A

Major Project

On

FACIAL MOTION CAPTURE SYSTEM USING DEEP LEARNING

(Submitted in partial fulfillment of the requirements for the award of Degree)

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CMR TECHNICAL CAMPUS

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2017-21

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project entitled "**FACIAL MOTION CAPTURE SYSTEM USING DEEP LEARNING**" being submitted by **SARIKA DANAM (177R1A0508), K.SHRESTA (177R1A0520) & MEGHNA N JANAPURE (177R1A0538)** in partial fulfillment of the requirements for the award of the degree of B. Tech in Computer Science and Engineering to the Jawaharlal Nehru Technological University Hyderabad, is a record of BONAFIDE work carried out by him/her under our guidance and supervision during the year 2020-21.

The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

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EXTERNAL EXAMINER

Submitted for viva voice Examination held on _____

ACKNOWLEGDEMENT

Apart from the efforts of us, the success of any project depends largely on the encouragement and guidelines of many others. We take this opportunity to express our gratitude to the people who have been instrumental in the successful completion of this project. We take this opportunity to express my profound gratitude and deep regard to my guide

Mr. Dr. RajKumar Patra, Associate Professor for his exemplary guidance, monitoring and constant encouragement throughout the project work. The blessing, help and guidance given by him shall carry us a long way in the journey of life on which we are about to embark.

We also take this opportunity to express a deep sense of gratitude to Project Review Committee (PRC) Coordinators: **Mr. J. Narasimha Rao, Mr. B. P. Deepak Kumar, Mr. K. Murali, Dr. Suwarna Gothane and Mr. B. Ramji** for their cordial support, valuable information and guidance, which helped us in completing this task through various stages.

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Finally, we would like to take this opportunity to thank our family for their constant encouragement, without which this assignment would not be completed. We sincerely acknowledge and thank all those who gave support directly and indirectly in the completion of this project.

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ABSTRACT

This project is titled as “Facial Motion Capture System Using Deep Learning”. The objective of this project is to develop Automatic Facial Motion Capture System which can take human facial images containing some expression as input and recognize and classify it into seven different expression class such as : Neutral, Angry, Disgust, Fear, Happy, Sadness, Surprise. Detecting Emotion from Facial Expression has become an urgent need because of its immense applications in Artificial Intelligence such as Human-Computer Collaboration, Data Driven Animation, Human-Robot communication etc. Since it is a demanding and interesting problem in Computer Vision, several works had been conducted regarding this topic. The objective of this project is to develop a Facial Motion Capture system based on Convolutional Neural Network with data augmentation. This approach enables to classify seven basic emotions consist of Angry, Disgust, Fear, Happy, Neutral, Sad and Surprise from Image data. Convolutional neural network with data augmentation leads to higher training accuracy than the other existing models (which is 96.24%) as well as helps to overcome their limitations.

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1.INTRODUCTION

1.1 PROJECT SCOPE

This project is titled as “Facial Motion Capture System using Deep Learning”. The objective of this project is to develop Automatic Facial Motion Capture System which can take human facial images containing some expression as input and recognize and classify it into seven different expression classes such as: Neutral, Angry, Disgust, Fear, Happy, Sadness and Surprise. This project uses machine-learning methods and computer vision to identify Facial Expression from the Input. First, we use convolutional neural networks to classify human facial key points for each image. We then compare a number of classification algorithms that use certain features to predict the Emotion.

1.2 PROJECT PURPOSE

This has been developed to facilitate the identification, retrieval of the items and information. System is built with manually exclusive features. In all cases system will specify object which are physical or on performance characteristics. They are used to give optimal distraction and other information. Data are used for identifying, accessing, storing and matching records. The data ensures that only one value of the code with a single meaning is correctly applied to give entity or attribute as described in various ways.

1.3 PROJECT FEATURES

The main features of this project are that the designer now functions as a problem solver and tries to sort out the difficulties that the enterprise faces. The solutions are given as proposals. The proposal is then weighed with the existing system analytically and the best one is selected. The proposal is presented to the user for an endorsement by the user. The proposal is reviewed on user request and suitable changes are made. This is loop that ends as soon as the user is satisfied with proposal.

2. SYSTEM ANALYSIS

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SYSTEM ANALYSIS

System Analysis is the important phase in the system development process. The System is studied to the minute details and analyzed. The system analyst plays an important role of an interrogator and dwells deep into the working of the present system. In analysis, a detailed study of these operations performed by the system and their relationships within and outside the system is done. A key question considered here is, "what must be done to solve the problem?" The system is viewed as a whole and the inputs to the system are identified. Once analysis is completed the analyst has a firm understanding of what is to be done.

2.1 PROBLEM DEFINITION

A detailed study of the process must be made by various techniques like Image processing, feature recognition etc. The data collected by these sources must be scrutinized to arrive to a conclusion. The conclusion is an understanding of how the system functions. This system is called the existing system. Now the existing system is subjected to close study and problem areas are identified. The designer now functions as a problem solver and tries to sort out the difficulties that the enterprise faces. The solutions are given as proposals. The proposal is then weighed with the existing system analytically and the best one is selected. The proposal is presented to the user for an endorsement by the user. The proposal is reviewed on user request and suitable changes are made. This is loop that ends as soon as the user is satisfied with proposal.

2.2 EXISTING SYSTEM

In the existing system Support vector machine (SVM) is a supervised machine learning model that uses classification algorithms for two-group classification problems. After giving an SVM model sets of labeled training data for each category, they are able to categorize new text. In this proposed algorithm, initially detecting eye and mouth, features of eye and mouth are extracted using Gabor filter, LBP and PCA is used to reduce the dimensions of the features. Finally, SVM is used to identify the expression and facial action units.

2.2.1 LIMITATIONS OF EXISTING SYSTEM

- SVM algorithm is not suitable for large data sets.
- SVM does not perform very well when the data set has more noise i.e. target classes are overlapping.
- In cases where the number of features for each data point exceeds the number of training data samples, the SVM will underperform.
- As the support vector classifier works by putting data points, above and below the classifying hyperplane there is no probabilistic explanation for the classification.

2.3 PROPOSED SYSTEM

The aim of proposed system is to develop a system of improved facilities. The proposed system can overcome all the limitations of the existing system. The system provides higher accuracy and reduces the classification work. The existing system has several disadvantages and many more difficulties to work well. The proposed system tries to eliminate or reduce these difficulties up to some extent. The proposed system helps the user to work user friendly and he can easily do his jobs without time lagging.

2.3.1 ADVANTAGES OF THE PROPOSED SYSTEM

The system is very simple in design and to implement. The system requires very low system resources and the system will work in almost all configurations. It has got following features

- Ensure data accuracies.
- Minimum time needed for the various processing.
- Greater efficiency.
- Better service.
- User friendliness and interactive.
- Minimum time required.

