WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

An Analysis of Music Recommendation Systems Tailored to Emotional States

Potnuru Keerthi[1], Manisha Das[2]

[1]Department of Computer Science and Engineering -AI&DS, GMR Institute of Technology, Rajam, 532127, Andhra Pradesh, India.
[2]Department of Computer Science and Engineering -AI&DS, GMR Institute of Technology, Rajam, 532127, Andhra Pradesh, India.
E-Mail(s):[1]potnurukeerthi2005@gmail.com, [2]manishadas2281@gmail.com
DOI : https://doi.org/10.55248/gengpi.5.1124.3408

ABSTRACT

Nowadays, people rely on music to soothe their moods. With increasing stress due to work pressure and financial concerns, many turn to music for relief. However, most of the music players today provides user preferences rather than emotions. Since music is a powerful source of enjoyment, if users receive music recommendations based on their mood, it could greatly enhance their experience. This approach could help individuals manage their problems, particularly as the number of music albums available continues to grow, making it challenging to find the right music. albums is enormous and it sometimes requires more than one search to reach the required music. This paper presents a music recommendation system based on user feelings such as happiness, sadness, neutrality, anger, etc., by associating the music with the emotions of the user, thus decreasing stress and increasing concentration on work .Here, convolutional neural networks and deep learning play a key role in facial recognition, enabling the music recommendation algorithm to suggest music based on the combination of facial expressions and therefore enhance the user experience by recommending music based on true real-time facial expressions, thus making the listening experience more immersive and emotionally resonant.

Keywords: *convolutional neural networks, deep learning, Emotional States, facial recognition, Music Recommendation.*

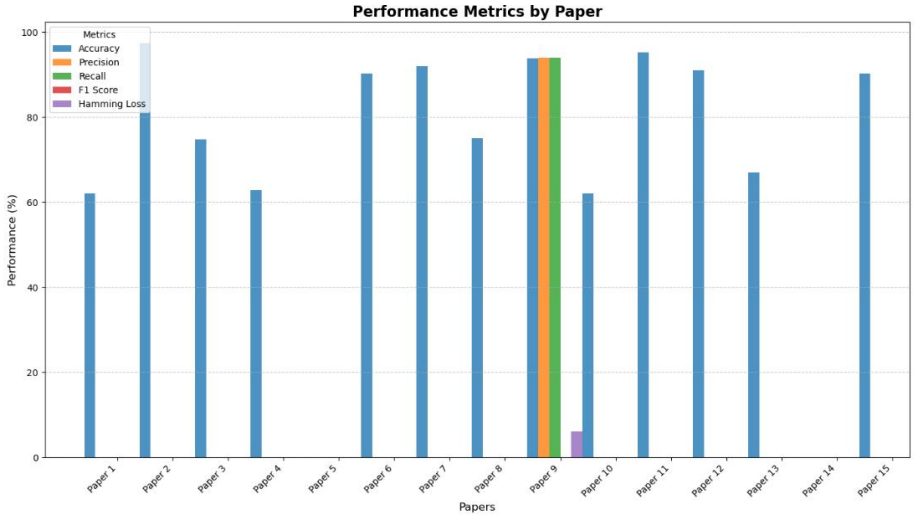
Introduction

Music holds a profound influence in human life, often serving as a tool for emotional expression and regulation. Personalized systems of music recommendation have been of great interest in recent years because they may enhance the user experience by providing tracks consistent with individual preferences. A new frontier in this field involves tailoring recommendations based on users' emotional states. With advancements in artificial intelligence, machine learning, and affective computing, these systems can now detect emotions using inputs such as facial expressions, speech, and recommend music that fits the user's current mood. This approach not only enhances user engagement but also opens the possibility of improving mental health through music therapy. Understanding how emotion-based music recommendations work is key to designing systems that offer personalized, emotionally intelligent interactions. It is through music that most people today find a way to trigger feelings or moods whenever the pace of the world undermines one's rhythm. Of course, music tends to be an important indicator of emotional experience. Music is integral to shaping emotional experiences. Whether a person is happy, sad, stressed, or calm, the music they listen to can mirror or even influence their emotions. Most of the current music recommendation systems are genre-based or rely on previous listening habits, and thus are not likely to reflect real-time emotional states. While these systems offer some personalization aims to fill that gap by using facial recognition technology to analyze a user's emotions and recommend music accordingly. This is through the use of CNN interpretation of facial expressions in real-time, which allows it to make an inference of the user's emotional state.Then it develops a more personalized and emotionally connected music experience for the user, where the recommended tracks adjust to the emotional state of the user. This is how the approach really makes music recommendation intuitive and adaptive for discovering, including being emotionally intelligent. It really brings the power of the music closer to the real-time emotions of the listener-to better uplift, relax, or energize.

