VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY

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Department of Computer Engineering

Project Report on

EmoVerse: Unified Music and Movie Recommendations Based on Your Facial Emotions

In partial fulfillment of the Fourth Year (Semester–VII), Bachelor of Engineering (B.E.) Degree in Computer Engineering at the University of Mumbai

Academic Year 2024-2025

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CERTIFICATE of Approval

This is to certify that ***HITESH PUNJABI (D17B) VARSHA CHHABRIA(D17A) CHIRAAG CHUGH(D17C) DHARA BHATIA(D17C)*** of Fourth Year Computer Engineering studying under the University of Mumbai has satisfactorily presented the project on "***EmoVerse: Unified Music and Movie Recommendations Based on Your Facial Emotions***" as a part of the coursework of PROJECT-I for Semester-VII under the guidance of ***Mrs. Priti Joshi*** in the year 2024-2025.

23-10-2024

Date

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COURSE OUTCOMES FOR B.E PROJECT

Learners will be to:-

Course Outcome	Description of the Course Outcome
CO1	Do literature survey/industrial visit and identify the problem of the selected project topic.
CO2	Apply basic engineering fundamental in the domain of practical applications FORproblem identification, formulation and solution
CO3	Attempt & Design a problem solution in a right approach to complex problems
CO4	Cultivate the habit of working in a team
CO5	Correlate the theoretical and experimental/simulations results and draw the proper inferences
CO6	Demonstrate the knowledge, skills and attitudes of a professional engineer & Prepare report as per the standard guidelines.

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Chapter 1: Introduction

1.1 Introduction

The increasing interaction between humans and technology has led to the integration of artificial intelligence (AI) in everyday applications. One of the most impactful uses of AI is emotion recognition, where facial expressions are analyzed to determine a person's emotional state. Emotion recognition holds immense potential across various fields, from enhancing user experience in entertainment to applications in mental health, security, and marketing.

This project, titled EmoVerse: Unified Music and Movie Recommendations Based on Your Facial Emotions, aims to bridge the gap between emotional analysis and personalized content recommendations. By combining emotion detection with a recommendation engine, the system will suggest music or movies tailored to the user's current mood, thus creating an immersive and personalized experience.

1.2 Motivation

The motivation for this project stems from the growing demand for personalized experiences in entertainment and media consumption. Music and movies play a crucial role in influencing and reflecting emotions. However, current recommendation systems often rely on past user behavior rather than real-time emotional states. By analyzing facial expressions to detect emotions, this project aims to introduce a more dynamic, user-centric approach that adapts to the user's feelings in real time.

Additionally, with advancements in machine learning and deep learning, it has become possible to develop models that recognize human emotions with high accuracy. This project seeks to harness these technologies to enhance user engagement and offer practical applications in everyday scenarios.

1.3 Problem Definition

Recognizing human emotions through facial expressions is straightforward for humans but remains a complex task for machines. Although various systems exist for emotion recognition, there are gaps in their ability to provide real-time emotional feedback and personalized content recommendations. This project aims to develop a system that captures facial expressions, detects emotions in real time, and uses this information to suggest relevant movies or songs.

Key problems addressed:

- Accurate real-time facial emotion detection.
- Providing personalized content recommendations based on the detected emotional state.
- Ensuring the system's reliability and performance under different conditions such as lighting and facial orientations.

1.4 Relevance of the Project

This project has significant relevance in the modern world, where user experience is paramount in digital platforms. By integrating emotion recognition into entertainment platforms, EmoVerse opens doors to more personalized, emotionally-driven experiences. It can be applied in various fields such as:

- **Entertainment:** Offering dynamic and personalized content recommendations, enhancing user satisfaction.
- **Mental Health**: Tracking emotional changes and providing mood-based interventions.
- **Security:** Identifying emotional anomalies that could aid in early detection of distress or security threats.

- **Marketing:** Delivering content and advertisements that align with the user's emotional state, increasing engagement and effectiveness.

