FACIAL EMOTION RECOGNITION USING FACE-API

##### A PROJECT REPORT

###### ***Submitted by***

##### DIVYA SRI.G [211418104056]

##### HUMSIKA.R [211418104087]

##### KEERTHANA THILAGAM.D[211418104120]

***in partial fulfillment for the award of the degree***

***of***

**BACHELOR OF ENGINEERING**

IN

# COMPUTER SCIENCE AND ENGINEERING



PANIMALAR ENGINEERING COLLEGE

**(An Autonomous Institution, Affiliated to Anna University, Chennai)**

##### MAY 2022

**PANIMALAR ENGINEERING COLLEGE**

###### (**An Autonomous Institution, Affiliated to Anna University, Chennai)**

**BONAFIDE CERTIFICATE**

Certified that this project report **“FACIAL EMOTION RECOGNITION USING FACE-API”** is the bonafide work of “**DIVYA SRI.G[211418104056], HUMSIKA.R[211418104087], KEERTHANA THILAGAM.D [211418104120]”** who carried out the project work under **Dr. R. JOSEPHINE LEELA, M.E.,Ph.D.,** supervision.

**SIGNATURE SIGNATURE**

**Dr. S.MURUGAVALLI ,M.E.,Ph.D. Dr. JOSEPHINE LEELA,****M.E.,Ph.D.,**

**HEAD OF THE DEPARTMENT SUPERVISOR**

**PROFESSOR**

DEPARTMENT OF CSE,DEPARTMENT OF CSE,

PANIMALAR ENGINEERING COLLEGE, PANIMALAR ENGINEERING COLLEGE,

NASARATHPETTAI, NASARATHPETTAI,

POONAMALLEE, POONAMALLEE,

CHENNAI-600 123. CHENNAI-600 123.

Certified that the above mentioned students were examined in End Semester project viva-voice held on\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**INTERNAL EXAMINER EXTERNAL EXAMINER**

**DECLARATION BY THE STUDENT**

We **DIVYA SRI.G** [211418104056], **HUMSIKA.R** [211418104087],

**KEERTHANA THILAGAM.D** [211418104120] hereby declare that this project report titled “FACIAL EMOTION RECOGNITION USING FACE-API”, under the guidance of  **Dr.R.JOSEPHINE LEELA** **M.E., Ph.D.,** is the original work done by us and we have not plagiarized or submitted to any other degree in any university by us.

**1. DIVYA SRI.G**

**2. HUMSIKA.R**

**3. KEERTHANA THILAGAM.D**

**ACKNOWLEDGEMENT**

We would like to express our deep gratitude to our respected Secretary and Correspondent **Dr.P.CHINNADURAI, M.A., Ph.D.** for his kind words and enthusiastic motivation, which inspired us a lot in completing this project.

We express our sincere thanks to our Directors **Tmt.C.VIJAYARAJESWARI**, **Dr.C.SAKTHI KUMAR,M.E.,Ph.D and Dr.SARANYASREE**

**SAKTHI KUMAR B.E.,M.B.A.,Ph.D.,** for providing us with the necessary facilities to undertake this project.

We also express our gratitude to our Principal **Dr.K.MANI, M.E., Ph.D**. who facilitated us in completing the project.

We thank the Head of the CSE Department, **Dr.S.MURUGAVALLI, M.E.,Ph.D.,** for the support extended throughout the project.

We would like to thank my Project Guide **Dr. R. JOSEPHINE LEELA M.E.,Ph.D.,**

and all the faculty members of the Department of CSE for their advice and encouragement for the successful completion of the project.

**ABSTRACT**

Emotions are a powerful tool in communication and one way that humans show their emotions is through their facial expressions. One of the challenging and powerful tasks in social communications is facial expression recognition, as in non-verbal communication, facial expressions are key. In the field of Artificial Intelligence, Facial Expression Recognition (FER) is an active research area, with several recent studies using Convolutional Neural Networks (CNNs). Emotion detection research has been widely utilized in many different fields including Human-Computer Interaction and Ubiquitous Computing. Facial Emotion Recognition is a technology which is used to **analyze our facial expressions from videos or images in order to reveal information on one's emotional state.** Face detection is one of the most common applications of Artificial Intelligence. There are many attempts to make an automatic facial expression analysis tool as it has application in many different fields such as robotics, medicine, driving assist systems, and lie detector. It is the task of classifying facial emotions into several categories such as anger, fear, surprise, sadness, disgust, neutral and happiness. We will be implementing JavaScript API (face-api.js) introduced by Vincent Mühler for detecting facial emotions on the browser.

TABLE OF CONTENTS

| **CHAPTER NO.** | **TITLE** | **PAGE NO.** |
| --- | --- | --- |
|  | **ABSTRACT** | iii |
|  | **LIST OF TABLES** | iv |
|  | **LIST OF FIGURES** | vi |
|  | **LIST OF SYMBOLS, ABBREVIATIONS** | vii |
| **1.** | **INTRODUCTION** | 1 |
|  | 1.1 Overview | 5 |
|  | 1.2 Problem Definition | 6 |
| **2.** | **LITERATURE SURVEY** | 8 |
| **3.** | **SYSTEM ANALYSIS** | 13 |
|  | 3.1 Existing System | 14 |
|  | 3.2 Proposed system | 14 |
|  | 3.3 Feasibility Study | 15 |
|  | 3.4 Hardware Environment | 16 |
|  | 3.5 Software Environment | 16 |
| **4.** | **SYSTEM DESIGN** | 17 |
|  | 4.1 ER diagram | 18 |
|  | 4.2 Use Case Diagram | 19 |
|  | 4.3 Class Diagram | 20 |
|  | 4.4 Sequence Diagram | 21 |
|  | 4.5 Activity Diagram | 22 |
|  | 4.6 Collaboration Diagram | 23 |
| **5.** | **SYSTEM ARCHITECTURE** | 24 |
|  | 5.1 Module Design Specification | 26 |
|  | 5.2 Model Description | 27 |
| **6.** | **SYSTEM IMPLEMENTATION** | 29 |
|  | 6.1 Sample code | 30 |
| **7.** | **PERFORMANCE ANALYSIS** | 46 |
|  | 7.1 Results & Discussion | 47 |
|  | 7.2 Test Cases & Reports | 48 |
| **8.** | **CONCLUSION** | 50 |
|  | 8.1 Conclusion and Future Enhancements | 51 |
| **9.** | **APPENDICES** | 52 |
|  | A.1 Sample Screens | 53 |
| **10.** | **REFERENCES** | 58 |

