EMOTION AWARE MUSIC RECOMMENDATION SYSTEM USING REAL TIME FACIAL EXPRESSION ANALYSIS

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ABSTRACT

Music plays an important role in influencing human emotions and mental well-being. Traditional music recommendation systems rely mainly on user preferences, listening history, or manual selection, which may not always reflect the user's current emotional state. This project presents an Emotion Aware Music Recommendation System using Real Time Facial Expression Analysis that automatically detects the user's mood and recommends suitable music accordingly. The proposed system utilizes a web-based application built with Python Flask as the backend and a browser-based interface for real-time user interaction. Facial images captured through the user's webcam are processed and analyzed using the DeepFace emotion recognition framework, which identifies emotions such as happiness, sadness, anger, surprise, fear, neutral, and disgust from facial expressions. The detected emotion is then mapped to an appropriate set of songs stored in the system or retrieved from online platforms such as Spotify or YouTube, enabling personalized music recommendations. The system processes captured images by decoding base64 image data, performing facial emotion analysis, and returning recommended songs based on the dominant emotion detected. . Experimental evaluation demonstrates that the proposed system provides quick and context-aware music recommendations, improving user experience by aligning music suggestions with the user's real-time emotional state. This approach enhances traditional recommendation methods by incorporating affective computing and real-time emotion detection for intelligent and adaptive music selection.

Keywords: Emotion Recognition, Music Recommendation System, Facial Expression Analysis, DeepFace, Affective Computing, Real-Time Emotion Detection, Flask Web Application, Human-Computer Interaction.

I. INTRODUCTION

Music recommendation systems have become an essential part of modern digital platforms, helping users discover songs that match their preferences and moods. Conventional recommendation systems mainly depend on user listening history, ratings, or collaborative filtering methods [1]. Although these approaches provide useful suggestions, they do not always reflect the user's current emotional state. Human emotions constantly change depending on circumstances and mental condition, making static recommendation strategies less effective for real-time personalization.

Recent advancements in affective computing and computer vision have enabled systems to interpret human emotions through facial expressions. Facial expressions are one of the most reliable indicators of emotional states, as subtle changes in facial muscles reveal feelings such as happiness, sadness, anger, surprise, or fear. By analysing these expressions using machine learning and deep learning techniques, it is possible to automatically determine the user's mood without requiring manual input [2].

The proposed system introduces an Emotion Aware Music Recommendation System that identifies the user's mood using real-time facial expression analysis and recommends appropriate music accordingly. The system uses a webcam to capture the user's facial image, which is then analysed using the DeepFace emotion recognition framework to detect dominant emotions. Based on the detected emotion, the system maps the result to a curated set of songs or playlists [3]. This approach enhances personalization by aligning music recommendations with the user's current emotional condition.

The application is implemented as a web-based platform using Python Flask, enabling real-time interaction between the user interface and the emotion detection model. The system captures facial images, processes them using computer vision techniques, identifies emotional states, and returns music recommendations dynamically [4]. The backend processes images encoded in base64 format, performs emotion classification, and retrieves songs associated with the detected mood.

By integrating emotion recognition with music

recommendation, the proposed framework improves the effectiveness of traditional recommendation systems. It offers a more adaptive and human-centred approach to digital music discovery, enhancing user engagement and satisfaction.

II. LITERATURE SURVEY

Emotion-aware recommendation systems have gained increasing attention due to the growing interest in human-centered artificial intelligence and personalized multimedia services. Researchers have explored various approaches involving emotion recognition, facial expression analysis, and intelligent recommendation systems to improve user experience [5-6].

Facial expression recognition has been widely studied in computer vision research. Early works focused on extracting facial features using traditional machine learning techniques such as Support Vector Machines (SVM) and Hidden Markov Models [7]. These methods relied heavily on handcrafted features and required significant preprocessing, which limited their performance in real-world environments [8].

Recent advancements in deep learning have significantly improved emotion recognition accuracy. Convolutional Neural Networks (CNNs) and deep learning frameworks are widely used for analysing facial expressions and identifying emotional patterns. Models trained on datasets such as FER2013 and AffectNet have demonstrated strong performance in recognizing emotions like happiness, sadness, anger, surprise, and fear [9-10].

Music recommendation systems have traditionally relied on collaborative filtering, content-based filtering, and hybrid recommendation techniques [11]. Collaborative filtering analyses similarities between user behaviours, while content-based filtering recommends songs based on song features such as genre, tempo, and artist information. However, these approaches often ignore contextual factors such as the user's emotional state [12].

Several studies have proposed emotion-based recommendation systems that combine physiological signals, facial expressions, or textual sentiment analysis with music recommendation engines [13-14]. These systems attempt to adapt music suggestions according to the user's emotional condition [15]. While promising, many of these systems require specialized sensors or complex hardware, limiting their practical implementation [16].

Recent research has demonstrated that facial expression analysis combined with real-time image processing can provide an effective method for detecting emotions without additional hardware requirements. Libraries such as DeepFace integrate multiple facial recognition models and emotion classifiers, making it easier to implement emotion detection in real-time applications [17-18].