2.4 FEASIBILITY STUDY

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. Three key considerations involved in the feasibility analysis are

- Economic Feasibility
- Technical Feasibility
- Social Feasibility

2.4.1 ECONOMIC FEASIBILITY

The developing system must be justified by cost and benefit. Criteria to ensure that effort is concentrated on project, which will give best, return at the earliest. One of the factors, which affect the development of a new system, is the cost it would require.

The following are some of the important financial questions asked during preliminary investigation:

- The costs conduct a full system investigation.
- The cost of the hardware and software.
- The benefits in the form of reduced costs or fewer costly errors.

Since the system is developed as part of project work, there is no manual cost to spend for the proposed system. Also, all the resources are already available, it gives an indication of the system is economically possible for development.

2.4.2 TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

2.4.3 BEHAVIORAL FEASIBILITY

This includes the following questions:

- Is there sufficient support for the users?
- Will the proposed system cause harm?

The project would be beneficial because it satisfies the objectives when developed and installed. All behavioral aspects are considered carefully and conclude that the project is behaviorally feasible.

2.5 HARDWARE & SOFTWARE REQUIREMENTS

2.5.1 HARDWARE REQUIREMENTS:

Hardware interfaces specifies the logical characteristics of each interface between the software product and the hardware components of the system. The following are some hardware requirements.

- Processor : Intel Dual Core@ CPU 2.90GHz.
- Hard disk : 16GB and Above.
- RAM : 4GB and Above.
- Monitor : 5 inches or above.

2.5.2 SOFTWARE REQUIREMENTS:

Software Requirements specifies the logical characteristics of each interface and software components of the system. The following are some software requirements,

- Operating system : Windows 8, 10
- Languages : Python
- Backend : Deep Learning, Flask
- IDE : Jupyter

3. ARCHITECTURE

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3.1 PROJECT ARCITECTURE

This project architecture shows the procedure followed for breed detectionusing machine learning, starting from input to final prediction.

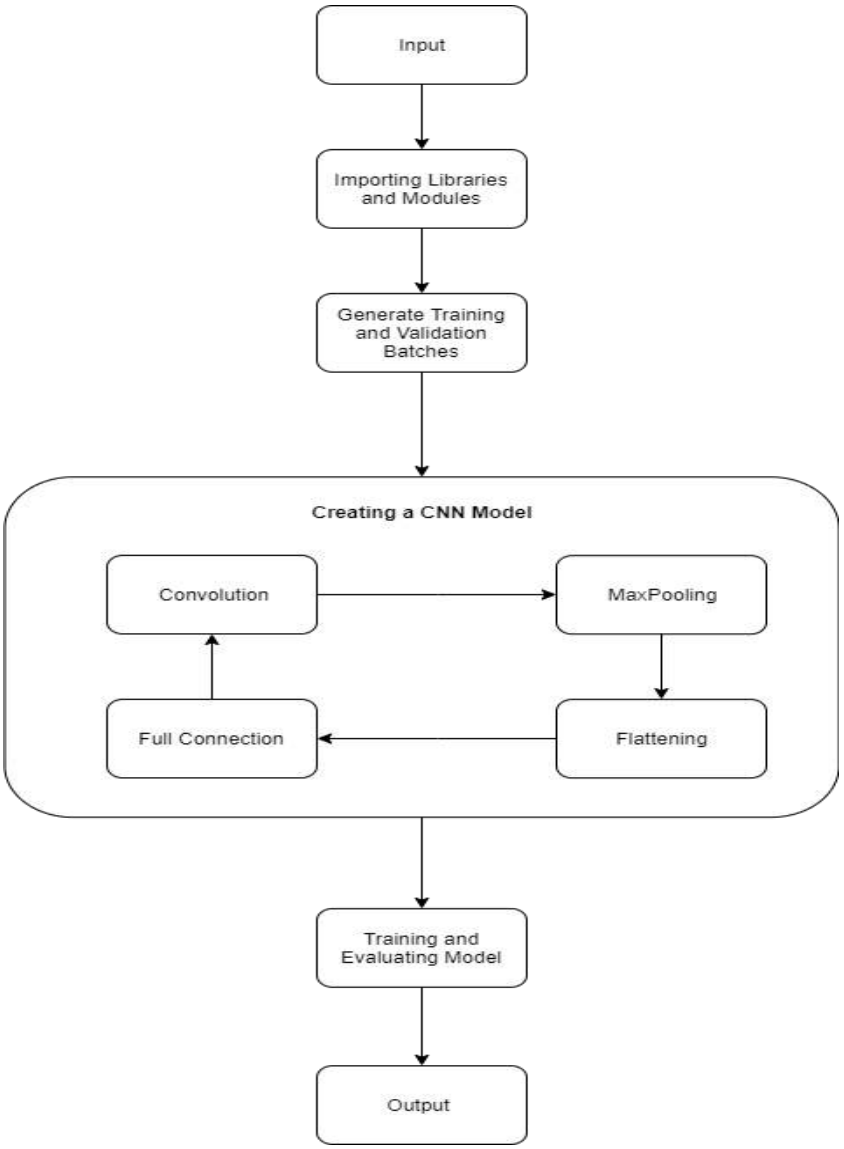

Figure 3.1.1: Project Architecture of Facial Motion Capture System

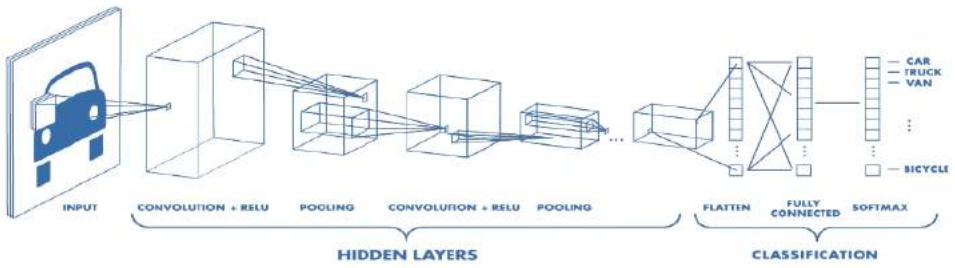

Figure 3.1.2: Internal Architecture of CNN Model

3.1.3 DESCRIPTION

Input Data: Input data is generally in .mp4 format or the camera source of the computer where the data is fetched and mapped in the data framed from the source columns.

Importing Modules and Libraries: Libraries such as TensorFlow, KERAS, Flask etc. can be imported.

Generating Training and Validation Batches: In this following step we are going to generate the Training and validation batches of dataset.

CNN Model:
Convolution: The term convolution refers to the mathematical combination of two functions to produce a third function. It merges two sets of information. In the case of a CNN, the convolution is performed on the input data with the use of a filter or kernel (these terms are used interchangeably) to then produce a feature map.