**LIST OF FIGURES**

|  |  |  |
| --- | --- | --- |
| **FIGURE NO.** | **TITLE** | **PAGE NO**. |
| 4.1 | ER Diagram | 18 |
| 4.2 | Use Case Diagram | 19 |
| 4.3 | Class Diagram | 20 |
| 4.4 | Sequence Diagram | 21 |
| 4.5 | Activity Diagram | 22 |
| 4.6 | Collaboration Diagram | 23 |
| 5 | System Architecture | 24 |
| A.1 | Screen Shot of Home Page | 53 |
| A.1 | Screen Shot of Login Page | 54 |
| A.1 | Screen Shot of Landing Page | 55 |
| A.1 | Screenshot of Emotion (Happy), age  and gender | 56 |
| A.1 | Screenshot of Emotion (Surprised), age and gender | 57 |

**LIST OF ABBREVIATIONS**

|  |  |
| --- | --- |
| **Abbreviation** | **Meaning** |
| FER | Facial Emotion Recognition |
| CNN | convolutional neural networks |
| LBP | Local binary patterns |
| CK | Canada-Kohn |
| JAFFE | Japanese female facial expression |
| API | Application Programming Interface |
| DBM | Deep Boltzmann Machine |
| SVM | Support Vector Machine |
| AU | Action unit |
| KDEF | Karolinska Directed Emotional Faces |
| LSTM | Long Short-Term Memory |
| UML | Unified Modeling Language |
| SSD | Single Shot Detector |
| ECG | Electrocardiogram |

**CHAPTER 1**

**INTRODUCTION**

**CHAPTER 1**

**INTRODUCTION**

The research on facial emotion recognition has become extensive these recent years. Facial recognition system is a technology that is capable of matching an individual’s face from a digital image or a video frame against a database of faces, usually employed for the authentication of users ID, and also by measuring facial features from a given image.  It is mostly used for security purposes, widely used in the range of applications for government and enterprises use. The aim of facial emotion recognition model is to help us in identifying the state of human emotion (example: neutral, happy, sad, surprise, anger, disgust) based upon the facial images. The challenge on facial emotion recognition is to automatically recognize facial emotion state with high accuracy.

Generally, it involves three stages. They are, (i) Face Detection, (ii) Feature Extraction and (iii) Emotion Classification. In the first stage, it will locate user’s face through webcam or from images and will be shown as face bounding boxes. At the second stage, after detecting the position user’s face, facial features will be extracted as 68 face landmark points of that individual (i.e., eyes, brows, mouth, nose, jawline). After getting the required facial features in the final stage, the model should be trained to generate labels for the respective emotions based on the trained data.

Face-API is a JavaScript API built on top of Tensorflow core API which implements several CNNs (Convolutional Neural Networks) to solve face detection, face recognition and face landmark detection, optimized for the web and for mobile devices that is commonly used for face detection and face recognition via browser. In this paper, we will be using Face-api.js developed by Vincent Mühler which is a Javascript library that helps us to recognize emotions for multiple individuals along with age and gender through browser by four pre-trained models.

**APPLICATION PROGRAMMING INTERFACE**

Application programming interfaces, or APIs, simplify software development and innovation by enabling applications to exchange data and functionality easily and securely.

An application programming interface, or API, enable one’s applications’ data and functionality to external third-party developers, business partners, and internal departments within their companies. This allows services and products to communicate with each other and leverage each other’s data and functionality through a documented interface.

Developers don't need to know how an API is implemented; they simply use the interface to communicate with other products and services. API use has surged over the past decade, to the degree that many of the most popular web applications today would not be possible without APIs.

**FACE DETECTION AND ANALYIS IN API**

Face detection is required as a first step in all the scenarios. In this step the human faces are detected in an image or video and returns the rectangle coordinates of their locations. One can also program to return a unique ID that represents the stored face data. This is used in later operations to identify or verify faces.

Optionally, face detection can extract a set of face-related attributes, such as head pose, age, emotion, facial hair, and glasses. These attributes are general predictions, not actual classifications. Some attributes are useful to ensure that your application is getting high-quality face data when users add themselves to a Face service. For example, your application could advise users to take off their sunglasses if they're wearing sunglasses.

**APPLICATION OF FACIAL EXPRESSION RECOGNITION**

Facial expression recognition (FER) system has many applications in advertisements, health-care, education, wearable devices, and more

**Education Sector :** The automatic emotion detection can help to conduct better learning in education [22]. For example, while providing lectures in a class room full of students, if the teacher can see the emotional state of the students in real time, she/he can modify the lecture instantly as needed.

**Lie Detection:** Emotion recognition can be used for lie detection [20] at the time of investigation or in other similar situations

**Music and Emotion:** Mikuckas et al. [19] discuss the impact of music on emotional state and vice-versa. A system can be developed to suggest songs based on a person’s emotion.

**Banking:** Emotion recognition APIs can be used to gather emotions to make better financial decisions [2]. Financial advisors can use these APIs to gather insight into the minds of their clients, whom they may have never met.

**HealthCare**: Facial expressions can indicate mental health disorders including depression, anxiety and trauma.

**1.1 OVERVIEW**

Facial recognition is a way of recognizing or verifying a person’s identity by looking at their face. It identifies people in photos, videos, or real-time using facial recognition systems. Face detection is one of the most common applications of Artificial Intelligence. There are many attempts to make an automatic facial expression analysis tools as it has application in many different fields such as robotics, medicine, driving assist systems, and lie detector. When people are experiencing basic emotions, their faces will display a variety of expression patterns, each with its own set of characteristics and distribution scale. Facial expression recognition is a crucial part of human-computer interaction that allows computers to understand facial expressions based on human thinking. According to the processing of facial expression recognition process can be divided into three important modules such as face detection, feature extraction and classification module. In our project, we will be using face-api.js which is a JavaScript API for face detection and face recognition in the browser implemented on top of the tensorflow.js

**1.2 PROBLEM DEFINITION**

Human facial expressions can be easily classified into seven basic emotions: happy, sad, surprise, fear, anger, disgust, and neutral. Face recognition is important for the interpretation of facial expressions in applications such as intelligent, man-machine interface and communication, intelligent visual surveillance, teleconference and real-time animation from live motion images. Our facial emotions are expressed through activation of specific sets of facial muscles. These sometimes subtle, yet complex, signals in an expression often contain an abundant amount of information about our state of mind. Through facial emotion recognition, we are able to measure the effects that content and services have on the audience/users through an easy and low-cost procedure. Through human recognition we can measure the effect of the content and services at a lower cost and easily. Humans are well trained in reading the emotions but can computer do a better job. To solve this, we can give machines the ability to make inference about our emotional states.