Literature Survey

CNN (Convolutional Neural Network) models have shown promising results in emotion detection, achieving an improved accuracy of 62.1 percent using the FER2013 dataset. Compared to traditional machine learning models, CNN provides better accuracy for this task [1]. It effectively addresses the cold start problem and is built using deep neural networks that involve forward and backward passes. Importantly, the system ensures user privacy by processing emotions locally on the device [2]. By employing CNN and opencv for emotion classification, the system achieves an accuracy of 62.1 percent, and this model can also be applied for behaviour and lie detection. The architecture of this system is based on a 7-layer CNN structure, and the

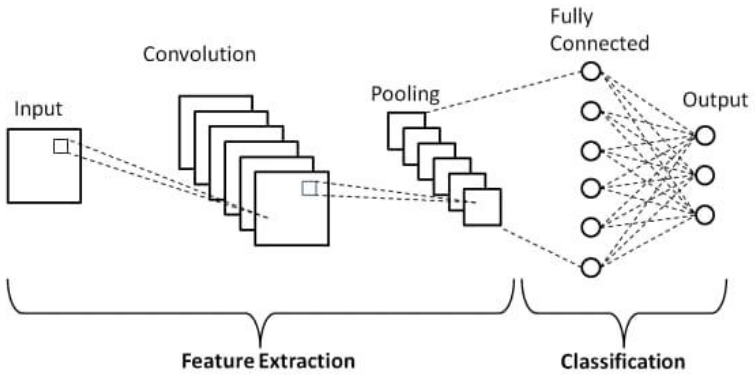
final layer utilizes a sigmoid function, whereby the accuracy is 74.8 %[3].Additionally, this model integrates CNN and fuzzy classification to make mood-based song recommendations, achieving an accuracy of 62.88 percent and a root mean square error (RMSE) of 2.9. CNN and Haar cascades are used for emotion detection, while the Adam optimizer speeds up the learning process [4]. Another approach uses CNN for facial expression recognition, combined with Mediapipe for real-time face detection, and Streamlit is employed for recommending music [5]. The Face Action Coding System (FACS) is used to categorize emotions and generate playlists based on detected moods. This model employs the Fisherface algorithm and Principal Component Analysis (PCA) to achieve efficiency rates between 90 percent and 95percent [6]. By applying deep learning and CNN, the system avoids overfitting by using the Softmax activation function and the Mini Xception model, achieving a 92 percent accuracy rate in emotion recognition [7]. In another implementation, a Java-based face detector identifies emotions, and songs are manually uploaded and categorized in Firebase according to language and emotion. Emotions are captured through snapshots and emojis, which are recognized using tensorflow, resulting in 75 percent accuracy [8]. A hybrid approach of using Long ShortTerm Memory (LSTM) and CNN results in a 93.88 percent accuracy rate. In this system, SVM is used for sentiment analysis with 95.1 percent accuracy in English, and music is recommended through a third-party app [9]. Hybrid techniques are also applied for non-English languages, combining machine learning and lexicon-based sentiment analysis. In this case, emotions are derived from text or speech inputs to generate playlists, with an overall accuracy of 91percent [10]. A CNN-based system detects faces and generates an automated playlist based on user input, structured in four modules: real-time capture, face recognition, emotion detection, and music recommendation [11]. Other systems use machine learning models for facial expression recognition, opencv for face detection, and pywhatkit for playing music via youtube. In this setup, CNN is employed for emotion classification, achieving a 64.52percent accuracy rate [12]. A combination of CNN and RNN is also explored, where CNN is used for emotion detection (65percent accuracy) and RNN for facial recognition (41percent accuracy) [13]. Another system recommends music based on either heart rate or facial emotions, with particularly high accuracy for detecting happiness (98percent) compared to sadness (40percent). Here, Microsoft Azure is used for facial detection, and the system suggests music according to positive or negative mood classifications. If the emotion doesn't match the detected mood, neutral music is played [14]. In one approach, music classification is 97.69percent accurate, while emotion recognition achieves 90.23percent accuracy. Music is classified based on characteristics such as lyrics, tempo, pitch, and rhythm using CNN[15].



