A Project Report

EMOTION BASED MUSIC RECOMMENDATION SYSTEM

in partial fulfilment for the award of the degree Of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

submitted by

B. NAVEEN	**19B91A0518**
D. NAGASWAPNA	**19B91A0545**
D. ARUN	**19B91A0541**

Under the Guidance of

DR K RAMAPRASADA RAJU

Professor

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SRKR ENGINEERING COLLEGE (A)

ChinnaAmiram, Bhimavaram, West Godavari Dist., A.P.

[2022 – 2023]

A Project Report

EMOTION BASED MUSIC RECOMMENDATION SYSTEM

in partial fulfilment for the award of the degree of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

submitted by

B. NAVEEN	**19B91A0518**
D. NAGASWAPNA	**19B91A0545**
D. ARUN	**19B91A0541**

Under the Guidance of

DR K RAMAPRASADA RAJU

Professor

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SRKR ENGINEERING COLLEGE (A)

ChinnaAmiram, Bhimavaram, West Godavari Dist., A.P.

[2022 – 2023]

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SRKR ENGINEERING COLLEGE (A)

ChinnaAmiram, Bhimavaram, West Godavari Dist., A.P.

[2022 – 2023]

BONAFIDE CERTIFICATE

This is to certify that the project work entitled **"EMOTION BASED MUSIC RECOMMENDATION SYSTEM"** is the bonafide work of **"B. NAVEEN, D. NAGASWAPNA, D. ARUN"** who carried out the project work under my supervision in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering.

SUPERVISOR	**HEAD OF THE DEPARTMENT**
DR. K Ramaprasada Raju	**DR. V. Chandra Shekar**
Professor	**Professor**

SELF DECLARATION

We here by declare that the project work entitled **“EMOTION BASED MUSIC RECOMMENDATION”** is a genuine work carried out by us in B. Tech, (Computer Science and Engineering) at SRKR Engineering College (A), Bhimavaram and has not been submitted either in part or full for the award of any other degree or diploma in any other institute or University.

B. NAVEEN (19B91A0518)

D. NAGASWAPNA (19B91A0545)

D. ARUN (19B91A0541)

ABSTRACT:

This project's main goal is to recommend song list of songs based on emotion which are detected using facial expression and some parameters such artist, language, musician. Through the camera, this system reads our facial expressions and identifies our emotions before recommending a list of songs. The ability to read a person's emotions from their face is crucial. The necessary input is directly taken from the subject's face. This, input can be used, among other things, to extract data that can be used to infer a person's mood. The list of songs that fit the "mood" derived from the input provided before can then be obtained using this data. This reduces the time-consuming and laborious effort of manually classifying songs into various lists and assists in creating a songs list that is suitable for a particular person depending on their emotional characteristics. The goal of the Emotion based music recommendation system is to scan and understand the data, then create a List of Songs based on the given criteria.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBRIVATIONS

Acronym	Abbreviation
ACTSEA	Advanced Ceramic and Technology for Sustainable Energy Applications
API	Application Programming Interface
CCTV	Closed Circuit Television
CNN	Convolutional Neural Network
CV	Computer Vision
DRL	Diagnostic Reference Levels
EDA	Electrodermal Activity
EMRS	Emotion based Music Recommendation System
FC	Fully Connected layer
GSR	Galvanic Skin Response
HRV	Heart Rate Value / Heart Rate Variability
KNN	K-Nearest Neighbour
LBP	Local Binary Pattern
NaN	Not a Number
PPG	Photoplethysmography
ReLU	Rectified Linear Unit
RGB	Red Green Blue
SVM	Support Vector Machine
XML	Extensible Markup Language

1.INTRODUCTION:

Everyone has tough times. If a person can eventually calm down, there is rarely much cause for concern. Yet the body will rebel if you live under stress for an excessive amount of time and get too little sleep. The irritation and tiredness still hang on in the person right after they get out of bed and might feel gloomy or sad. The irritation comes with the consequence like being less patient with people, situations and would likely withdraw from important deals in their life. Work requires extra effort, and focusing might be challenging. Sometimes the possibility of betterment starts to fade and life doesn't seem as pleasant as it once did. In modern times, every human is over stressed that leads to the lack of quality in their work. Workplace stress can make it harder to concentrate and cause headaches, stomachaches, sleep disruptions, and irritability. Anxiety, sleeplessness, high blood pressure, and a compromised immune system can be brought on by ongoing stress.

If sad mood hits in, if we listen to the favorite pop song or a little bit beat song then the sadness will be gone and it sometimes gives the motivation to do the work in the effective way. But selection of the music in that state leads to the more decrement in the mood. So, the recommendation system will help in very efficient way, as the author gets to choose but the person might not be in the situation to choose the genre of the song.

The recommendation systems are also including the music suggestion so that it becomes simpleto the user to get the particular Songs List. Several music recommendation algorithms exist, content-based (recommendations based on the similarities between two songs' characteristics or,in our instance, their content), collaborative (recommendations based on users' tastes that are comparable and employing ratings matrices for each piece of material, in our example a song). The Music recommendation with the content based includes all the previous data which we search in the social media are, like Spotify app. However, stressed individuals may or may not have preferences that align with their previously searched data. Collaborative music recommendations are best for emotion-based recommendations.

Different persons have different emotions, single person’s emotion is not same at different times, so recommendation based on the emotion is more effective to increase the quality of the mood of the person. The music recommendation system based on the emotion is very effective to personalize the songs list of the person. The human face is crucial in determining an individual's mood. To detect the emotion firstly we have to recognize the face of the user then the emotion is detected using the face and from the detected emotion the Songs List is recommended.

From the research papers the music recommendation based on the emotion is mainly detected through the face of the user is mainly extracted from the webcam or the camera of the user’s device. Nowadays everyone is using the smart mobiles without the age limit, which is having the webcam facility so this recommendation system can be accessed from the camera devices. From the face taken from the user is used for the extraction of the emotion. Face detection, which is used to identify faces in the photos, is the first and most important stage in face recognition. It falls under the category of object detection and has a variety of applications, including security, biometrics, law enforcement, entertainment, and personal safety. Face detection technology is employed for real-time tracking and surveillance of people and things. It is frequently employed in cameras to recognize numerous appearances in the frame, including DSLRs and mobile cameras. Facebook also employs a face identification algorithm to find and identify faces in photos. And there are several technologies available to extract emotions from the human body in addition to the face. Sensor technology is also can be used to sense the emotion of the human.

Face detection methods:

The face detection methods are divided into four categories, and the face detection algorithms could belong to two or more groups. These categories are as follows-

- Feature-Based
- Appearance-Based
- Knowledge-Based
- Template Matching

Appearance based is the best process in this system so it is selected. From the detected face the emotion is classified. Humans show a great deal of variability in their abilities to recognize emotion. Emotions are not only conveyed through facial expressions, but can also be detected through IoT sensors. The GSR and PPG signals are commonly used to detect emotions. According to these emotions the songs list is recommended. The sensors gather information from the user, such as the amount of perspiration they create, and based on that sweat and heartbeat, they identify the person's emotions.

"Finally, the song list recommendation is where the efficiency of the project depends, the song list should be recommended according to the user's emotion. So, based on the user's emotion, the recommendation should take the emotion as the input from the user and recommend the song list for the user. The online API will also do the same process, for recommending the song list they use the stored data of the user to recommend the song list. This will not work in all times, as the mood of the user differs in many conditions. So, to overcome all these problems, emotion-based music recommendation systems are developed according to the user's perception."

The report is further organized into different chapters as follows; chapter 2 informs the existing research papers related to Music Recommendation System. The current systems, how they developed, and the technologies and methodologies they used to create the system are explained. In chapter 3, the problem statement of the proposed method is determined. In chapter 4, the methodology and technologies which are being used in the proposed system are explained. Chapter 5 describes how the proposed methodology can implement the plan. Chapter 6 shows the results obtained from the proposed method using a public images dataset. Chapter 7 concludes the report. In the chapter 8 the research papers from the different articles are mentioned as references.

2.LITERATURE SURVEY:

Music serves a vital function in people's lives as it helps alleviate stress caused by various activities such as work and personal responsibilities. Therefore, a songs list is recommendation system tailored to individual interests can contribute to greater relaxation. There are various types of emotion-based music recommendation systems, including those based on physiological signals such as heart rate, those that use facial expression recognition.

2.1 Physiological Signals:

The wearable computing device integrates galvanic skin response (GSR) and photo plethysmography (PPG) physiological sensors to obtain signals from a user, which are used to classify their emotion [4].

The sensors gather user information and store it in the cloud, where it is analyzed to determine the user's emotions, which are then outputted.

This information is then fed to a collaborative or content-based recommendation engine as supplementary data, to enhance the performance of existing recommendation engines.

2.1.1 IoT Sensors:

The Galvanic Skin Response (GSR) and Photoplethysmography (PPG) physiological signals are used for detecting the emotions. According to these emotions the playlist is recommended by Ayata at all [4].

- GSR (Galvanic Skin Response):

The GSR is employed to gauge the skin's electrical conductance. Emotional states such as stress or surprise can result in modifications in the skin's resistance.

The GSR is utilized to record physiological responses associated with excitement. When individuals become excited, their bodies release sweat, which causes changes in the amount of salt on the skin and alters the skin's electrical conductance.

- PPG(Photoplethysmography):

PPG sensors identify fluctuations in optical blood volume within the micro-vascular bed of the tissues. The PPG system includes a detector and red/infrared light-emitting diodes that serve as the light source to track tissue light intensity variations either through transmission or reflection.

The system database stores the emotional effects of past recommendations on the user to improve future recommendations. As the impact of the same musical track can differ among users, these effects are considered in the recommendations.

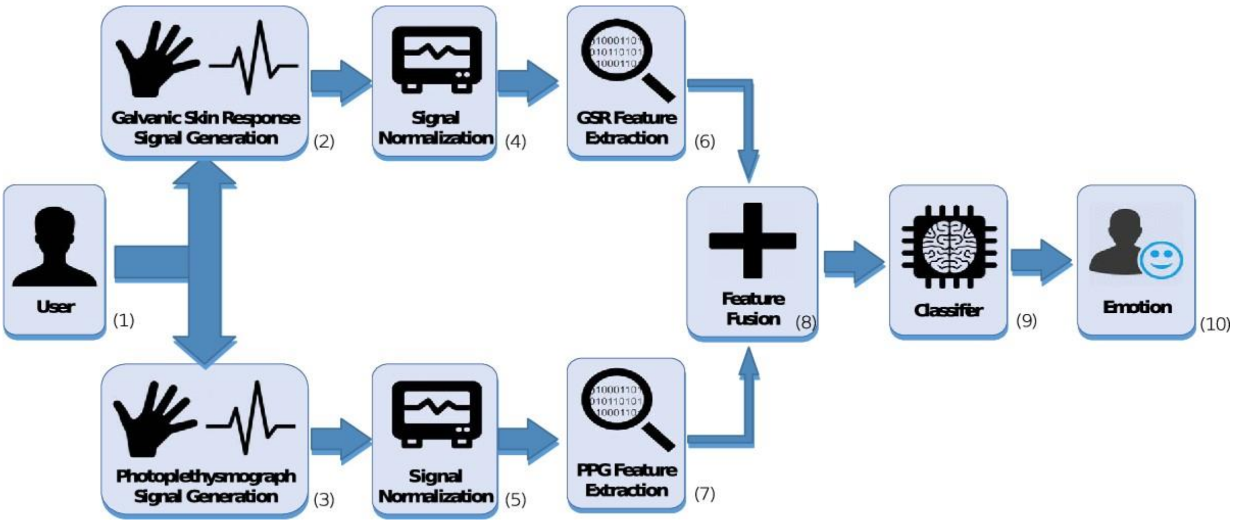


Fig 2.1 Architecture for the physiological signals

2.1.2 Wearable devices:

S. Vindhya at all used Deep reinforcement learning for recommending songs based on user information. (Mainly age, mood, gender, and stress levels from Heart Rate Value (HRV). HRV is measured with any wearable devices or heart monitoring applications and exported to data in a .csv file to a DRL-based system. Relatively high-level stress converted to null gain for the model and low-level stress converted to positive reward for the model.

