MUSIC RECOMMENDATION USING EMOTION DETECTION

A MINI PROJECT REPORT

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Under the guidance of

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to the APJ Abdul Kalam Technological University
in partial fulfillment of the requirements for the award of the Degree of

Bachelor of Technology
in
Computer Science and Engineering

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July 2022

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CERTIFICATE

*Certified that Mini Project work entitled "**Music Recommendation using Emotion detection**" is a bonafide work done by **Jithin Mathew (RET19CS107), Joanne juneie (RET19CS108), John Jais (RET19CS111), Joshna Ann Salu (RET19CS115)** of Sixth semester in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science and Engineering of the APJ Abdul Kalam Technological University during the academic year 2021-2022.*

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Place : Kakkanad

Date : 02/08/2022

ACKNOWLEDGEMENT

We are extremely honored to thank Prof. (Dr). P.S. Sreejith, Principal, RSET who has always made sure that our ladder to success was leaning against the right wall. We thank him for his constant help and support. We thank Dr. Dhanya P M, HoD, Department of Computer Science & Engineering, RSET whose help and guidance has been a major factor in completing our journey.

We express our gratitude to our Project Coordinator and Class-In-Charge, Ms. Sangeetha Jamal, Asst. Professor, Dept. of Computer Science & Engineering for her/his support and timely help whenever it was required. She has been a great mentor without whom this would have been incomplete.

We extend our sincere and heartfelt thanks to our guide Mr. Uday Babu P, Asst. Professor, Dept. of Computer Science & Engineering, RSET for taking the time and effort to review our work and providing valuable advice and feedback from time to time. Last but not the least we would like to express our heartfelt and sincere gratitude to our family and friends for their constant support throughout this entire journey.

Jithin Mathew, Joanne Juneie, John Jais, Joshna Ann Salu

ABSTRACT

Our project, Music recommendation using emotion detection, was to develop a music recommendation system using emotion detection to help users find better playlists that suits their mood. The simple working of our project is as given. A picture of the user showing an emotion is given as input. The face is detected to recognize the emotion. According to the emotion extracted from the input picture, the related playlist is displayed. The emotions that will be recognized will be happy and sad. The two emotions, happy and sad, have a separate playlist. Datasets were downloaded from Kaggle initially, images were also added manually for precise accuracy. From the given playlist the user will select a song. The song selected will be played using a music player. The project was built with Python in Visual Studio Code.

CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

GUI	Graphical User Interface
CNN	Convolutional Neural Network
SVM	Support-Vector Machines
HAAR	Huntsville Area Association Of Realtors.

CHAPTER 1

INTRODUCTION

1.1 General Background

The aim of this project is to to develop a music recommendation system using emotion recognition. The algorithm used for emotion recognition is the Viola Jones Algorithm which can quickly and accurately detect objects in images and works particularly well with the human face.The Viola-Jones Object Detection Framework combines the concepts of Haar-like Features, Integral Images, the AdaBoost Algorithm, and the Cascade Classifier to create a system for object detection that is fast and accurate.

1.2 Objective

The primary objective for this project is to create a music recommendation system without the user having to search for songs based on his/her mood. The system captures an image of the user, detects the current emotion of the user using the Viola Jones algorithm and then displays a playlist based on that emotion, making it easier for the user to just play songs according to his/her mood. A Graphical User Interface has been developed for users to interact with the system effortlessly.

1.3 Motivation

Music is an essential part of our lives and it helps to raise someone's mood, get them excited or calm him/her down. Playing the right music according to the person's mood is integral, and this is where our project comes in. We have developed a system that detects the current emotion of the user and recommends a playlist for them according to his/her mood. Hence the user can save the time he/she would spend searching for songs that would fit his/her mood.

1.4 Summary of Report

This report briefly describes the development of our project "Music Recommendation Using Emotion Detection". Chapter 1 is the introduction and it provides a short description of the project. Chapter 2 deals with the Literature Survey. Different approaches were taken into consideration and the best among them was chosen. Chapter 3 deals with the Proposed Methods that have been used to develop the project. Chapter 4 contains the Results and Discussion of the project, the output of the system can be seen here. Chapter 5 deals with the Conclusion and Future Scope of the project and it summarizes the work we have done in developing the system. Reference contains all the papers that have been referenced in order to develop the system. Appendix A contains the base paper used for implementing the project. Appendix B includes the code of the working system. Appendix C consists of mapping of the project objectives with POs and PSOs.

Chapter 2

LITERATURE SURVEY

2.1 A STUDY ON HUMAN DETECTION SYSTEM

Ahambhavi Bhardwaj; Ashutosh Dixit; Kshitij Yadav; Gokul Rajan V; 2021; [2]

Convolution Neural Network CNN was used for classification of images. This paper deals with finding the emotion by dissecting the face of a person into eyes and lips to analyze the expression. A person's facial expressions can easily be divided into seven basic senses: happiness, sadness, surprise, fear, anger, disgust, and neutrality. The facial expressions are expressed by activating certain sets of facial muscles.

With facial expressions, the effects that content and services wear on the users can be measured in a simple and low-cost process. The common processes of facial recognition include: Data Collection, Pre-processing,Feature extraction. The Four components Facial emotion detection system are the following:

- Detecting key landmarks on face
- Extraction of facial features and textures
- Separation of facial action
- Modeling of emotional expression

Difficulty in making emotion available in different languages. There are limitations with different types and versions of the software such as dataset input is only textual data, pattern, video and audio inputs are invalid.

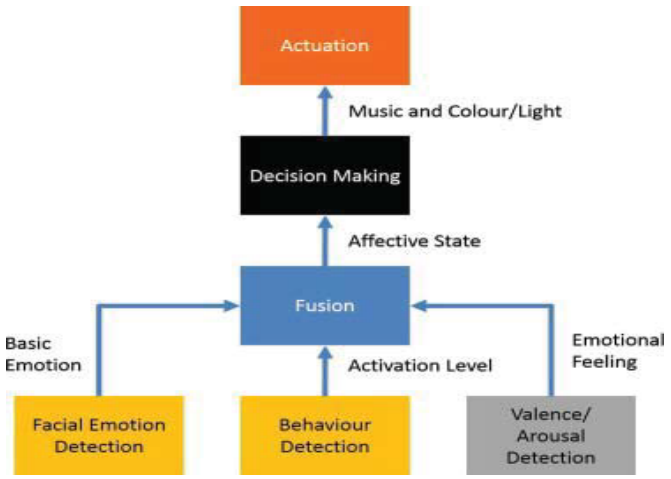


Fig 2.1.1 Architecture of emotion detection system

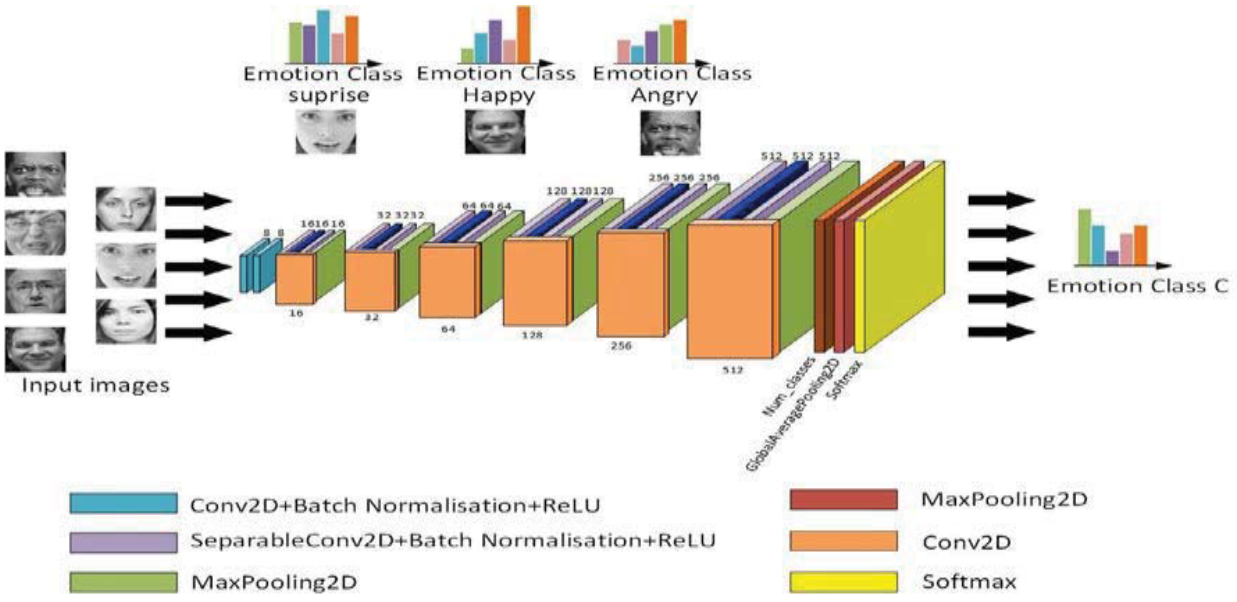


Fig 2.1.2 Basic Structure of the CNN

2.2 MUSIC RECOMMENDER SYSTEM FOR USERS BASED ON EMOTION DETECTION THROUGH FACIAL FEATURES

Aurobind V. Iyer; Viral Pasad; Smita R. Sankhe; Karan Prajapati; 2019; [1]

2.2.1. FACIAL EMOTION DETECTION TECHNIQUES

Facial emotions are considered as the most important factor in people's communication which enable us to perceive other people's intentions. The primary steps in any fundamental face recognition system consist of three steps: first, the face is detected, then face features extracted and represented as vectors, finally, the face is recognized. There are many models for deep learning, but the Convolutional Neural Network (CNN) is the most widely used model in the face recognition field. They conclude that CNN can successfully learn facial features and detect facial emotions in an improved manner.

2.2.2. STUDIES ON FACIAL EXPRESSION RECOGNITION

Recently, there has been considerable interest from the commercial sector, especially the retail sector, in using the technology of facial expression recognition to measure the satisfaction of its customers.

The CNN model was able to identify the emotions into three types: positive, negative, and natural. While happiness will be recognized as a positive emotion, and anger, disgust, sadness, and contempt classified as negative emotions.

