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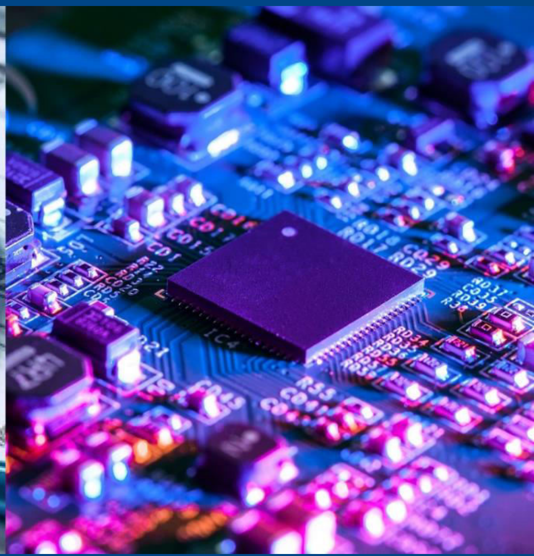

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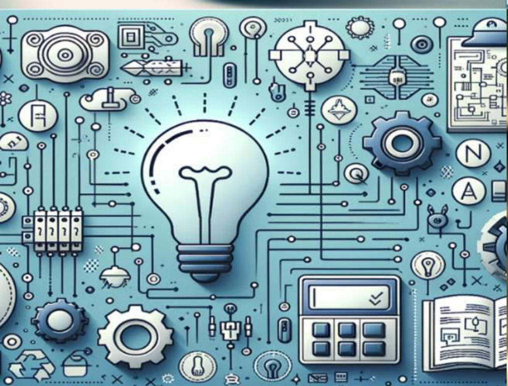

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Emotion-Based Music Recommendation System using Facial Emotion Recognition

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ABSTRACT: This paper presents an emotion-based music recommendation system that leverages real-time facial emotion recognition to provide personalized music suggestions. Utilizing MediaPipe for facial landmark detection and a pre-trained machine learning model for emotion classification, the system identifies emotions such as happiness, sadness, anger, and surprise from live video frames. These emotions are mapped to music recommendations, retrieved via YouTube searches based on user preferences like language and singer. The system employs Streamlit for an interactive user interface, ensuring seamless real-time processing. Despite its effectiveness, challenges include emotion detection accuracy and limited emotion range. The proposed system enhances user engagement and emotional well-being by aligning music with mood, demonstrating potential for further integration with advanced AI techniques.

KEYWORDS: Emotion Recognition, Music Recommendation, Facial Landmarks, MediaPipe, Machine Learning, Streamlit, YouTube Integration.

I. INTRODUCTION

Music significantly influences emotional experiences and well-being, yet traditional recommendation systems often rely on user history and genre preferences, overlooking real-time emotional states. This results in a disconnected listening experience, as users struggle to find music resonating with their current mood. The proposed emotion-based music recommendation system addresses this gap by integrating artificial intelligence (AI), computer vision, and music analysis to deliver personalized suggestions based on real-time emotional cues.

The system employs MediaPipe, a Google-developed framework, for real-time facial and hand landmark detection, extracting features indicative of emotional states. These features are processed by a pre-trained machine learning model to classify emotions, which are then mapped to music recommendations. Streamlit provides an intuitive interface, allowing users to customize preferences such as language and singer, while YouTube integration facilitates dynamic song retrieval. This approach aims to enhance user engagement and emotional well-being by offering a context-aware music discovery process.

II. PROBLEM DEFINITION

The vast availability of music on platforms like Spotify, Apple Music, and YouTube overwhelms users seeking songs aligned with their emotional state. Traditional systems, focusing on genres or past behavior, fail to address momentary moods, leading to a less satisfying experience. Music's potential to regulate emotions—uplifting mood with energetic tracks or reducing stress with calming sounds—is underutilized without real-time emotional awareness.

The challenge is to develop a dynamic system that detects a user's emotional state in real-time using facial expressions and recommends music tailored to that state. This requires integrating emotion recognition, computer vision, and music analysis. Key hurdles include achieving accurate emotion detection under varying conditions, ensuring seamless integration with music platforms, and addressing privacy concerns related to facial data.

