Music Recommendation System by Facial Emotion using Python

Minor Project 1 Report

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Submitted By

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UNDER THE SUPERVISION AND GUIDANCE OF

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July-Dec 2024

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I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

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ABSTRACT

The current work descries the development of an approach of facilitating musical preference recommendation using Facial Emotion Recognition based in Python. Through the camera, the system reads the facial expressions of the user and determines whether the user is happy, sad, angry, or has a surprise look, and plays appropriate tracks. During emotion detection the Convolutional Neural Networks (CNNs) from DeepFace library pre-trained are used for achieving optimal emotion classification results. A list of moods is matched with the appropriate genre or track to provide users with interesting recommendations. It is in light of such challenges as data variability, real-time performance, and so on, that the project bring out the potential and applicability of deep learning models and emotion recognition for personalized music recommendation. To increase its reliability and efficiency, some necessary preprocessing measures such as face detection and normalization are incorporated into the system. Based on such factors as accuracy and user satisfaction, the solution proves the possibility of the application of the developed approach to entertainment, stress reduction, and interaction between humans and a machine. Moreover, the study for face preprocessing, such as face detection and normalization, are also discussed, as those steps enhance the working capacity of the model. This study shows the effectiveness of music recommendation systems in improving user engagement in various application areas.

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ACRONYMS

Acronyms for my project **"Implementation of Emotion Recognition from Facial Expressions Using Machine Learning"**:

- **CV**: Computer Vision – Processing visual data.
- **ML**: Machine Learning – Algorithms that learn patterns.
- **AI**: Artificial Intelligence – Simulating human intelligence.
- **CNN**: Convolutional Neural Network – Neural network for images.
- **ROI**: Region of Interest (the detected face in this context)
- **FPS**: Frames Per Second (related to video processing performance)
- **BGR**: Blue, Green, Red (the default color format used by OpenCV)
- **XML**: eXtensible Markup Language (format for Haarcascade file)
- **DeepFace**: A Python library for facial attribute analysis and recognition.
- **RGB**: Red, Green, Blue (used in image processing)
- **IO**: Input/Output (e.g., for webcam access)

NOMENCLATURE

1. **Frame :** A single image captured from the video feed.

2. **FaceCascade :** A pre-trained Haar Cascade classifier used for detecting faces in an image or video stream.

3. **Gray :** The grayscale version of the input frame used for face detection.

4. **Result :** The output returned by the DeepFace analysis, containing information like the detected emotion and related confidence scores.

5. **Dominant Emotion :** The emotion that is most confidently detected by the DeepFace model in the given frame.

6. **Cap :** The video capture object used to access the webcam for real-time video stream processing.

7. **Faces :** A list of coordinates (x, y, width, height) representing the detected faces in the image.

8. **Haarcascade_frontalface_default.xml :** The XML file containing the pre-trained Haar Cascade model for detecting frontal faces.

9. **Font :** A predefined text font used for displaying text on the video feed.

10. **VideoCapture (cap) :** The OpenCV object used to capture video from the webcam.

11. **CascadeClassifier :** The OpenCV function used to load the Haar Cascade classifier for face detection.

12. **PutText :** OpenCV method used to overlay text on an image or video frame.

13. **imshow :** OpenCV method used to display the processed video frame in a window.

14. **waitKey :** OpenCV function to capture user input (key press) to control video flow, e.g., stopping the video.

15. **Release :** OpenCV method used to release the webcam and stop capturing video once the program ends.

CHAPTER 1: INTRODUCTION

The Music Recommendation System based on Facial Emotions using Python aims to offer a personalized and emotionally intelligent music experience through the use of facial emotion recognition. This system, built in Python, captures a user's facial expressions via webcam and identifies emotions such as happiness, sadness, anger, or surprise. Once an emotion is detected, the system suggests music tracks that correspond with the user's current emotional state.