Max – Pooling: Maximum pooling, or max pooling, is a pooling operation that calculates the maximum, or largest, value in each patch of each feature map. The results are down sampled or pooled feature maps that highlight the most present feature in the patch, not the average presence of the feature in the case of average pooling.

Flattening: Flattening is converting the data into a 1-dimensional array for inputting it to the next layer. We flatten the output of the convolutional layers to create a single long feature vector. And it is connected to the final classification model, which is called a fully-connected layer.

Full Connection: Fully Connected Layer is simply, feed forward neural networks. Fully Connected Layers form the last few layers in the network. The input to the fully connected layer is the output from the final Pooling or Convolutional Layer, which is flattened and then fed into the fully connected layer.

Training and Evaluating Model: Thus, created model is trained and evaluated to get the Output and the accuracy.

3.2 USE CASE DIAGRAM

3.2.1 USE CASE DIAGRAM OF FACIAL MOTION CAPTURE SYSTEM

In the use case diagram, we have basically two actors who are the User and the System. The User has to set the path for the Input file whether it is a video file or the WEBCAM (in this case the path is 0). Now, after we run the main program, a URL will be generated using Flask.

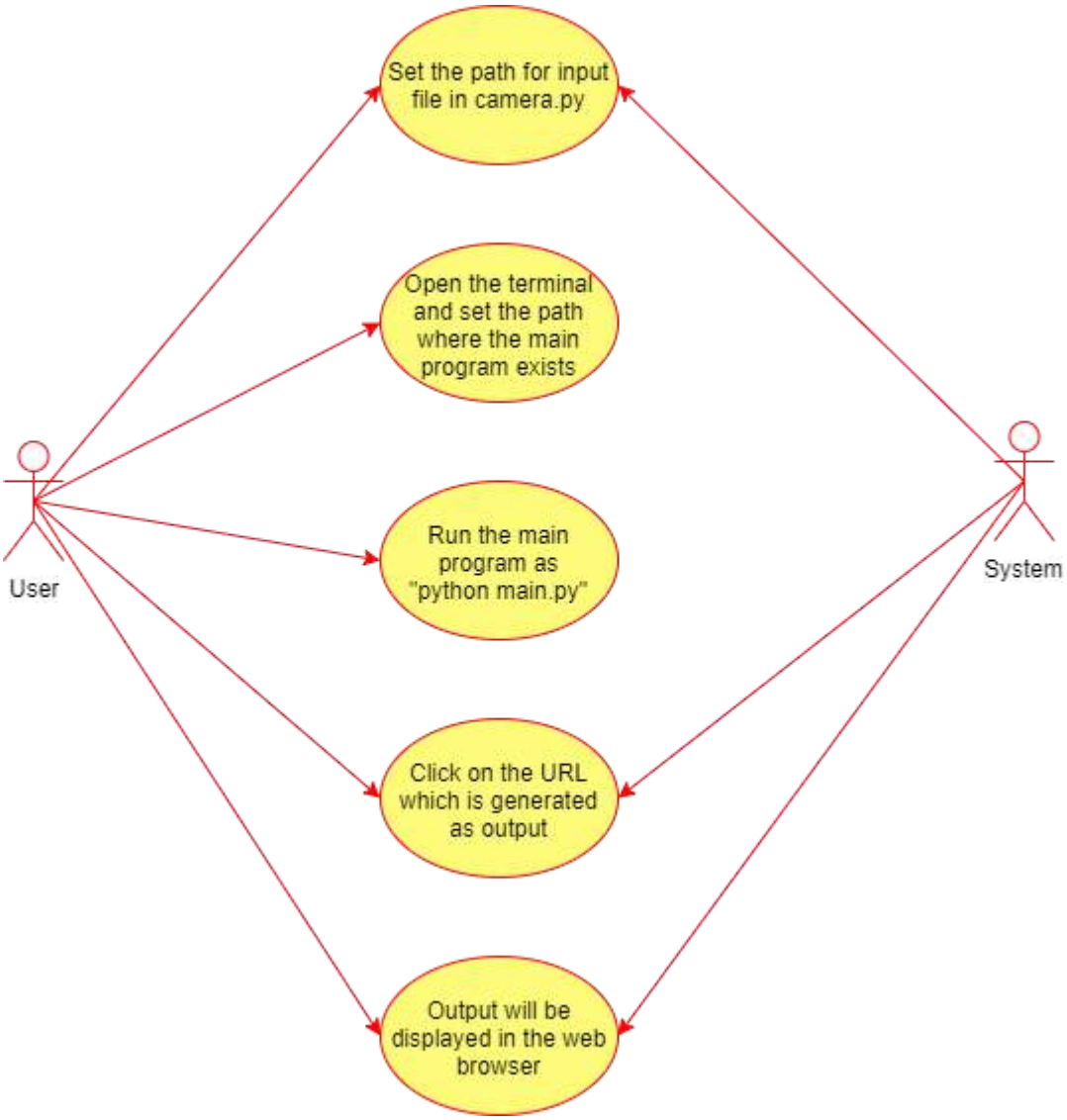

Figure 3.3.1: Use Case Diagram for user for Facial Motion Capture System

3.2.2 USECASE DIAGRAM OF CREATION OF CNN MODEL

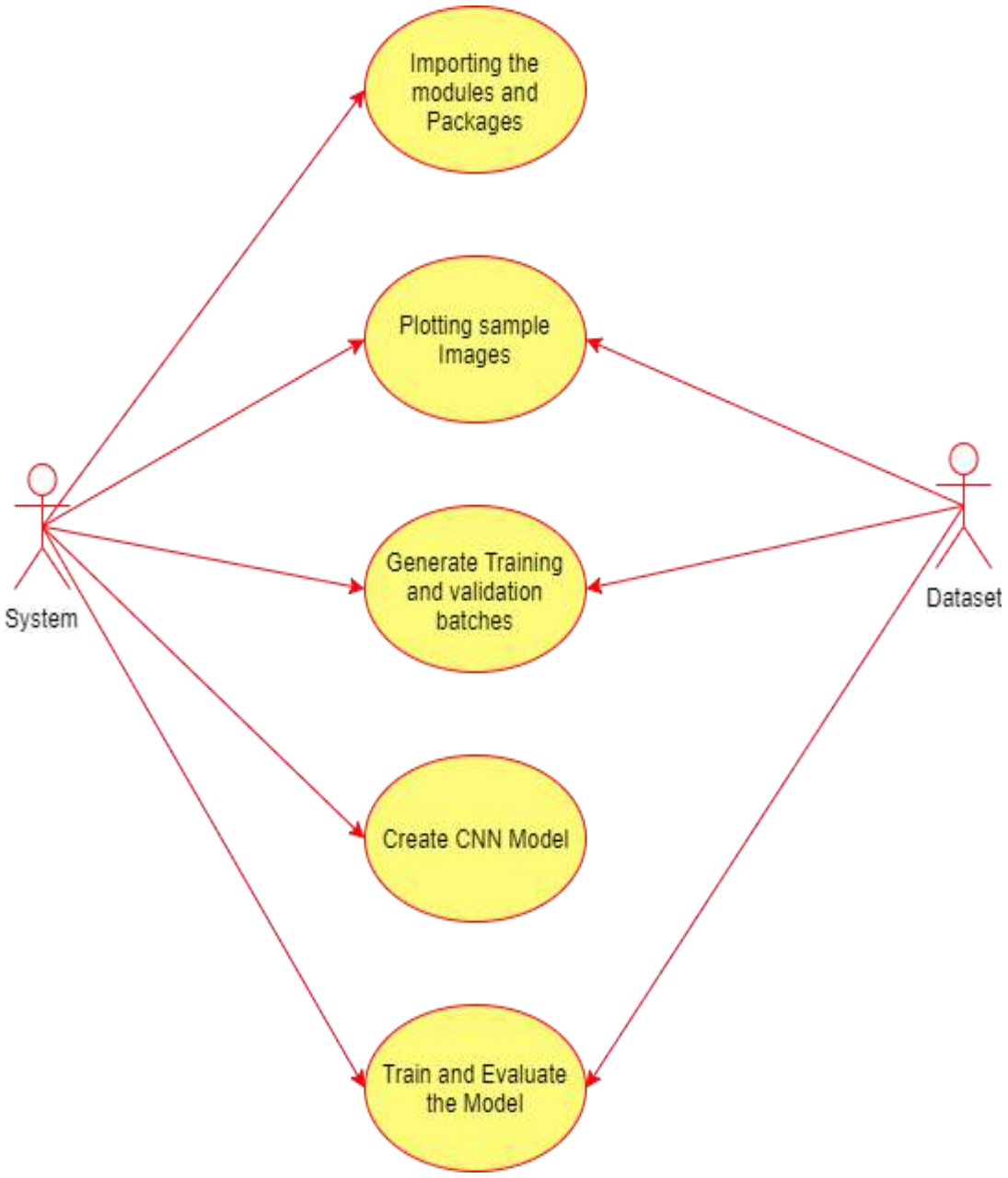

Figure 3.3.2: Use Case Diagram for user for Creation of CNN Model

3.3 CLASS DIAGRAM

Class Diagram is a collection of classes and objects.

