VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"Jnana Sangama", Belagavi-590018

A project synopsis on

"Multimodal Sensing for Enhanced User Experience and Well-being"

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SUBMITTED BY

SAHANA C D (1JB22CS129)

SINCHANA HEGDE (1JB22CS150)

SOURAKSHA S HALINGALI (1JB22CS155)

Under the Guidance of

Mr Dhananjaya M

Assistant Professor

Dept. of CSE

and

Dr. Roopa M J

Associate Professor

Dept. of CSE

SJBIT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SJB INSTITUTE OF TECHNOLOGY

No.67, BGS Health & Education City, Dr. Vishnuvardhan Rd, Kengeri, Bengaluru, Karnataka 560060

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CHAPTER -1

INTRODUCTION

In today's digital era, the integration of artificial intelligence (AI) and machine learning has significantly transformed human-computer interaction, enabling systems to better understand and respond to user emotions. One such advancement is the development of affective computing applications that leverage emotion detection to enhance user experience. Music, as a powerful medium for influencing and reflecting emotions, presents a unique opportunity for personalized recommendations based on an individual's emotional state.

This study explores a machine learning-based approach for real-time emotion detection and music recommendation**.** The system utilizes facial expression analysis to infer a user's emotional state and recommends music that aligns with that emotion. The detected emotions are then mapped to a curated music database using a recommendation model trained on key musical attributes such as tempo, rhythm, and melody**.**The project encompasses several key phases, including data acquisition and preprocessing, model training, integration into a software application, and continuous evaluation for performance improvements. By bridging computer vision, deep learning, and music recommendation systems**,** this work contributes to the field of affective computing, offering a novel approach to enhancing user well-being through emotionally intelligent technology.

One notable application of multimodal sensing lies in the intersection of emotion detection and music recommendation. By harnessing advanced machine learning techniques, such as convolutional neural networks (CNNs), systems can analyze facial expressions captured via webcams or video feeds to infer a user's emotional state. This emotional intelligence is then coupled with a music recommendation model that aligns specific emotional states with corresponding musical features—such as tempo, rhythm, and melody—to suggest tailored music.

By combining data acquisition, model training, and seamless deployment, this field demonstrates the transformative impact of multimodal sensing in areas like affective computing. The continual evaluation and retraining of models ensure these systems remain dynamic, accurate, and attuned to individual needs over time. This work opens new frontiers in human-centered technology, emphasizing both technical innovation and its profound implications for personal and societal well-being.

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LITERATURE SURVEY

Author's	Year	Title	Methodology	Pros/Cons
D. Vaishnavi Reddy, B. Somaditya , O. Sathvika[1]	2022	Emotion-Based Music Recommendation System	Computer vision techniques are used for facial expression analysis . A deep learning model and Support Vector Machine (SVM) are trained to recognize emotions from facial images.	Pros: Provides personalized music recommendations based on real-time emotions. Cons: Emotion detection is based only on facial expressions, ignoring other factors like context.
Sriraj KatkuriMahitha ChegoorDr. K.C. SreedharM [2]	2023	Emotion-Based Music Recommendation System	Haar Cascade algorithm is used for facial detection.The implementation involves OpenCV for image processing, CNNs for emotion detection, and Python for integration.	Pros: Uses Machine learning models for accurate emotion Cons:Dependence on facial expressions may not work well for users masking emotions.
Renuka Devi D., IndiaSwetha Margaret T. Stella Maris [3]	2024	NeuroSymphony – AI-Tailored Music for Cognitive and Emotional States	Facial emotion detection using AI and machine learning .Uses a facial recognition.Incorporates cognitive psychology principles to enhance emotional well-being through music.and accounting problems.	Pros:Integrates with existing music platforms (Spotify, etc.), ensuring vast song availability. ConsPotential biases in AI emotion detection models based on dataset limitations.