III. OBJECTIVES

The primary objective is to create an emotionally intelligent music recommendation system that enhances user experience through personalized, mood-based suggestions. Key goals include:

1. **Real-Time Emotion Detection**: Utilize MediaPipe and machine learning to classify emotions (e.g., happiness, sadness) from facial expressions captured via webcam, ensuring continuous adaptation to the user's mood.
2. **Emotion-Music Mapping**: Link detected emotions to music characteristics (e.g., tempo, energy), recommending songs that align with or alter the user's emotional state, surpassing traditional genre-based systems.
3. **Seamless User Experience**: Provide a passive system where emotions are detected without manual input, delivering instant recommendations via an intuitive Streamlit interface.
4. **Emotional Well-Being**: Leverage music's therapeutic potential to regulate emotions, suggesting calming tracks for stress or uplifting songs for low moods, enhancing mental health.

IV. LIMITATIONS

Despite its innovation, the system faces several limitations:

1. **Accuracy of Emotion Detection**: MediaPipe's facial landmark detection is sensitive to lighting, webcam quality, and facial visibility. Cultural differences and subtle expressions may lead to misclassification, impacting recommendation relevance.
2. **Lack of Convolutional Neural Networks (CNNs)**: The current model, relying on facial landmarks, lacks CNNs' ability to capture nuanced facial patterns, limiting accuracy for complex emotions like anxiety or nostalgia.
3. **Limited Range of Emotions**: The system detects basic emotions (happiness, sadness, anger, surprise, neutral), overlooking nuanced states, reducing recommendation precision.
4. **Dependence on Webcam**: Requiring a webcam excludes users without cameras and raises privacy concerns, particularly in public settings.
5. **Limited Music Recommendation Capabilities**: Current YouTube-based recommendations lack deep music feature analysis (e.g., tempo, danceability), limiting personalization compared to potential Spotify integration.

V. METHODOLOGY

A. Proposed System

The proposed system integrates facial emotion recognition with music recommendation, capturing real-time video via a webcam, processing it with MediaPipe, and classifying emotions using a pre-trained model. Users input preferences (language, singer) via Streamlit, and the system generates YouTube search queries based on detected emotions and inputs, redirecting users to relevant songs.

The workflow includes:

- **User Input**: Collecting language and singer preferences.
- **Video Capture**: Using OpenCV for real-time frame acquisition.
- **Emotion Detection**: MediaPipe extracts facial landmarks, processed by a machine learning model to classify emotions.
- **Music Recommendation**: Emotions are mapped to song categories, with YouTube searches providing recommendations.
- **User Interface**: Streamlit ensures interactive, real-time engagement.

B. Modules

The system comprises:

1. **User Input Module**: Gathers preferences for personalization.
2. **Video Processing Module**: Captures and preprocesses video frames.
3. **Facial Expression Recognition Module**: Detects emotions using MediaPipe.
4. **Emotion Processing Module**: Stores and manages detected emotions.
5. **Music Recommendation Module**: Maps emotions to songs.
6. **YouTube Integration Module**: Redirects to song results.

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7. **UI Module**: Provides an interactive Streamlit interface.

VI. DESIGN

A. System Design

The system architecture is modular, ensuring efficient data flow:

