Facial feature extraction
iv.) Emotion classification

Description about all these processes are given below-

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 the noise b. Convert The Image To Binary/Grayscale. c. Pixel Brightness Transformation. d. Geometric Transformation.

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 “faceregistration”.

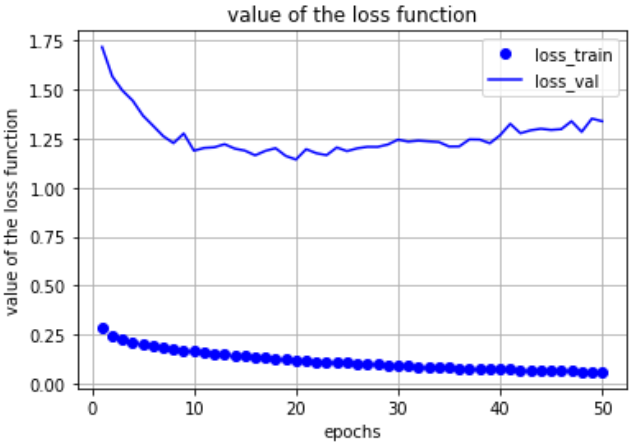
3. Facial Feature Extraction : Facial Features extraction is an important step in face recognition and is defined as the process of locating specific regions, points, landmarks, or curves/contours in a given 2-D image or a 3D range image. In this feature extraction step, a numerical feature vector is generated from the resulting registered image.

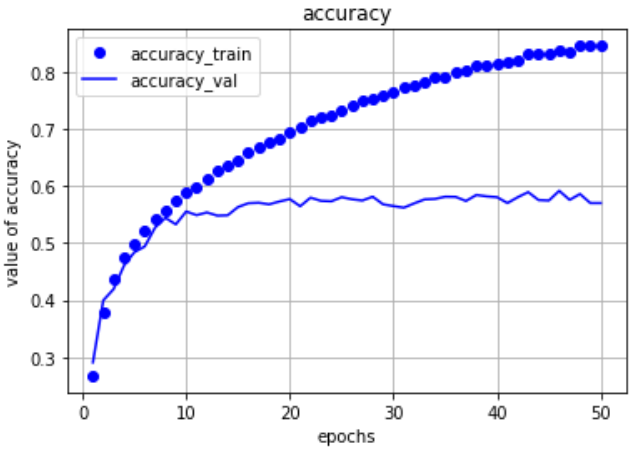
Common features that can be extracted are:- a. Lips b. Eyes c. Eyebrows d. Nose tip

4. Emotion Classification : In this step, of classification, the algorithm attempts to classify the given faces portraying one of the seven basic emotions.

6. IMPLEMENTATION

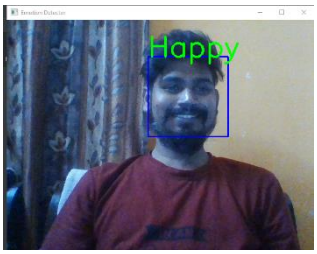
- **Accuracy and Loss of the Model:-**

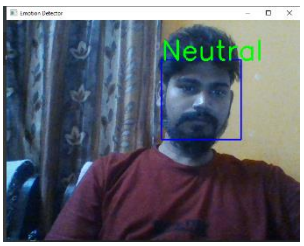


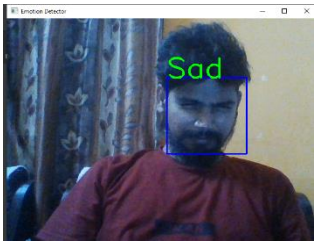


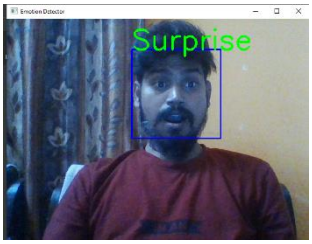
7. OUTPUT SCREENSHOTS

- **Prediction of Facial Expressions on Web Interface**









8. Clustering:

Clustering (also called cluster analysis) is a task of grouping similar instances into clusters. More formally, clustering is the task of grouping the population of unlabeled data points into clusters in a way that data points in the same cluster are more similar to each other than to data points in other clusters. The clustering task is probably the most important in unsupervised learning, since it has many applications.

for example:

• **Data analysis:** often a huge dataset contains several large clusters, analyzing which separately, you can come to interesting insights.

• **Anomaly detection:** as we saw before, data points located in the regions of low density can be considered as anomalies

• **Semi-supervised learning:** clustering approaches often helps you to automatically label partially labeled data for classification tasks.

• **Indirectly clustering tasks (tasks where clustering helps to gain good results):** recommender systems, search engines, etc.

• **Directly clustering tasks**: customer segmentation, image segmentation, etc.

Building a clustering model

Clustering models allow you to categorize records into a certain number of clusters. This can help you identify natural groups in your data.

Clustering models focus on identifying groups of similar records and labeling the records according to the group to which they belong. This is done without the benefit of prior knowledge about the groups and their characteristics. In fact, you may not even know exactly how many groups to look for.

This is what distinguishes clustering models from the other machine-learning techniques—there is no predefined output or target field for the model to predict.

These models are often referred to as **unsupervised learning** models, since there is no external standard by which to judge the model's classification performance.

9. SOFTWARE REQUIREMENTS

As the project is developed in python, we have used PyCharm for Python 3.7.9.

PyCharm :- PyCharm is a dedicated Python Integrated Development Environment (IDE) providing a wide range of essential tools for Python developers, tightly integrated **to create a convenient environment for productive Python, web, and data science development**.

IDE : - Python 3.7.9

Google Colab :- Colab notebooks are **Jupyter notebooks that run in the cloud and are highly integrated with Google Drive**, making them easy to set up, access, and share.

Libraries :- OpenCV, Tensorflow, Keras, Numpy, Pandas and matplotlib.

Hardware Interfaces

1.Processor : Intel CORE i3 processor with minimum 2.9 GHz speed.

2. RAM : Minimum 4 GB.

3. Hard Disk : Minimum 1 TB.

Software Interfaces

1. Microsoft Word- 2003

2. Database Storage : Microsoft Excel

3. Operating System : Windows10

10. Conclusion

In this project a Emotion/Facial Recognition model has been trained and saved. It can recognize/detect the facial expressions of an individual on a real time basis that whether the individual is Neutral, Angry, Disgust, Fear, Happy, Sad, Surprised.

The behavioral aspect of this system relates the attitude behind different expressions as property base. The property bases are alienated as exposed and hidden category in genetic algorithmic genes. The gene training set evaluates the expressional uniqueness of individual faces and provide a resilient expressional recognition model in the field of biometric security.

11. FUTURE SCOPE :

It is important to note that there is no specific formula to build a neural network that would guarantee to work well. Different problems would require different network architecture and a lot of trail and errors to produce desirable validation accuracy. This is the reason why neural nets are often perceived as "black box algorithms.". 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

But due to lack of highly configured system we could not go deeper into dense neural network as the system gets very slow and we will try to improve in these areas in future.

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.

Having examined techniques to cope with expression variation, in future it may be investigated in more depth about the face classification problem and optimal fusion of color and depth information.

Further study can be laid down in the direction of allele of gene matching to the geometric factors of the facial expressions. The genetic property evolution framework for facial expressional system can be studied to suit the requirement of different security models such as criminal detection, governmental confidential security breaches etc.

12. REFERENCES

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