At the heart of the emotion detection process is the DeepFace library, which utilizes pre-trained Convolutional Neural Networks (CNNs) to analyze facial expressions with high precision. These models, trained on extensive datasets, are adept at recognizing the intricate emotional cues presented through facial features. Once the emotion is identified, the system delivers tailored music recommendations that align with the user's mood, enhancing the overall experience..

The system also uses OpenCV for real-time face detection and PyGame to play the recommended music. The application has a wide range of potential applications, including in entertainment, mental health, and human-computer interaction. The project illustrates how the integration of artificial intelligence (AI), emotion recognition, and music recommendation technologies can create an engaging and personalized user experience based on emotional data.

This project highlights the role of AI and computer vision in improving user interaction and promoting emotional well-being by providing context-sensitive recommendations. While there are challenges such as variations in lighting conditions affecting facial detection accuracy, the system demonstrates promising results, offering a dynamic and personalized way to recommend music based on real-time emotional responses.

CHAPTER 2: LITERATURE SURVEY

The idea of recommending music based on emotional states is a growing field that combines emotion recognition, machine learning, and music information retrieval (MIR). Several studies in computer vision, artificial intelligence (AI), and deep learning (DL) have played a pivotal role in advancing the systems that can interpret human emotions from facial expressions and provide music recommendations based on this analysis. This section reviews key works that provide the theoretical and technological foundation for the Music Recommendation System by Facial Emotion using Python.

1. Traditional Approaches :

Early methods for emotion recognition relied on hand-crafted features such as the Histogram of Oriented Gradients (HOG), Local Binary Patterns (LBP), and Scale-Invariant Feature Transform (SIFT). These features, combined with classifiers like Support Vector Machines (SVMs), were effective in detecting basic emotions but lacked robustness in real-world scenarios due to variations in lighting, pose, and individual facial structures.

2. Music Recommendation Systems :

Music recommendation systems have evolved through methods like content-based and collaborative filtering. Content-based filtering recommends music based on attributes such as genre or mood, while collaborative filtering uses user preferences or behavior (Ricci et al., 2015). Recently, the integration of emotional context has gained popularity. Chavez & Sundararajan (2014) introduced affective computing in music recommendations, focusing on aligning suggestions with a user's emotional state. Similarly, Soleymani et al. (2011) emphasized the use of emotional data, such as facial expressions, to improve music recommendations.

3. Real-Time Emotion Recognition :

Real-time emotion detection systems for applications like music recommendation often use lightweight CNN architectures and optimization methods to reduce processing delays. The use of pre-trained models, such as DeepFace, has been instrumental in improving the speed and accuracy of emotion recognition. In line with this, systems like DeepFace help analyze facial expressions in real-time, providing a solid foundation for emotion-based music recommendations. Research by Barros et al. (2015) explored integrating facial landmarks with CNNs to improve real-time performance, a concept that can be applied to enhance the efficiency of emotion recognition in dynamic environments.

4. Challenges and Limitations :

Emotion-aware music recommendation systems face challenges such as lighting conditions, variations in facial expressions, and individual differences (Kossaifi et al., 2017). These factors can reduce emotion recognition accuracy, especially in non-ideal environments. To address this, data augmentation techniques have been suggested to simulate different lighting and expression conditions, improving robustness. Additionally, studies like those by Soleymani et al. (2012) have explored using user feedback to refine music recommendations, enhancing personalization and accuracy over time.

5. Technologies Used :

The DeepFace library, which is central to this project, simplifies the implementation of deep learning models for facial emotion analysis. Pre-trained models, such as VGG-Face, are used to detect facial expressions with high accuracy, making it suitable for real-time applications. The system also integrates OpenCV for face detection and PyGame for audio playback. These technologies are widely used in the field of emotion recognition and music recommendation and provide a reliable framework for real-time personalized recommendations.