INPUT

FACE DETECTION

FEATURE EXTRACTION

FEATURE CLASSIFICATION

OUTPUT

**Facial Emotion Recognition System**

* The common approach to facial emotion recognition consists of three steps: face detection and tracking, feature extraction and expression classification. Face detection stage processes the facial images, without human intervention to find the face region from the input images or sequences.
* After face is positioned, the next step is to extract discriminative information caused by facial expressions. Facial expression recognition is the last stage of the systems. The facial changes can be identified either as prototypic emotions or as facial action units.
* Even Though humans are filled with various emotions, modern psychology defines six basic facial expressions: Happiness, Sadness, Surprise, Fear, Disgust, and Anger as universal emotions.
* Facial muscles movements help in identifying human emotions. The facial features are the key parameters that can be considered for recognizing emotions. The facial parameters include eyebrow, mouth, nose, eyes and cheeks.

**CHAPTER 2**

**LITERATURE SURVEY**

**CHAPTER 2**

**LITERATURE SURVEY**

* **K. Lekdioui[1]**, proposed a new facial decomposition for basic emotion states recognition. Based on facial landmarks detected by IntraFace algorithm, seven regions of interest (ROI), corresponding to the main components of face, are first extracted to represent face image. A preprocessing stage is then applied on these ROIs for resizing and partitioning them into blocks, before performing feature extraction to build face feature descriptor. Finally, a multiclass SVM classifier is utilized to infer emotion state. A comprehensive experimental study, using different local features, is carried out to compare the proposed method to two state of the art methods; one is based on whole face as a single ROI and the other one uses facial decomposition with six ROIs.
* **M. Shamim Hossain[2],** In this paper an emotion recognition system for mobile applications has been proposed. The Bandlet transform is applied to some selective frames, which are extracted from the video, to give some sub band images. Local binary patterns (LBP) histogram is calculated from the sub band images. This histogram describes the features of the frames. The Bandlet transform and the LBP are used as features, which are then selected by the KW feature selection method. The GMM based classifier is applied to recognize the emotions. Two publicly available datasets are used (Canade-Kohn (CK) and the Japanese female facial expression (JAFFE)).
* **Mostafa Mohammadpour[3],** In this paper they have presented an emotion recognition system for detecting action units (AUs) which is a coding of facial movements in psychological framework. A CNN is developed for optimal feature extraction and detecting AUs and by means of detecting seven expressed emotions. To evaluate the proposed model, Cohn-Kanade database is used by incorporating AU while other works in the literature used a direct CNN . The experimental results proven that the Deep CNNs are able to learn characteristics of facial expression and increase facial emotion recognition accuracy.
* **Renuka S. Deshmukh [4]**, In this paper, they have discussed various attributes, methods and emotional labels that are considered by various emotion API system and also gives an overview of the databases available for inferring emotion through human facial features. The facial expression detection tools lump human emotion that can be categorized as Joy, Sadness, Anger, Fear, Surprise, Contempt, and Disgust. With this facial emotion detection, algorithms detect faces within a photo or video. There are various tools developed for emotion detection and recognition: Microsoft cognitive services, Kairos, Eyris EmoVu, Sky biometric application, Affectiva, Emotient etc. This paper gives a brief introduction towards various tools and description in terms of their features, the approach or methods through which they are implemented.
* **Ma Xiaoxi, Lin Weisi[5],** In this paper, they have implemented several learning methods: Support Vector Machine(SVM)and Deep Boltzmann Machine (DBM) for facial emotion recognition, which are all excellent methods in general and the aim is to construct the prediction system which is most suitable to the challenge. Comparing the experiment results of different prediction systems, the best performance of Occurrence Detection of AUs is obtained by emotional facial classification system with SVM. This paper mainly focuses on the implementation and comparison of different learning methods.
* **Yang-Yen Ou[6],**used a webcam to capture the image as a visual system input. Then, facial image is obtained through high performance face detect neural network. Facial landmarks is used to correct the face. After that, we input facial image into the multi-person emotion recognition system. In order to improve the accuracy of emotion recognition, a hybrid emotion recognition is proposed based on Convolutional Neural Network. The experimental results have demonstrated the effectiveness of the proposed system, for facial expression; the other hand, the age and gender analysis system, which are realized by Microsoft Azure API, are integrated on the human understanding system.
* **Muhammad Abdullah[7],** In this paper, they proposed using a well-trained CNN followed by RNN is equally effective for Video Facial Expression Recognition as for other similar tasks e.g. Action Recognition. Testing a simple, single layer LSTM to learn the temporal features from stacked spatial features extracted by a CNN for each video. This single layer LSTM network demonstrated very good performance on extracted feature sequences.To validate our system only for visual facial expression analysis, so we used the data in video-only mode to validate our proposed method(RAVDESS DATASET).
* **Saibal Manna[8],** In deep learning, convolutional neural networks (CNN) have gained attention for face recognition but to train CNN requires more data, which is very difficult in case of applications like criminal activities (robbery, murder, etc).and therefore,this paper proposed a face recognition system that makes searching for criminals easy and quick with less time and hence efficiently helps police and administration .A pretrained model i.e FaceNet (FN) is used for face recognition from video. FN modifies the face images into a close-packed Euclidean space where separations extent the face nearness. It has been found that among all models, the FaceNet model represents the highest accuracy, after training with a particular dataset.It can work with any sort of pictures and is sensibly strong to changes in face appearance or orientation.
* **Geetika Dhand[9],** In this study, they presented a model for recommending songs on the basis of facial expression mood detection and recommending appropriate music to the user. This project proposes designing and developing a music recommendation system on the basis of emotion captured through face recognition. In order to identify the mood of the song, mean values of the song features are generated with respect to each emotion using Logistic Regression. The emotion extracted from the user's face is used to extract a random song from the same mood genre in the dataset and is queued after the song playing.
* **D.Ram Kiran[10],**In this paper, Facial Expression detection and Recognition can be utilized to improve access and security like the most recent Apple iPhone does, enable installments to be handled without physical cards. Facial expressions detection and recognition is a vigorously explored point and there are huge amounts of assets on the web. We have attempted different opensource activities to locate the ones that are least difficult to actualize while being precise. Face detection is executed utilizing skin color detection and division. Predefined packages in python like Keras, OpenCV and Face Detection module are discussed in detail and also used.
* **S. K. Khanal et al[11],** performed analysis of two famous emotion recognition APIs under the facial images of various poses. The experiments were done with the public dataset which is KDEF dataset containing 980 images of each type of five poses fullleft, half-left, straight, half-right, and full-right with the seven emotions (Anger, Afraid, Disgust, Happiness, Neutral, Sadness, Surprise). It has been discovered that overall recognition accuracy is best in Microsoft Azure for straight images, whereas the face detection capability is better in Google. The Microsoft Azure did not detect almost any of the images with full left and full right profile, but Google detected almost all of them. The Microsoft API presents an average true positive value up to 60%, whereas Google presents the maximum true positive value 45.25%.