The authors used a neural network for processing and extracting music genre and emotional features from the audio files, and they recommended them based on the previous feedback on stress levels. S. Vindhya at all used music playlists from Emotify game, Biometrics for stress monitoring Kaggle dataset contains Heart Rate Variability (HRV) and Electrodermal activity (EDA) for monitoring stress levels [8].

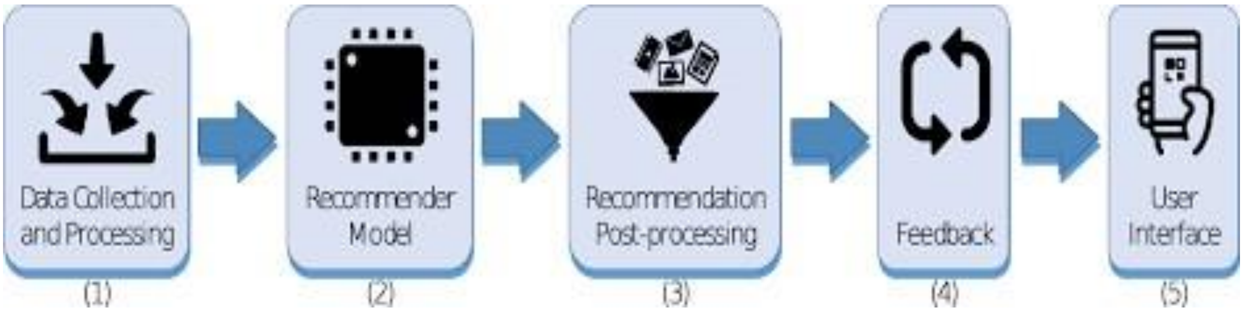


Fig 2.2 Workflow in the Recommendation system on previous Feedback

2.1.3 Psychologically-Inspired Music Recommendation System

In the paper [10], they decided to analyze the following features of songs from Spotify API: valence, energy, tempo, danceability, liveness, loudness. All six features have different density values distributions, which makes it challenging for them to compare with different songs. For that reason, before comparing these features, they standardized them to the same normal distribution, which is called a z-score transformation.

They created an accumulative vector variable called ’Mood Vector’, which consists of all 6 features as a single one-dimensional vector. In order to compare all these features across all the songs in the dataset, they calculated Euclidean distances between a chosen song and all the other songs in our dataset and save them as a ’Distance’ variable.

They sorted the ‘Distance’ variable by its length and pick the top K songs. These songs are now the result of the content-based filtering performed by their recommendation system. In this project, they used the Spotify popularity score feature. The score is assigned to all the songs in their dataset in range between 0 and 100, with 100 being the most popular. The score reflects the overall popularity of a song’s artist on the platform. After sorting the output of the previous step by this popularity score, finally get the recommendation playlist. In the paper [5] Mobile Net which is a CNN architecture model for Image Classification and Mobile Vision was used for emotion detection. Firebase was considered as a backend server to recommend playlist by Ankitha Mahadik in March 2022.

2.2 Facial expression:

When a person experiences an emotion, such as happiness, anger, sadness, or surprise, their face tends to reveal some signs. The face is the primary means by which emotions are communicated to others, and it plays a crucial role in human social interaction.

To detect an individual's emotional state, the position of their eyebrows, mouth, and nostrils are typically observed.

Playlist recommendation system according to their interest gives more relaxation, So Emotion based music recommendation system is recommended, From the literature verified Emotion Based Music Recommendation System consists of three main tasks. They are:

- Facial Detection
- Emotion Detection
- Playlist Recommendation

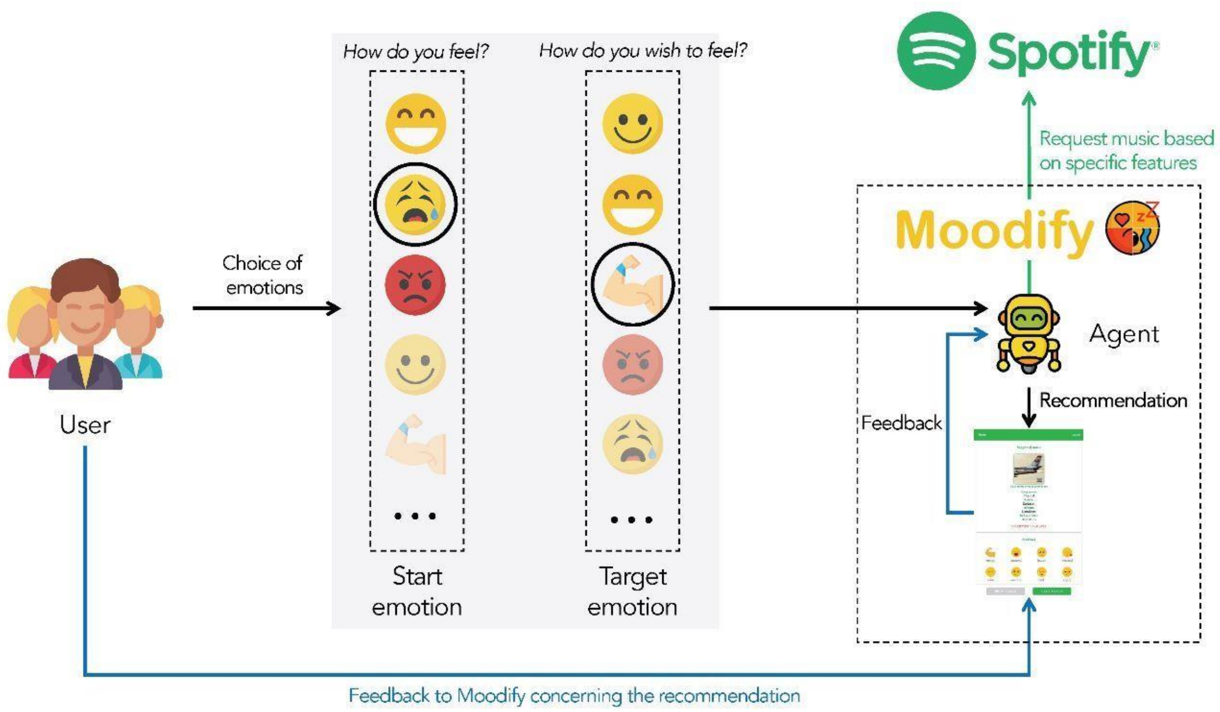


Fig 2.3 Architecture of the playlist recommendation on the detected emotion

2.2.1 Facial Detection:

The first category of emotion-based music recommendation system is to identify the emotion based on the facial expressions from the face image. Facial detection plays an important role in detecting the emotion of the user.

2.2.1.1Using OpenCV technique:

OpenCV is the open-source technique used for the CV, ML image processing. The OpenCV technique is used widely for many projects. To capture the face from the webcam OpenCV technique is used. OpenCV able detect mood from facial expressions by using facial points.

2.2.1.2Face Detector Class in JAVA:

In the paper [2] they detected the face with the Face Detector class available in Java. This class is used to load the trained cascaded set of faces which we will be using to detect faces for any input image

2.2.1.3Viola-Jones Algorithm:

Viola-Jones algorithm is a machine-learning technique for object detection. The algorithm was primarily conceived for face detection. The Viola-Jones algorithm is an efficient solution for resource-constrained devices. Given a grayscale image, the algorithm analyses many windows of different sizes and positions and tries to detect the target object by looking for specific image features in each window.

A.V Iyer uses the viola-Jones algorithm in the recognition of the face and changes the figureinto the grayscale to detect every curve of the face and crops the unwanted backgrounds to detect the facial emotions correctly without any disturbances. LBP (Local Binary Pattern) is usedhere for the extraction of the image, then it will be stored [3].

2.2.2Emotion Detection:

The technique of detecting human emotion is known as emotion recognition. The precision with which people can gauge the emotions of others varies greatly. The use of technology to assist humans in recognizing emotions is a relatively new field of study. The main part of the project is to detect the emotion, from the papers the emotion detection is as follows:

2.2.2.1Deep learning technique:

Deep learning technique Convolutional Neural Networks (CNN) is also used for the emotion recognition, the deep learning techniques (CNN) are faster than the Machine Learning techniques KNN. For CNN the fundamental building block is neuron. It is fully connected network so the output coming from the CNN is more accurate. CNN reduces the image into a form which is easier to process, without losing the features and gives good prediction. It can also be used large datasets.

CNN is used in many projects, [1][5][6] used the CNN for the better result for their project.

2.2.2.2EMOPLAYER application:

Android application EMO PLAYER It sends the image to the server which detects emotion and sends it back to the application.[3] It recommends playlist for the detected mood. In this the emotion recognizes up to 3moods only (anger, sad and happy).

2.2.2.3Calculating cumulative mood:

Every consumer visiting a mall floor will have their mood recognized by the mood-based music system based on visuals from the CCTV camera. According to the mood the administrator wants the customers to be in and the ambiance of the floor, it will determine the crowd's overall mood and offer a playlist. The system is designed to provide consumers with a better and more positive experience, which would encourage them to remain longer and increase their likelihood of making additional purchases. It creates a healthy and joyfulwork atmosphere by enabling employees to serve customers in a better mood. However not everycustomer's want will be met by the system. The playlist must be manually updated. For mood detection, it requires consistent pictures from the CCTV cameras. When wearing a mask, mood detection is not feasible [12].

2.2.2.4Using lyrics for classification:

Shashi Kumar at all used machine learning approach by using support vector machine (SVM) to identify emotion in 1161 lyrics by using 9 emotions categories with single and multiple labels on emotion, and compared with other classifiers that achieved 0.66 and 0.83 on the F1 scale. In this project, the single labeled dataset includes genre, artist, year, title, lyrics, and labels(emotions). Each lyric is assigned an emotion label. For feature extraction, n-gram is used to predict the next item in the sequence and read the data in contiguous sequence from corpus. In this model linear supervised learning classification is used to fit the data provided by returning the best fit hyper-plane that categorizes our data [13].