Methodology

This section, explains the methods employed to conduct our survey on music recommendation systems using emotion detection techniques. The primary objective was to analyze and summarize current trends and methodologies, with a focus on the use of CNN in real-time emotion-based music recommendations.

A Convolutional Neural Network (CNN) is a deep learning algorithm especially apt for image and video analysis. It has been designed to automatically learn features hierarchies in space adaptively from input images. Therefore, it is powerful for applications, such as facial recognition, emotion detection, and image classification.



In music recommendation systems using emotion recognition:

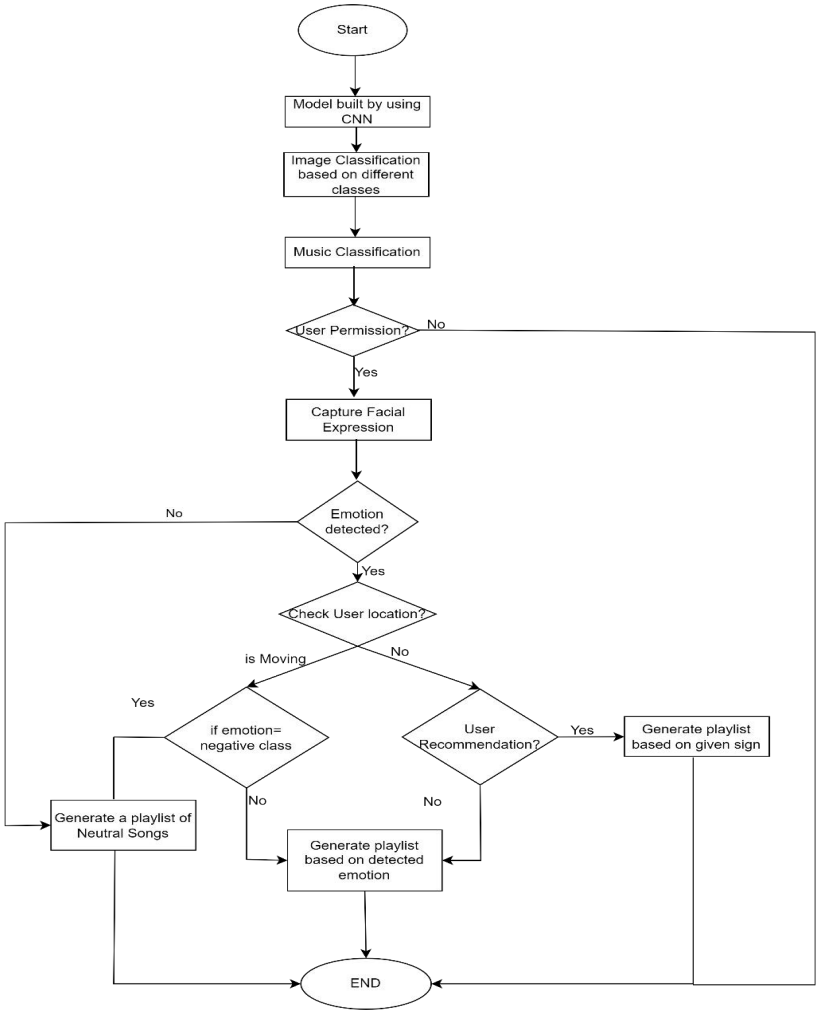
- CNN identifies facial expressions of the user and categorize their emotional status or state (happy, sad, neutral, etc.).

- It proposes music whose mood is either in sync with or otherwise brings a change to a positive direction, based on the sensed emotion.