2.2.3. MUSIC AND THEIR EFFECT ON THE MOOD

Since the main concern in the proposed system centered around detecting the user's emotions and improving their moods by music, we are going to deal with four types of emotions or moods, and we have to choose four types of music that best suit it.

It has been proven that Classical music can reduce anxiety and depression in short-term effectively, while, new age music that is characterized by loud music, and fast tempo, this type of music increases relaxation and decreases tension. On the opposite side, listening to Grunge Rock increases the negative emotions and decrease positive ones.

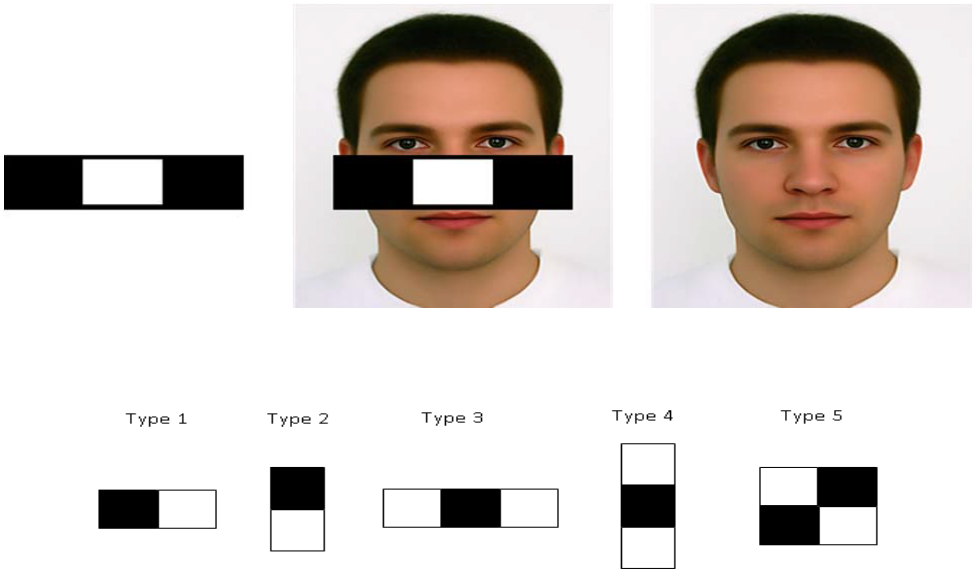


Fig 2.2.1 Haar Feature

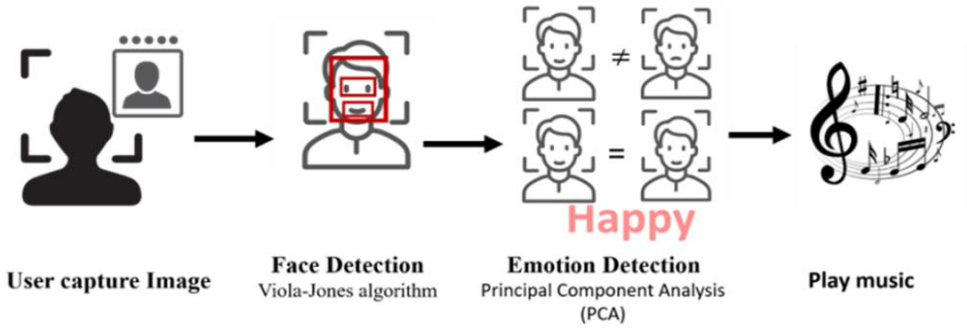


Fig 2.2.2 The proposed System Architecture

2.3 EMOTION BASED MOOD ENHANCING MUSIC RECOMMENDATION

Charvi Jain; Kshitij Sawant; Mohammed Rehman; Rajesh Kumar; 2018; [3]

Emotion of the user can be easily guessed by looking at his face. For this purpose of face detection and emotion recognition, studying the features from his face is necessary. The problems associated with face detection include background elements, lighting conditions, pose and facial expression.

Face detection is an image processing technology that is used in many applications that detects human faces from digital images. Face detection is considered as a special case of object detection.

Methods to do detect frontal human faces are the following:

- Canny Edge Detection
- Viola Jones Algorithm

Emotion recognition methods are the following:

- Eigenface method
- Fisherfaces method

The project captures an image of the user using the camera of his device to detect face from this image. The application will then identify the emotion from the face detected. Based on the emotion recognized, it will send the emotion to the music server and will fetch a suitable playlist.

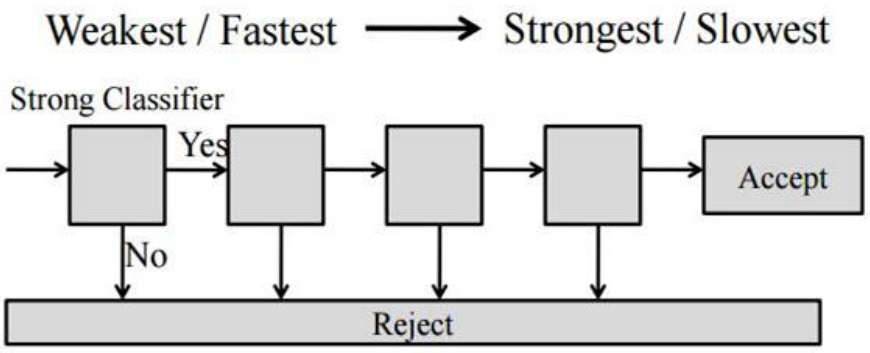


Fig 2.3.1 Cascading Classifiers

2.4. EMOTION DETECTION AND CHARACTERIZATION USING FACIAL FEATURES

Ahlam Alrihail; Alaa Alsaedi; Kholood Albalawi; Liyakathunisa Syed; 2017; [4]

This paper aims to detect faces from any given image, extract facial features (eyes and lips) and classify them into 6 emotions (happy, fear, anger, disgust, neutral, sadness). The training data is passed through a series of filters and processes and is eventually characterized through a Support Vector Machine(SVM), refined using Grid Search. The testing data then tests the data and their labels and gives the accuracy of classification of the testing data in a classification report. For face detection and feature extraction Viola Jones Algorithm was used. For classifying into emotions following methods were used:

- Fisherface Classifier
- Support Vector Machine
- Gabor Filter
- Discrete Wavelet Transform(DWT)
- Histogram Of Gradients (HOG)

With the help of these algorithms and filters they were able to detect and extract the features of human faces and classify them into 6 emotions (happy, fear, anger, disgust, neutral, sadness).

Fig 2.4.1 Input face image and predicted result "happy"

2.5 EMOSIC - AN EMOTION BASED MUSIC PLAYER FOR ANDROID

Karthik Subramanian Nathan; Manasi Arun; Megala S Kannan; 2017; [5]

This paper proposes an efficient and accurate model of an app that would generate a playlist based on the current emotional state and behavior of the user. This proposed system is based on real-time extraction of facial expressions as well as extracting audio features from songs to classify into a specific emotion that will generate a playlist automatically such that the computation cost is relatively low.

2.5.1. FACIAL EMOTION ANALYSIS

A picture is uploaded and its face rectangle is computed using the Viola Jones algorithm that uses a HAAR filter to obtain the Internal image with coordinate points of our facial features. These coordinates are used to classify the emotion depicted in the image using an SVM classifier. Based on the results of the classifier each emotion tag is assigned a score and the tag with the maximum score is returned as the emotion of the user.

2.5.2. SONG EMOTION ANALYSIS TECHNIQUES

- Feature Extraction
  - Short and Mid-Term Analysis.
  - Tempo Analysis
- Regression
- Valence Arousal Plane

The app EMOSIC was developed and since both facial and song emotion are computed the results obtained are much better than other music players that only analyze facial emotions and keep a fixed song dataset.

Chapter 3

PROPOSED METHOD

3.1 Problem definition

To create a software to detect the face and extract the image of the user. The software should display a music playlist for the emotion detected. The user is allowed to select the song of his/her choice.

3.2 Scope of the work

The software is coded to detect the emotion of the user and displays the corresponding playlist. The input given is a live picture of the user of which the trained model detects the face and extracts the emotion from the picture. The output is the music app which displays the playlist for the detected emotion and the user is free to select whatever song he likes. The GUI is done in kivy and the music app is done in tkinter. The project was completed in a three month span.

3.3 Methodology

3.3.1 Viola Jones Algorithm

Viola-Jones is quite powerful and its application has proven to be exceptionally notable in real-time face detection.Viola-Jones was designed for frontal faces, so it is able to detect frontal the best, rather than faces looking sideways, upwards or downwards. Before detecting a face, the image is converted into grayscale, since it is easier to work with and there's less data to process. The Viola-Jones algorithm first detects the face on the grayscale image and then finds the location on the colored image.Viola-Jones outlines a box and searches for a face within the box. It is essentially searching for these haar-like features, which are scalable, rectangular frames that are used to compare how pixels relate to each other; specifically how dark one is to the other. We use Integral Images because Haar-like features are actually rectangular, and the integral image process allows us to find a feature within an image very easily as we already know the sum value of a particular square and to find the difference between two rectangles in the regular image, we just need to subtract two squares in the integral image.The algorithm shrinks the image to 24 x 24 and

looks for the trained features within the image. It needs a lot of facial image data to be able to see features in the different and varying forms. That's why we need to supply lots of facial image data to the algorithm so it can be trained. The algorithm learns from the images we supply it and is able to determine the false positives and true negatives in the data, allowing it to be more accurate. We would get a highly accurate model once we have looked at all possible positions and combinations of those features.The AdaBoost (Adaptive Boosting) Algorithm is a machine learning algorithm for selecting the best subset of features among all available features. The output of the algorithm is a classifier called a *"Strong Classifier"*. A Strong Classifier is made up of a linear combination of *"Weak Classifiers"* (best features).A Cascade Classifier is a multi-stage classifier that can perform detection quickly and accurately. Each stage consists of a strong classifier produced by the AdaBoost Algorithm. From one stage to another, the number of weak classifiers in a strong classifier increases. It is one of the fastest and most accurate algorithms for face detection and has served as the foundation for face recognition.