2.2.3Playlist Recommendation:

The third and final step in the Music recommendation system is playlist recommendation, the playlist can be recommended in the following ways,

2.2.3.1Pywhatkit:

Pywhatkit is a library that offers a range of beneficial functionalities, and it is easy to use, without the need of any extra setup. It’s currently among the most widely used libraries for automating YouTube tasks. The only drawback is its accuracy is 64.52% [1].

2.2.3.2API Keys:

Web API also provides access to user related data, like playlists and music that the user saves in the Your Music library. Such access is enabled through selective authorization, by the user.
Gayatri Pranitha and all, used APIs to recommend playlist of songs based on the mood that was detected. Python is one of the best sources for facialrecognition and it has modules for music like Spotify, SoundCloud. The songs can be accessed through API keys, sometimes it is difficult to get the playlist from the API [2].

2.3.3.3Recommendations based on previous history:

The user enters the music they want as the first thing in the system [9]. Once the user has input the necessary music, 10 related songs are then suggested to him. Title, Artist, and Top Genre are the first three features that are taken into account by the procedure, and they are done by taking Angular distance and Euclidean distance. They used the method cosine similarity and class Count Vectorizer for this. After counting the number of phrases that appeared in a given feature using a count vectorizer stored in an object, structured data is employed by cosine similarity to get the similarity score. If NaN values are discovered, they are swapped out for an empty string. A list of enumerations is created for the similarity score once the cosine similarity between the characteristics has been determined. Firstly the model that is displayed on the frontend and then predicts the seven songs that are the most similar.

In Emotion based music recommendation system, a music playlist is recommended to the user to enhance their mood based on the emotion detected. Sulochana and all used a playlistdataset that has emotion labels in Kaggle and ACTSEA to provide music [7].

Outline of Literature Survey:

The literature survey discusses how the current models of recommendation systems work to recommend playlists of songs to users. These systems use the front camera of devices to capture an image of the user's face, which is then recognized using the Viola-Jones algorithm. Based on the detected mood, the system recommends a playlist of songs, which can be accessed through music services like Spotify and SoundCloud.

However, it also highlights a challenge in accessing playlists from APIs. To address this, the alternative emotion recognition system has been proposed. This system uses IoT sensors,such as GSR and PPG signals, to detect emotions and suggest playlists accordingly. While this framework is effective, using IoT sensors can add some complexity to the system.

The rephrased version of the literature survey aims to convey the same information in a more concise and readable manner. It highlights that the current recommendation system models rely on the Viola-Jones algorithm and facial expression detection to detect mood and recommend playlists. It also mentions that the system integrates with popular music services like Spotify and SoundCloud.

3.PROBLEM STATEMENT:

In today's world, people often experience periods of stress in their lives, and there are several ways to relieve this stress. Music is a simple and effective method for reducing stress. Music has been shown to have a powerful impact on our emotional state, and can be an effective tool for managing stress. Listening to music can help to reduce feelings of anxiety and promote relaxation, making it an ideal way to unwind after a long day or during a stressful period in our lives. This project is focused on creating a system that can recommend song playlists based on the user's emotions. It does so by detecting facial expressions using a camera and then using various factors such as the artist, language, and musician to suggest appropriate songs. The system first processes the image data, which involves loading, resizing, and displaying images. This is accomplished using the OpenCV library, a widely-used library for image processing tasks. To identify emotions, a neural network is employed. In particular, a feed-forward CNN is utilized, which is a type of neural network that is commonly used for image analysis and recognition. This CNN is trained on a dataset of facial expressions and corresponding emotions, which allows it to recognize emotions in real-time from the camera feed. By combining the neural network with the image processing capabilities of the OpenCV library, the system is able to detect and respond to the user's emotions in real-time. This project also offers interactivity by allowing the user to input parameters such as the artist, language, and musician. This provides a more personalized experience and allows the system to suggest songs that are tailored to the user's individual preferences. Since the system does not rely on APIs, it is straightforward and user-friendly, making it easy for users to interact with and enjoy.

4.METHODOLOGY:

4.1. Architecture:

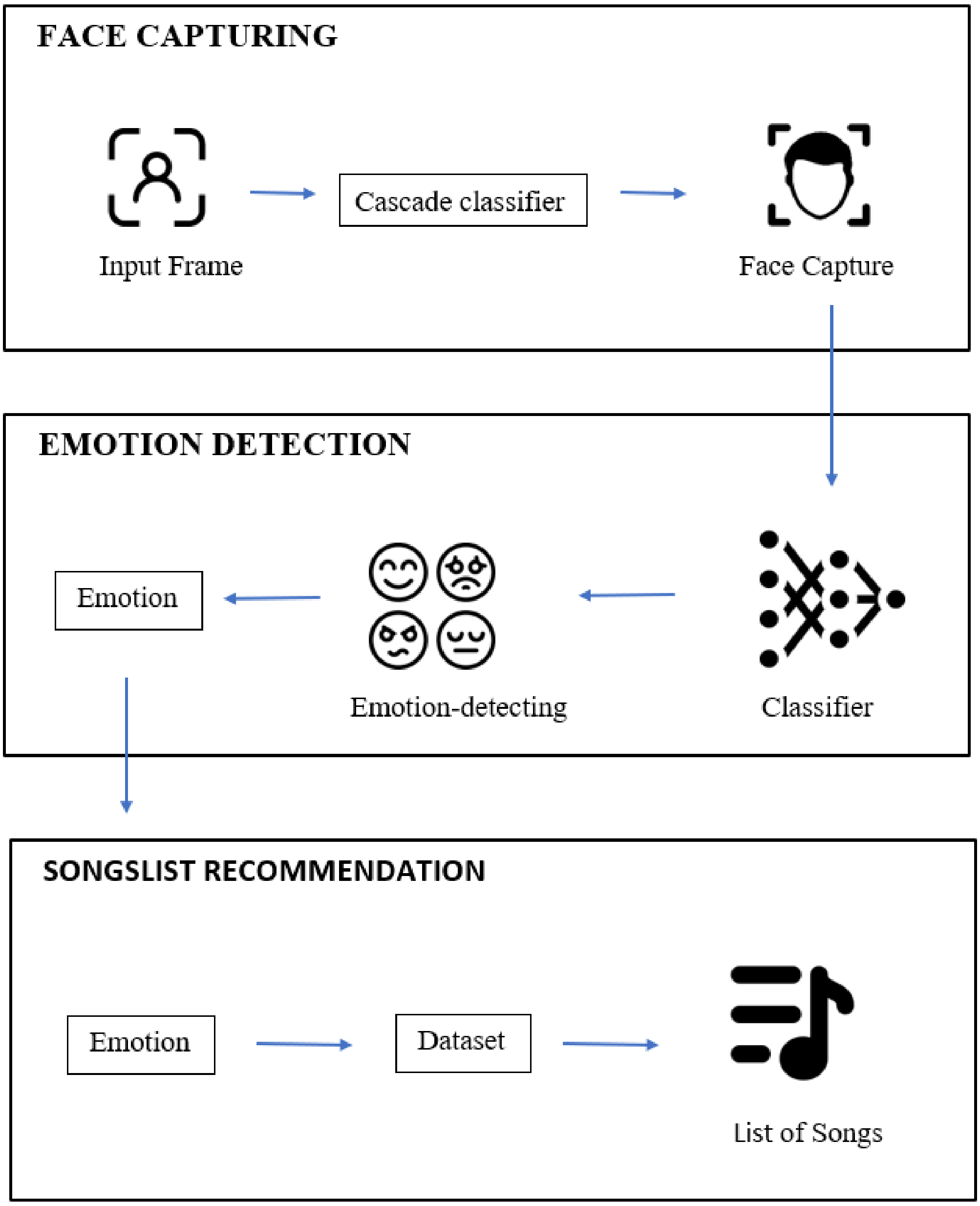


FIG 4.1 ARCHITECTURE OF EMRS

4.2 Capturing of Face:

The capturing of the face is the main and crucial point in the emotion detection, the process of the capturing of the face is as follows:

1. Frame detection
2. Face detection
3. Face extraction

4.2.1 Frame Detection:

- The first step in the process is to turn on the user's webcam, which captures a sequence of six frames or images. Each of these frames will have different levels of sharpness, brightness, and contrast due to a variety of factors such as lighting conditions and camera settings.
- To determine which frame is the clearest and most suitable for further processing, the frames are analysed using a set of algorithms. These algorithms typically take into account factors such as the sharpness, brightness, and contrast of each frame to determine which one is the best quality.
- Once the clearest frame has been selected, it can be used for the extraction of the person's face. This involves identifying the location and boundaries of the face within the selected frame. This process is usually done using a technique called "face detection," which uses machine learning algorithms to analyse the pixels in the image and identify regions that are likely to contain a face.
- Once the face has been identified, it can be extracted from the rest of the image using a process called "face recognition." This involves comparing the features of the detected face to a database of known faces to determine the identity of the person.
- Overall, frame detection is an important step in the process of analysing facial expressions because it ensures that the most suitable image is selected for further processing, which helps to improve the accuracy and reliability of the facial expression analysis.

4.2.2 Face detection:

- After the clearest frame has been selected and the face has been extracted from the frame, the next step is to detect the coordinates of the face in the extracted frame. This is done using the OpenCV library, which is a popular open-source computer vision library that provides many powerful tools for image processing and analysis.
- One of the key features of OpenCV is its ability to detect faces in images using pre-trained models. These models have been trained on large datasets of images and are capable of detecting faces in a wide range of conditions and environments.
- To begin the face detection process, the extracted face image is first converted from a 3-dimensional RGB image to a 2-dimensional grayscale image. This is done because grayscale images are easier to process and analyse than colour images, and also because many face detection algorithms work better with grayscale images.
- Once the image has been converted to grayscale, the OpenCV library is used to apply the face detection model to the image. The library contains pre-trained models that can detect faces in images and output the coordinates of the faces. The face in the image isrepresented by these coordinates, which may be used to crop the image and isolate the face for additional processing.
- All things considered, face recognition is a crucial stage in the analysis of facial expressions since it enables us to recognise and isolate the face in an image, which is required for effectively detecting and analysing facial expressions.
- The retrieved frame is processed by the OpenCV library by looking at the pixel values and looking for patterns that resemble faces. To simplify processing and enhance algorithm performance, the image is converted to a grayscale 2D image. Using pre-trainedmodels like Haar cascades, the library identifies facial features such as the eyes, nose, andmouth. The algorithm identifies patterns in pixel values using machine learning techniques to classify facial features. After detecting the face, the library outputs its coordinates representing its location and size in the image, which can be used for further processing, such as facial expression analysis.

4.2.3 Face Extraction:

- Haar features are based on the mathematical concept of the Haar wavelet. They are similar to edge detection in that they identify variations in the intensity of the image pixels.
- However, Haar features differ in that they look for specific patterns of variation across multiple adjacent pixels.
- There are three main types of Haar features that are commonly used for face detection:

  Edge features: These features detect edges and lines in an image.