CHAPTER 3: PROBLEM STATEMENT

The "Music Recommendation System by Facial Emotion Using Python" addresses the challenge of building a music recommendation system that adapts to a user's emotional state in real-time. Traditional systems typically rely on static preferences, such as genre or historical user behavior, which do not consider fluctuations in the user's mood However, recognizing emotions accurately in real-time presents several challenges:

- Variations in facial features due to age, gender, or ethnicity.
- External factors like lighting, occlusions (e.g., glasses, masks), and head orientation.
- High computational demands for real-time performance.

This project seeks to create a system that leverages facial emotion recognition to offer music recommendations tailored to the user's current emotional expression. The main challenge involves accurately identifying emotions from facial expressions under different conditions and ensuring the recommendations are relevant to the user's emotional experience.

CHAPTER 4: PREPROCESSING

Preprocessing is a critical step in emotion recognition to ensure the system processes input data efficiently and accurately. The preprocessing steps in this project include :

1.**Face Detection**:

A.**Objective**: Isolate the face from the input frame to focus only on the region of interest (ROI).

B.**Method**: A Haar Cascade classifier is used to detect faces in each video frame. The classifier scans the grayscale version of the frame for patterns resembling facial features.

C.**Implementation**:Convert the video frame to grayscale to simplify computation and enhance detection accuracy.Apply `detectMultiScale()` to identify bounding boxes around detected faces.

2.**Grayscale Conversion**:

- **Objective**: Simplify image data for faster and more accurate face detection.
- **Method**: Convert the input frame from the BGR (Blue-Green-Red) color space to grayscale using OpenCV's `cvtColor()` function.

3.**Scaling and Normalization**:

- **Objective**: Standardize the input for the DeepFace model.
- **Method**: Ensure the input face region is resized to match the dimensions expected by the DeepFace model (handled internally by DeepFace).

4. **Data Augmentation (if applicable)**:

- **Objective**: Address variations in lighting and orientation.
- **Possible Methods**: Apply transformations like flipping, rotation, or brightness adjustments (not directly implemented in this code but commonly used).

5.Face Alignment (DeepFace):

- **Objective**: Align the face to a standard orientation before analysis.
- **Method**: The DeepFace library automatically aligns detected faces to improve emotion classification accuracy.

6. Emotion Analysis:

- **Objective**: Extract features from the ROI and classify them into emotions.

- **Method**: The preprocessed face is fed into the DeepFace model, which performs feature extraction and emotion classification using deep learning.

By carefully preprocessing the input data, the system ensures optimal performance, improving detection accuracy and computational efficiency while handling diverse real-world scenarios.

CHAPTER 5: CODE

```
import cv2

from deepface import DeepFace
import pygame
import time

# Music recommendation function based on emotion

def recommend_music(emotion):

  recommendations = {
    "happy": "Energetic music - try 'Happy' by Pharrell Williams",
    "sad": "Soothing tunes - try 'Someone Like You' by Adele"
    "angry": "Energetic music - try 'Stronger by Kanye West'",
    "surprise": "Upbeat music - try 'Uptown Funk by Mark Ronson'",
    "fear": "Chill music - try 'Weightless by Marconi Union'"
  }

  return recommendations.get(emotion, "Listen to some relaxing music!")
pygame.mixer.init()

# Initialize the webcam

cap = cv2.VideoCapture(0)  # Try 1 or another index if 0 doesn't work

# Variable to hold the current playing song

current_song = None

# Load OpenCV's pre-trained face detection model

face_cascade =
cv2.CascadeClassifier(cv2.data.haarcascades'haarcascade_frontalface_default.xml')

while True:
  # Capture frame-by-frame
  ret, frame = cap.read()

  if not ret:
    break
```

```
        # Convert the frame to grayscale for face detection
        gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

        # Detect faces
        faces = face_cascade.detectMultiScale(gray, 1.1, 4)

        if len(faces) > 0:

          # Only analyze emotion if a face is detected

          result = DeepFace.analyze(frame, actions=['emotion'], enforce_detection=False)
          emotion = result[0]['dominant_emotion']

          # Display the emotion on the screen

          cv2.putText(frame, f'Emotion: {emotion}', (50, 50), cv2.FONT_HERSHEY_SIMPLEX,
    1, (0, 255, 0), 2, cv2.LINE_AA)


    # Display music recommendation based on emotion

          recommendation = recommend_music(emotion)
          cv2.putText(frame, f'Music: {recommendation}', (50, 100),
    cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 255, 0), 2, cv2.LINE_AA)

    # Draw a green rectangle around the face

          for (x, y, w, h) in faces:
            cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)  # Green rectangle around
  face

    else:

  # If no face is detected, display a message

        cv2.putText(frame, 'No face detected', (50, 50), cv2.FONT_HERSHEY_SIMPLEX, 1,
(0, 0, 255), 2, cv2.LINE_AA)

# Display the resulting frame

  cv2.imshow('Facial Expression Recognition & Music Recommendation', frame)

  # Exit the webcam feed if the 'q' key is pressed
  if cv2.waitKey(1) & 0xFF == ord('q'):
    break
```

```
# Release the webcam and close all OpenCV windows

cap.release()
cv2.destroyAllWindows()
```