3.3.2 Selection of data

Two sets of data have been used for the creation and testing of software. Datasets are used for training the model to detect the face and to identify if the emotion is happy or sad and for the music playlist. The data set for training is taken from Kaggle and manually added. The data set for the music playlist has been manually added according to happy and sad.

3.3.3 Training of Model

The model used for the face detection and emotion recognition is the HAAR classifier.

It is an Object Detection algorithm used to identify faces in an image or a real time video. The algorithm uses edge or line detection features. HAAR cascade in OpenCV was selected as the model as they are very fast at computing the HAAR like features due to the use of integral images. Given an image(this algorithm works on grayscale images), the algorithm looks at many smaller subregions and tries to find a face by looking for specific features in each subregion. It needs to check many different positions and scales because an image can contain many faces of various sizes. Viola and Jones used Haar-like features to detect faces in this algorithm.

The Viola Jones algorithm has four main steps, which we shall discuss in the sections to follow:

1. Selecting Haar-like features
2. Creating an integral image
3. Running AdaBoost training
4. Creating classifier cascades

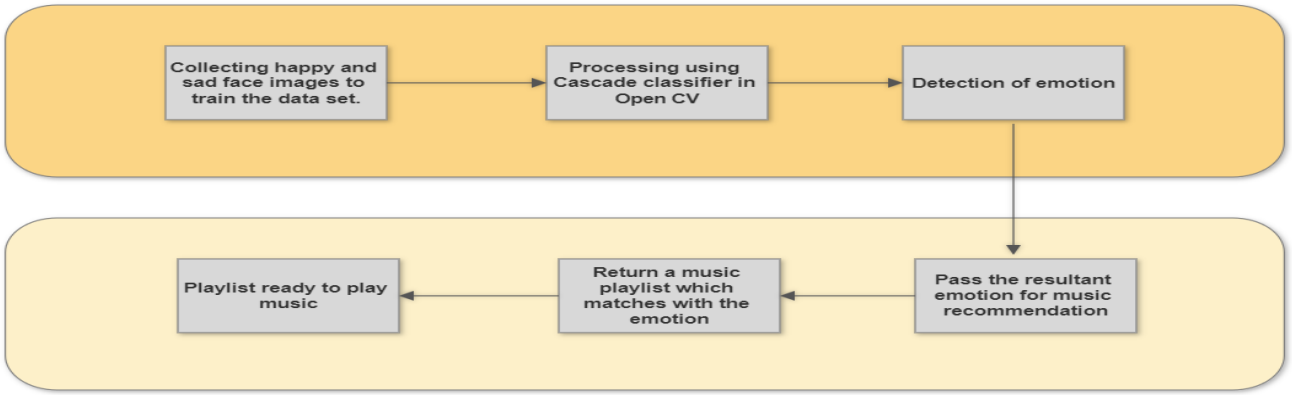
3.3.4 Facial Recognition and Emotion Detection

The data set taken from Kaggle did not have the expected pixels for the model training. Hence the option of manually entering the data set. The pictures selected should have the faces and their emotion visible for the model to train. Haar-like features are digital image features used in object recognition. All human faces share some universal properties of the human face like the eyes region is darker than its neighbor pixels, and the nose region is brighter than the eye region. A simple way to find out which region is lighter or darker is to sum up the pixel values of both regions and compare them. The sum of pixel values in the darker region will be smaller than the sum of pixels in the lighter region. If one side is lighter than the other, it may be an edge of an eyebrow or sometimes the middle portion may be shinier than the surrounding boxes, which can be interpreted as a nose This can be accomplished using Haar-like features and with the help of them, we can interpret the different parts of a face.

3.3.5 Evaluation

The emotion was detected accurately using the droid camera. The extracted emotion is displayed to the user for confirmation and the music playlist corresponding to the emotion is also displayed accurately. the user can quit or continue further after closing the music playlist window.

3.4 System Architecture



3.4.1 Architecture diagram

3.5 Design of the system

3.5.1 Front end Design

The front end of the project was developed with Kivy 2.1.0. Kivy is a graphical user interface open source Python library that allows developers to develop multi-platform applications on Windows, macOS, Android, iOS, Linux, and Raspberry-Pi. In addition to the regular mouse and keyboard inputs, it also supports multitouch events. The applications made using Kivy will be similar across all the platforms but it also means that the applications' feel or look will differ from any native application.

The logo page is displayed initially along with the button to capture the image. The captured emotion is displayed with a show emotion button. The emotion detected is displayed along with the button to play music, the user may play his/her choice of music.

3.5.2 Back End Design

The back end of the project was developed in Python 3.10 language in Visual Studio Code. An image is captured real-time which is then inspected to check if it's a human face. After detecting the human face, the emotion is detected using facial features which include eyes, lips to detect the emotion. The detected emotion is passed into the result file.The recognition.py file detects the emotion and stores the emotion detected in a file result.txt.

The result file is read to accept and display the emotion detected in the previous component. The string in the result file is given as input to the music player to display the respective music playlist which is then played by the user.

3.5.3 Overall Design

The logo page is displayed initially along with the button to capture the image. The captured emotion is displayed with a show emotion button.An image is captured real-time which is then inspected to check if it's a human face. After detecting the human face, the emotion is detected using facial features which include eyes, lips to detect the emotion. The detected emotion is passed into the result file.The recognition.py file detects the emotion and stores the emotion detected in a file result.txt. The result file is read to accept and display the emotion detected in the previous component. The string in the result file is given as input to the music player. The emotion detected is displayed along with the button to play music, the user may play his/her choice of music.

3.6 Module Division

3.6.1 Dataset Collection and Organization

The dataset for the project were images which were taken from Kaggle, as the images were not pixelated as per requirement, images were added into the dataset manually. Happy and sad emotion images were collected with the purpose of the Emotion detection system. These images were used to successfully train the model.

3.6.2 Dataset Preprocessing

The images used for training the model were first converted to grayscale inorder as it less data to work with.The Viola-Jones algorithm first detects the face on the grayscale image and then finds the location on the colored image. Viola-Jones outlines a box (as you can see on the right) and searches for a face within the box. The algorithm shrinks the image to 24 x 24 and looks for the trained features within the image.A lot of facial image data to be able to see features in the different and varying forms.

3.6.3 Model

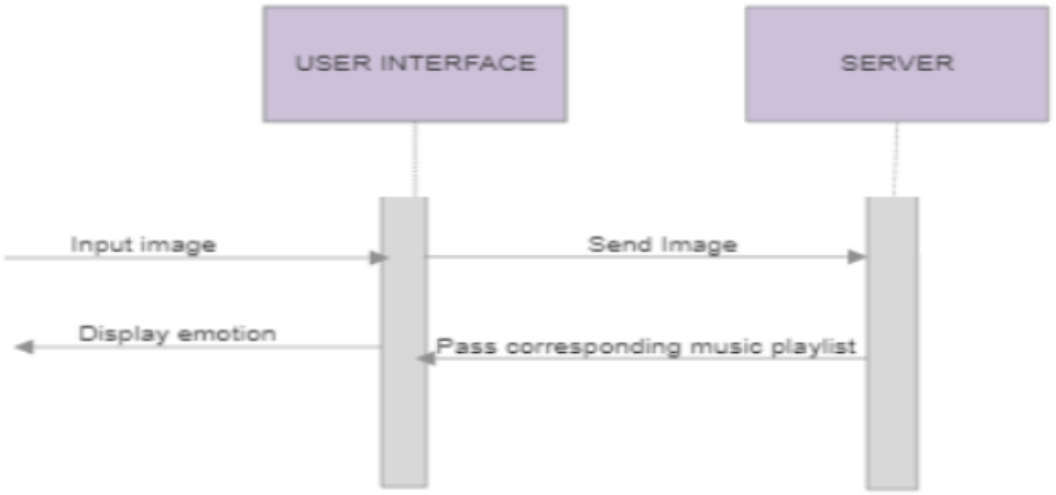
The model used for the face detection and emotion recognition is the HAAR classifier. It is an Object Detection algorithm used to identify faces in an image or a real time video. The algorithm uses edge or line detection features. The model has an accuracy 95%. HAAR cascade in OpenCV was selected as the model as they are very fast at computing the HAAR like features due to the use of integral images.

3.6.4 Evaluation

The emotion detection system is perceived to be slower in firing the camera window. The result obtained from the project is less accurate on using the laptop’s webcam due to less pixelated image but great accuracy on using phone camera. The emotions were detected correctly and the correct playlists were displayed.

3.6.5 System design

The user first gives an image as input, the server checks if it's a valid input input(here checks if it is a human face). The corresponding music playlist along with the emotion predicted is displayed to the user.



3.6.5.1 Sequence Diagram

3.7 Algorithms

3.7.1 PHASE - 1 :

Detection of emotion and development of Music player.

In the first phase of the project the facial recognition and emotion detection was completed using Viola Jones algorithm. The user interface for Music player was developed using tkinter GUI toolkit for Python.

3.7.2 PHASE - 2 :

In the second phase of the project, the music player was updated to display the respective playlist(depending on the 2 emotions).

3.7.3 PHASE – 3 :

In the third phase of the project, the music player was linked with the emotion detection system. The emotion detected from the emotion detection system was written into a text file result which was then read by the music player to display the respective playlist.

3.7.4 PHASE - 4 :

In the final phase of the project the GUI for the project was developed. The GUI was build with Kivy, a graphical user interface open source Python library.

3.8 Implementation

The project was implemented to display music playlist by detecting the emotion from the face of the user. Initially the music player and emotion detection system were built separately. Later on they were linked together in such a manner that the output ,which is the emotion detected, from the emotion detection system was given as input to the music player to play the corresponding music.