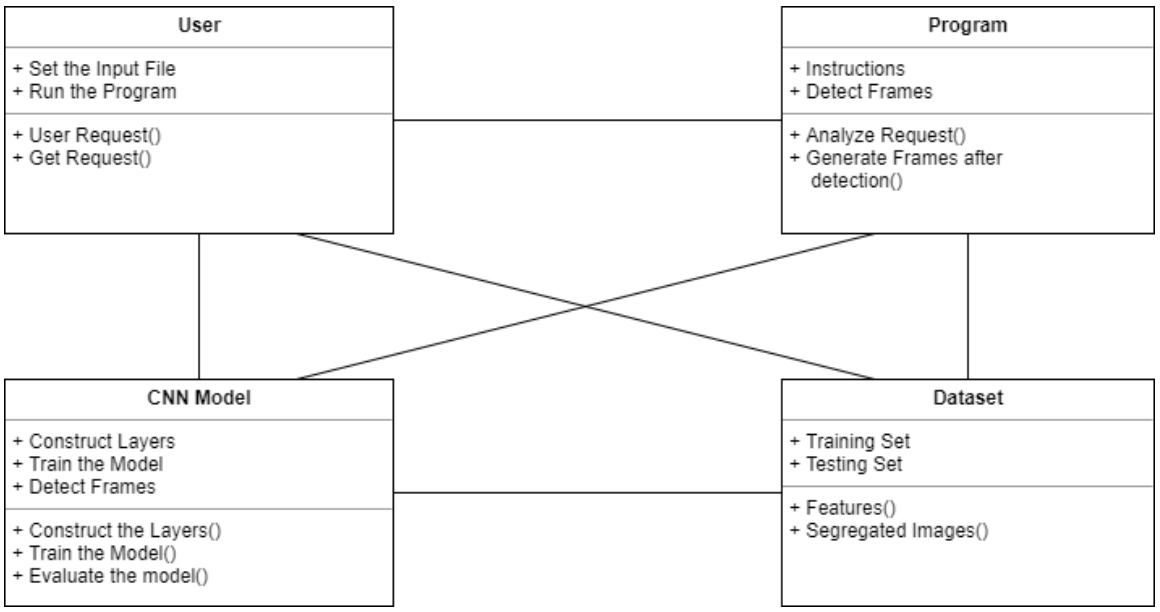

Figure 3.4: Class Diagram for Facial Motion Capture System

3.4 SEQUENCE DIAGRAM

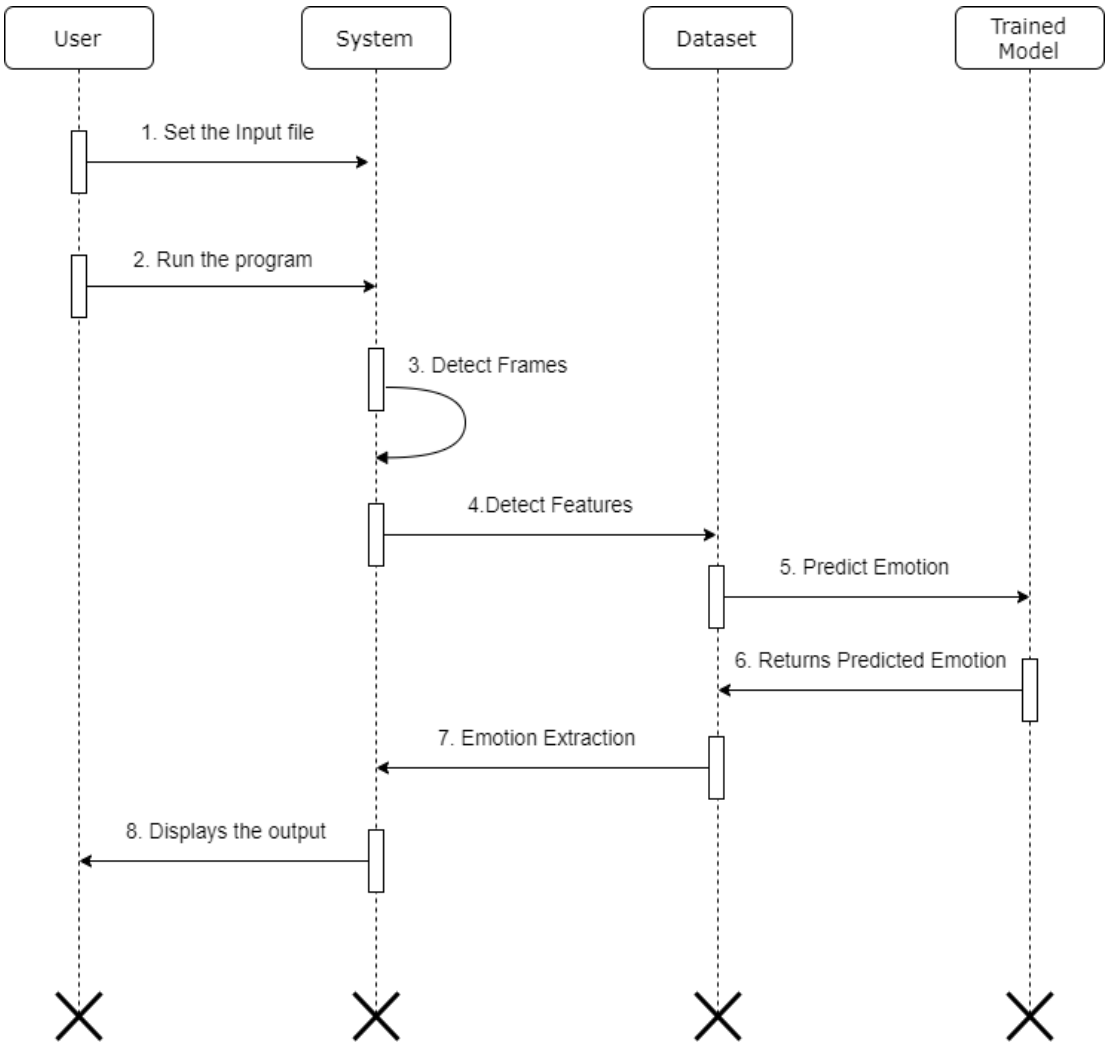

Figure 3.5: Sequence Diagram for Facial Motion Capture System

3.5 ACTIVITY DIAGRAM

It describes about flow of activity states.

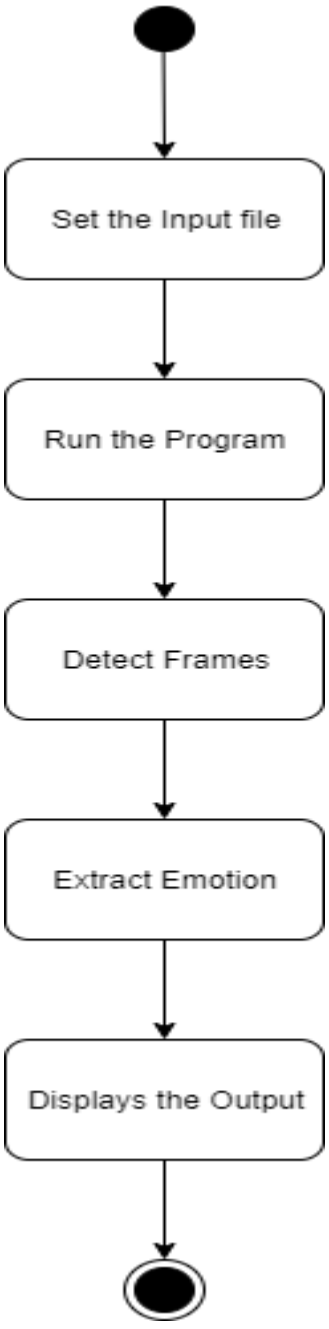

Figure 3.5: Activity Diagram for Facial Motion Capture System

4. IMPLEMENTATION

4. IMPLEMENTATION

This project "Facial Motion Capture System" is mainly based on CNN Model. Unless other existing systems, here we are creating our own CNN Model of 4 layers. Every layer is very well constructed as per the norms.

WORKING:

This project consists of 3 Modules.

1) CNN Module
2) Input Module
3) Main Module

4.1 CNN Module

This CNN Module is crucial module in this project. In this module, CNN convolution layers will be created. Every CNN Layer must involve 4 basic methods with various parameters. The main basic four methods of CNN layers are:

a) Convolution
b) Max-Pooling
c) Flattening
d) Full Connection

Convolution: The term convolution refers to the mathematical combination of two functions to produce a third function. It merges two sets of information. In the case of a CNN, the convolution is performed on the input data with the use of a filter or kernel (these terms are used interchangeably) to then produce a feature map.

Max – Pooling: Maximum pooling, or max pooling, is a pooling operation that calculates the maximum, or largest, value in each patch of each feature map. The results are down sampled or pooled feature maps that highlight the most present feature in the patch, not the average presence of the feature in the case of average pooling.

Flattening: Flattening is the process of conversion of the data into one-dimensional array, which is used as input to the next layer. We flatten the output of the convolutional layers to create a single long feature vector. And it is connected to the final classification model, which is called a fully-connected layer.

Full Connection: Fully Connected Layer is simply, feed forward neural networks. Fully Connected Layers form the last few layers in the network. The input to the fully connected layer is the output from the final Pooling or Convolutional Layer, which is flattened and then fed into the fully connected layer.