QiongHu, Masrah Azrifah Azmi Murad, Qi Li [4]	2025	Advancing Music Emotion Recognition – Large-Scale Dataset Construction and Evaluator Impact Analysis	Combined discrete and continuous emotion models to improve interpretabile Conducted cross-validation with existing datasets like DEAM, PMEmo, and 1000 Songs..	Pros: Largest MER dataset to date, covering multiple languages and Cons: Cross cultural interpretation challenges
eetraj Kumar Shaw, Romit Chattopadhyay, Anubhab Paul [5]	2025	Entertainment Recommendation and Rating System Based on Emotions	Integrates computer vision and machine learning to analyze emotions dynamically. Recommends content beyond past preferences by prioritizing emotional responses.	Pros: Enhances content discovery, reducing decision fatigue digital entertainment. Cons: Emotion misinterpretation risks
Ashok ChikaraddiSanjanG JanakkiSuvarna KanakaraddiPraveenkumar S M [6]	2025	Emotion-Driven Music Recommender System with Deep Learning and Streamlit Integration	The system is trained on the Facial Emotion Recognition (FER-2013) dataset. Convolutional Neural Networks (CNNs) and Multi-Task Convolutional Neural Networks (MTCNNs) for emotion detection.	Pros: High accuracy in emotion recognition 96% validation, testing.Cons: Computationally demanding, requiring high-performance hardware.

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OBJECTIVES

The project aims to detect emotions from facial expressions using a convolutional neural network and recommend personalized music based on the user's emotional state. It strives to integrate these capabilities into a seamless application for enhanced user experience and continuous system improvement.

- Accurate Emotion Identification: To accurately detect and interpret human emotions by integrating multiple data sources (text, speech, facial expressions, etc.).
- Enhanced Human-Computer Interaction: Improve user experiences by enabling systems to respond empathetically and appropriately to users' emotional states.
- Personalized Support: Offer personalized emotional support in applications like mental health monitoring, adapting responses to individual needs and emotional states.
- Real-Time Processing: Enable real-time emotion detection across multiple modalities to facilitate dynamic and responsive interactions in various settings.

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PROBLEM STATEMENT

The challenge in multi-modal emotion detection and music recommendation lies in accurately interpreting emotional states through diverse modalities (e.g., text, speech, facial expressions) and using this information to recommend music that aligns with the user's emotional needs.

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METHODOLOGY

The development of the emotion detection and music recommendation system follows a structured machine learning pipeline, incorporating computer vision, deep learning, and recommendation algorithms**.** The methodologies used in this project include:

1. Data Acquisition and Preprocessing

- Facial Expression Dataset**:**
  - Collect facial images or video frames labeled with emotions (e.g., happy, sad, neutral, angry, surprised).
  - Use publicly available datasets such as FER-2013, CK+, or AffectNet for training the emotion detection model.
  - Perform image preprocessing, including grayscale conversion, resizing, normalization, and data augmentation to improve model generalization.
- Music Dataset**:**
  - Gather a collection of songs labeled with emotional tags (e.g., energetic, calming, uplifting).
  - Extract key musical features such as tempo, rhythm, melody, and lyrics sentiment for recommendation purposes.

2. Convolutional Neural Network (CNN) for Emotion Detection

- Implement a deep learning-based CNN model for classifying facial expressions into distinct emotional categories.
- Train the CNN using labeled image data, applying techniques such as batch normalization, dropout, and adaptive learning rates to enhance model performance.
- Utilize OpenCV and TensorFlow/Keras for real-time emotion detection through webcam input.

3. Music Recommendation Model

- Develop a machine learning-based recommendation system that matches detected emotions with appropriate music tracks.

- Use collaborative filtering, content-based filtering, or hybrid recommendation techniques to improve song selection.
- Leverage Spotify API, Librosa, or custom datasets for feature extraction and mapping emotions to music.

4. Integration and Deployment

- Build a software application that combines the emotion detection and music recommendation components.
- Implement a real-time processing pipeline that captures facial expressions, classifies emotions, and instantly suggests suitable music.
- Use Flask, Django, or Streamlit for developing a user-friendly interface.

5. System Evaluation and Performance Optimization

- Assess model accuracy, precision, recall, and F1-score for both emotion detection and music recommendation models.
- Conduct user testing to measure satisfaction and effectiveness in matching emotions with music preferences.
- Continuously update and retrain models using new data for improved performance.

CONCLUSION

This project demonstrates the potential of leveraging machine learning and multimodal sensing to create innovative and impactful applications. By integrating emotion detection through facial expressions with personalized music recommendations, the system enhances user experience and promotes emotional well-being. The continuous evaluation and retraining of models ensure adaptability and accuracy, making it a dynamic and evolving solution. This work not only advances the field of affective computing but also underscores the transformative role of technology in addressing human-centered needs and improving quality of life.

REFERENCES

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