3.8.1 Software Utilized

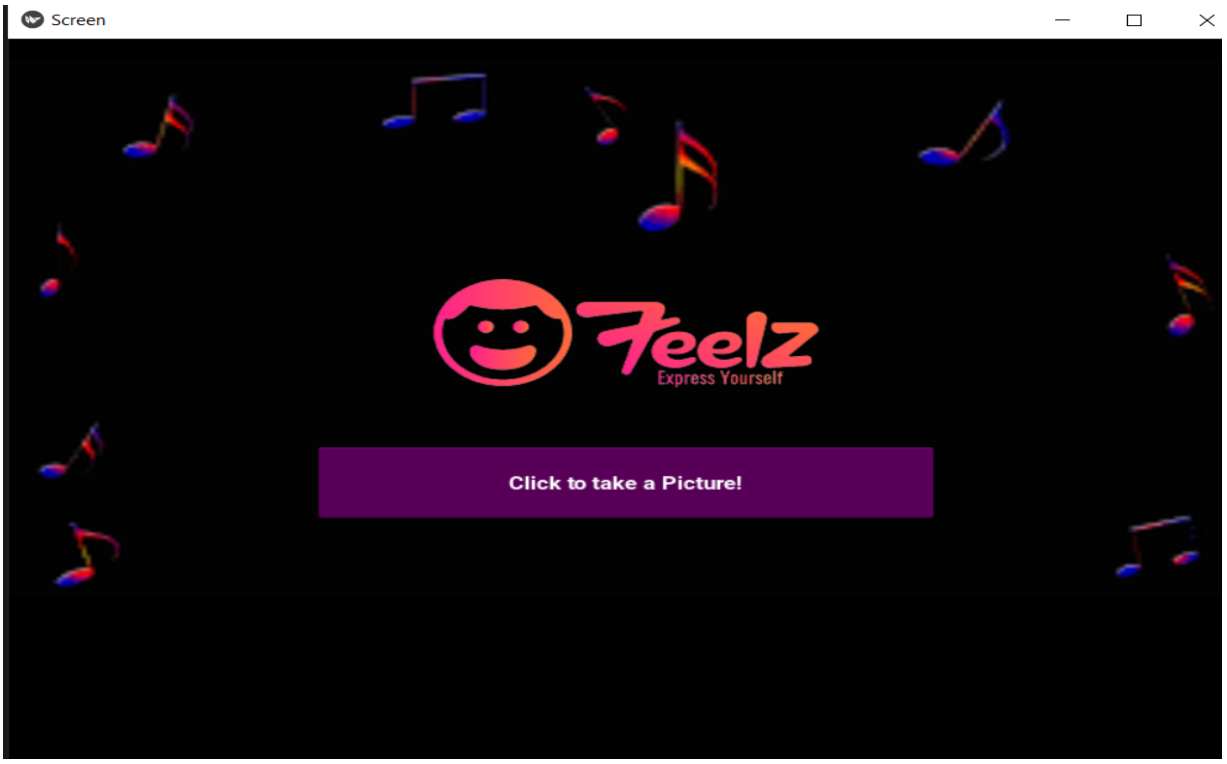
Software utilized in building our project are Visual Studio Code, Python 3.10 and Kivy 2.1.0.

3.8.2 User interaction with web application

The user interacts with the system with the help of GUI, Kivy. The user is taken to the first page from there on pressing the capture image button, and is taken to a camera window. The captured image is displayed on the screen. The user presses the button, shows emotion, to see the result. On clicking the play button, the music player is fired. The user presses the emotion button to play the playlist.

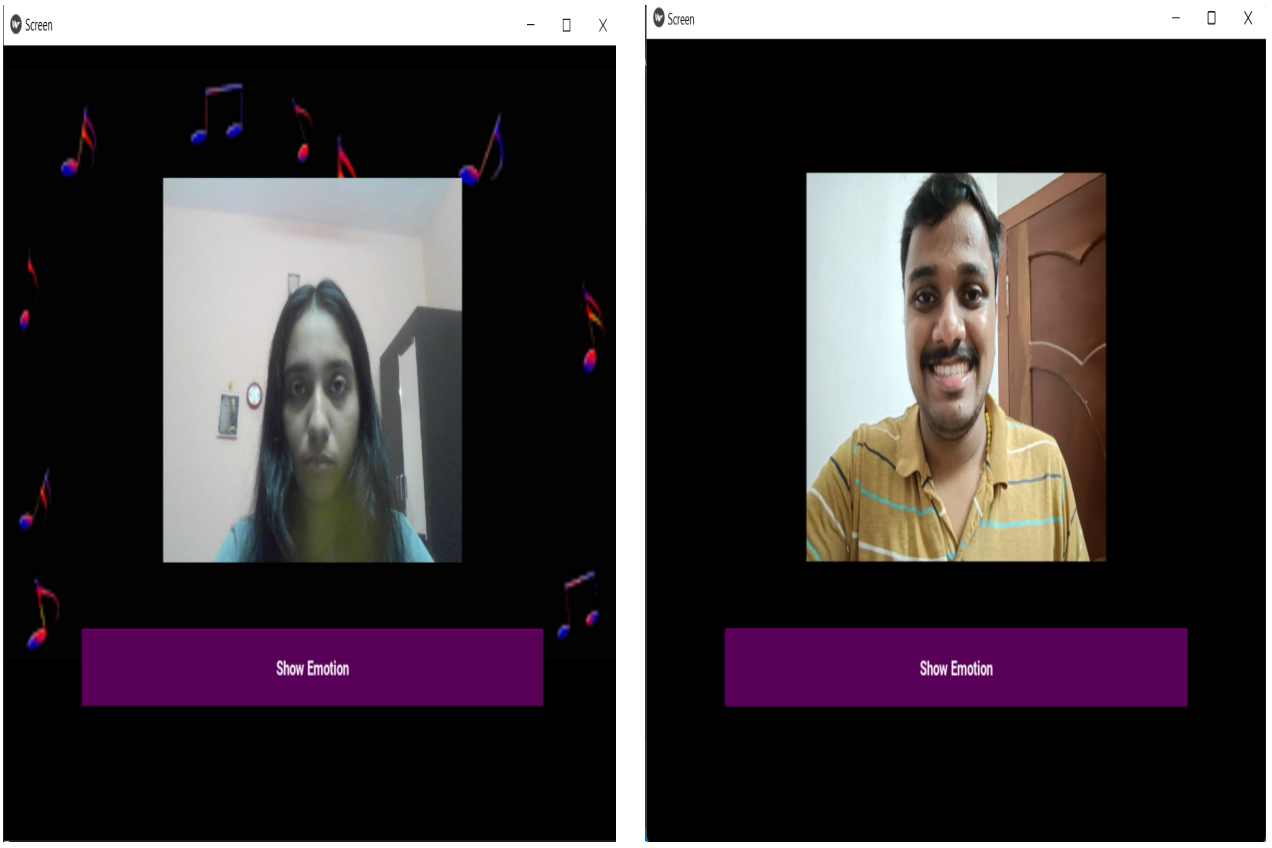
CHAPTER 4

RESULT AND DISCUSSIONS



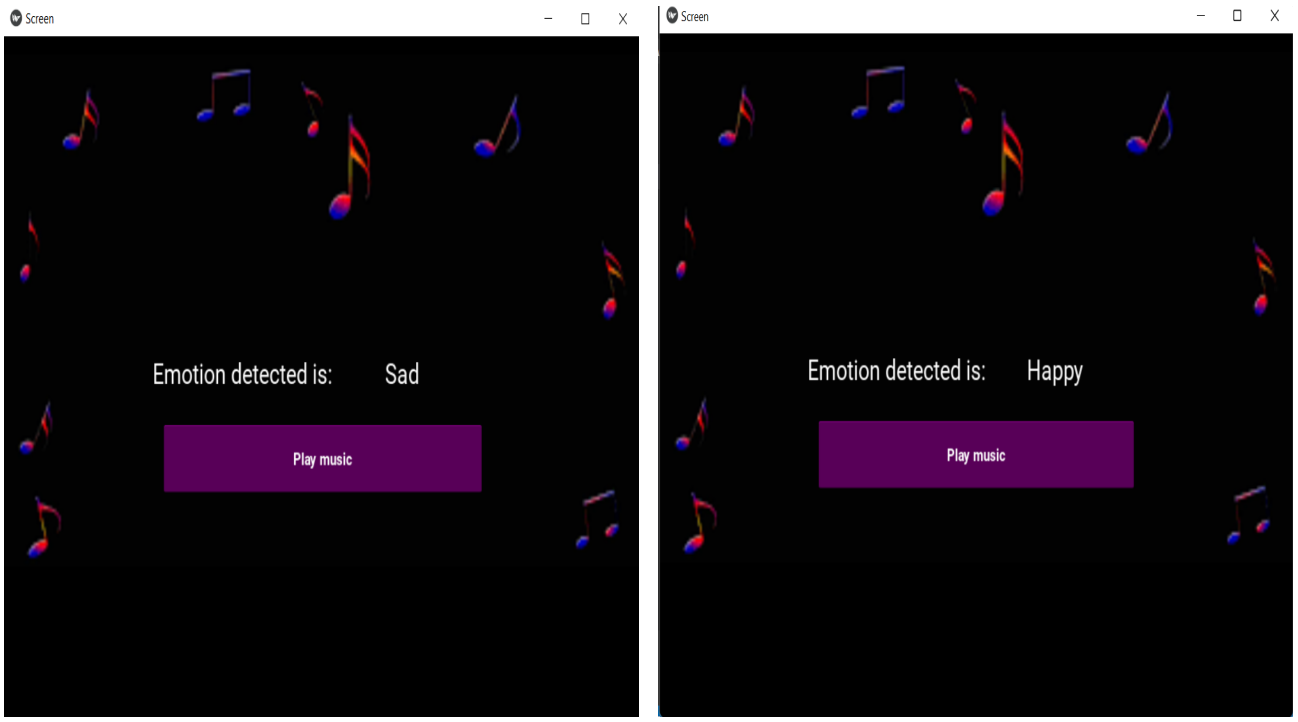
4.1 Home Page

The opening screen shows the application name and the button that allows the user to click the picture. On the button click, a window pops up to take the live picture of the user. The window quit Q is clicked. The Camera used here should have high pixels and clarity for the image. After taking the picture, the user is directly taken to the next screen to show the image take. The next screen shows the image captured by the application. It also shows a button asking if the user wants to see the emotion detected. On the button press, the user is taken to another screen showing the emotion that has been detected by the application.

