Sentiment Based Enhanced Music Recommendation System Using CNN

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Abstract— This project carries out the real-time emotion detection with music recommendation using facial expression analysis. In this system, the system classifies facial expressions into seven separate emotions: Angry, Disgusted, Fear, Happy, Sad, Surprise, and Neutral. It is done by implementing a pre-trained Convolutional Neural Network (CNN). Live video feed from a webcam has been processed in order to carry out face detection and emotion prediction based on the detected facial features using OpenCV's Haar Cascade classifier. Once the system detects the state of emotion, it selects a song that has a connection with the emotional state identified on a pre-listed list tied with each emotional state, retrieves it from YouTube using a youtubesearchpython library, and allows the system to play the song in a web browser. In this manner, it provides for an automatic response through the form of music pertaining to the emotion identified by the system. Its applications combine aspects from machine learning, computer vision, and music recommendation toward potential applications in interactive entertainment, personal media experience, and emotional well-being tools.

Keywords: Emotion detection, music recommendation, Convolutional Neural Network (CNN), YouTube integration.

I. INTRODUCTION

Emotion recognition from facial expressions has become a critical element of human-computer interaction. This has allowed systems to perceive human emotions in real-time and, by returning them, provided a greater number of applications for interactive as well as personalized experiences. Advanced AI and computer vision have made emotion interpretation from facial cues possible, bringing many possibilities toward personalized and interactive applications. This paper presents a system that integrates the analysis of real-time facial expressions toward personalizing music recommendation.

The system uses a pre-trained CNN model to classify an emotion. It detects seven distinct emotions, which include Angry, Disgusted, Fear, Happy, Sad, Surprise, and Neutral. It captures the video frame through the webcam, where the system starts processing the facial features using the OpenCV Haar Cascade classifier for face detection followed by the prediction of emotion. Once the emotion is sensed, this will activate a recommendation for the music at which the system selects a song from a list predetermined that corresponds to the detected emotional state.

The functionality of the system will combine machine learning, with an aim to detect an emotion; computer vision will be utilized for the purpose of face detection; and techniques for recommending music. In this, the system has an impact on the whole experience of the user by choosing and playing a song that can match the current emotional situation of the user. These technologies present real-time detection of emotion and personal recommendations that can apply to different domains such as entertainment, mental health, and even a personalized user experience.

II. RELATED WORK

Facial Expression Recognition Using CNNs:
Computer vision has gained much importance regarding facial expression recognition. The powerful tool for these applications is Convolutional Neural Networks (CNNs). The features automatically drawn from facial images can be of great utility to describe happiness, sadness, or anger using CNNs. This capability of hierarchical facial landmark extraction, like eye, mouth, and eyebrow extraction, makes CNNs superior to traditional approaches of machine learning. The most usual method utilized for emotion detection is CNNs, especially when facial expression analysis is needed in real-time applications.

Emotion Detection Systems and Applications:

Hence, emotion detection systems can be applied in various domains such as entertainment, health, and education. Such a system detects and responds to the emotional states of the user in real-time so that a personalized experience is generated. For instance, emotion-aware interfaces change the delivery of contents as they relate to the emotional state of the user, thereby enhancing the engagement and interaction. Such systems are mainly utilized on entertainment platforms, where users' feedback may enforce the content or the interactions and can provide a dynamic and personal experience.

Emotion Detection-based Music Recommends a System:
Since the emotion-detection is to be integrated with music recommend systems, the idea will now be selecting songs according to the emotional status of the user. Such systems may give their users a music recommendation that either matches or might influence the mood of the user by detection of facial expression or some other cue towards emotion detection. Multimodal emotion detection, like facial recognition, voice analysis, or physiological signals, aids in providing more accurate emotion classification. It is that kind of methodology that would enhance the user experience giving a recommendation based on the emotional context of the situation and will give the user either emotional well-being or entertainment.

Music and Emotion Interaction:
Music has been known for centuries as something that has the ability to impact the emotional state of an individual. From Psychology Research, high emotional responses triggered by music range from happiness, sadness, to even excitement. Existing relationships have inspired systems that utilize music in modulating or improving emotional states. Music-based recommendation systems on emotions aim to adjust the music offerings to the mood of the listener, based upon the psychology impact which the music apparently has for increasing well-being, or making entertainment or therapeutic environments more interesting.

Open Source Tools for Emotion Recognition:
Several open source libraries have been engaged in emotion recognition systems development. For example, OpenCV proved to be highly useful for real time face detection as well as image processing. Its Haar Cascade classifier is considered to be the most accepted method of facial detection within video feeds. Deep learning frameworks, such as TensorFlow and Keras, have made it pretty straightforward to develop models which are capable of emotion identification; all these pre-trained networks can be easily trained towards specific tasks. Usefully, libraries such as FERPlus sitting on top of TensorFlow are very useful because they really provide a kind of turnkey emotion-detection pipeline which would accelerate the development and deployment of such emotion recognition systems.