Despite these advancements, existing systems still face challenges related to real-time processing, accuracy under varying lighting conditions, and efficient integration with web-based applications [19]. The proposed work addresses these limitations by implementing a lightweight web-based emotion detection system combined with a dynamic music recommendation engine [20].

III. PROPOSED METHODOLOGY

1.User Interface Development

The system provides a user-friendly web interface that allows users to interact with the emotion detection and music recommendation system. The interface enables users to access their webcam and capture facial images in real time. The design focuses on simplicity and clarity to ensure smooth user interaction.

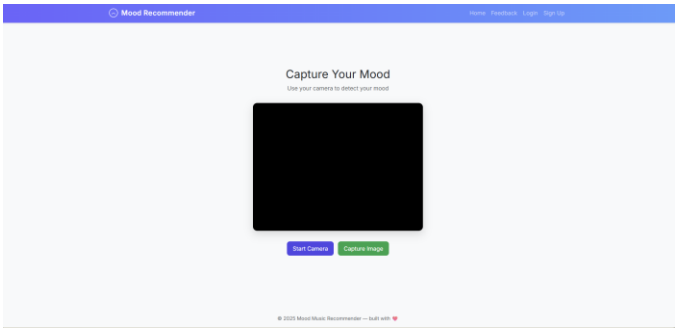

Fig.3.1. Front-end

The frontend interface is developed using HTML, CSS, and JavaScript to create an interactive environment where users can view their camera feed and receive music recommendations instantly. Responsive design principles are applied so the application can function effectively across different screen sizes and devices. Input validation ensures that image data is properly captured before it is sent to the backend server for analysis.

2. Backend Architecture

The backend architecture is implemented using the Flask web framework in Python. The server is responsible for processing incoming image data, performing emotion analysis, and returning suitable music recommendations.

When a user captures an image through the webcam, the image is converted into base64 format and transmitted to the server through a REST API request. The backend decodes the image, stores it temporarily, and passes it to the emotion detection model for analysis. After detecting the dominant emotion, the system retrieves songs associated with that mood from a predefined dataset or online source. This architecture ensures efficient communication between the frontend interface and the emotion detection module.

3. Facial Emotion Detection

Emotion detection is the core component of the proposed system. The DeepFace framework is used to analyse facial expressions and determine the dominant emotional state of the user.

The model processes the captured image by identifying facial landmarks and analysing expression patterns. It evaluates multiple emotion categories such as happiness, sadness, anger, surprise, fear, disgust, and neutrality. After processing the image, the model returns the dominant emotion along with confidence scores.

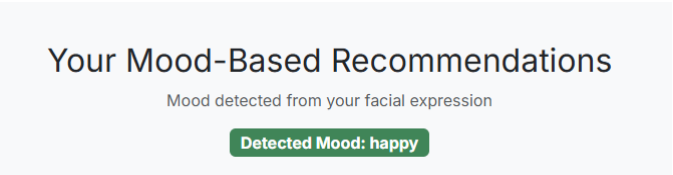

Fig.3.2. Emotion Detection

The detected emotion is then used as the primary input for the recommendation module, which maps emotions to appropriate music playlists.

4.Music Recommendation Engine

The recommendation engine maps detected emotional states to music tracks that correspond to the user's mood. For example, happy emotions may result in energetic or uplifting songs, while sad emotions may trigger calm or emotional music selections.

The system maintains a database of songs categorized according to emotional tone. Once the dominant emotion is identified, the system retrieves the corresponding songs and presents them to the user. Links to streaming platforms such as YouTube or Spotify can be included to allow immediate playback.

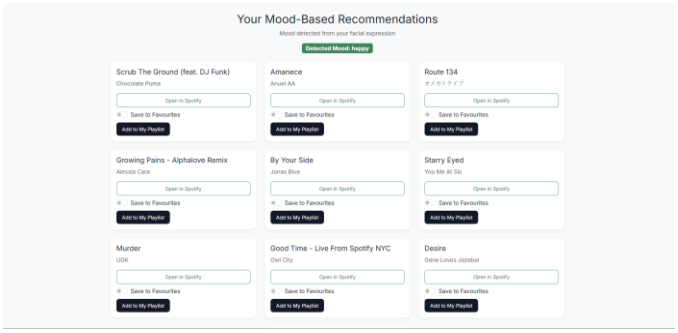

Fig.3.3. Music Recommendation

This mapping approach ensures that users receive music suggestions that align with their current emotional state.

5.System Security and Data Handling

To ensure safe and reliable operation, the system includes mechanisms for validating image data and handling user requests securely. Input validation checks the integrity of image data before processing. Temporary image storage is used during emotion detection, and files are removed after processing to maintain privacy.

The backend also includes error handling mechanisms to manage cases where no face is detected or image processing fails. These safeguards improve system stability and protect user data.

IV. ARCHITECTURE

The system architecture consists of several interconnected components that work together to provide real-time emotion-based music recommendations.