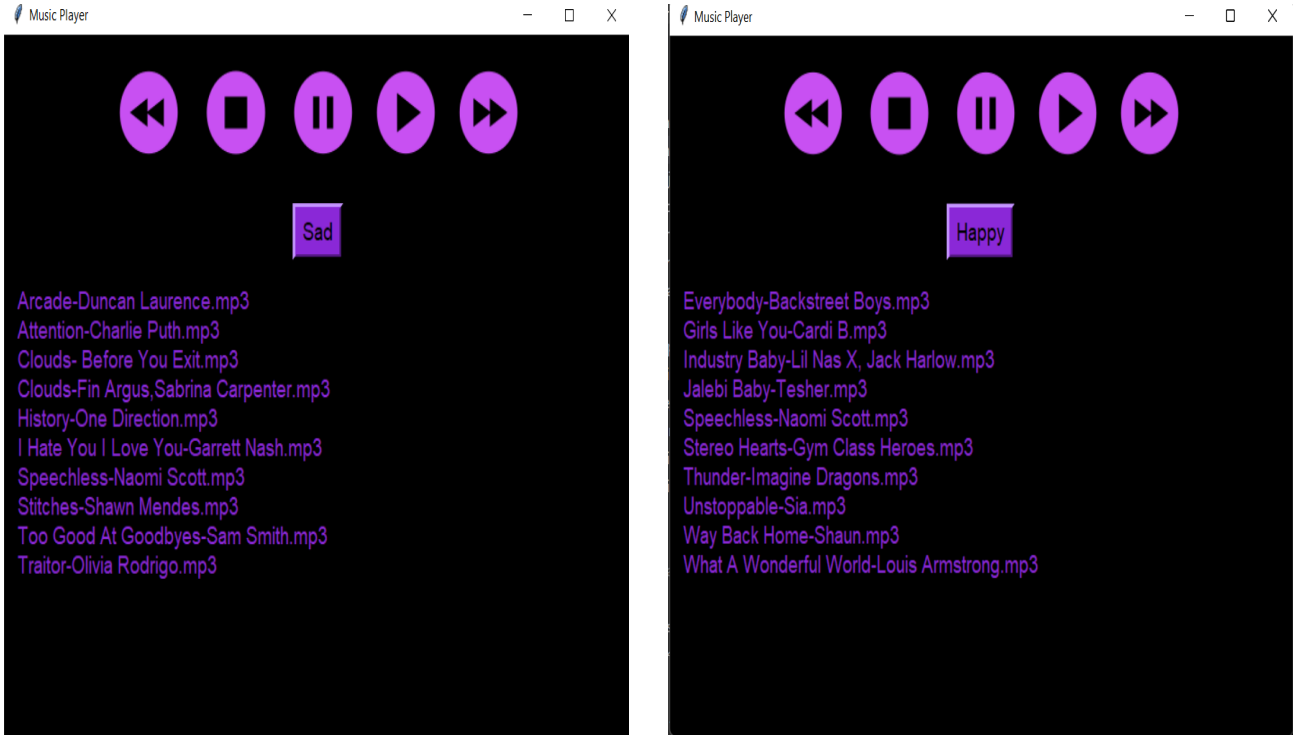


4.2 Image Display

On the same window a button is present asking the user if they want to show the music app. In the second screen in the above picture, on the left side is the image captured for the sad emotion and on the right side is the image captured for the happy emotion. Displays the picture so that the user can verify the images and decide to take retakes. The next screen has the emotion displayed and the user is asked if they want to play the music. The emotion can be cross checked by the user and proceed to play music. The music app window is a pop screen. it has the buttons for play, pause, stop and to change the music. There is also a listbox that shows the list of songs for each emotion. The user is allowed to select a song of their choice and listen to it. The next screen is to quit the application.



4.3 Emotion Display



4.4 Music App

Chapter 5

CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

The Music Recommendation using Emotion Detection system is a research based project work that has been implemented through various phases as has been enumerated throughout the report. The understanding of the Viola Jones algorithm and its implementation in the project has been made possible by thorough theoretical study. The proper functioning of different modules were made possible by the continuous effort of the team. The system has been developed in a way that is efficient and accurate. The GUI of the program has been developed in such a way that it is aesthetically pleasing to the user and is easy to understand and use for people of every demographic.

5.2 SCOPE OF FUTURE WORK

The proposed system currently identifies the two emotions - Happy and Sad. In the future, the system can be modified to identify more emotions like Anger, Fear, Neutral, Surprise and so on. This can be implemented by adding the appropriate dataset of images and by training the model to detect these emotions. The music playlists can also be modified to contain more songs of each type of emotion, providing the user with a variety of songs to choose from.

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https://www.kaggle.com/datasets/ananthu017/emotion-detection-fer .

APPENDIX A

IEEE PAPER

2019 Developments in eSystems Engineering (DeSE)

Music Recommender System for users based on Emotion Detection through Facial Features

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***Abstract*— In recent years, facial emotion detection received massive attention because of its applications in computer vision and human-computer interaction fields. Due to the active works in this field, various algorithms and applications were proposed and implemented. In this research, we propose a recommender system for emotion recognition that is capable of detecting the user emotions and suggest a list of appropriate songs that can improve his mood. A brief search was conducted on how music can affect the user mood in short-term to gain knowledge and enable us to provide the users with a list of music tracks that work well on improving the user moods. The proposed system detects the emotions, if the subject has a negative emotion then specific playlist will be presented that contains the most suitable types of music that will improve his mood. On the other hand, if the detected emotion is positive, a suitable playlist will be provided which includes different types of music that will enhance the positive emotions. Implementation of the proposed recommender system is performed using Viola-Jonze algorithm and Principal Component Analysis (PCA) techniques, we were able to implement the proposed system successfully in MATLAB(R2018a).**

Keywords—*Emotion Detection, Principal Component Analysis, Recommender System , Viola-Jonze.*

I. INTRODUCTION

Communicating between individuals is a major aspect of everyday life. It conveys accurate details and millions of information among humans, whether in the form of words, tone or expression. The expression provided by the face and body is the best means to understand people in communication. In particular, the facial expression is one of the basic elements of human communication and can be considered a form of nonverbal communication [1]. Facial expressions refer to a movement of one or more facial muscles or skin. The aim of these movements is to express the facial emotions of an individual such as happy, sad, natural and surprised.

Figure 1. Face detection

Face detection and emotion detection are two separate concepts that are considered are given high significance in recent research fields like digital image processing, pattern recognition communities, and computer vision. Face detection is defined as the process that is composed of two steps: first, finding faces in a picture or video and does not care if the face refers to a person or not. Then, it draws a surround box of every face in the image in any expression, orientation, facial pose, illumination, and occlusions, shown in figure 1. Emotion detection is considered as one of the facial expressions and is the main process for identifying emotions of human's face.

Nowadays, emotion detection is considered as one of the most important techniques that are used in many applications such as smart card application, surveillance, image database investigation, criminal, video indexing, civilian applications, security and adaptive human-computer interface with multimedia environments [2]. Moreover, emotion detection provides more reliable and inexpensive way to know the opinions of customers about their products. In the past, most enterprise and shops rely on using traditional marketing methods such as advertising, sale points, satisfaction surveys, and price etc. These methods may be useful in some cases, but it is expensive, consumes a lot of time and are potentially unreliable.

Hence, the main objective of this paper is to implement a system that is able to detect user emotions, which can be happy, sad, natural or surprised. Then after the emotion is determined the proposed system will provide the user with a music playlist that contains music clips of certain music types which improve the user's mood. For example, if the user expression is classified as happy then the most suitable playlist will be enabled which is the classical music playlist to choose from various music clips. For the system implementation, we mainly depend on Viola-Jonze Algorithm and PCA to detect the user emotions.

The rest of the paper is organized as follows: section II presents the preliminaries. Literature review is presented in section III. Section IV presents the description of the proposed system. Results and discussion are presented in section V. Finally we conclude the paper in section VI.

978-1-7281-3021-7/19/$31.00 ©2019 IEEE
DOI 10.1109/DeSE.2019.00188

II. PRELIMINARIES

A. Viola-Jones algorithm

This algorithm was proposed by Paul Viola and Michael Jones in 2001 [3]. It is a Robust, fast and real-time object detection and used to detect different kinds of objects but it was highly motivated in use on detection of facial features like the mouth, eyes, face, and nose. The algorithm mainly depends on using the haar features selection filters. The haar feature selection filters means all human faces share a group of similar properties, for example, the human nose is brighter than the eye and eyes appear darker than the upper cheeks. Also, the place and dimension of the nose, eyes, and mouth similar in all human beings for example in figure 2, Haar feature show the same bridge of nose. Haar features differ in height and width based on the sum of the black and white pixel as shown in figure 3. The Haar features are able to detect different parts of the face such as the cheeks, nose, and eyes etc. The adaboost feature is used to remove unwanted features. Hence, based on Haar features and Adaboost feature face can be detected and resized on the standard resolution.

Figure 2. One of Haar Features that used for Face Detection

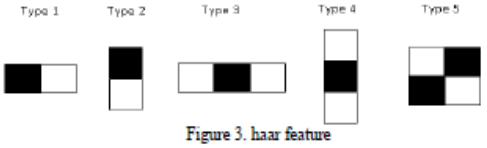

Figure 3. haar feature

B. Principal Component Analysis (PCA) method

This algorithm was proposed by Karl Pearsonin in 1901[4]. PCA is a statistical method which is based on orthogonal transformation that transform a set of observations of possibly correlated variables to a set of linearly uncorrelated variables of values called principal components [18]. PCA is used in data set to reduce the dimensionality and at the same time maintain the characteristics of dataset. Principal component analysis algorithms are used in a lot of applications and one of these applications is facial recognition and emotion detection.

The aim of PCA in emotion detection field is to convert each image in a training set to eigenface as shown in the following steps:

1. Collect set of images (training set) and all these pictures should have the same lighting conditions and aligned mouth and eyes among all images(normalized).
2. Convert each image in training set to one vector by concatenating the pixels of the rows and store it in a single column.
3. Store all images in the training set into one matrix. Each column represents an image.
4. Calculate the mean and then subtract it from each image in the training set.
5. Calculate the eigenvectors and eigenvalues of the matrix of covariance.
6. Select the principal components and arrange eigenvectors and sort the eigenvalues in descending order.