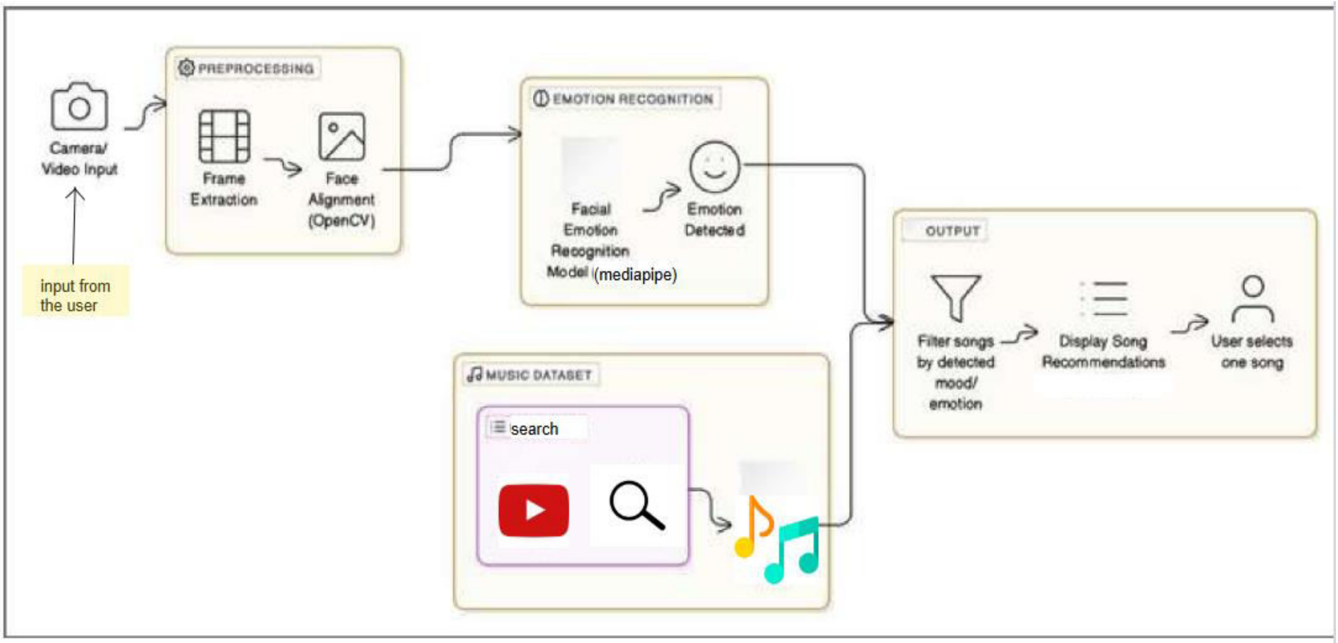
- **User Input Module**: Collects preferences via Streamlit.
- **Video Processing Module**: Uses OpenCV for frame capture and preprocessing.
- **Facial Expression Recognition Module**: MediaPipe detects landmarks.
- **Emotion Processing Module**: Stores emotions for continuity.
- **Music Recommendation Module**: Maps emotions to songs using predefined datasets.
- **YouTube Integration Module**: Generates search queries.
- **UI Module**: Streamlit interface with WebRTC for video streaming.

Technologies: Python, OpenCV, MediaPipe, NumPy, Streamlit, Keras.

B. Architecture

The architecture comprises five components:

1. **User Input**: Captures video and preferences.
2. **Preprocessing**: Aligns and normalizes frames using MediaPipe.
3. **Emotion Recognition**: Classifies emotions with a pre-trained model.
4. **Music Database**: Retrieves songs via YouTube based on emotion and preferences.
5. **Output**: Displays recommendations in a browser.



C. Methods and Algorithms

1. **Preprocessing**:
   - Frame extraction, face alignment, and normalization using OpenCV and MediaPipe.
2. **Facial Emotion Recognition**:
   - MediaPipe extracts landmarks; a machine learning model classifies emotions.
3. **Music Recommendation**:
   - K-Means clustering groups songs by emotional attributes (e.g., valence, energy).
4. **Music Search**:
   - Streamlit UI integrates YouTube searches for dynamic recommendations.

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VII. RESULTS

A. Introduction

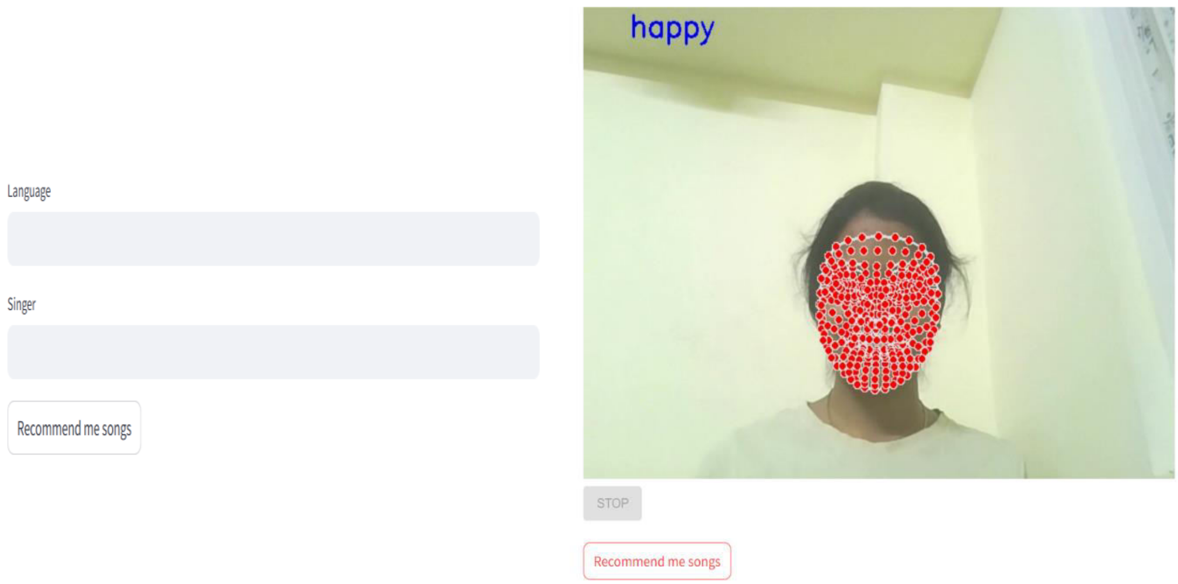
The system effectively recognizes emotions and delivers mood-aligned music recommendations. Testing shows high accuracy in controlled environments, with minor variations under suboptimal conditions (e.g., poor lighting). The K-Means clustering enhances recommendation diversity, and user feedback highlights engagement and usability.