|  |
| --- |
|  |
| **CHAPTER 3**  **SYSTEM ANALYSIS**  **CHAPTER 3**  **SYSTEM ANALYSIS**  **3.1 EXISTING SYSTEM**     * In existing system, a facial expression recognition method based on a novel facial decomposition has been proposed. * First, seven regions of interest (ROI), representing the main components of face (left eyebrow, right eyebrow, left eye, right eye, between eyebrows, nose and mouth), are extracted using facial landmarks detected by IntraFace algorithm. * Different local descriptors, such as LBP, CLBP, LTP and Dynamic LTP, are used to extract features. Finally, feature vector, representing face image, is fed into a multiclass support vector machine to achieve the recognition task. |
| * 1. **PROPOSED SYSTEM** * In the proposed system, we are making use of CNNs(Convolutional Neural Networks) Algorithm which are a class of [neural network](https://www.sciencedirect.com/topics/chemical-engineering/neural-network) that allow greater extraction of features from captured videos. * CNNs take video data, train the model, and then classify the features automatically for healthier [classification](https://www.sciencedirect.com/topics/computer-science/classification). * CNNs are used in many applications like image recognition, face recognition, and video analysis. * Four models that are applied for face detection and face recognition in the browser **:-** Face Detection Model (Tiny Face Detector) , 68 Point Face Landmark Detection Models , Face Expression Recognition Model, Age and Gender model |

|  |  |
| --- | --- |
| **3.3 FEASIBILITY STUDY**  **SOCIAL FEASIBILITY**   * Facial recognition is a biometric form of technology used to identify human faces. By scanning an individual’s face, it will confirm their identity. This could mean that an individual can’t have multiple driver’s licenses, state IDs or could be identified within a law enforcement database. * Facial recognition is one of the key components for future intelligent vehicle applications, like determining whether a person is allowed or authorized to operate a vehicle. * In face analysis, face detection helps identify which parts of an image or video should be focused on to determine age, gender and emotions using facial expressions. Some of the Face Recognition APIs are, * Microsoft Computer Vision API * Lambda Labs API * Kairos * Face++   **ECONOMIC FEASIBILITY**  Let us assume, KLOC = 10K;  Estimation of development Effort (E):  Estimation of development Time (D):  Where,  KLOC is the estimated size of the software product indicate in K**ilo Lines Of Code.**  are constants for each group of software products.  Development time(D) is the estimated time to develop the software, expressed in months,  Effort(E) is the total effort required to develop the software product, expressed in person months (PMs). | |
| * 1. **HARDWARE ENVIRONMENT** * Processor: i3 or more * RAM: 4 GB or more * The NetBeans IDE is free, open source, cross-platform, feature-rich, easy to use * SQLyog runs on all Windows version from Vista/2008 and higher as well as "Windows Server" systems of same generations and provides you with powerful means to manage your MySQL databases. | |
| **3.5 SOFTWARE ENVIRONMENT** | | | |

* Operating System : Windows 7 / 8 / 10
* Language : Java
* Developing Tool : NETBEANS
* Technologies : JSP, Servlet
* Backend : MySQL Server
* Back End Tool : SQLyog

**CHAPTER 4**

**SYSTEM DESIGN**

|  |
| --- |
| **CHAPTER 4**  **SYSTEM DESIGN**  **4.1. ER DIAGRAM** |

|  |
| --- |
| Fig 4.1 ER diagram  Fig 4.1 shows how the user, Admin and the face emotion recognition system relate to each other within the system. The user can enter name, password and mail id. The admin is able to see the emotion detected of the user through the face emotion recognition system using the four pre-trained models. The Emotion, Age and gender is then displayed to the User.  **4.2 USE CASE DIAGRAM**    Fig 4.2 Use case Diagram  Fig 4.2 describes how the Actors like user and Admin uses the system and how it operates internally. The user can register, login and validate details, then the system can capture the user’s face and their facial features resulting in the emotion recognition. The admin can also do the registration and view the emotions.  **4.3 CLASS DIAGRAM** |
| Fig 4.3 Class diagram  Fig 4.3 shows the functions of each class used in our system. The class names here are the User, Admin and Emotion recognition system. The attributes of User are the username, password, email and methods are to sign up and login. Likewise for admin the attributes are name, password, mail id and methods are to create canvas, toggle control, start detection and so on.,. Lastly the Emotion recognition system has attributes webcam and model path and its methods are tiny face detector, face landmark, face expression net and age and gender net.  **4.4 SEQUENCE DIAGRAM** |
| Fig 4.4 Sequence diagram  Fig 4.4 depicts the workflow of facial emotion recognition system. Here, the user can register and login and those details are validated by the admin. After that, the webcam is enabled. The faces of the users are detected and the facial features are extracted by the pre-trained model which then predicts the emotion of each user along with their age and gender.  **4.5 ACTIVITY DIAGRAM**  DEETCTS EMOTIONS  [true]  REGISTER/LOGIN  EXTRACTS FACIAL FEATURES  VALIDATING DETAILS  ENABLE WEBCAMM  [false] |

|  |
| --- |
| Fig 4.5 Activity diagram  Fig 4.5 captures the dynamic behavior of the system. When a user registers or logins successfully, the webcam turns on to capture the video of user’s face. Followed by, the face is detected and the facial features are extracted which results in the detection of emotion of that user. |