4.2 Input Module

This module is used to choose the Input Mode for the project.

We generally are providing two types of Input data. We can either give a video file to detect the expression of frames of it or we can use our web camera as the input source to identify the expressions.

When we give video as input to our project, then it will divide the whole video into respective frames according to the length and duration of the Video. After dividing the frames, it will now consider every frame and try to find out the faces in it. As it identifies a face, the expression of the face will be identified by considering the matrix portion of the areas such as Eyebrows, Forehead, Cheeks and Mouth. Soon the Expression detected, a blue bordered box will be drawn over the face en-titled with the matching Expression.

4.3 Main Module

This module is used as the platform to display the output.

All the modules are attached and linked to the main module. Execution of the Main module or program will lead to generation of output. This includes some python packages which are Flask and Render-template. Flask is a micro web framework which does not require particular tools or libraries. It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions.

Execution of the main program will generate a Flask link which will be generally the local host. By clicking on the link, we are now taken to the browser (any browser). Our output will get displayed over there.

We can further change the Outlook of the Website by changing font and styles in the main module.

5. RESULT AND DISCUSSION

RESULT AND DISCUSSION:

The Main aim of our project is to detect 7 expressions which as Angry, Sad, Fear, Neutral, Disgust, Happy, Surprise.

The CNN Model which has been created will be trained by executing the ipynb file. JUPYTER notebook is used to run the facial_expression_training.ipynb file.

The required packages are gathered, training and validation batches have to be generated. After batches are generated, CNN model creation will be done.

5.1 Angry Expression Detection

The Expression "Angry" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead and Mouth.