  Line features: These features detect edges and lines at different angles in an image.

  Center-surround features: These features detect differences in intensity between the central region of an image and the surrounding regions.

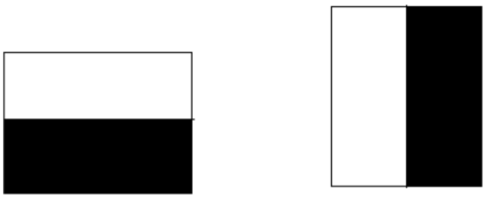


Fig 4.2 Edge feature

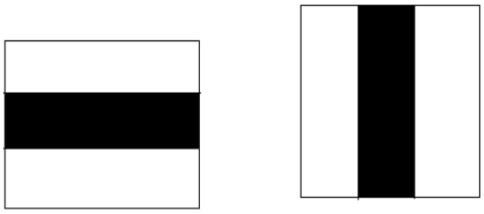


Fig 4.3 Line feature

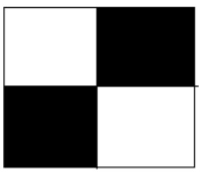


Fig 4.4 Four rectangle feature or the center surrounded feature

- Each Haar feature is a binary classifier that evaluates whether a specific pattern is present in a given image region. The classifier produces a high score if the pattern is present and a low score if it is not. The Cascade classifier can accurately determine whether a face is present in a picture by merging various Haar characteristics and classifiers.

- The Gray scale image's matrix is used as the basis for the Haar classifier, which iterates over the matrix according to the specified step count for each feature.
- The delta is subtracted from each step of the feature and placed in the data frame under the size and position header. Where W is white region value and B is black region value.

$$D1 = W - B \qquad \textit{Eq.1}$$

- The value of the bright region in the Gray scale image is always greater than the dark region in the image.
- From these techniques the Face is extracted and represented with the rectangle box around the face.

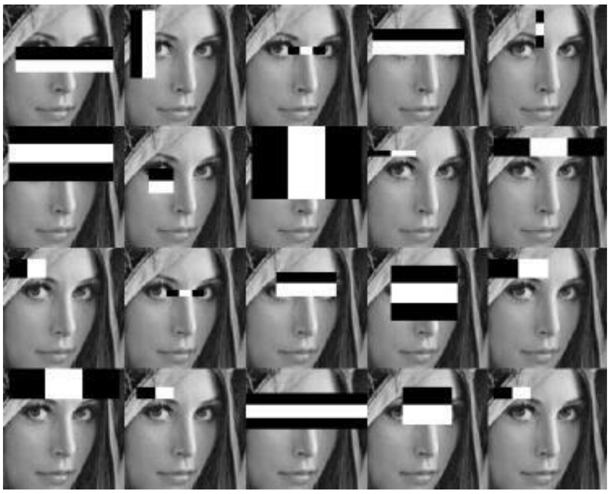


Fig 4.5 Haar Classifier

- From these techniques the Face is extracted and represented with the rectangle box around the face.

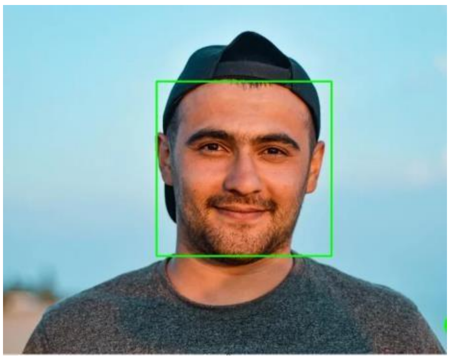


Fig 4.6 Detected Image

4.3 Emotion Detection:

Neural Network is employed to detect emotion. The Neural Network learns from the data that is fed into it. To detect emotion from facial expressions, Because CNN functions directly on the pictures rather than focusing on feature extraction, like other neural networks do, it is chosen because it accepts input as a two-dimensional array.

In CNN, there are mainly three layers used, they are:

1. Input Layer
2. Hidden Layer
3. Output Layer

Use of CNN in emotion detection:

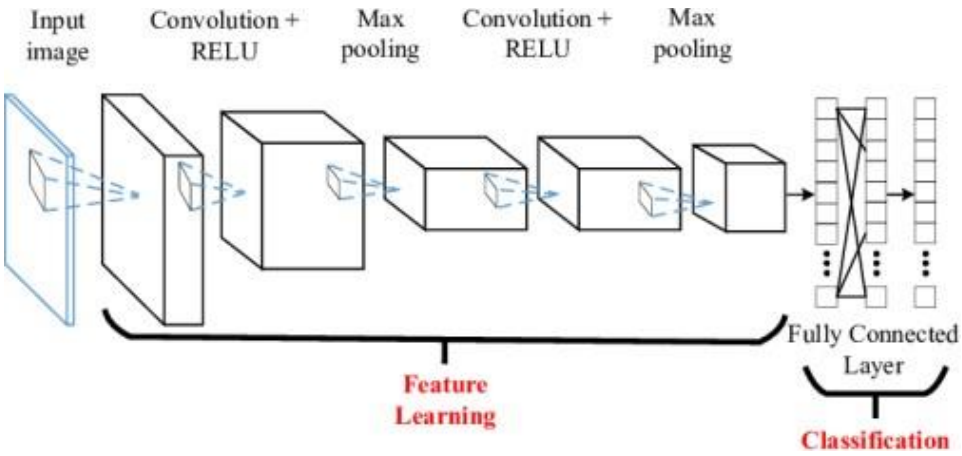


Fig 4.7 CNN Model

4.3.1 Input Layer:

Once the Cascade Classifier has identified potential objects in an image, the output of the classifier can be used as the input layer of a CNN. A CNN is a deep learning algorithm that can learn and extract features from images in a hierarchical manner, making it well-suited for object recognition tasks.

4.3.2 Hidden Layer:

1. Convolution Layer:

   The convolution Layer performs a dot product between how matrices, where one matrix is a kernel and the other is an input image. The kernel is smaller than the input image and the "Activation Map" matrix is obtained, which is reusable. So, the Activation Map takes only important pixels as meaningful information to reduce the memory requirement.

2. Activation Layer:

As pictures and faces are not linear, while convolution is a linear process, non-linearity layers are used to add non-linearity to the Activation Map. Rectified Linear Unit (RELU) is one of the popular Activation functions with the right kind of learning rate and it computes the function

f(x) = max (0, x). *Eq.2*

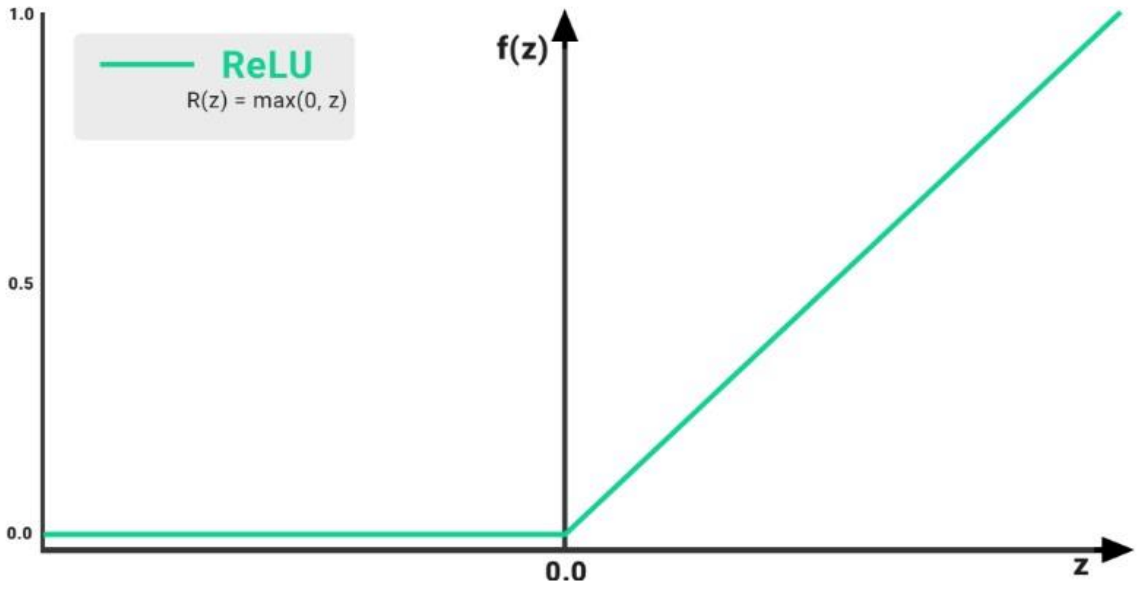


Fig 4.8 ReLU Graph

3. Pooling Layer:

The pooling layer simply reduces the dimensionality of the matrix, such as the 4*4 matrix converted to a 2*2 matrix by replacing the maximum value (or) Average value. Here the max pooling technique is used, Where the maximum of the submatrix is taken as the output.

4.3.3 Output Layer:

The softmax function is employed as the activation function in the output layer because it forecasts a multinomial probability distribution. This causes the input image to be classified as having an emotion.

4.4 Songs List Recommendation:

The List of songs is recommended based on the emotion got in the extraction and according to that list is recommended. The suggested music list should uplift or improve the user's mood.

- Emotion
- Searching from the Dataset
- Songs list as the output

Emotion: The user's mood should be lifted or improved by the recommended music list.

Songs List:

- Finally, the songs list is recommended for the user, to enhance their mood, for example if the user is angry then to relax him the relaxing songs list is recommended.
- And if the person is Neutral to Make him happy the happy songs will be recommended, in some situation the person may like to listen to the sad songs, so the person who is in the Neutral mood if they want to listen to the sad songs of their personalization a button will be given then he can click and can get that too. It will also applicable for the person who are in the happy mood.
- For the person who are in sad the model will recommend the happy mood to get out of the person from the sad mood.

5.IMPLEMENTATION:

5.1. Prerequisite:

5.1.1. Data Collecting:

This project uses Fer dataset that is available on the Kaggle platform. It is a free source. This dataset contains totally 7 classes for classifying the images into Happy, Fear, Disgust, Surprise, Sad, Anger, Neutral images. Moreover, there are 35,000 photos in all across 7 categories in the collection. And these are the names of the seven emotions:

0 indicates anger; 1 disgust; 2 fear; 3 happiness; 4 sadness; 5 surprise; and 6 neutrality.

5.2. Model Building:

For building the model object, it needs the images data. For that, the dataset contains 35,000 images which are already categorized based on the emotion class.

Also, for ease in building the model, all of the photographs are provided in grayscale. First, it needs to import all the required deep learning and other libraries like matplotlib, keras, numpy, pandas, seaborn etc.

Now the picture needs to resize to 48 x 48 dimension. As the pictures are in different sizes it is very difficult to build the model. So as a step of preprocessing mainly resize all the picturessize as 48 x 48. Moreover, the class data is coded as follows: 0 = Anger, 1 = Disgust, 2 = Fear, 3 = Glad, 4 = Sad, 5 = Surprise, and 6 = Neutral.