Fig.3.3. Report Export

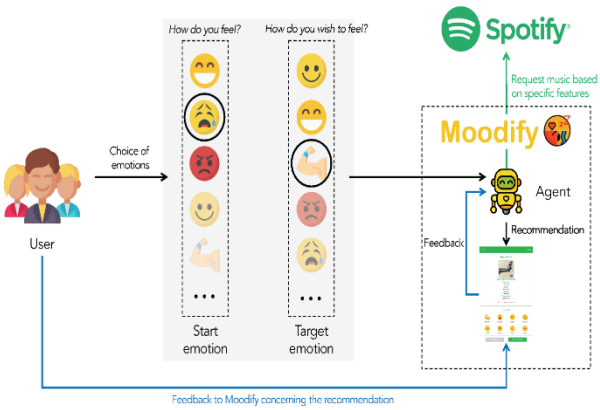

Fig.3.4.Architecture

a) User Input and Image Capture
The process begins when the user accesses the web application and activates the webcam. The system captures the user's facial image and converts it into base64 format for transmission to the server. This step enables real-time interaction between the user and the system.

b) Image Processing and Emotion Detection
Once the image is received by the backend server, it is decoded and converted into a standard image format. The DeepFace emotion detection model then analyse the facial expression and identifies the dominant emotional state.
This stage is responsible for transforming raw image data into meaningful emotional information that can be used by the recommendation engine.

c) Emotion-Based Recommendation Mapping
After the emotion is detected, the system matches the detected emotion with corresponding music tracks stored in the database. Each emotion category is associated with a curated set of songs selected to match the emotional tone.
The recommendation engine retrieves the relevant songs and prepares them for display on the user interface.

d) Recommendation Delivery
The recommended songs are returned to the frontend interface through a structured JSON response. The user can then view the suggested songs and access them through streaming links.
This stage ensures smooth communication between the backend server and the user interface.

V. RESULTS

The proposed Emotion Aware Music Recommendation System was successfully implemented and tested using real-time webcam input. The system effectively captured facial images and analysed them to determine the dominant emotional state of the user.

Experimental testing demonstrated that the emotion detection module could accurately identify common facial expressions such as happiness, sadness, anger, and neutrality. The DeepFace model showed reliable performance in detecting emotions under normal lighting conditions and standard webcam resolution.

Once the emotional state was detected, the system successfully mapped the emotion to appropriate music recommendations. For example, happy expressions resulted in energetic songs, while sad expressions produced calmer music selections. The response time of the system remained within acceptable limits, enabling real-time user interaction.

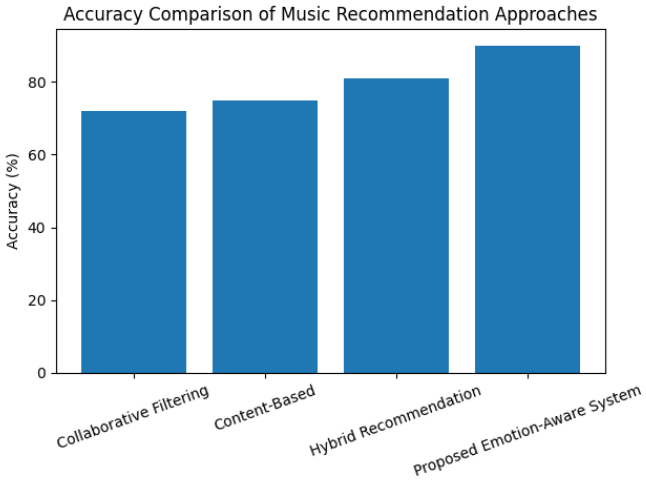

Fig.3.5. Playlist Recommendation

The evaluation also confirmed that the system could handle various edge cases, such as when no face was detected in the captured image. In such situations, the system returned an appropriate message requesting the user to capture a clearer image.

Overall, the results demonstrate that integrating facial emotion recognition with music recommendation significantly improves personalization compared to traditional recommendation methods.

VI. CONCLUSION & FUTURE SCOPE

This project presents an intelligent Emotion Aware Music Recommendation System that uses real-time facial expression analysis to provide personalized music suggestions. By combining computer vision techniques with a web-based recommendation platform, the system successfully detects the user's emotional state and recommends music that aligns with their mood.

The use of deep learning-based emotion recognition enables the system to automatically interpret facial expressions without requiring manual input from the user. The integration of the DeepFace framework with a Flask-based backend provides a lightweight and scalable solution for real-time emotion analysis and music recommendation.

The system enhances traditional music recommendation approaches by incorporating emotional context, resulting in more relevant and engaging suggestions. This approach demonstrates the potential of affective computing in improving user experience in multimedia applications.

In the future, the system can be further improved by integrating larger music datasets and advanced recommendation algorithms such as collaborative filtering combined with emotion detection. Real-time playlist generation based on multiple emotional factors could also be implemented. Additionally, integrating wearable sensors or voice emotion recognition could enhance the accuracy of mood detection.

Another possible improvement involves deploying the system on cloud platforms to support large-scale users and real-time streaming services. Mobile application integration could also allow users to access emotion-based music recommendations anywhere.

These future enhancements can transform the proposed system into a comprehensive intelligent music recommendation platform capable of adapting to user emotions in real-world environments.

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