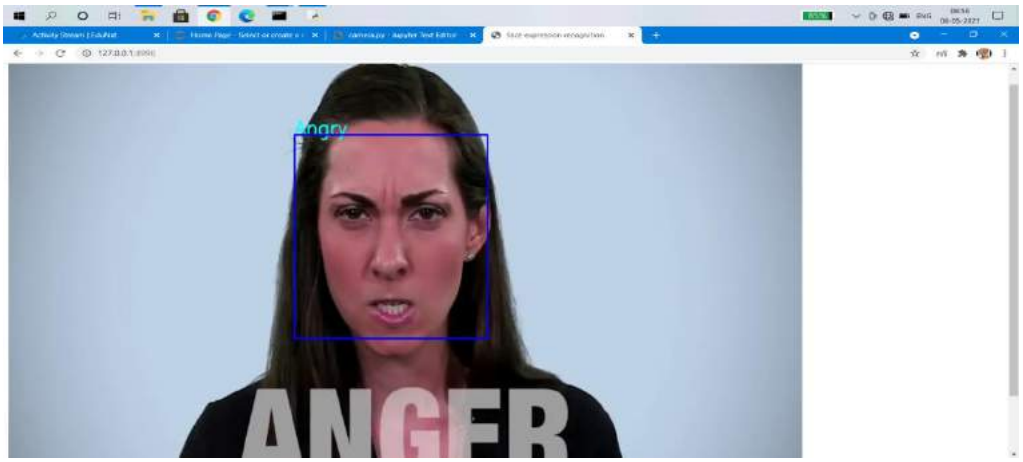

Fig. 5.1 Angry Expression Detection

5.2 Fear Expression Detection

The Expression "Fear" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

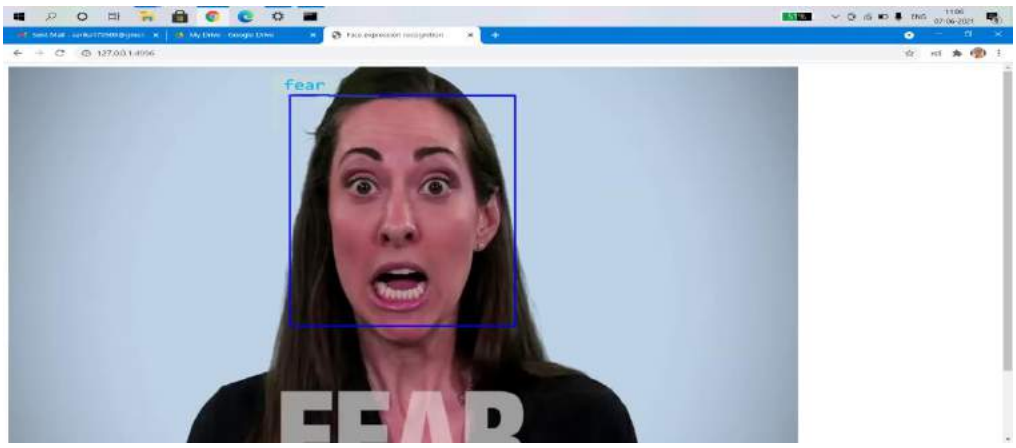

Fig. 5.1 Fear Expression Detection

5.3 Happy Expression Detection

The Expression “Happy” has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Mouth and Cheeks.

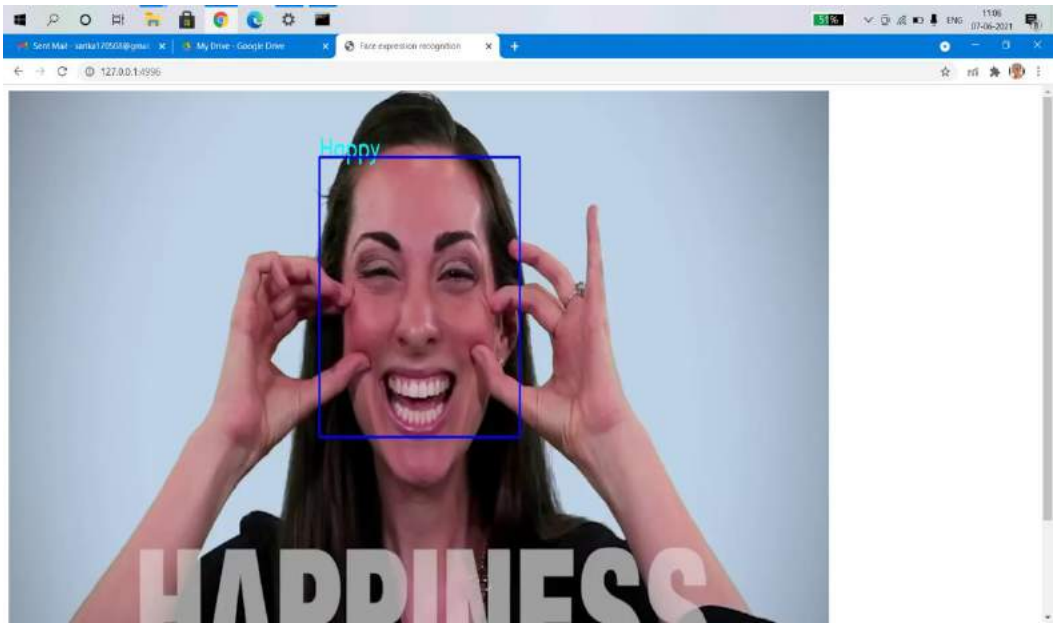

Fig. 5.3 Happy Expression Detection

5.4 Neutral Expression Detection

The Expression “Neutral” has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead and Cheeks.