III. PROBLEM STATEMENT

Most interactive systems lack real-time detection of the user's emotional state and therefore do not customize the experience, and that, after all, is what such a system is meant to do. This project develops a facial expression recognition-based emotion detection system, which triggers personalised music recommendations. The challenge here is to accurately detect various emotional states such as happiness, sadness or anger from facial expressions in dynamic environments and map these emotions to relevant music selection. Combining emotion detection with music recommendation is intended to enhance the engagement and satisfaction of users of such entertainment or therapeutic applications.

IV. PROPOSED METHODOLOGY

1. Data collection and preprocessing
To start the system, a webcam will capture the video frames in real-time. Each frame would be processed to check for face and then use the faces to detect emotions. The system utilizes OpenCV's Haar Cascade Classifier for face detection. In fact, the face detection on such grayscale frames is much simplified using OpenCV's Haar Cascade Classifier.

2. Emotion Detection Using CNN
The system's core is based on a pre-trained CNN model, specifically designed for facial emotion classification. That is, the system makes use of a CNN model that has been trained on a large dataset of facial images with one of the following emotions: Angry, Disgusted, Fear, Happy, Sad, Surprise, and Neutral. Then, the system loads the pre-trained model, facialemotionmodel.h5, to classify emotions. The extracted face is cropped, resized, and converted to a grayscale image before being input to the model for the prediction of emotions. The selected emotion

is the one with the highest predicted probability of the detected emotion.

3. Emotion Tracking Over Time
To ensure that the system responds to emotions detected over a longer time, the detected emotions are stored in a list, detected_emotions_over_time. This allows the system to assess emotional trends over time. A system that tracks emotions has the potential to offer a far more personalized user experience, where the music listened to will be accordingly recommended according to the user's mood.

4. Mapping Emotion to Song
Once a feeling is identified, the system associates it with a corresponding list of songs that are expected to capture and sensitize the detected feeling. A dictionary called songs_by_emotion stores lists of songs that correspond to each emotion. For instance, an Happy emotion might solicit upbeat, cheerful songs, while a Sad emotion would call in more melancholic music selections. The corresponding list of songs pertaining to the emotion is randomly selected, and the songs are formatted for play.

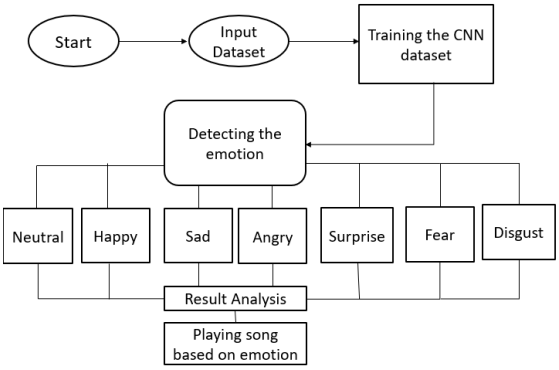
5. Song Based on Emotion
In case an emotion is found, the system will automatically generate a song that suits the emotional state detected. To achieve this, the system employs the use of the YouTube search API which is a class in the youtubesearchpython library to search for a video about the song selected. According to the song name, the song's video is retrieved and a link to the video is opened in the default web browser of the user, so that the user may listen to the music suggested.
If the song is not available on YouTube, then the system sends a notification to the user.

6. Real-time Detection and Feedback
Emotion detection and music recommendation is done in real time. The system continuously captures frames from the webcam and processes each frame to detect faces. The emotions predicted are matched with songs which are recommended to the user in real time, making the entire experience seamless. An important feature of this system is real-time adaptation of content—like adjusting music according to the emotional state of the user—to improve user engagement and well-being.

7. Performance Optimization
The emotion detection process is optimized by regulating the frequency of predictions for maximum efficiency and minimal overhead of computation. This system detects emotions at a predictable interval of 1 second; therefore, the processing unit will not be overloaded with emotion classification requests that will weigh heavily on the system's resources, affecting its performance.

8. User Interaction with System Control
The system is running in a loop, tracking and updating the emotional state of the user. The user has the control to the system via a simple interface; the 'q' key terminates the program and closes the webcam feed. This interaction enables the user to turn the emotion detection and music recommendation system on and off.

9. System Outputs and Results
As the system processes the video frames, it displays the detected emotions on the screen along with the faces being evaluated. It also tracks and displays the total list of detected emotions during the session. The results can then be used in further analysis such as analyzing the emotion distribution and getting an insight into the emotional trends during the user interaction.



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