**4.6 COLLABORATION DIAGRAM**

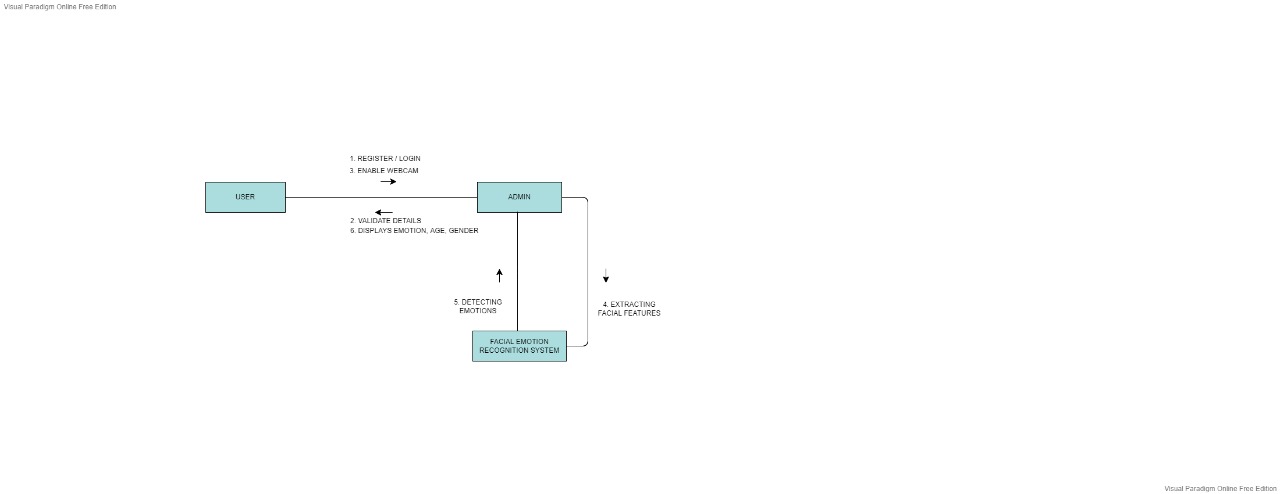


Fig 4.6 Collaboration diagram

Fig 4.6 shows the collaboration diagram, which is also known as a communication diagram, that is used to portray the object's architecture in the system. The objects being User, Admin and facial emotion recognition system. Here the messages are numbered in order based on the flow from object to object.

**CHAPTER 5**

**SYSTEM ARCHITECTURE**

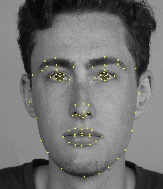
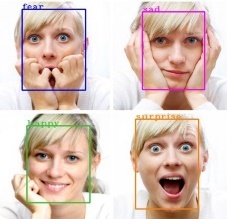
**CHAPTER 5**

**SYSTEM ARCHITECTURE**

FACE DETECTION

Extracting the required facial features captured from the video



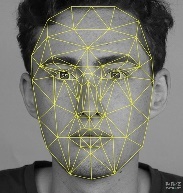
Capturing user’s video

1. Happy
2. Sad
3. Angry
4. Disgusted
5. Surprised
6. fear

Detecting and classifying the user’s face based on several emotions along with age and gender

Face Detector

Model

68 pt Face landmark Model

Face Recognition Model

CLASSIFICATION

Face Expression Recognition Model

Face-api.js

Fig 5 SYSTEM ARCHITECTURE

Fig 5 describes the working of system architecture for facial emotion recognition. Firstly, the webcam captures the user’s face which is then used to detect the face, this system is also able to detect multiple faces. Secondly, the facial features are extracted using the pre-trained land mark detection model. Thirdly, using the face expression recognition model the emotions of each individual is detected and displayed along with the age and gender using the age and gender recognition model.

**5.1 MODULE DESIGN SPECIFICATION**

**Registration**: The user can register/login to the system by giving their necessary details. The user credentials will be validated by the system.

**Face Detection**: This module helps us to identify and extract parts of the user’s face from videos or image should be focused on. Using the Tiny Face Detector model, the user’s face will be located and returned as bounding boxes. This model has been trained to predict bounding boxes of each individual’s face.

**Feature Extraction**: For extracting the facial feature, we are making use of 68 Point Face Landmark model. This pre-trained landmark detector identifies 68 points ((x, y) coordinates) in an individual’s face. These points localize the region around the user’s eyes, brows, nose, mouth, chin and jaw.

**Emotion Recognition**: Emotion recognition is the task to analyze, interpret and classify human emotion through the analysis of facial features. This module uses a pre-trained face expression model to classify seven emotions (happy, sad, angry, disgusted, neutral, surprised, fear) along with estimating age and gender using age and gender model.

**5.2 MODELS DESCRIPTION**

We are making use of four pre-trained models for face detection and face expression recognition along with age and gender. The four models are described in detail in the following section,

**FACE DETECTION MODEL:**

**Tiny Face Detector:**

* The Tiny Face Detector is a very efficient, real-time face detector, which is faster, smaller and less resource consuming compared to the SSD Mobile net V1 face detector model, this in return performs slightly less well on detecting small faces. This model is extremely mobile and web friendly.
* The face detector has been trained on a custom dataset of approximately 14K images labelled with bounding boxes. Moreover, the model has been trained to predict bounding boxes that covers the entire facial feature points, resulting in better performance when combined with face landmark detection.
* We can compute the Euclidean distance between two face descriptors and judge whether two faces are similar based on a threshold value (for 150 x 150 sized face images 0.6 is a good threshold value).

**68-POINT FACE LANDMARK DETECTION MODELS:**

This model implements a lightweight 68-point face landmark detector with better accuracy at faster rate. The models have been trained on a dataset of ~35k face images labelled with 68 face landmark points. This model is used to track and locate the 68 facial points on a person’s face.

**FACIAL EXPRESSION RECOGNITION:**

The face expression recognition model is lightweight, fast and provides reasonable accuracy. The model has a size of roughly 310kb and it employs depth wise separable convolutions and densely connected blocks. It has been trained on a variety of images from publicly available datasets as well as images scraped from the web. Wearing glasses might decrease the accuracy of the prediction results.

Facial expression recognition is the task of classifying the expressions on face images into various categories such as anger, fear, surprise, sadness, happiness and so on.

**AGE AND GENDER RECOGNITION MODEL**:

Age and gender classification is a dual-task of identifying the age and gender of a person from an image or video. The age and gender recognition model is a multitask network, which employs a feature extraction layer, an age regression layer and a gender classifier.