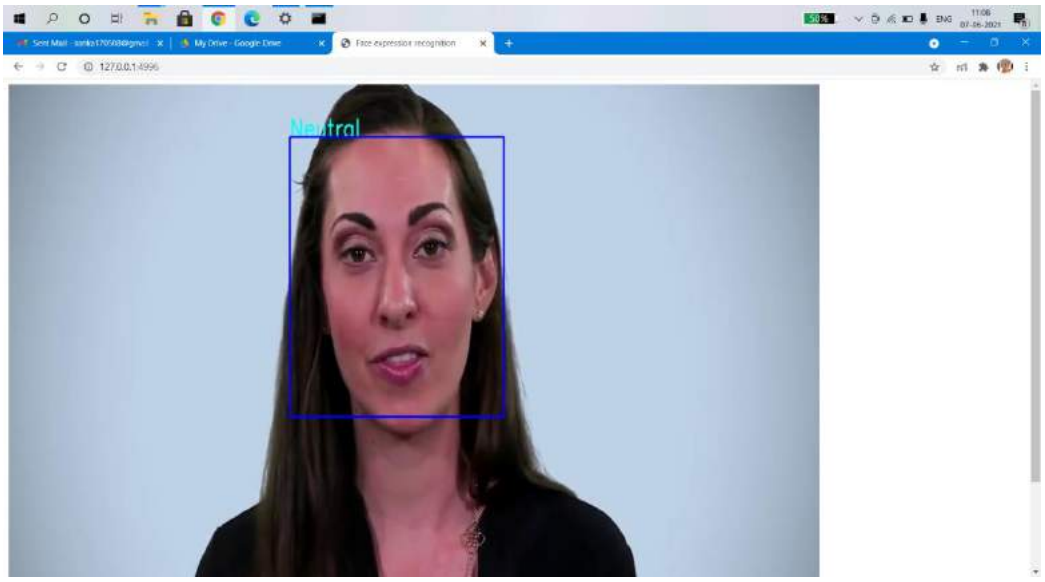

Fig. 5.4 Neutral Expression Detection

5.5 Sad Expression Detection

The Expression “Sad” has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

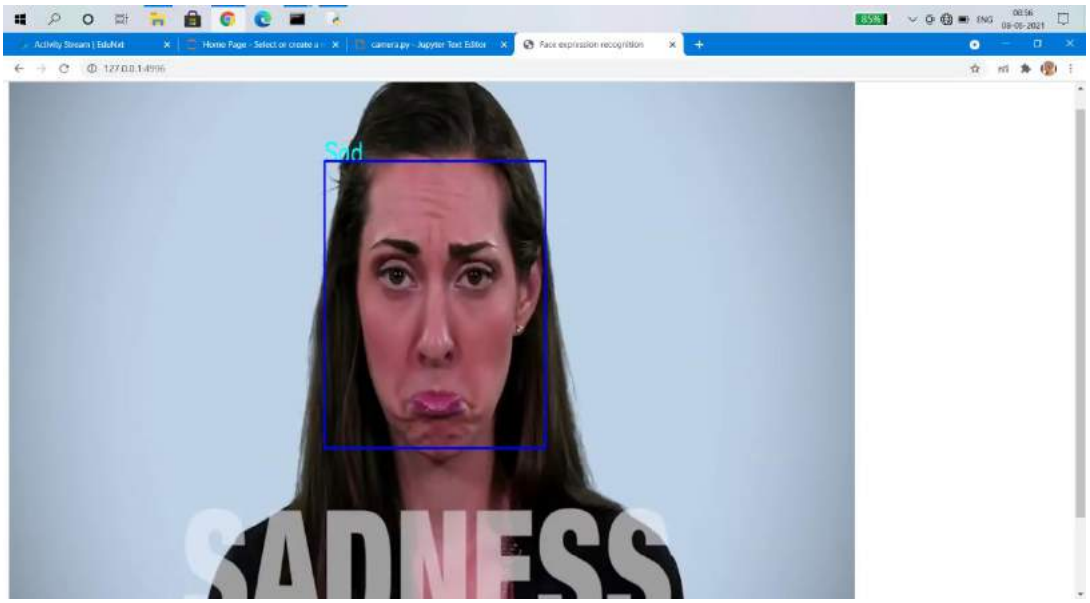

Fig. 5.5 Sad Expression Detection

5.6 Surprise Expression Detection

The Expression “Surprise” has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

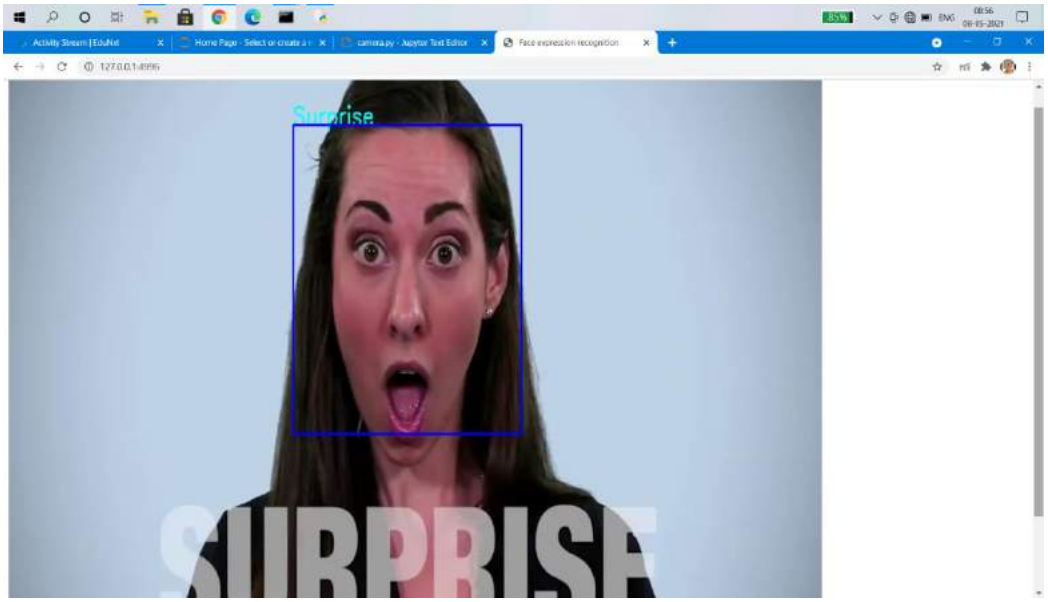

Fig. 5.6 Surprise Expression Detection

5.7 Disgust Expression Detection

The Expression “Disgust” has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

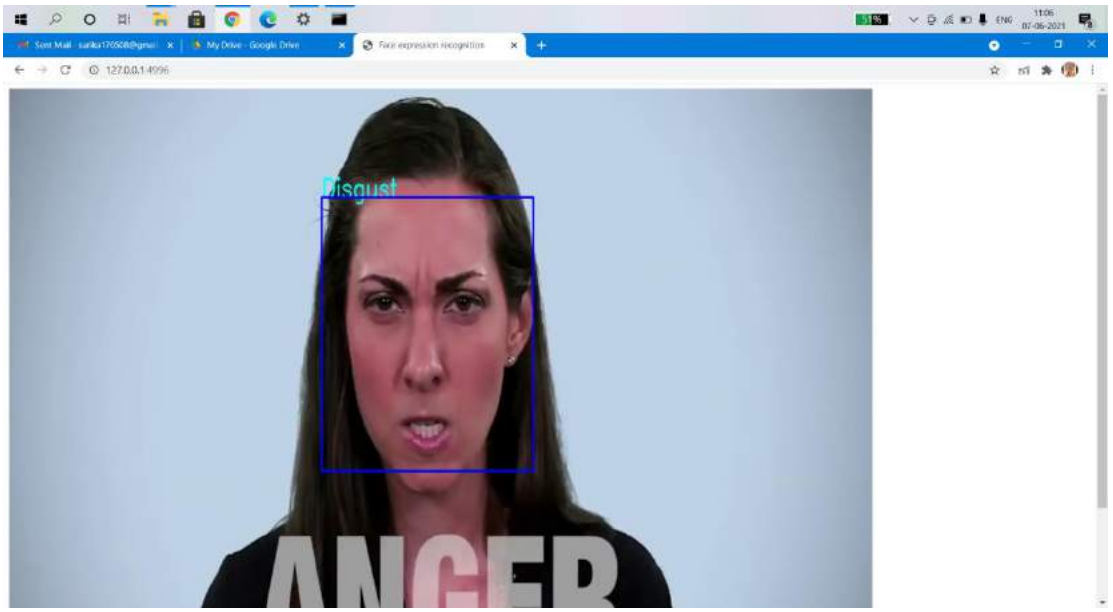

Fig. 5.7 Disgust Expression Detection

6. CONCLUSION

6. CONCLUSION & FUTURE SCOPE

6.1 PROJECT CONCLUSION

The project is titled as “Facial Motion Capture System Using Deep Learning”. This project provides facility for identifying different emotions of the person. This system is developed with scalability in mind. The project is developed with modular approach. All modules in the system have been tested with valid data and invalid data and everything work successfully. Thus, the system has fulfilled all the objectives identified and is able to replace the existing system.