Now as a next step create the training and testing dataset with the help of the method ImageDataGenerator ().

Here during the model creation, there is no need of any cropping the images or changing the color of the images or any face detection or face extraction.

This is because our dataset contains all the images are of directly the faces of the various people and also the given images are of the grayscale. So, there is no need of any color conversions.

Now after the preprocessing and creating the training and testing datasets then directly move on to the convolutional neural networks.

This CNN is the main part of the entire model building

A neural network type called a convolutional neural network, or CNN or ConvNet, is particularly adept at processing input with a grid-like architecture, like an image. A binary representation of visual data is a digital picture. It is made up of a grid-like arrangement of pixels, each of which has a pixel value to indicate how bright and what colour it should be.

Simply said, CNN converts a picture into a lesser dimension while preserving its qualities by extracting its features.

There are five different layers in CNN:

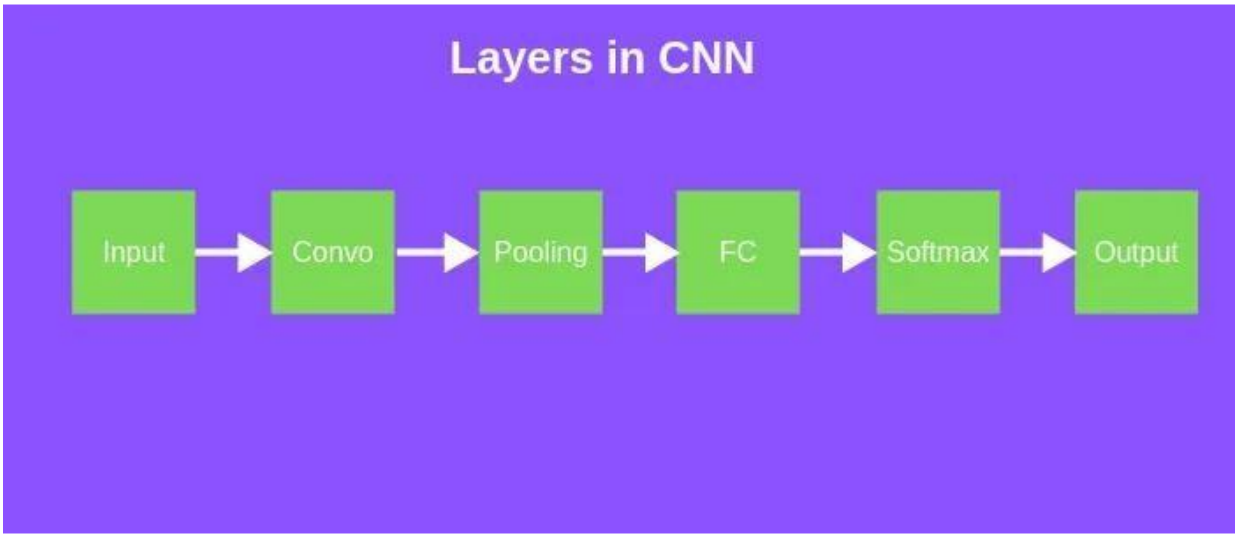


Fig 5.1 Layers in CNN model

5.2.1 Input layer :

Image data should be present in the input layer of CNN. A three-dimensional matrix is used to represent image data. It must be transformed into a single column.For example, if you have a picture that is 48 × 48, or 2304, you must convert it to 2304 x 1 beforeputting it into the input. During training with "m" samples, the dimension of the input will be (2304, m).

5.2.2 Hidden layer:

5.2.2.1 Convolution Layer:

Convo layer is also known as a feature extractor layer since it is where features from the picture are retrieved. Before computing the dot product between the receptive field and the filter, a portion of the picture is first linked to the Convo layer to execute the convolution operation. The operation produces a single integer representing the output volume. The filter isthen moved by a Stride across the following receptive field of the identical input image, and the process is repeated.

5.2.2.2 Pooling Layer:

After convolution, the spatial volume of the input picture is reduced using a pooling layer. Between two convolution layers, it is employed. The use of FC after the Convo layer without the use of pooling or maximum pooling will be computationally costly, which is something does not want in the model. Thus, the maximum pooling is the sole method for reducing the spatial volume of the input picture.

5.2.2.3 Fully connected Layer:

There are neurons, weights, and biases in a fully linked layer. Neurons in one layer are linked to neurons in another layer through this. It is employed to educate users to categorise photos into several categories.

- **Softmax / Logistic Layer:**

The final layer of CNN is called Softmax or Logistic layer. It is located at the bottom of FC layer. Softmax is used for multi-classification, whereas logistic is used for binary classification.

5.2.3 Output Layer:

At the very end, this output layer comprises a label that is one hot encoded, i.e., it produces target values that fall between 0 and 6. Already the model know that 0 means Anger and so on.This gives a complete description about the algorithm used. In this algorithm, the model mainly used ReLU as activation function.

Upon completion of model building, the accuracy of the model can be evaluated using the test set target values and the model-generated target values, which were obtained by inputting the test set as the input data. Various methods such as accuracy_score and F1 score can be used to determine the accuracy.

The model object is stored as "**model.h5**" for later use in the emotion detection phase, eliminating the need to repeatedly build the model object.

5.3 Image acquisition:

5.3.1 Frames detection and Frames selection:

Whenever a person is in front of the webcam it takes 9 frames / images of the person. Later only one frame is selected from these 9 frames and the frame is selected based on the clarity of the image, blurriness.

5.3.2 Feature extraction:

The input is an image in RGB colors, which is then converted to a grayscale image and resized to 48 x 48 x 1, where 1 represents grayscale.

Now for detecting the face in the image the file named "**haarcascade_frontalface_default.xml"**. This XML file contains all the information about detecting the face in an image.

After loading the file and providing the grayscaled image as input, the total number of detected faces is returned. If no faces are detected, the result will be "No face detected".

The co-ordinates of all the detected faces in the image are obtained. The face image is then extracted and used as input for the next phase, which is emotion detection.

5.4 Emotion detection:

The model object is applied to the grayscale face image that was previously received as input. The model returns a number between 0 and 6, which corresponds to an inferred emotion.

The numerical value is converted into an emotion label. This label is then passed as input to the next phase.