Total MAE (Mean Age Error): 4.54

Total Gender Accuracy: 95%

### Test results for different age category groups

| **Age Range** | **0 -3** | **4 -8** | **9 -18** | **19 - 28** | **29 - 40** | **41 - 60** | **60 - 80** | **80+** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MAE | 1.52 | 3.06 | 4.82 | 4.99 | 5.43 | 4.94 | 6.17 | 9.91 |
| Gender Accuracy | 0.69 | 0.80 | 0.88 | 0.96 | 0.97 | 0.97 | 0.96 | 0.9 |

**CHAPTER 6**

**SYSTEM IMPLEMENTATION**

**CHAPTER 6**

**SYSTEM IMPLEMENTATION**

**6.1 SAMPLE CODE**

**face-detection.html**

<body>

<main>

<div class="container mt-1">

<div class="row">

<div class="col-12 col-md-4 col-xl-3 align-top">

<div class="row mb-3">

<div class="col-md-10 col-6 form-control">

<label class="form-switch">

<input type="checkbox" id="webcam-switch">

<i></i> Webcam </label>

<button id="cameraFlip" class="btn d-none"></button>

</div>

<div class="col-md-10 col-6 form-control">

<label class="form-switch disabled">

<input type="checkbox" disabled id="box-switch">

<i></i> Bounding Box </label>

</div>

<div class="col-md-10 col-6 form-control">

<label class="form-switch disabled">

<input type="checkbox" disabled id="landmarks-switch">

<i></i> Landmarks </label>

</div>

<div class="col-md-10 col-6 form-control">

<label class="form-switch disabled">

<input type="checkbox" disabled id="expression-switch">

<i></i> Expression </label>

</div>

<div class="col-md-10 col-6 form-control">

<label class="form-switch disabled">

<input type="checkbox" disabled id="age-gender-switch">

<i></i> Age & Gender </label>

</div>

<div class="col-md-10 col-6 mt-2">

Wanna go to Home page? <a href="signin.html" target="\_blank"><button class="btn"><span>HOME</span>

</button></a>

</div>

</div>

</div>

<div class="col-12 col-md-8 col-xl-9 align-top" id="webcam-container">

<div class="loading d-none">

Loading Model

<div class="spinner-border" role="status">

<span class="sr-only"></span>

</div>

</div>

<div id="video-container">

<video id="webcam" autoplay muted playsinline></video>

</div>

<div id="errorMsg" class="col-12 alert-danger d-none">

Fail to start camera <br>

1. Please allow permission to access camera. <br>

2. If you are browsing through social media built in browsers, look for the ... or browser icon on the right top/bottom corner, and open the page in Sarafi (iPhone)/ Chrome (Android)

</div>

</div>

</div>

</div>

</main>

<script src="js/face-detection.js"></script>

</body>

</html>

**face-detection.css**

#webcam-container {

padding: 0;

}

canvas {

position: absolute;

top: 0;

left: 0;

}

video {

background: black;

width: 100% !important;

height: auto !important;

margin: 0;

border: 0px;

}

#cameraFlip {

width: 32px;

height: 32px;

margin-left: 10px;

position: absolute;

cursor: pointer;

background-color: transparent;

background-position : center center;

background-repeat:no-repeat;

background-image : url(../images/camera\_flip.png);

}

.loading{

position: absolute;

top: 0;

bottom: 0;

left: 0;

right: 0;

z-index: 300000;

border: white 1px;

color: white;

padding: 75px 26px;

font-size: 22px;

margin: auto;

width: 200px;

height: 200px;

}

.spinner-border {

position: absolute;

top: 0;

left: 0;

width: 200px;

height: 200px;

color: white;

z-index:300000;

filter: alpha(opacity=80);

-moz-opacity: 0.8;

opacity: 0.8;

}

@media screen and (max-width: 575px) {

.form-control {

height: 40px;

margin-bottom: 5px;

padding: 15px 0px 15px 10px;

border: 0px;

}

}

@media screen and (min-width: 576px) {

.form-control {

padding-top: 15px;

padding-bottom: 15px;

height: 60px;

margin-bottom: 5px;

}

}

.camerasList {

width: 90%;

}

.form-switch {

display: inline-block;

cursor: pointer;

-webkit-tap-highlight-color: transparent;

}

.form-switch i {

position: relative;

display: inline-block;

margin-right: .5rem;

width: 46px;

height: 26px;

background-color: #e6e6e6;

border-radius: 23px;

vertical-align: text-bottom;

transition: all 0.3s linear;

}

.form-switch i::before {

content: "";

position: absolute;

left: 0;

width: 42px;

height: 22px;

background-color: #fff;

border-radius: 11px;

transform: translate3d(2px, 2px, 0) scale3d(1, 1, 1);

transition: all 0.25s linear;

}

.form-switch i::after {

content: "";

position: absolute;

left: 0;

width: 22px;

height: 22px;

background-color: #fff;

border-radius: 11px;

box-shadow: 0 2px 2px rgba(0, 0, 0, 0.25);

transform: translate3d(2px, 2px, 0);

transition: all 0.2s ease-in-out;

}

.form-switch:active i::after {

width: 28px;

transform: translate3d(2px, 2px, 0);

}

.form-switch:active input:checked + i::after { transform: translate3d(16px, 2px, 0); }

.form-switch input { display: none; }

.form-switch input:checked + i { background-color: #4BD763; }

.form-switch input:checked + i::before { transform: translate3d(18px, 2px, 0) scale3d(0, 0, 0); }

.form-switch input:checked + i::after { transform: translate3d(22px, 2px, 0); }

.form-switch input:disabled + i { background-color: #eeeeee; cursor: not-allowed; }

.form-switch input:disabled + i::after {

box-shadow: 0 2px 2px rgba(0, 0, 0, 0.10);

}

.disabled {

color: #aaa;

cursor: not-allowed;

}

#errorMsg {

position: absolute;

top: 0;

left: 0;

padding: 20px;

z-index: 999999;

}

.btn {

display: inline-block;

border-radius: 4px;

background-color: #625bff;

border: none;

color: #FFFFFF;

text-align: center;

font-size: 23px;

padding: 10x;

width: 150px;

transition: all 0.5s;

cursor: pointer;

margin: 30px;

}

.btn span {

cursor: pointer;

display: inline-block;

position: relative;

transition: 0.5s;

}

.btn span:after {

content: '\00bb';

position: absolute;

opacity: 0;

top: 0;

right: -20px;

transition: 0.5s;

}

.btn:hover span {

padding-right: 25px;

}

.btn:hover span:after {

opacity: 1;

right: 0;

}

**register.css**

:root{

--form-height:550px;

--form-width: 900px;

/\* Sea Green \*/

--left-color: #625bff;

/\* Light Blue \*/

--right-color: #c9c8e9;

}

body, html{

width: 100%;

height: 100%;

margin: 0;

font-family: 'Helvetica Neue', sans-serif;

letter-spacing: 0.5px;

}

.container{

width: var(--form-width);

height: var(--form-height);

position: relative;

margin: auto;

box-shadow: 2px 10px 40px rgba(22,20,19,0.4);

border-radius: 10px;

margin-top: 50px;

}

.overlay{

width: 100%;

height: 100%;

position: absolute;

z-index: 100;

background-image: linear-gradient(to right, var(--left-color), var(--right-color));

border-radius: 10px;

color: white;

clip: rect(0, 385px, var(--form-height), 0);

}

.