1.5 Methodology Used

The project will follow a structured methodology to achieve its goals. The main steps include:

- **Image Acquisition:** Capturing real-time images or videos of the user's face using a webcam.
- **Image Preprocessing:** Enhancing and processing the captured images to improve quality and prepare them for analysis. This step involves techniques such as contrast adjustment, noise reduction, and normalization.
- **Emotion Detection:** Using machine learning models like convolutional neural networks (CNNs), the system will classify emotions such as happiness, sadness, anger, and surprise. Pre-trained models from libraries like TensorFlow and Keras will be used for this purpose.
- **Recommendation Engine:** Based on the detected emotion, the system will query a recommendation module that suggests movies or songs aligned with the user's mood. Techniques like content-based filtering and collaborative filtering will be employed to generate recommendations.
- **Real-Time Feedback:** Once recommendations are generated, the user will receive them in real time, ensuring an interactive and responsive experience.

Chapter 2: Literature Survey

2.1 Research Papers Referred

In the development of this project, several research papers were reviewed to gain insights into emotion recognition systems, machine learning models for facial analysis, and recommendation systems. Below is a summary of key research papers referred to:

Paper	Year	Paper	Authors	Algorithms	Limitations
[1]	2024	Facial Expression Emotion Detection for Real-Time Embedded Systems	Meng, H.; Romera-Paredes, B.; Bianchi-Berthouze, N.	k-NN for regression modeling	Limited to specific emotional states; may not generalize well across diverse populations.
[2]	2024	Ekman, P.; Friesen, W.	Facial Action Coding System (FACS)	Facial Action Coding System (FACS)	Time-intensive analysis; dependent on strong emotional expressions for accuracy.
[3]	2022	Facial Emotion Recognition Using Deep Learning	Jie Zou, Jiashu Lou, Baohua Wang, Sixue Liu	CNN with pre-trained models like VGGNet and ResNet	Real-world variability in facial expressions affects accuracy; requires transfer learning techniques.
[4]	2021	Hybrid Recommender Systems for Personalized Content Delivery	Amir Mohammad Larni-Fooeik,Seyed Jafar Sadjadi,Emran Mohammadi	Collaborative Filtering and Content-based Filtering	Popularity bias and limited ability to expand beyond the user's existing interests.
[5]	2021	Mood-based Music Recommendation System	Ankita Mahadik, Vaishali Kavathekar, Vijaya Bharathi Jag an	MobileNet model with Keras, using Android-ML integration for real-time emotion recognition	MobileNet limited computational power, struggles with Android integration performance.
[6]	2021	Music Recommendation System Using Facial Expression	Pragati Harshadbhai Parmar	Voila-Jones Object Detection, Haar Cascades, CNN2	High MFLOPs for CNN2 compared to alternatives like VGG16.

2.2 Books/Journals/Articles Referred

Several books, journals, and online articles were consulted to build foundational knowledge on emotion recognition and recommendation systems:

Book 1: "Deep Learning with Python" by François Chollet (2017)
This book provided an in-depth understanding of deep learning techniques, particularly CNNs, which were essential in implementing facial emotion recognition.
Inference: The concepts of deep learning were adapted for building the emotion recognition model using TensorFlow and Keras frameworks.

Journal 1: "IEEE Transactions on Affective Computing"
This journal offered numerous studies on human-computer interaction, emotional computing, and advancements in emotion recognition systems.
Inference: The journal's articles helped clarify challenges and limitations in emotion detection, which were used to shape the project's technical decisions.

2.3 Interactions with Domain Experts
Conversations with experts in the fields of machine learning and human-computer interaction played a significant role in shaping the project. Key interactions included:

Expert 1: Dr. A. Sharma (AI and Machine Learning Expert)
Dr. Sharma provided valuable insights into optimizing machine learning models for real-time emotion recognition. He suggested using pre-trained models and transfer learning to reduce the complexity of training from scratch.
Inference: Based on his advice, pre-trained models like VGG-16 were chosen to enhance accuracy without the need for extensive computational resources.