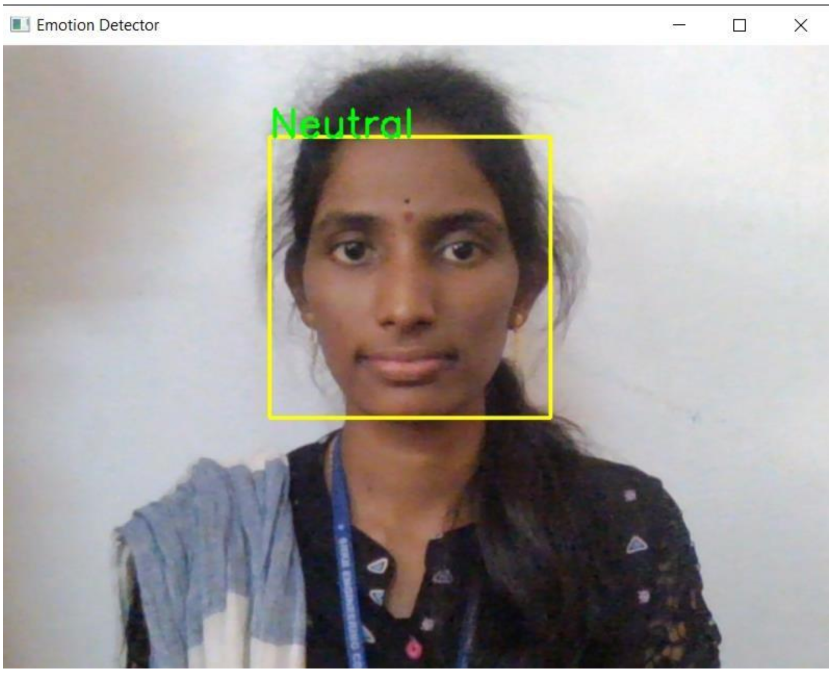


Fig 5.2 Emotion Detected - Neutral

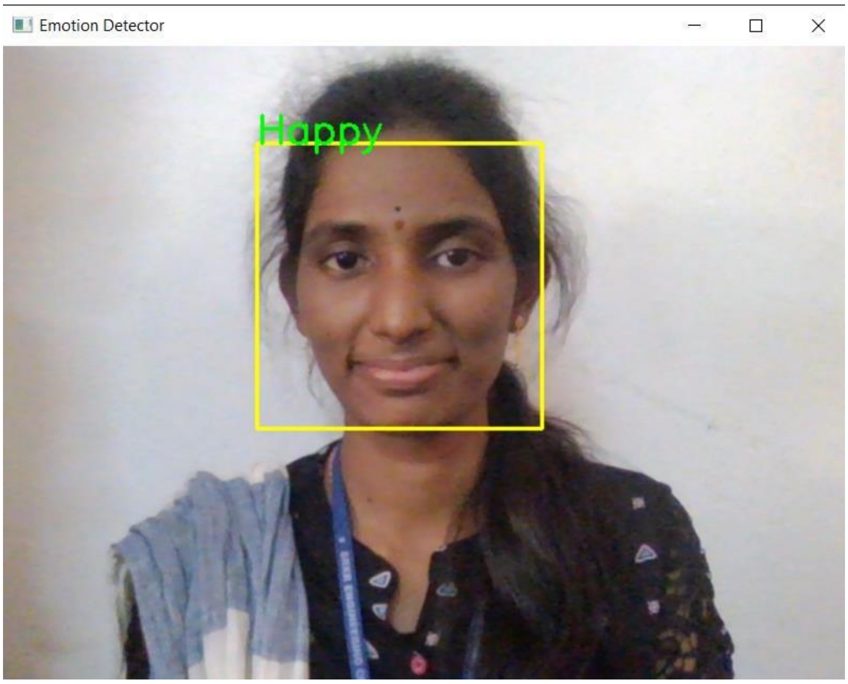


Fig 5.3 Emotion Detected - Happy

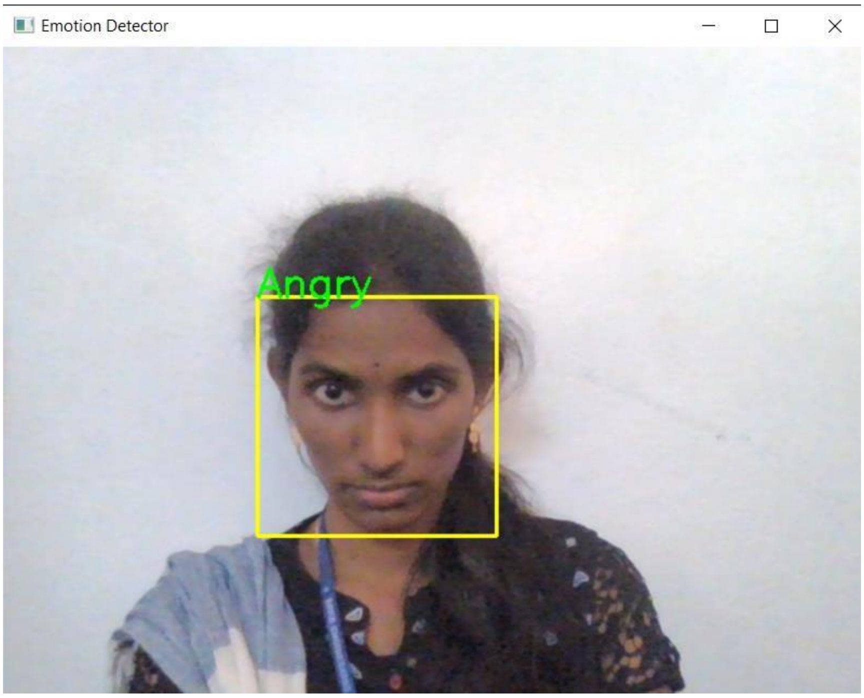


Fig 5.4 Emotion Detected - Angry

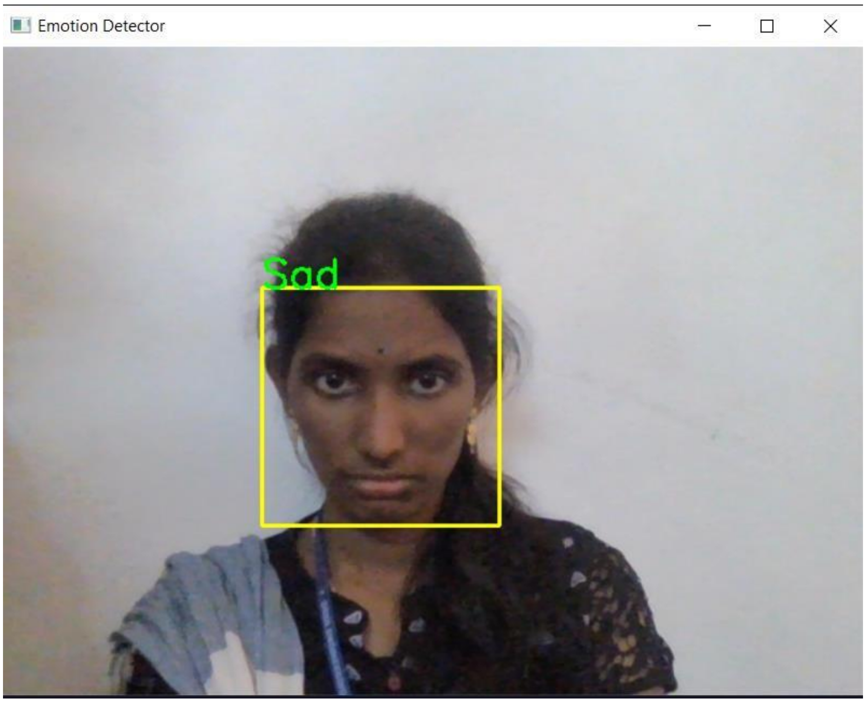


Fig 5.5 Emotion Detected - Sad

5.5 Songs list recommendation:

In this application, the user's favored features like Musician name, Language, and Artist (singer) are already saved at the time of signing in.

Now, when the emotion is given as an input, the application compares the emotion with the user's favorite specifications and then generates the output as a List of Songs.

Customized songs lists will be recommended for different emotions and favorite specifications. Additionally, there is a button available to select another emotion other than the one given as input.

The button enables the user to add more customization.

For **happy** or **surprise** emotions, it's recommended to listen to songs that improve the user's mood, such as happy and upbeat songs.

For **anger** or **disgust** emotions, it's suggested to listen to songs that help the user relax, such as calming and soothing songs.

For **sad** or **fearful** emotions, it's advised to listen to songs that can uplift the user's mood, such as happy and comforting songs.

For **neutral** emotions, it's recommended to listen to songs that can improve the user's mood, such as happy and uplifting songs.

Users' emotions are categorized into 7 classes based on the model training. However, for song recommendations, we group them into 4 categories: happy, sad, neutral, and anger. While these are considered primary or basic emotions, there are various other emotions that can fall within these categories or arise from them. For example:

Happy: Feelings such as enthusiasm, excitement, contentment, and love are among the various positive emotions that can stem from happiness.

Sad: In addition to sadness, emotions like grief, despair, disappointment, and loneliness can also be classified as negative emotions within this category.

Neutral: While emotions such as boredom, apathy, and calmness may not be inherently positive or negative, they can still be classified within the neutral category.

Anger: Negative emotions like frustration, irritation, resentment, and hostility are among the range of emotions that can stem from anger.

Fig 5.6 Songslist for the Happy Person

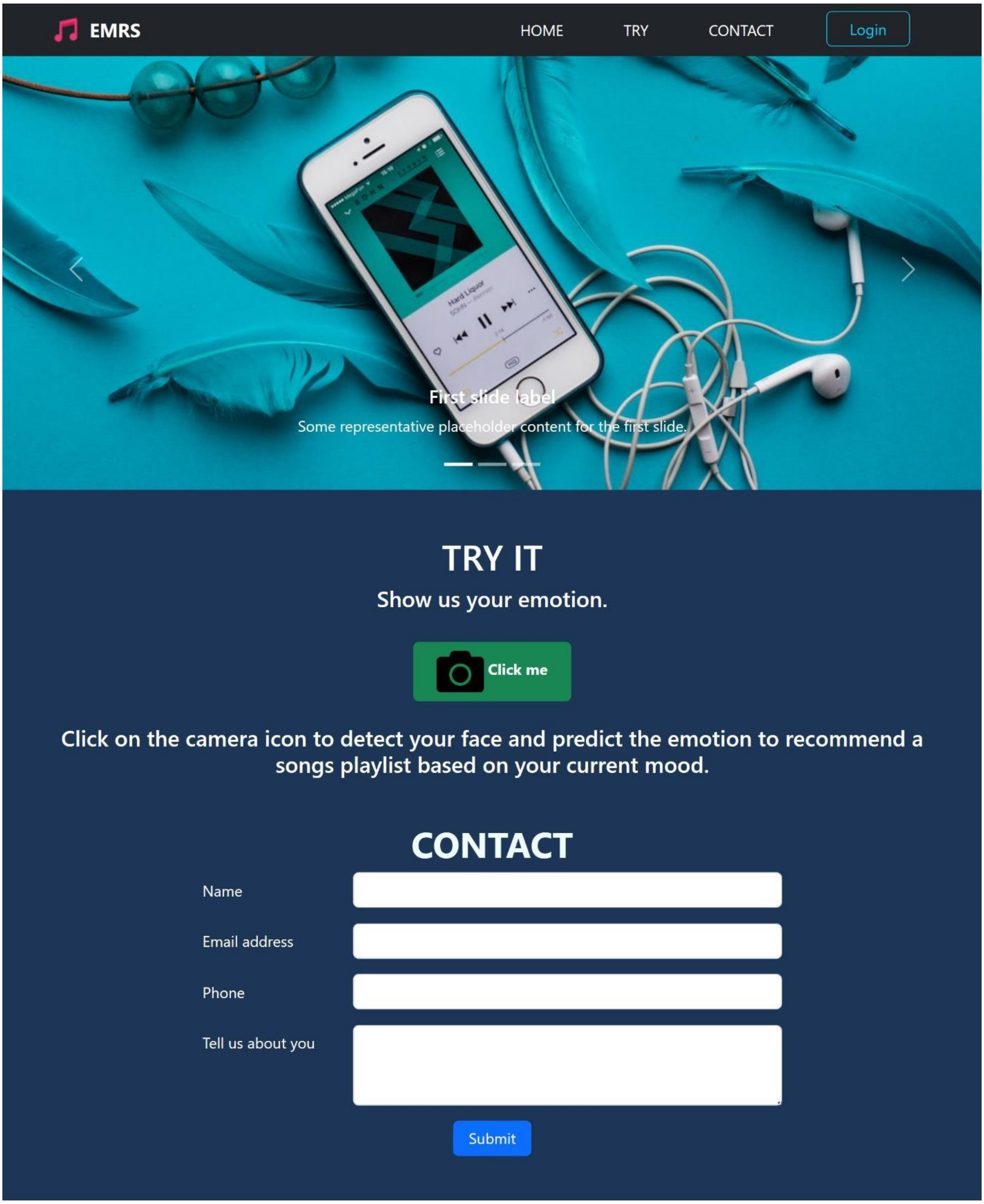


Fig 5.7 Home Page for new user

6.RESULT ANALYSIS:

The given system that utilizes machine learning techniques to recommend a playlist of songs to a user based on their detected emotions. The system uses a Convolutional Neural Network (CNN) algorithm to classify emotions detected from facial expressions. This means that the system can analyze a user's face and identify their current emotional state by using the trained model.

To capture the face, the system uses the Cascade Classifier, which is a algorithm that is used to detect objects in images. The classifier checks whether the input image satisfies the key features for a face and divides the image into integral parts. This allows the system to identify the face within the image and analyze it for emotions.

Once the face is identified, the system blurs the face image to remove irrelevant details and dimensions. The system then utilizes the CNN algorithm to train the data multiple times to increase accuracy and decrease loss. The CNN model used in the system has a dropout of 0.25, kernel of 3x3, and layers of 56, 128, 256, and 512. This means that the CNN model has multiple layers, each with different numbers of nodes, which are used to extract features from the input image and classify the emotions.

Model1 -	Droupout – 0.25
	Kernal – 3X3
	Layers - 56,128,256,512
	Epochs - 48
	Max Pool Filter – 2X2

Early stopping is also used in the system to monitor validation loss and stop training when the distance between validation loss and training loss increases significantly. This helps prevent overfitting of the model and ensures that the model is accurate and reliable.