B. Pseudocode

```
START
LOAD model (model.h5) and labels (labels.npy)
SET UP MediaPipe Holistic
INITIALIZE session state for emotion
DEFINE EmotionProcessor:
  FUNCTION recv(frame):
    CONVERT frame to BGR, flip horizontally
    DETECT face, hand landmarks
    EXTRACT features (face, hands)
    PREDICT emotion using model
    DISPLAY emotion on frame
    STORE emotion
    RETURN processed frame
DEFINE Streamlit UI:
  INPUT language, singer
  IF inputs filled, START webcam feed
  IF "Recommend me songs" clicked:
    IF no emotion, SHOW warning
    ELSE, OPEN YouTube with query (emotion+language+singer)
    RESET emotion state
END
```

C. Results

The system accurately detects emotions like happiness, redirecting users to relevant YouTube results (e.g., "happy Telugu Sid Sriram"). User tests confirm intuitive interaction and relevant recommendations, though minor delays in YouTube fetching suggest optimization needs.



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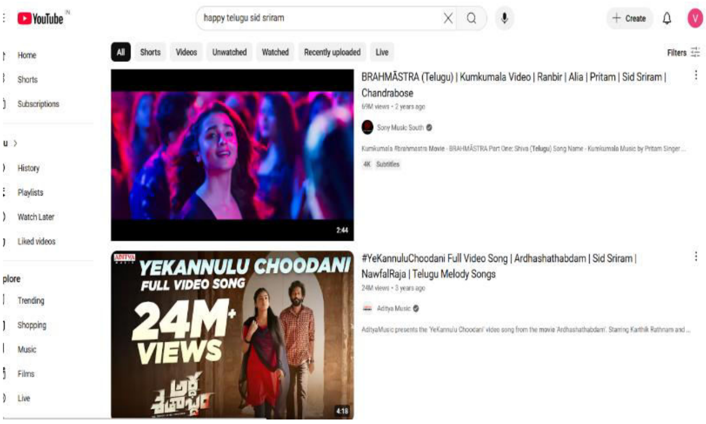

VIII. CONCLUSION

A. Conclusion

The emotion-based music recommendation system successfully integrates AI-driven emotion recognition with personalized music suggestions, enhancing user engagement and emotional well-being. MediaPipe and machine learning enable accurate real-time emotion detection, while Streamlit and YouTube ensure a seamless experience. Limitations like lighting sensitivity and basic emotion range highlight areas for improvement, but the system demonstrates significant potential for AI-driven personalization.

B. Future Scope

Future enhancements include:

- Improved Emotion Recognition: Fine-tuning models with diverse datasets and multimodal inputs (voice, physiological signals).
- Advanced Recommendations: Integrating Spotify/Apple Music and AI-based filtering (e.g., lyrics, tempo).
- Optimized Performance: Using TensorFlow Lite for low-power devices.
- Expanded Emotions: Detecting nuanced states like nostalgia.
- Wellness Applications: Suggesting meditation or motivational content.
- Privacy: Edge computing for local processing.
- Commercial Use: Applications in smart homes, gaming, and customer service.

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