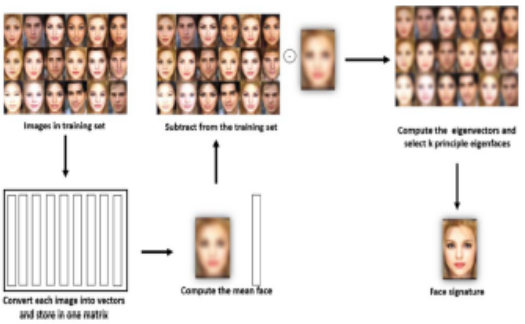

Figure 4. step of PCA method

III. LITERATURE REVIEW

A. Facial emotions Detection Techniques

Facial emotions is considered as the most important factor in people's communication which enable us to perceive other people's intentions. Typically, people deduce the other people emotional states such as joy, anger, sadness, and fear through two main channels: voice tone and facial expression [1]. Mehrabian [5], state that two-thirds of people communication is carried in non-verbal communication and facial expression represents the largest component in this percentage. While only one third of emotion is conveyed in the verbal communication. For that reason, nowadays one of the main fields in computer vision is facial emotion recognition due to its academic significant and commercial potential.

If we look at the studies in this field since its inception so far, we find that the methods used by researchers can be divided into two main classes: conventional and neural networks-based methods.

In conventional methods, to infer the human emotions from the still images, researchers work on detecting the face and landmark (e.g. eyes, nose, and mouth) as a first step, then, they extract spatial features and end this process by classifying the expressions based on the extracted features to conclude and output the result.

One of the studies that is applied in the conventional approaches is Ghimire and Lee research [6], they depend on two kinds of geometric features that rely on 52 landmark

position and angle. Also, they used a pair of classifiers: Support Vector Machine(SVM) for feature vectors and multi class Adaboost during dynamic time warping.

Dhavalikar and Kulkarni [7] proposed a face recognition system that was implemented in three steps: the first step involves detecting the face using different techniques: 1) YCbCr to detect skin color, 2) Lighting compensation, and 3) Morphological operations to select only the desired part of the face. In the second step, they extract the appearance features using AAM approach. Finally, the extracted features are recognized depending on Euclidean Distance approach. This system achieved a high accuracy rate estimated at 90%-95%.

The primary steps in any fundamental face recognition system consist of three steps: first, the face is detected, then face features extracted and represented as vectors, finally, the face is recognized. Based on that Agrawal and Khatri proposed a technique that employs the Viola-Jones system to detect faces in an image and the principal component analysis to extract features [8].

In another study [9], they introduced a system for face recognition that depends on the whole face image, not on the local features. They also utilized the Viola-Jonze for the face detection, PCA to extract the features from the images then the Linear Discriminant Analysis was applied over the eigen faces that are represented by the PCA to minimize the PCA limitation. Then the similarity between two images vectors were measured using the Square Euclidean Distance. They conclude in their study that as the images of the training increased , the rate of the recognition also improved.

The techniques that are used in the former two studies are similar to the techniques that we used in the implementation of the proposed system. We employed the Viola-Jones as a method for detecting the faces that are characterized by its capability in achieving advanced rate in recognizing faces. For features extraction and dimensionality reduction, PCA will be used.

In the meantime, the researchers went to use deep learning techniques that reduce in high percentage the dependent on face physics models and replace it by end-to-end learning models. There are many models for deep learning, but the Convolutional Neural Network (CNN) is the most widely used model in face recognition field.

Alizadeh and Fazel proposed a CNN for facial expression recognition to classify the expression into one of the seven well-known emotions types: happy, sad, angry, neutral, fear, surprise, and disgust. They conclude that CNN can successfully learn the facial features and detect facial emotions in an improved manner. In addition, they found that using the hybrid features did not add any improvement for the model accuracy, and they recommend to depend only on one raw pixel data for model learning purpose [10].

B. Studies on Facial expression recognition Applications

Recently, there has been considerable interest from the commercial sector, especially the retail sector, in using the technology of facial expression recognition to measure the satisfaction of its customers.

The well-known Walmart retails-Stores in America lately announced its intention to build a facial recognition system to measure in real-time their customer sentiment and take the appropriate action to improve the customer experience and to preserve their loyalty in the long term [11].

CaliBurger restaurants in California is another example on the retail sector that employed facial recognition technology by linking it to the loyalty program. They installed the software in their ordering kiosks, and the program works on to identify the customer's faces who registered in the company's loyalty program and then display a menu relying on customer preferences. John Miller, CEO of Cali Group state that the software application will help the restaurant chain to provide an interactive, specialized experience [12].

Karim et. al., proposed system that was able to successfully produce statistical information about customer satisfaction, they used image processing approaches to implement the system. Their system is able to identify regular customers faces, blacklisted customers, expression classification, and for new customers, they used age and gender classification. They conduct the experiments in a coffee shop at AIT (Asian Institute of Technology). In the expression module, they used Levi and Hassncer [13] CNN model to identify the emotions into three types: positive, negative, and natural. While the happiness will be recognized as a positive emotion, and anger, disgust, sadness, and contempt classified as negative emotions [14].

C. Music and their effect on the Mood

Different studies investigated the music and how it will affect the human in different ways, some researchers studied how music affects people modes in the short term or long term, while other focused on its impact on customers' behavior and measured their satisfaction on the service provided [15], Also some researchers proved its usefulness in patients' therapy [16].

Since the main concern in the proposed system centered around detecting the user emotions and improving their moods by music, we are going to deal with four types of emotions or moods, and we have to choose four types of music that best suit it.

In literature, it has been proven that the Classical music can reduce the anxiety and depression in short-term effectively, while, new age music that characterized by loud music, and fast tempo, this type of music increase relaxation and decrease tension. On the opposite side, listing to the Grunge Rock increases the negative emotions and decrease positive ones. Designer music that was identified by the upbeat rhythm will work on increasing emotional and mental balance. For the happy emotion, we intend to emphasize this emotion, so we compose the happy playlist of classical music

tracks, while the natural playlist consists of new age music and the surprised and sad playlist of designer music tracks [17].

IV. PROPOSED METHODOLOGY

The proposed system is a music controller that is based on automatic emotion detection. A webcam is used to capture the images that will be used as input to the proposed system, then it goes to the expression detector to classify it to one of four classes "Happy", "Natural", "Sad", and "Surprised" as shown in Figure 5.

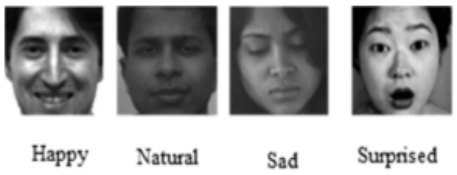

Figure 5. Examples on the Four Emotion

Depending on the expression or the emotion that are detected the corresponding music playlist will be presented to the user to select from a group of the music clips. For example, if the user expression is classified as happy then the happy music playlist will be enabled to the users to choose from the music clips. For the dataset, we used free dataset that is available on the internet, it contains 182 images in four emotions: happy, natural, surprised, and sad. The stages of the proposed approach is shown in Figure 6.

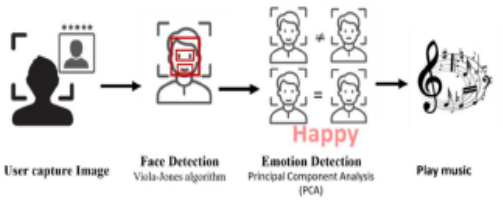

Figure 6. The proposed System Architecture

A. Image Acquisition

As a first step in the proposed system, we begin by acquiring the image of the user's face using a built-in laptop webcam (or any external camera can be employed). The face image to be correctly processed in the proposed system must contain one face in the frontal position in a uniformly illuminated background. Also, it should not be on the user face anything that could impede the process of detection such as glasses. For that, we allow the user to recapture the image to get a picture compatible with the standards of the proposed system in case the first picture does not fulfill the criteria. To enable that in MATLAB the support package of image acquisition toolbox for OS generic video interface was installed.

B. Face Detection

After acquiring the image, the system will start to detect the face by applying the Viola-Jones algorithm. This Algorithm is considered as one of the first frameworks that recognize the objects in real time. Simply, Viola-Jones scan the images using a sub-window to detect the features of the face in the image. When the face is determined, the image is cropped to contain the face only, to enhance the proposed system performance. Also, the Viola-Jones is reused to identify and crop the left and right eyes and mouth separately. The outcome of this step is four images, face, right eye, left eye, and mouth images.

C. Emotion Detection

Next the user sentiment must be detected, we use PCA method which is a well-known approach that is often used to detect face emotions. PCA will construct the face space and the eigenvectors that has the highest eigenvalues will be selected. Also, the acquired image will be projected over the face space. After that the emotion is detected by computing for the user image the scores for each emotion, then the emotion of the image is determined by getting the maximum score of the calculated emotion scores.

D. Enabling the correspondent Emotion playlist

The proposed system is depending on the detected emotion will present the correspondent music playlist. Since we have four emotions, we also have four playlists that offer music clips that are carefully chosen. For happy emotion, the classical music playlist will be activated, while the new age music playlist is dedicated to the natural emotion. For the negative emotions, surprised and sad the designer music playlist will be enabled to enhance the user mood to a better mood.

V. RESULT AND DISCUSSION

In the proposed work, we were able to successfully implement a system that utilizes the Viola-Jonze algorithm with the help of PCA to detect the emotion that are depicted in the acquired image to suggest depending on that the most suitable playlist will be recommended through which we aim to improve the user's mode. Figure 7 and 8 shows a screenshot of the proposed system and how the system provides the appropriate list based on the detected mode.

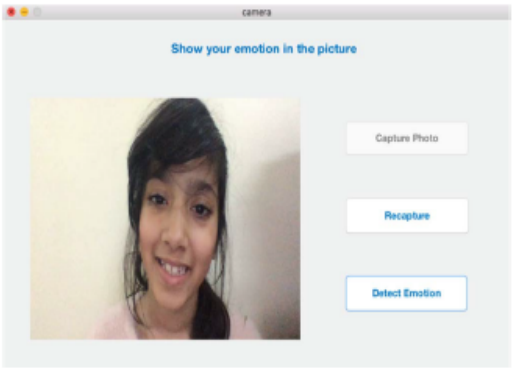

Figure 7. The system interface to capture the image.