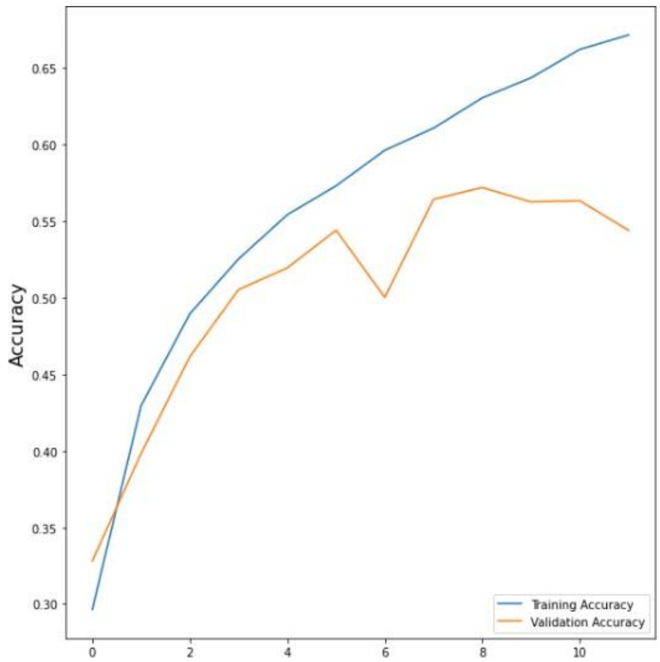


Fig 6.1 Accuracy Graph of model1

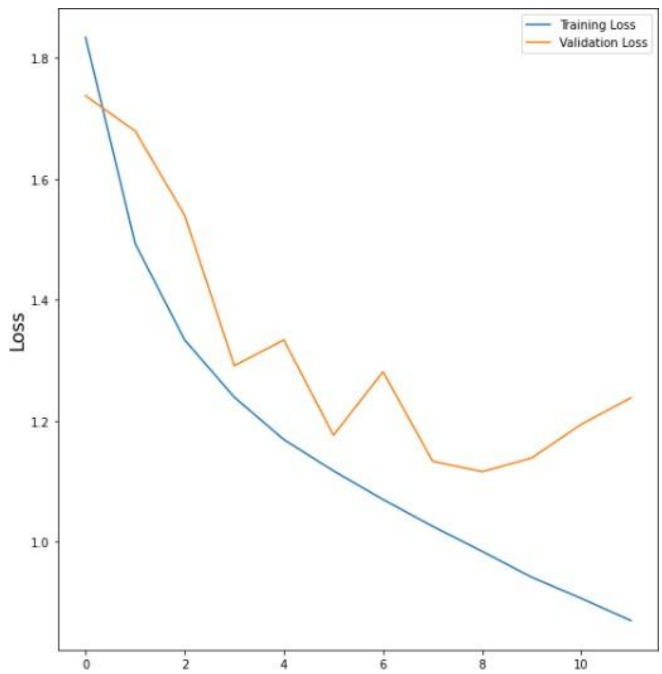


Fig 6.2 Loss Graph of model1

Model2 - Droupout – 0.25

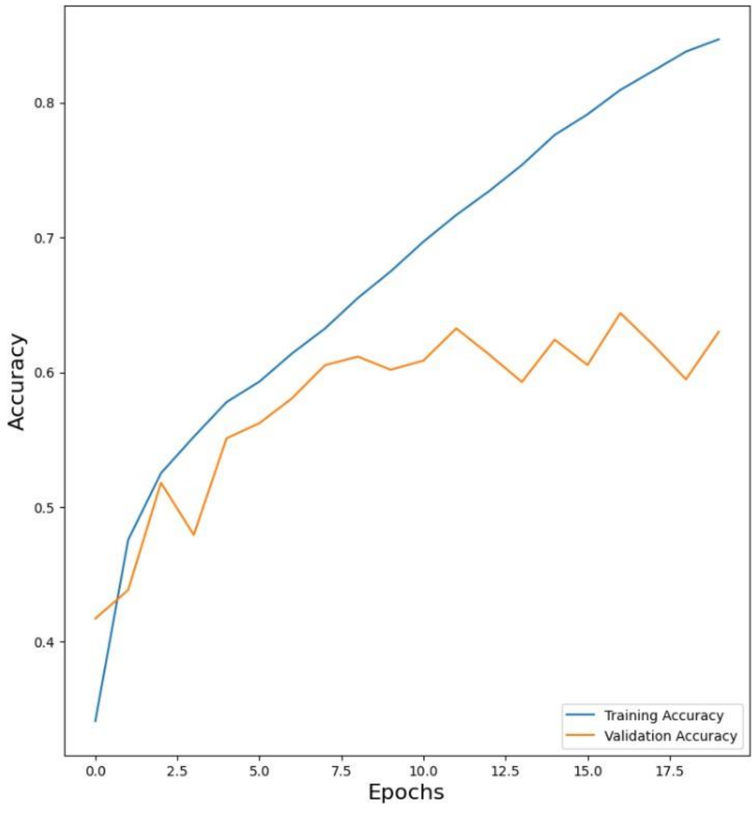
Kernal – 3X3

Layers - 56,128,256,512

Epochs - 48

Max Pool Filter – 2X2

The system doesn't utilize early stopping to monitor validation loss, and the model is trained until all epochs are finished. This approach improves the model's accuracy, as it continues to train the data until it's fully exhausted. As a result, the accuracy has been boosted from 65% to 84%.



6.3 Accuracy Graph of model 2

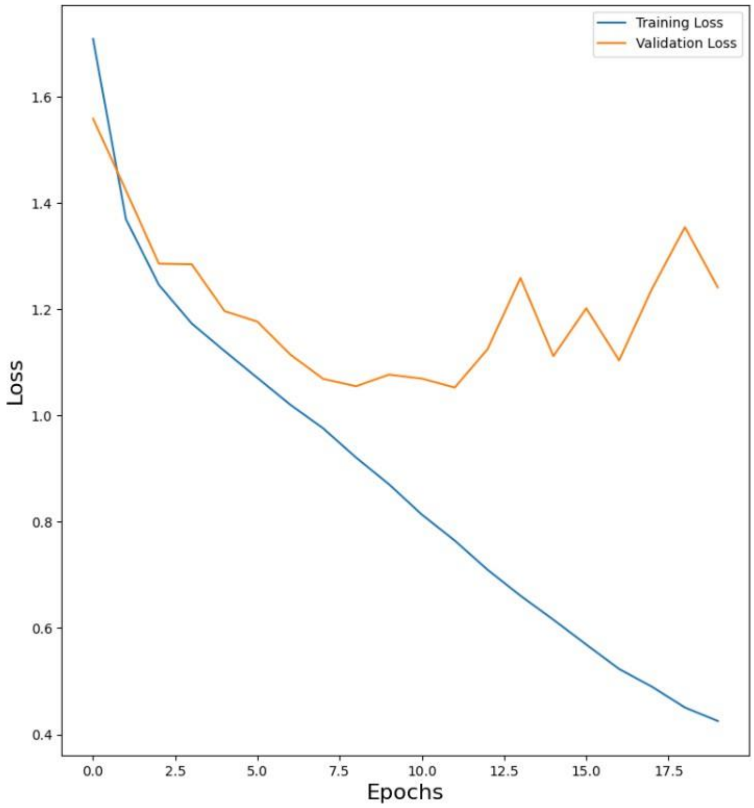


Fig 6.4 Loss Graph of model2

So, we used the model2 in our project building, and as the result the emotion is recognised.

Finally, once the emotion is detected from the model, the system recommends a playlist of songs to the user based on the detected emotion. The playlist is designed to help the user change their mood and improve their emotional state. Overall, the system utilizes machine learning techniques to provide personalized music recommendations based on a user's emotional state.

7.CONCLUSION:

The main objective of the proposed model is to provide real-time music recommendations based on the user's emotions. This is achieved through image processing, which captures the face and detects it using OpenCV, and converts it into matrix form. The model utilizes a CNN algorithm, which has shown excellent performance in analyzing emotions from image data. It is trained on a dataset of 35,000 labelled images, encompassing five distinct expressions: happy, sad, angry, neutral, and surprised. The proposed CNN model has achieved high accuracy, and it considers several parameters such as dropout (0.25), epochs (48), filters (64), and pooling (2) to recognize facial expressions using the Facial Expression Recognition dataset. The recommended playlist is tailored to the person's emotions and preferences, making it more personalized and valuable in managing stress and discomfort. This project fosters interactivity by requesting input parameters such as the preferred singer, language, and musician, ensuring a user-friendly and intuitive system. As it does not rely on APIs, there is no risk of reduced interaction or accuracy. In summary, this proposed model has been designed to provide a personalized and effective music recommendation system based on the user's emotions and preferences, making it an invaluable tool for stress management and promoting relaxation.

8.REFERENCES:

[1] S. K. Sana, G. Sruthi, D. Suresh, G. Rajesh, G. V. Subba Reddy (2022), "Facial emotion recognition-based music system using convolutional neural networks." *Materials Today: Proceedings*, Vol.62, No.7, pp. 4699-4706.

[2] Gayatri Pranita Prabhakar Sutar, Kashish Kumari, Ritesh Pandey, Laxmikant Malphedwar, Rajesh V. Kherde (May 2022), "A Preliminary report on Emotion based API Music Player.", *International Research Journal of Modernization in Engineering Technology and Science (IRJMETS)*, Vol.4, Issue 5, pp. 2716-2722.

[3] Aurobind V. Iyer, Viral Pasad, Smita R. Sankhe, Karan Prajapati (2017),"Emotion based mood enhancing music recommendation." *2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, pp. 1573-1577.

[4] Ayata Deger, Yusuf Yaslan, and Mustafa E. Kamasak (2018) "Emotion based music recommendation system using wearable physiological sensors." *IEEE transactions on consumer electronics* 64.2, pp. 196-203.

[5] Ankita Mahadik, Shambhavi Milgir, Janvi Patel, Vijaya Bharathi Jagan, Vaishali Kavathekar (2021), "Mood based Music Recommendation system." *International Journal of Engineering Research & Technology (IJERT)*, Vol 10, pp. 553-559.

[6] Kalsait, Dipika D. (February 2022) "Review Paper on Facial Expression Based Music Recommendation System.", *International Research Journal of Modernization in Engineering Technology and Science (IRJMETS)*, pages: 188-192.

[7] M. Sheshan Perera, Sulochana Rupa Singhe (2021), “Music Recommendation System based on Emotions in User’s Social Media behavior.” *TechRxiv*, doi : https://doi.org/10.36227/techrxiv.14493828.v1.

[8] S. Vindhya, K. Randri (2021), “Emotion-based music recommendation system using a deep-reinforcement learning approach”, *Analytics Vidhya*, doi : https://doi.org/10.48550/arXiv.2205.03459.

[9] Varsha Verma, Ninad Marathe, Parth Sanghavi, Prashant Nitnaware (2021), "Music Recommendation System Using Machine Learning", *International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT) Vol 7 Issue 6,* pp. 80-88.

[10] Rozhevskii, Danila, Jie Zhu, and Boyuan Zhao. (2022) "Psychologically-Inspired Music Recommendation System." *arXiv preprint arXiv:2205.03459*, https://medium.com/analytics-vidhya/emotion-based-music-recommendation-system-using-a-deep-reinforcement-learning-approach-6d23a24d3044

[11] P. V. Kothawale, Alfiya Samirahmad Kazi, Aakanksha Popat Patil, Samruddhi Prashant Patil, Mahima Mahavir Choudhary (2022), "Music Recommendation System Using Facial Emotion", *International Journal of Research Publication and Reviews,* Vol 3, no 7, pp 19-22.

[12] Afzal Mukhtar, Hritika Rahul Mehta, Abirami S., Sukeerthi Adi, Dr. Kamatchi Priya L. (2022), "Mood Based Music Recommendation for a Mall using Real-time Image", *Journal of Positive School Psychology* Vol. 6, No. 3, pp 2975–2981.

[13] Shashikumar G Totad, Spoorthi N Patil, Geeta R. Bharamagoudar (2022), "Emotion Based Music Classification", *Journal of Next Generation Technology,* Vol 2, No. 1, pp 22-29.