.overlay-text-left-animation{

animation: text-slide-in-left 1s linear;

}

.overlay-text-left-animation-out{

animation: text-slide-out-left 1s linear;}

const webcamElement = document.getElementById('webcam');

const webcam = new Webcam(webcamElement, 'user');

const modelPath = 'models';

let currentStream;

let displaySize;

let convas;

let faceDetection;

$("#webcam-switch").change(function () {

if(this.checked){

webcam.start()

.then(result =>{

cameraStarted();

webcamElement.style.transform = "";

console.log("webcam started");

})

.catch(err => {

displayError();

});

}

else {

cameraStopped();

webcam.stop();

console.log("webcam stopped");

}

});

$('#cameraFlip').click(function() {

webcam.flip();

webcam.start()

.then(result =>{

webcamElement.style.transform = "";

});

});

$("#webcam").bind("loadedmetadata", function () {

displaySize = { width:this.scrollWidth, height: this.scrollHeight }

});

$("#detection-switch").change(function () {

if(this.checked){

toggleContrl("box-switch", true);

toggleContrl("landmarks-switch", true);

toggleContrl("expression-switch", true);

toggleContrl("age-gender-switch", true);

$("#box-switch").prop('checked', true);

$(".loading").removeClass('d-none');

Promise.all([

faceapi.nets.tinyFaceDetector.load(modelPath),

faceapi.nets.faceLandmark68TinyNet.load(modelPath),

faceapi.nets.faceExpressionNet.load(modelPath),

faceapi.nets.ageGenderNet.load(modelPath)

]).then(function(){

createCanvas();

startDetection();

})

}

else {

clearInterval(faceDetection);

toggleContrl("box-switch", false);

toggleContrl("landmarks-switch", false);

toggleContrl("expression-switch", false);

toggleContrl("age-gender-switch", false);

if(typeof canvas !== "undefined"){

setTimeout(function() {

canvas.getContext('2d').clearRect(0, 0, canvas.width, canvas.height)

}, 1000);

}

}

});

function createCanvas(){

if( document.getElementsByTagName("canvas").length == 0 )

{

canvas = faceapi.createCanvasFromMedia(webcamElement)

document.getElementById('webcam-container').append(canvas)

faceapi.matchDimensions(canvas, displaySize)

}

}

function toggleContrl(id, show){

if(show){

$("#"+id).prop('disabled', false);

$("#"+id).parent().removeClass('disabled');

}else{

$("#"+id).prop('checked', false).change();

$("#"+id).prop('disabled', true);

$("#"+id).parent().addClass('disabled');

}

}

function startDetection(){

faceDetection = setInterval(async () => {

const detections = await faceapi.detectAllFaces(webcamElement, new faceapi.TinyFaceDetectorOptions()).withFaceLandmarks(true).withFaceExpressions().withAgeAndGender()

const resizedDetections = faceapi.resizeResults(detections, displaySize)

canvas.getContext('2d').clearRect(0, 0, canvas.width, canvas.height)

if($("#box-switch").is(":checked")){

faceapi.draw.drawDetections(canvas, resizedDetections)

}

if($("#landmarks-switch").is(":checked")){

faceapi.draw.drawFaceLandmarks(canvas, resizedDetections)

}

if($("#expression-switch").is(":checked")){

faceapi.draw.drawFaceExpressions(canvas, resizedDetections)

}

if($("#age-gender-switch").is(":checked")){

resizedDetections.forEach(result => {

const { age, gender, genderProbability } = result

new faceapi.draw.DrawTextField(

[

`${faceapi.round(age, 0)} years`,

`${gender} (${faceapi.round(genderProbability)})`

],

result.detection.box.bottomRight

).draw(canvas)

})

}

if(!$(".loading").hasClass('d-none')){

$(".loading").addClass('d-none')

}

}, 300)

}

function cameraStarted(){

toggleContrl("detection-switch", true);

$("#errorMsg").addClass("d-none");

if( webcam.webcamList.length > 1){

$("#cameraFlip").removeClass('d-none');

}

}

function cameraStopped(){

toggleContrl("detection-switch", false);

$("#errorMsg").addClass("d-none");

$("#cameraFlip").addClass('d-none');

}

function displayError(err = ''){

if(err!=''){

$("#errorMsg").html(err);

}

$("#errorMsg").removeClass("d-none");

}

**CHAPTER 7**

**PERFORMANCE ANALYSIS**

**CHAPTER 7**

**PERFORMANCE ANALYSIS**

**7.1 RESULTS & DISCUSSIONS**

Facial emotion recognition systems are laying the foundation for a variety of applications that could be beneficial to the world. The simplicity of our project is one of its best features. Our project is implemented using JavaScript and can be accessed directly using our preferred browser. There are numerous benefits to using a simple emotion detection and identification model. We will be able to receive immediate feedback and results of people's emotion alongside with their gender and age, which will be beneficial for marketing, generating suggestions, and so on.

**7.2 TEST CASES & REPORTS:**

**Test Case:** **Registration Test Priority**: **High**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.no** | **Action** | **Inputs** | **E Expected**  **Result** | **Actual**  **Result** | **Testcase:**  **P Pass/fail** |
| 1 | Launch Application | Click button | Home page | Home page | Pass |
| 2 | Enter correct  email, name  and password | Enter email id, Password and Name | Login successful | Login successful | Pass |
| 3 | Enter wrong name and password | Enter wrong username and password | Prompts invalid username and password | Prompts invalid username and password | Pass |
| 4 | Submit button | Click button | Login successful | Login successful | Pass |