The constraints are met and overcome successfully. The system is designed as like it was decided in the design phase. The system is very flexible and versatile. Validation checks induced have greatly reduced errors. Provisions have been made to upgrade the software. The application has been tested with live data and has provided a successful result. Hence the project has proved to work efficiently.

6.2 FUTURE SCOPE

In future, we can use other convolutional neural networks by downloading the modules directly into the project files. The software can be developed further to include lot of modules because the proposed system is developed on the view of future. We can connect to other databases by including them.

7. BIBILOGRAPHY

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7.1 REFERENCES

[1] Angelova and S. Zhu. Efficient object detection and segmentation for fine-grained recognition. 2013 Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2013.

[2] J. L. et al. Dog breed classification using part localization. Computer Vision: ECCV 2012, pages 172–185, 2012.

7.2 WEBSITES

[1] https://web.stanford.edu/class/cs231a/prev_projects_2016/output%20(1).pdf

FACIAL MOTION CAPTURE SYSTEM USING DEEP LEARNING

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1. Introduction:

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As the support vector classifier works by putting data points, above and below the classifying hyper plane there is no probabilistic explanation for the classification.

2.2 Proposed system:

The aim of proposed system is to develop a system of improved facilities. The proposed system can overcome all the limitations of the existing system. The system provides higher accuracy and reduces the classification work.

The existing system has several disadvantages and many more difficulties to work well. The proposed system tries to eliminate or reduce these difficulties uptosome extent.The proposedsystem helps the userto work user friendly and he can easily do his jobs without time lagging. The system is very simple in design and to implement. The system requires very low system resources and the system will work in almost all configurations.

Figure3.1.1: Project Architecture of Facial Motion Capture System

3.2 Project description:

Input Data: Input data is generally in .mp4 format or the camera source of the computer where the data is fetched and mapped in the data framed from the source columns.

Importing Modules and Libraries: Libraries such as TensorFlow, KERAS, Flask etc. can be imported.

Generating Training and Validation Batches: In this following step we are going to generate the Training and validation batches of dataset.

CNN Model:

Convolution: The term convolution refers to the mathematical combination of two functions to produce a third function. It merges two sets of information. In the case of a CNN, the convolution is performed on the input data with the use of a filter or kernel (these terms are used interchangeably) to then produce a feature map.

Max – Pooling: Maximum pooling, or max pooling, is a pooling operation that calculates the maximum, or largest, value in each patch of each feature map. The results are down sampled or pooled feature maps that highlight the most present feature in the patch, not the average presence of the feature in the case of average pooling.

Flattening: Flattening is converting the data into a 1-dimensional array for inputting it to the next layer. We flatten the output of the convolutional layers to create a single long feature vector. And it is connected to the final classification model, which is called a fully-connected layer.

Full Connection: Fully Connected Layer is simply, feed forward neural networks. Fully Connected Layers form the last few layers in the network. The input to the fully connected layer is the output from the final Pooling or Convolutional Layer, which is flattened and then fed into the fully connected layer.

Training and Evaluating Model: Thus, created model is trained and evaluated to get the Output and the accuracy.

SOFTWARE DESIGN

Software design sits at the technical kernel of the software engineering process and is applied regardless of the development paradigm and area of application. Design is the first step in the development phase for any engineered product or system. The designer's goal is to produce a model or representation of an entity that will later be built. Beginning, once system requirement have been specified and analyzed, system activities -design, code and test that is required to build and verify software.

The importance can be stated with a single word "Quality". Design is the place where quality is fostered in software development. Design provides us with representations of software that can assess for quality. Design is the only way that we can accurately translate a customer's view into a finished software product or system. Software design serves as a foundation for all the software engineering steps that follow. Without a strong design we risk building an unstable system – one that will be difficult to test, one whose quality cannot be assessed until the laststage.

During design, progressive refinement of data structure, program structure, and procedural details are developed reviewed and documented. System design can be viewed from either technical or project management perspective. From the technical point of view, design is comprised of four activities – architectural design, data structure design, interface design and procedural design.

4. RESULT AND DISCUSSION:

4.1 Angry Expression Detection

The Expression "Angry" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead and Mouth.

Fig. 4.1 Angry Expression Detection

4.2 Fear Expression Detection

The Expression "Fear" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

Fig. 5.1 Fear Expression Detection

4.3 Happy Expression Detection

The Expression "Happy" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Mouth and Cheeks.

Fig. 4.3 Happy Expression Detection

4.4 Neutral Expression Detection

The Expression "Neutral" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead and Cheeks.

Fig. 4.4 Neutral Expression Detection

4.5 Sad Expression Detection

The Expression "Sad" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

Fig. 4.5 Sad Expression Detection

4.6 Surprise Expression Detection

The Expression "Surprise" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

Fig.4.6 Surprise Expression Detection

4.7 Disgust Expression Detection

The Expression "Disgust" has been detected in the below figure. The main areas of face which has been considered are Eyebrows, Forehead, Mouth and Cheeks.

Fig. 4.7 Disgust Expression Detection

5. Conclusion and future scope

5.1PROJECTCONCLUSION

The project is titled as "Facial Motion Capture System Using Deep Learning". This project provides facility for identifying different emotions of the person. This system is developed with scalability in mind. The project is developed with modular approach. All modules in the system have been tested with valid data and invalid data and everything work successfully. Thus, the system has full-filled all the objectives identified and is able to replace the existing system.

The constraints are met and overcome successfully. The system is designed as like itwas decided in the design phase. The system is very flexible and versatile. Validation checks induced have greatly reducederrors. Provisions have been made to upgrade the software. The application has been testedwith live data and has provided a successful result. Hence the project has proved to workefficiently.

5.2FUTURE SCOPE

In future, we can use other convolutional neural networks by downloading the modulesdirectly into the project files. The software can be developed further to include lot of modulesbecause the proposed system is developed on the view of future. We can connect to other databasesbyincludingthem.

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