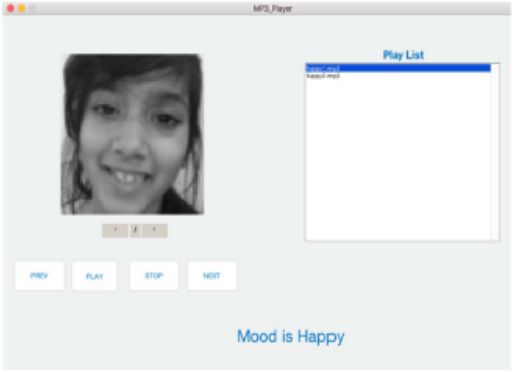

Figure 8. The result of emotion detection with matching music.

During the testing phase, we asked five people to test the proposed system and each one capture a single image for the four emotions: happy, natural, surprised, sad. As shown in table1 and figure 9, we found that most of the time the proposed system detects the emotions correctly. There are further observations we would like to highlight, we noticed that the happy face without showing the teeth may be classified as neutral, likewise, surprised face when the teeth appears may classified as happy, and when the teeth don't appear sometimes it's classified as sad because of the shape of the mouth and that may justify the cases that their detection was not accurate. The testing images are real-time images which affected the accuracy. The accuracy results in table1 depends on the training dataset, so if we increase the size of the training set the accuracy will be improved.

TABLE 1 ACCURACY OF EMOTION DETECTION IN THE PROPOSED SYSTEM

Person	Mode	Accuracy for the correct mode	Right Mode
Person 1	Happy	82%	Yes
	Sad	76%	Yes
	Neutral	97%	Yes
	Surprised	69%	Yes
Person 2	Happy	79%	Yes
	Sad	73%	Yes
	Neutral	98%	Yes
	Surprised	99%	Yes
Person 3	Happy	46%	No (Neutral with accuracy 72%)
	Sad	59%	Yes
	Neutral	98%	Yes
	Surprised	52%	No (Happy with accuracy 62%)
Person 4	Happy	60%	Yes
	Sad	45%	Yes
	Neutral	84%	Yes
	Surprised	60%	No (Sad with accuracy 0.072)
Person 5	Happy	40%	Yes
	Sad	66%	Yes
	Neutral	69%	Yes
	Surprised	56%	Yes

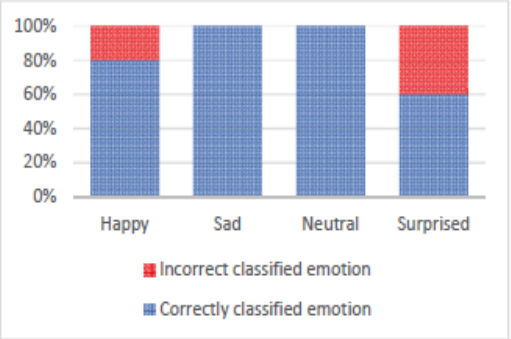

Figure 9. The image classification results.

VI. CONCLUSION

In this paper, we provide an overview about how the music can affect the user's mood and how choosing the right music tracks improve the user moods. Also, we showed the emotion detection techniques. To implement the proposed system, we used PCA and viola-Jonze Algorithm. The implemented system were able to detect the user emotions. The emotions that the system can detect were happy, sad, natural or surprised. After determining the user's emotion, the proposed system provided the user with playlist that contains music matches that detected the mood. The music was chosen to improve the user emotion after studying which type of music is suitable for each mood.

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APPENDIX B
PROGRAM CODE

creating_dataset_of_faces.py:

```
import cv2

with open('src/happy.txt','r') as f:
    images = [line.strip() for line in f]

face_detector = cv2.CascadeClassifier('src/haarcascade_frontalface_default.xml')

# For each Emotion, enter one numeric face id
face_id = input('\n Enter Emotion id end press <return> ==>  ')

#0 for happy
#1 for sad

count = 0

for image in images:
    img = cv2.imread("src/data_set/happy/"+image)
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    faces = face_detector.detectMultiScale(gray, 1.3, 5)

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

        cv2.rectangle(img, (x,y), (x+w,y+h), (255,0,0), 2)
        count += 1

        # Save the captured image into the datasets folder
        cv2.imwrite("src/dataset/User." + str(face_id) + '.' + str(count) + ".jpg", gray[y:y+h,x:x+w])
```

training_images.py

```
import cv2
import numpy as np
from PIL import Image
import os

# Path for face image database
path = "src/dataset"

recognizer = cv2.face.LBPHFaceRecognizer_create()
detector = cv2.CascadeClassifier("src/haarcascade_frontalface_default.xml");

# function to get the images and label data
def getImagesAndLabels(path):

    imagePaths = [os.path.join(path,f) for f in os.listdir(path)]
    faceSamples=[]
    ids = []

    for imagePath in imagePaths:

        PIL_img = Image.open(imagePath).convert('L') # convert it to grayscale
        img_numpy = np.array(PIL_img,'uint8')

        id = int(os.path.split(imagePath)[-1].split(".")[1])
        faces = detector.detectMultiScale(img_numpy)

        for (x,y,w,h) in faces:
            faceSamples.append(img_numpy[y:y+h,x:x+w])
            ids.append(id)
```

```
    return faceSamples,ids

print ("\n [INFO] Training faces....")
faces,ids = getImagesAndLabels(path)
recognizer.train(faces, np.array(ids))

# Save the model into trainer/trainer.yml
recognizer.write("src/trainer/trainer.yml")

# Print the number of Emotions trained and end program
print("\n [INFO] {0} Emotions trained. Exiting Program".format(len(np.unique(ids))))
```

recognition.py

```
import cv2
import numpy

recognizer = cv2.face.LBPHFaceRecognizer_create()
recognizer.read("src/trainer/trainer.yml")
cascadePath = "src/haarcascade_frontalface_default.xml"
faceCascade = cv2.CascadeClassifier(cascadePath)

font = cv2.FONT_HERSHEY_SIMPLEX

#initiate id counter
id = 0

# Emotions related to ids: example ==> Anger: id=0,  etc
names = ['Happy', 'Sad']

# Initialize and start realtime video capture
cam = cv2.VideoCapture(0)
cam.set(3, 640) # set video widht
cam.set(4, 480) # set video height

# Define min window size to be recognized as a face
minW = 0.1*cam.get(3)
minH = 0.1*cam.get(4)
while(True):
    ret, img =cam.read()
    cv2.imshow('Emotion Detector', img)
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break
cv2.imwrite("src/plainpic.jpg",img)
```

```
gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)

faces = faceCascade.detectMultiScale(
    gray,
    scaleFactor = 1.2,
    minNeighbors = 5,
    minSize = (int(minW), int(minH)),
    )
for(x,y,w,h) in faces:
    cv2.rectangle(img, (x,y), (x+w,y+h), (0,255,0), 2)

    id, confidence = recognizer.predict(gray[y:y+h,x:x+w])

    # Check if confidence is less than 100 ==> "0" is perfect match
    if (confidence < 100):
        id = names[id]
        confidence = "  {0}%".format(round(100 - confidence))
    else:
        id = "unknown"
        confidence = "  {0}%".format(round(100 - confidence))

    cv2.putText(img, str(id), (x+5,y+15), font, 1, (255,255,255), 2)
f = open("result.txt", "w")
f.write(str(id))
f.close()


cv2.imwrite("src/generated_pic.jpg",img)

print("\n [INFO] Done detecting and Image is saved")
```

```
cam.release()
cv2.destroyAllWindows()
```

main.py

```
import tkinter as tk
from tkinter import END, ttk
from tkinter.messagebox import showinfo
import fnmatch
import os
from pygame import mixer

canvas = tk.Tk()
canvas.title("Music Player")
canvas.geometry("700x550")
canvas.config(bg = 'black')
rootpath=''

hrootpath = "songs\happy"
srootpath = "songs\sad"
pattern = "*.mp3"

mixer.init()

prev_img = tk.PhotoImage(file = "music_app/prev_img.png")
stop_img = tk.PhotoImage(file = "music_app/stop_img.png")
play_img = tk.PhotoImage(file = "music_app/play_img.png")
next_img = tk.PhotoImage(file = "music_app/next_img.png")
pause_img = tk.PhotoImage(file = "music_app/pause_img.png")




def button_command():
    listBox.delete(0,END)
```

```
    global rootpath

    if emotion_result == 'Happy':
      rootpath = hrootpath
      for root, dirs, files in os.walk(rootpath):
          for filename in fnmatch.filter(files, pattern):
              listBox.insert('end', filename)
    elif emotion_result == 'Sad':
       rootpath = srootpath
       for root, dirs, files in os.walk(rootpath):
          for filename in fnmatch.filter(files, pattern):
              listBox.insert('end', filename)


def select():
       label.config(text = listBox.get("anchor"))
       mixer.music.load( rootpath + "\\" + listBox.get("anchor"))
       mixer.music.play()


def stop():
    mixer.music.stop()
    label.config(text = "")
    listBox.select_clear('active')

def next():
    next_song = listBox.curselection()
    next_song = next_song[0] + 1
    next_sname = listBox.get(next_song)
    label.config(text = next_sname)
    mixer.music.load(rootpath + "\\" + next_sname)
```

```
    mixer.music.play()
    listBox.select_clear(0, 'end')
    listBox.activate(next_song)
    listBox.select_set(next_song)

def prev():
    next_song = listBox.curselection()
    next_song = next_song[0] - 1
    next_sname = listBox.get(next_song)
    label.config(text = next_sname)
    mixer.music.load(rootpath + "\\" + next_sname)
    mixer.music.play()
    listBox.select_clear(0, 'end')
    listBox.activate(next_song)
    listBox.select_set(next_song)

def pause():
    if pauseButton["text"] == "Pause":
        mixer.music.pause()
        pauseButton["text"] = "Play"
    else:
        mixer.music.unpause()
        pauseButton["text"] = "Pause"


top = tk.Frame(canvas, bg = "black")
top.pack(padx = 10, pady = 5, anchor = 'n')

#em_entry = tk.Entry(canvas, font=('poppins',24), width =14,bg = 'grey', bd=7)
#em_entry.pack(pady = 2, side = 'top')
f = open("result.txt", "r+")
```

```
emotion_result=f.read()
f.truncate(0)
f.close()

##8a28d73
emoButton = tk.Button(canvas, text=emotion_result,font = ('poppins', 14), bg = '#8a28d7',
borderwidth = 5, command = button_command )
emoButton.pack(pady = 10, side = 'top')

prevButton = tk.Button(canvas, image = prev_img, bg = 'black', borderwidth = 0, command = prev)
prevButton.pack(pady = 15, in_ = top, side = 'left',padx=10)

stopButton = tk.Button(canvas, image = stop_img, bg = 'black', borderwidth = 0, command = stop)
stopButton.pack(pady = 15, in_ = top, side = 'left',padx=10)

pauseButton = tk.Button(canvas, image = pause_img, text="Pause", bg = 'black', borderwidth = 0,
command = pause)
pauseButton.pack(pady = 15, in_ = top, side = 'left',padx=10)

playButton = tk.Button(canvas, image = play_img, bg = 'black', borderwidth = 0, command =
select)
playButton.pack(pady = 15, in_ = top, side = 'left',padx=10)


nextButton = tk.Button(canvas,  image = next_img, bg = 'black', borderwidth = 0, command = next)
nextButton.pack(pady = 15, in_ = top, side = 'left',padx=10)

listBox = tk.Listbox(canvas, fg = "#8a28d7", bg = "black", width = 300, font = ('poppins',
14),borderwidth= 0,highlightthickness=0)
listBox.pack(padx = 15, pady = 10)
```

```
label = tk.Label(canvas, text = '', bg = "black", fg = "white", font = ('Helvetica', 14))
label.pack(pady = 15)


canvas.mainloop()
```