**Module: Face Detection Test Priority: High**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.no** | **Action** | **Inputs** | **Expected**  **Result** | **Actual**  **Result** | **Testcase:**  **Pass/fail** |
| 1 | Open webcam | Click button to start | Open webcam | Opens webcam | Pass |
| 2 | Capture Video | User face | User’s face is captured through video | User’s face is captured through video | Pass |
| 3 | Detect faces with Bounding boxes | Face of user without any disturbance | Bounding boxed appears as a result of face being detected | Bounding boxed appears. | Pass |
| 4 | Feature extraction | User’s face | 68-point face landmark model is used | 68-point face landmark model is used | Pass |
| 5 | Detect more than 2 Faces | 3 people facing camera | Detects all people | Detects all people | Pass |

**Module: Emotion, Age and gender Recognition Test Priority: High**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.no** | **Action** | **Inputs** | **Expected Result** | **Actual Result** | **Testcase: Pass/fail** |
| 1 | Detect Happy as emotion with age and gender | Happy face | Emotion is recognized Happy | Emotion is recognized Happy | Pass |
| 2 | Detect surprise as emotion with age and gender | surprised face | Emotion is recognized Surprised | Emotion is recognized surprised | Pass |
| 3 | Detect sad as emotion with age and gender | sad face | Emotion is recognized sad | Emotion is recognized sad | Pass |
| 4 | Detect anger as emotion with age and gender | Angry face | Emotion is recognized as angry | Emotion is recognized as angry | Pass |

|  |
| --- |
| **CHAPTER 8**  **CONCLUSION**  **CHAPTER 8**  **CONCLUSION**  **8.1 CONCLUSION AND FUTURE ENHANCEMENTS**  For Future Enhancement, the proposed work can be enhanced by increasing the number of possible expressions other than anger, fear, disgust, joy, surprise, sadness, and neutral. Secondly, ECG signals can be used to detect emotions, resulting in higher accuracy. Our project can be utilized in different sectors like in medical field to monitor patient behavior, IT field to assign tasks based on emotions, and in any organization to learn more about employee status. As the facial expression recognition systems are becoming robust and effective in communications, many other innovative applications and uses are yet to be seen. We propose a new way to boost the performance of the APIs. Also, we show APIs still suffer in recognizing emotions in real life environments. We hope our work will provide an insight into the future works needed to be done in this arena to make these systems practical and perform well in real life scenario. |

|  |
| --- |
|  |
| **CHAPTER 9**  **APPENDICES**  **CHAPTER 9**  **APPENDICES**  **A.1 Sample Screens**  Screen Shot of Home Page:    Figure A.1: Screen Shot of Home Page  Screen Shot of Login Page:    Figure A.1: Screen Shot of Login Page  Screen Shot of Landing page after logging in:      Figure A.1: Screen Shot of Landing Page  Screen shot of happy emotion, age and gender being recognised:    Figure A.1: Screenshot of Emotion (Happy), age and gender  Screen shot of surprised emotion, age and gender being recognised:    Figure A.1: Screenshot of Emotion (Surprised), age and gender  **CHAPTER 10**  **REFERENCES**  **CHAPTER 10**  **REFERENCES**  1. Khadija Lekdioui, Yassine Ruichek, Rochdi Messoussi, Youness Chaabi, Raja Touahni, YEAR: May, 2017 “Facial Expression Recognition Using Face-Regions”, 2017 International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), DOI: 10.1109/ATSIP.2017.8075517  2.M.Shamim Hossain and Ghulam Muhammad, YEAR: February 2017, “An Emotion Recognition System for Mobile Applications”, Institute of Electrical and Electronics Engineering (IEEE), DOI: 10.1109/ACCESS.2017.2672829.  3.M.Mohammadpour, H. Khaliliardali, S. M. R. Hashemi and M. M. AlyanNezhadi, YEAR: February 2017 "Facial emotion recognition using deep convolutional networks,"2017 IEEE 4th International Conference on Knowledge-Based Engineering and Innovation (KBEI)*,* 2017, pp. 0017-0021, doi: 10.1109/KBEI.2017.8324974.  4. Renuka S. Deshmukh and Prof. Vandana Jagtap,YEAR: June,2017 “A Survey: Software API and Database for Emotion Recognition”, International Conference on Intelligent Computing and Control Systems (ICICCS), DOI: 10.1109/ICCONS.2017.82507273.  5. M.Xiaoxi, L. Weisi, H. Dongyan, D. Minghui and H. Li, "Facial emotion recognition," YEAR: August 2017,IEEE 2nd International Conference on Signal and Image Processing (ICSIP), 2017, pp. 77-81, doi: 10.1109/SIPROCESS.2017.8124509  6. Yang-Yen Ou, Bo-Hao Su, Shih-Pang Tseng, Liu-Yi-Cheng Hsu, Jhing-Fa Wang and Ta-Wen Kuan, YEAR: October 2018, “Efficient Emotion Recognition based on Hybrid Emotion Recognition Neural Network”, International Conference on Orange Technologies(ICOT), DOI: 10.1109/ICOT.2018.87059034.  7. M. Abdullah, M. Ahmad and D. Han ,YEAR : Jan 2020,"Facial Expression Recognition in Videos: An CNN-LSTM based Model for Video Classification," 2020 International Conference on Electronics, Information, and Communication (ICEIC)*,* 2020, pp. 1-3, doi: 10.1109/ICEIC49074.2020.9051332  8. S. Manna, S. Ghildiyal and K. Bhimani, YEAR : June,2020"Face Recognition from Video using Deep Learning," 2020 5th International Conference on Communication and Electronics Systems (ICCES), 2020, pp. 1101-1106, doi: 10.1109/ICCES48766.2020.9137927.  9. Dhand, Geetika and Beri, Tanisha and Sobti, Tanvi and Angrish, Vidhi, “Music Recommendation Using Sentiment Analysis from Facial Recognition”,(February 22, 2022).Available at SSRN: <https://ssrn.com/abstract=4041049> or [http://dx.doi.org/10.2139/ssrn.4041049](https://dx.doi.org/10.2139/ssrn.4041049)  10. D. Ram Kiran, K. Vinay Kumar, T. Kalyan, K. Ch. Kavya, K. Sarat Kumar, YEAR: July 2022, “Facial Expression Detection using Artificial Intelligence”, International Journal of Recent Technology and Engineering (IJRTE), DOI: <https://doi.org/10.35940/ijrte.2277-38785>  11. S. R. Khanal, J. Barroso, N. Lopes, J. Sampaio, and V. Filipe. YEAR : June 20-22, 2018, “Performance analysis of Microsoft’s and Google’s Emotion Recognition API using pose-invariant faces”. In Proceedings of Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion – Aristotle University of Thessaloniki, Greece, June 20-22, 2018 (DSAI 2018) https://doi.org/10.1145/3218585.3224223 |