APPENDIX

SAMPLE CODE

```
import matplotlib.pyplot as plt

import numpy as np

import pandas as pd

import seaborn as sns

import os

# Importing Deep Learning Libraries

from keras.preprocessing.image import load_img, img_to_array

from keras.preprocessing.image import ImageDataGenerator

from keras.layers import
Dense,Input,Dropout,GlobalAveragePooling2D,Flatten,Conv2D,BatchNormalization,Activatio
n,MaxPooling2D

from keras.models import Model,Sequential

from tensorflow.keras.optimizers import Adam,SGD, RMSprop

from keras.optimizers import gradient_descent_v2

#Data preparation

picturesize = 48

folderpath = "../input/face-expression-recognition-dataset/images/"

batchsize  = 32

# Training of the model

train = ImageDataGenerator()

val = ImageDataGenerator()

trainset = train.flow_from_directory(folderpath+"train",

                                     target_size = (picturesize,picturesize),

                                     color_mode = "grayscale",

                                     batch_size=batch_size,

                                     class_mode='categorical',
```

```
                                        shuffle=True)
testset = val.flow_from_directory(folderpath+"validation",
                                        target_size = (picturesize,picturesize),
                                        color_mode = "grayscale",
                                        batch_size=batch_size,
                                        class_mode='categorical',
                                        shuffle=False)
from tensorflow.keras.optimizers import Adam,SGD,RMSprop
noofclasses = 7
model = Sequential()

#1st CNN layer
model.add(Conv2D(64,(3,3),padding = 'same',input_shape = (48,48,1)))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size = (2,2)))
model.add(Dropout(0.25))

#2nd CNN layer
model.add(Conv2D(128,(5,5),padding = 'same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size = (2,2)))
model.add(Dropout (0.25))

#3rd CNN layer
model.add(Conv2D(512,(3,3),padding = 'same'))
model.add(BatchNormalization())
```

```
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size = (2,2)))
model.add(Dropout (0.25))

#4th CNN layer
model.add(Conv2D(512,(3,3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())

#Fully connected 1st layer
model.add(Dense(256))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(Dropout(0.25))

# Fully connected layer 2nd layer
model.add(Dense(512))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(Dropout(0.25))
model.add(Dense(no_of_classes, activation='softmax'))

optim = Adam(lr = 0.0001)
model.compile(optimizer=opt,loss='categorical_crossentropy', metrics=['accuracy'])
model.summary()
```

```
from tensorflow.keras.optimizers import RMSprop,SGD,Adam

from keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLROnPlateau


checkpoint = ModelCheckpoint("./model.h5", monitor='val_accuracy', verbose=1, save_best_only=True, mode='max')

epochs = 48

model.compile(loss='categorical_crossentropy',

        optimizer = Adam(lr=0.001),

        metrics=['accuracy'])

history = model.fit(trainset,

                steps_per_epoch=trainset.n//trainset.batchsize,

                epochs=epochs,

                validation_data = testset,

                validation_steps = testset.n//testset.batchsize )

# Ploting the graph

plt.figure(figsize=(20,10))

plt.subplot(1, 2, 1)

plt.suptitle('Optimizer : Adam', fontsize=10)

plt.ylabel('Loss', fontsize=16)

plt.plot(history.history['loss'], label='Training Loss')

plt.plot(history.history['val_loss'], label='Validation Loss')

plt.legend(loc='upper right')

plt.subplot(1, 2, 2)

plt.ylabel('Accuracy', fontsize=16)

plt.plot(history.history['accuracy'], label='Training Accuracy')

plt.plot(history.history['val_accuracy'], label='Validation Accuracy')

plt.legend(loc='lower right')

plt.show()
```

#Using of the model

from keras.models import load_modelfrom time

import sleep

from tensorflow.keras.preprocessing.image import img_to_arrayfrom

keras.preprocessing import image

import cv2

import numpy as npimport time

import statistics

faceclassifier = cv2.CascadeClassifier(r'C:\Users\NagaSwapnaDasari\Desktop\Project\Emotion_Detection_CNN-main\haarcascade_frontalface_default.xml')

classifier =load_model(r'C:\Users\NagaSwapnaDasari\Desktop\Project\Emotion_Detection_CNN-main\modelh5.h5')

labels = ['Angry','Disgust','Fear','Happy','Neutral', 'Sad', 'Surprise']capturing =

cv2.VideoCapture(0)

resultlist = []i=0

```
while i<50:

    _, frame = capturing.read()labelslist =

    []

    gray = cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)faces =

    faceclassifier.detectMultiScale(gray)

    for (x,y,w,h) in faces:

        cv2.rectangle(frame,(x,y),(x+w,y+h),(0,255,255),2)rgray =

        gray[y:y+h,x:x+w]

        rgray = cv2.resize(roi_gray,(48,48),interpolation=cv2.INTER_AREA)

        if np.sum([roi_gray])!=0:
            r = rgray.astype('float')/255.0r =

            img_to_array(r)
```

```
        r = np.expand_dims(r,axis=0) prediction =
        classifier.predict(roi)[0]
        labellist=labels[prediction.argmax()]
        resultlist.append(prediction.argmax())
        label_position = (x,y)

cv2.putText(frame,label,label_position,cv2.FONT_HERSHEY_SIMPLEX,1,(0,255,0),2)else:
        cv2.putText(frame,'No Faces',(30,80),cv2.FONT_HERSHEY_SIMPLEX,1,(0,255,0),2)
  cv2.imshow('Emotion Detector',frame)if
  cv2.waitKey(1) & 0xFF == ord('q'):
     breaki+=1


capturing.release()
cv2.destroyAllWindows()
```

23A01-2

ORIGINALITY REPORT

11%
SIMILARITY INDEX

PRIMARY SOURCES

1	www.jetir.org Internet	93 words — 1%
2	Deger Ayata, Yusuf Yaslan, Mustafa E.Kamasak. "Emotion Based Music Recommendation System Using Wearable Physiological Sensors", IEEE Transactions on Consumer Electronics, 2018 Crossref	58 words — 1%
3	Ram Krishn Mishra, Siddhaling Urolagin, J. Angel Arul Jothi, Pramod Gaur. "Deep hybrid learning for facial expression binary classifications and predictions", Image and Vision Computing, 2022 Crossref	58 words — 1%
4	machinelearning.conferenceseries.com Internet	41 words — 1%
5	github.com Internet	35 words — < 1%
6	hugoalbertotrujillomartinez.medium.com Internet	35 words — < 1%
7	developer.spotify.com Internet	32 words — < 1%

8	Lokesh Sai Kumar Dasari, Farooq Baig, Donepudi Jaswanth Sai, Govada Kevin Michael, Asileti Laxman, A Madhuri. "CNN based Mood Detection using Facial Expression", 2023 5th International Conference on Smart Systems and Inventive Technology (ICSSIT), 2023 Crossref	31 words — < 1%
9	medium.com Internet	27 words — < 1%
10	www.cameralyze.co Internet	25 words — < 1%
11	www.geeksforgeeks.org Internet	24 words — < 1%
12	Harsh Vardhan Guleria, Ali Mazhar Luqmani, Harsh Devendra Kothari, Priyanshu Phukan et al. "Enhancing the Breast Histopathology Image Analysis for Cancer Detection Using Variational Autoencoder", International Journal of Environmental Research and Public Health, 2023 Crossref	23 words — < 1%
13	link.springer.com Internet	19 words — < 1%
14	Bhawana Sati, Sameer Kumar, Karan Rana, Kuhil Saikia, Subrata Sahana, Sanjoy Das. "An Intelligent Virtual System using Machine Learning", 2022 IEEE IAS Global Conference on Emerging Technologies (GlobConET), 2022 Crossref	18 words — < 1%
15	Dongho Kang, Young-Jin Cha. "Autonomous UAVs for Structural Health Monitoring Using Deep	18 words — < 1%

Learning and an Ultrasonic Beacon System with Geo-Tagging",
Computer-Aided Civil and Infrastructure Engineering, 2018
Crossref

16 Byeong-jun Han. "Music emotion classification and context-based music recommendation", Multimedia Tools and Applications, 08/05/2009 — 17 words — < 1%
Crossref

17 iacis.org — 17 words — < 1%
Internet

18 "Computational Advancement in Communication, Circuits and Systems", Springer Science and Business Media LLC, 2022 — 16 words — < 1%
Crossref

19 "Artificial Neural Networks and Machine Learning – ICANN 2018", Springer Science and Business Media LLC, 2018 — 15 words — < 1%
Crossref

20 programs.wiki — 14 words — < 1%
Internet

21 isciia2020.bit.edu.cn — 13 words — < 1%
Internet

22 rc.library.uta.edu — 13 words — < 1%
Internet

23 www.jchps.com — 13 words — < 1%
Internet

24 André Teixeira Lopes, Edilson de Aguiar, Alberto F. De Souza, Thiago Oliveira-Santos. "Facial expression recognition with Convolutional Neural Networks: Coping with few data and the training sample order", Pattern — 12 words — < 1%

Recognition, 2017
Crossref

25 P. Sharath, G. Senthil Kumar, Boj K.S. Vishnu. "Music Recommendation System Using Facial Emotions", Trans Tech Publications, Ltd., 2023 — 12 words — < 1%
Crossref

26 Rajat Shenoy, Deepak Yadav, Harshita Lakhotiya, Jignesh Sisodia. "An Intelligent Framework for Crime Prediction Using Behavioural Tracking and Motion Analysis", 2022 International Conference on Emerging Smart Computing and Informatics (ESCI), 2022 — 12 words — < 1%
Crossref

27 www.researchgate.net — 10 words — < 1%
Internet

28 docslib.org — 9 words — < 1%
Internet

29 gssrr.org — 9 words — < 1%
Internet

30 www.coursehero.com — 9 words — < 1%
Internet

31 Aasim Raheel, Muhammad Majid, Majdi Alnowami, Syed Muhammad Anwar. "Physiological Sensors Based Emotion Recognition While Experiencing Tactile Enhanced Multimedia", Sensors, 2020 — 8 words — < 1%
Crossref

32 Ankita Gandhi, Kinjal Adhvaryu, Soujanya Poria, Erik Cambria, Amir Hussain. "Multimodal Sentiment Analysis: A Systematic review of History, Datasets, — 8 words — < 1%

Multimodal Fusion Methods, Applications, Challenges and Future Directions", Information Fusion, 2022
Crossref

33	S. G. Swingler. "Identification of multiple partial discharge sources", 2008 International Conference on Condition Monitoring and Diagnosis, 04/2008 Crossref	8 words — < 1%
34	ipfs.io Internet	8 words — < 1%
35	www.ijert.org Internet	8 words — < 1%
36	Saurav Joshi, Tanuj Jain, Nidhi Nair. "Emotion Based Music Recommendation System Using LSTM - CNN Architecture", 2021 12th International Conference on Computing Communication and Networking Technologies (ICCCNT), 2021 Crossref	6 words — < 1%
37	publications.polymtl.ca Internet	6 words — < 1%

EXCLUDE QUOTES	OFF	EXCLUDE SOURCES	OFF
EXCLUDE BIBLIOGRAPHY	OFF	EXCLUDE MATCHES	OFF