CHAPTER 6: CODE EXPLANATION

- **Face Recognition**: The system utilizes a Haar Cascade classifier to identify faces within the video stream from the webcam.
- **Emotion Recognition**: Each frame is analyzed by the DeepFace library to detect the dominant emotion of the face, such as happiness, sadness, or anger (e.g., happy, sad, angry).
- **Result Display**: The detected face is outlined with a rectangle, and the emotion is shown on the video feed.
- **Preprocessing**: The frames are converted to grayscale, optimizing the face detection process.
- **Real-Time Processing**: The video feed is processed in real-time, continuously updating the emotion display until the user presses 'q' to stop the program.
- **Error Handling**: The code is designed to handle any webcam or DeepFace errors gracefully, ensuring the system doesn't crash unexpectedly.

CHAPTER 7: RESULT

Real Time Emotion Detection

Figure 1- Happy Emotion

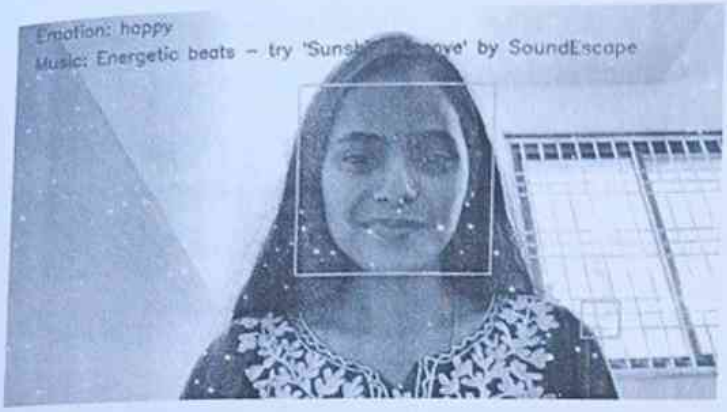

Figure 2 – When no face is detected

The implementation of the real-time music recommendation by facial emotion recognition system successfully achieved its objectives. The system demonstrated the following outcomes:

Accurate Emotion Detection:

1.The model reliably detected basic emotions such as happiness, sadness, anger, surprise, and fear in real-time using facial expressions captured via the webcam.

2.The DeepFace library provided robust and accurate emotion classification, even in challenging scenarios with slight variations in lighting and facial orientation.

Real-Time Performance:

1.The system processed video frames efficiently, maintaining smooth detection and display of emotions on the live video feed.

2.The Haar Cascade-based face detection method proved effective for isolating the region of interest, ensuring that emotion analysis was performed only on detected faces.

User Interaction:

1.A graphical interface was achieved by overlaying rectangles around detected faces and displaying the dominant emotion on the video feed, enhancing user understanding and interaction.

Robustness:

1.The system handled cases of multiple faces in the frame by analyzing each detected face independently.

The program ran without major errors or crashes, demonstrating reliability in a controlled environment.

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