graphics.kv

```
#:kivy 2.1.0
<ScreenOne>:
        BoxLayout:
                Image:
                        source: 'noteimg.png'
                        allow_stretch: True
                        size_hint_y: 1.2
        BoxLayout:
           orientation: 'vertical'
                padding: 200
                spacing: 50
           Image:
                source: 'logo.png'
                        size_hint_x: 1
                        size_hint_y: 2.5
                        width: 50
                        height: 50
                        allow_stretch: True
                BoxLayout:
        height: "60dp"
        size_hint_y: None
        Button:
           size_hint_x: 2
                                text: "Click to take a Picture!"
                                background_color: 1, 0, 1, 1
                           bold: True
                                on_press:
                                   root.callback()
                                   root.manager.transition.direction = 'left'
                                   root.manager.transition.duration = 1
```

```
                    root.switch_screen()
<ScreenTwo>:
    BoxLayout:
        Image:
            source: 'noteimg.png'
            allow_stretch: True
            size_hint_y: 1.2
    BoxLayout:
      orientation: 'vertical'
        padding: 100
        spacing: 50
      Image:
            id: img_label
            size_hint_x: 1
            size_hint_y: 2.5
            width: 100
            height: 100
            allow_stretch: True
        BoxLayout:
            height: "60dp"
            size_hint_y: None
            pos: '10dp','10dp'
            Button:
                size_hint_x: 2
                text: "Show Emotion"
                background_color: 1, 0, 1, 1
                bold: True
                on_press:
                    root.manager.transition.direction = 'left'
                    root.manager.transition.duration = 1
                    root.switch_screen()
```

```
<ScreenThree>:
        BoxLayout:
                Image:
                        source: 'noteimg.png'
                        allow_stretch: True
                        size_hint_y: 1.2
    BoxLayout:
                Image:
                        source: 'noteimg.png'
                        allow_stretch: True
                        size_hint_y: 1.2
        BoxLayout:
           orientation: 'vertical'
                padding: 200
                spacing: 40
                BoxLayout:
                   height: "10dp"
                   size_hint_y: None
                   Label:
                                text:'Emotion detected is:'
                                font_size: 25
                        Label:

                                id: emotion_label
                                text:''
                                font_size: 25
                BoxLayout:
                   height: "60dp"
        size_hint_y: None
        Button:
```

```
        size_hint_x: 2
                    text: "Play music"
                    background_color: 1, 0, 1, 1
                  bold: True
                    on_press:
                        root.musicplayer()
                      root.manager.transition.direction = 'left'
                      root.manager.transition.duration = 1
                      root.manager.current = 'screen_five'
<ScreenFive>:
    BoxLayout:
        Image:
            source: 'noteimg.png'
            allow_stretch: True
            size_hint_y: 1.2
    BoxLayout:
      orientation: 'vertical'
        padding: 100
        spacing: 50
        BoxLayout:
            height: "60dp"
            size_hint_y: None
            pos: '10dp','10dp'
            Button:
                size_hint_x:2
                text: "QUIT"
                background_color: 1, 0, 1, 1
        pos: 100, 500
                    bold: True
                    on_press:
                        app.stop()
```

graphics.py

```
        from kivy.app import App
from kivy.lang import Builder
from kivy.uix.screenmanager import ScreenManager, Screen
import os

Builder.load_file('graphics.kv')

class ScreenOne(Screen):

    def callback(self):
        os.system('python src/recognition.py')
    def switch_screen(self):
        screen_manager.switch_to(ScreenTwo(name ="screen_two"))

class ScreenTwo(Screen):
    global screen_manager
    def switch_screen(self):
        screen_manager.switch_to(ScreenThree(name ="screen_three"))
    def on_pre_enter(self, *args):
        lab=self.ids["img_label"]
        lab.source='src/plainpic.jpg'

class ScreenThree(Screen):
    def musicplayer(self):
        os.system('python music_app/main.py')
    def callemotion(self):
        f = open("result.txt", "r")
        emotion_result=f.read()
        f.close()
```

```
                lab=self.ids["emotion_label"]
                lab.text=emotion_result

        def on_enter(self, *args):
                self.callemotion()

class ScreenFive(Screen):
        def switch_screen(self):
                screen_manager.switch_to(ScreenOne(name ="screen_one"))
        pass

screen_manager = ScreenManager()
screen_manager.add_widget(ScreenOne(name ="screen_one"))
screen_manager.add_widget(ScreenTwo(name ="screen_two"))
screen_manager.add_widget(ScreenThree(name ="screen_three"))
screen_manager.add_widget(ScreenFive(name ="screen_five"))

class ScreenApp(App):
        def build(self):
                return screen_manager

if __name__ == "__main__":
        sample_app = ScreenApp()
        sample_app.run()
```

APPENDIX C
MAPPING THE PROJECT OBJECTIVES WITH POs AND PSOs

Course Outcome

Sl No.	Description	Blooms Taxonomy Level
CSD334.1	Think innovatively on the development of components, products, processes or technologies in the engineering field.	Knowledge(Level 1) Analyse(level 4)
CSD334.2	Apply knowledge gained in solving real life engineering problems .	Evaluate(level 2) Understand(level 5)

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSD334.1	-	3	-	2	-	-	1	-	3	2	1	3
CSD334.2	3	2	3	2	2	-	-	2	3	2	-	1

CO-PSO Mapping

	PSO1	PSO2	PSO3
CSD334.1	3	-	1
CSD334.2	3	3	2

Justifications for CO-PO/PSO Mapping

Mapping	Low/Medium/High	Justification
CSD334.1–PO4	M	Conduct investigations of complex problems : I used research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
CSD334.1–PO7	L	Environment and sustainability : I understood the impact of the professional engineering solutions in societal and environmental contexts, and demonstrated the knowledge of- and the need for- sustainable developments.
CSD334.1–PO9	H	Individual: We were able to function effectively as an individual, in multi-disciplinary settings.
CSD334.1–PO10	M	Communication : We were able to communicate effectively on complex Engineering activities with the Engineering Community and with society at large, such as, being able to comprehend and write effec- tive reports and design documentation, make effec- tive presentations, and give and receive clear instructions.
CSD334.1–PO11	L	Project Management and finance : Demonstrated knowledge and understanding of the Engineering and management principles and apply these to ones own work, to manage projects and in multi-disciplinary environments.
CSD334.1–PO12	H	Life-long learning : Recognized the need for, and have the preparation and ability to engage in inde- pendent and life-long learning in the broadest context of technological change.

CSD334.1–PSO1	H	Computer Science Specific Skills : Was able to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas by understanding the core principles and concepts of computer science.
CSD334.1–PSO3	L	Professional Skills : Was able to apply the fundamentals of computer science to formulate competitive research proposals and to develop innovative products to meet the societal needs thereby evolving as an eminent researcher and entrepreneur.
CSD334.2–PO1	H	Engineering Knowledge : Applied the knowledge of Mathematics, Science, Engineering fundamentals, and an Engineering discipline to the solution of complex engineering problems.
CSD334.2–PO2	M	Problem analysis : We were able to identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Engineering sciences.
CSD334.2–PO3	H	Design/Development of solutions : Designed solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
CSD334.2–PO4	M	Conduct investigations of complex problems : Used research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

CSD334.2–PO5	L	Modern Tool usage : Created, selected, and applied appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
CSD334.2–PO8	M	Ethics : Applied ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.
CSD334.2–PO9	H	Individual: We were able to function effectively as an individual, and in multi-disciplinary settings.
CSD334.2–PO10	M	Communication : Communicated effectively on complex Engineering activities with the Engineering Community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
CSD334.2–PO12	L	Life-long learning : Recognized the need for, and have the preparation and ability to engage in inde- pendent and life-long learning in the broadest context of technological change.
CSD334.2–PSO1	H	Computer Science Specific Skills : We were able to identify, analyze and design solutions for complex engineering problems in multi-disciplinary areas by understanding the core principles and concepts of computer science.
CSD334.2–PSO2	H	Programming and Software Development Skills : Acquired programming efficiency by designing algorithms and applying standard practices in soft- ware project development to deliver quality software products.

CSD334.2–PSO3	M	Professional Skills : Applied the fundamentals of computer science to formulate competitive research proposals and to develop innovative products to meet the societal needs thereby evolving as an eminent researcher and entrepreneur.