- It can actually work in real time, always reading the emotional expression of the user and adapting the playlist, making the music experience much more personal and emotionally involving.

By using CNN, music recommendation systems can become more intuitive and responsive, aligning song suggestions with the user's real-time emotions rather than just past preferences.

This approach helps enhance user engagement and can even be applied for therapeutic purposes, such as mood management. A proposed music recommendation system that combines emotion detection through facial expressions, user context-awareness, and personalized music recommendations.



The methodology includes the steps below:

1. Data Preparation:

The system uses two large datasets: the song lyrics dataset that falls into the category of mood-based ones like happy, sad, angry, and so on, and the facial expression image dataset like in FER2013 to train the emotion-detecting model. It categorizes the lyrics dataset into emotional categories to suffice in varied user moods.

2. Source of Facial Expression for Mood Detection:

The system captures the facial expressions by permission through the camera of the user. A convolutional neural network, trained on an image dataset, analyzes and classifies the emotional state of the user, which could be happy, sad, angry, or neutral. Activation function is used to decrease the error in recognizing the facial expression

3. User Context Awareness:

When the system detects that the user is in an emotional state, it asks whether the user is traveling or not. According to the response, it customizes its suggestion for music. If a person is traveling and the software identifies a strong emotion such as negative emotion(anger ,sad), then it starts playing soothing or neutral kind of music to ensure safety of the person.

4. User Preference and Music Recommendation:

The system, based on the emotion detected and context, generates personalized recommendations by asking the user which mode they prefer between ”positive” or ”negative”. These modes determine the emotional tone of the proposed music according to the current states the users are at:

- Happy: The song suggestions are happy in positive mode. There is no change in mood since the mood in the negative mode is already positive.
- Sad: If the mode is positive, then neutral songs are suggested to make the user feel better. In the case of negative mode, sad songs will be available as well because the system wants to match the feeling of the user.
- Angry: For the positive mode, neutral songs are suggested to calm the user. For the negative mode, angry or high-energy songs corresponding to the emotion are suggested.
- Neutral: Happy songs are suggested in the positive mode. No adjustments are needed since the user is in neutral mode for the negative mode.

Current User Emotion	Recommended Song Emotion	
	Positive	Negative
Happy	Happy	-
Sad	Neutral	Sad
Angry	Neutral	Angry
Neutral	Happy	-

This enhancement addresses the limitation of simply matching songs to a user's mood, which might not always help, especially when someone is feeling down. For example, if a user is in a bad mood, recommending only sad songs may reinforce that feeling, making it harder for them to lift their spirit. By asking the user to select either a positive or negative preference, the system can tailor recommendations more effectively. If the user selects the positive mode, the system will suggest uplifting and happy songs to help improve their mood. On the other hand, if the user chooses the negative mode, it will provide music that aligns with their current emotional state, such as sad songs if the user is feeling sad.

5. Real Time Adaptation:

The system continuously monitors the facial expressions of the user as he listens to the playlist. It dynamically adapts the playlist if his emotional state changes to ensure that the recommended playlist is always according to the mood and preferences of the user at any point in time.

This methodology encompasses facial emotion detection and user-provided input on the context and dynamic adaptation of the playlist to produce a personalized, context-aware music recommendation system sensitive to both emotional states and situational needs. User can enjoy music in until he updates his emotion.

Conclusion

In conclusion, the integration of advanced sentiment analysis and emotion detection into music recommendation systems represents a transformative step toward creating a deeply personalized, emotionally intelligent user experience. The system bridges user emotions and song selection via lexicon-based sentiment analysis that categorizes songs into rich emotional shades in terms of relevance and meaning. The dynamic adaptability of the system be it through real-time emotion monitoring or contextual awareness, for example, recommending uplifting tracks during negative moods or while

driving—increases user satisfaction and safety. Additionally, features allowing a user to flick between mood-aligned and mood-boosting tracks give the user more control and make the system more versatile and user-centric. Positioning the system as an emotional lifeline as well as being a means of entertainment makes it unique and even more inclusive. With advancements in AI and affective computing, the role of music in daily life is set to be rewritten in the closest terms yet - relating emotionally on the most advanced technologies.

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