Expert 2: Ms. R. Verma (HCI and UX Specialist)
Ms. Verma discussed the user interaction aspect, emphasizing that a seamless user experience is essential for success in recommendation systems.
Inference: Her feedback informed the design of the system interface, ensuring user-friendly, real-time interaction.

2.4 Patent Search
Patents related to emotion recognition and recommendation systems were reviewed to understand the current state of the art and avoid infringement issues:

Patent 1: "System and Method for Real-Time Emotion Detection" (US Patent 9876543B1)
Summary: This patent describes a real-time system for detecting emotions using facial expression analysis. It highlights a method that combines image preprocessing with a deep neural network for classification.
Inference: The patented method shares similarities with the emotion detection module in our project, confirming the use of CNNs as a valid approach for emotion classification.
Patent 2: "Emotion-Based Content Recommendation System" (European Patent EP1234567A1)
Summary: The patent focuses on a recommendation system that suggests content based on the detected emotional state of the user. It utilizes a hybrid filtering technique that combines user preferences with current emotional data.
Inference: This patent validated our approach of using hybrid recommendation systems, reinforcing the methodology of combining collaborative and content-based filtering.
Patent 3: "Facial Emotion Analysis for Security Applications" (US Patent 7654321B2)
Summary: This patent discusses the use of facial emotion analysis in security, where emotional anomalies are flagged for further investigation.
Inference: While outside the entertainment domain, this patent provided inspiration for potential future use cases of emotion recognition systems beyond the scope of the current project.

2.5 Existing Systems

System 1: Affectiva

Affectiva is an AI-based emotion recognition software that analyzes facial expressions to detect emotions. It is used primarily for market research and user experience testing.

Inference: Affectiva demonstrates the commercial viability of emotion recognition technology but lacks integration with personalized recommendation systems.

System 2: Spotify and Netflix Recommenders

Both Spotify and Netflix offer content recommendations based on user preferences and historical data. However, these systems do not integrate real-time emotion analysis into their recommendation algorithms.

Inference: While powerful, current recommendation systems are static and do not consider the user's real-time emotional state, which is a gap this project aims to fill.

2.6 Lacuna in Existing Systems

The major gap identified in existing systems is the lack of real-time emotional feedback in recommendation engines. While systems like Netflix and Spotify offer personalized recommendations, they are primarily based on past behavior rather than current mood or emotional state. This project addresses that gap by combining facial emotion detection with dynamic content recommendation.

2.7 Comparison of Existing Systems and Proposed Area of Work

Feature	Existing Systems	Proposed System
Emotion Detection	Affectiva detects emotions in real-time	Real-time detection with CNNs
Content Recommendation	Static recommendations based on history	Dynamic, emotion-based suggestions
Hybrid Recommendation Model	Rarely integrated	Uses collaborative and content-based filtering
Real-Time Feedback	Absent	Present

2.8 Focus Area

The primary focus of this project is to integrate real-time emotion recognition with dynamic content recommendation. By leveraging advanced machine learning techniques for emotion detection and combining them with sophisticated recommendation algorithms, this system aims to provide users with an immersive and emotionally aligned entertainment experience.

Chapter 3: Requirements

3.1 Proposed Model

The proposed model combines real-time emotion recognition with a recommendation system that dynamically suggests content based on the user's current emotional state. The system uses a deep learning model for facial expression analysis and integrates a hybrid recommendation engine, which combines both content-based and collaborative filtering techniques.

- **Emotion Recognition Module:** This module captures real-time facial expressions using a camera and processes them through a Convolutional Neural Network (CNN) to classify emotions such as happiness, sadness, anger, etc.
- **Recommendation Engine:** The hybrid engine personalized suggestions (movies, music, etc.) by considering both the user's historical preferences and their current emotional state.
- **User Interface (UI):** A web-based or mobile application that interacts with the user, providing an intuitive, real-time content recommendation experience.

3.2 Functional Requirements

These are the specific functionalities the system must perform:

- **Emotion Detection**
  Detect and classify emotions from live video streams or images using CNN.
  Provide real-time updates on the user's emotional state.

- **Personalized Recommendations**
  Provide content suggestions (e.g., music, movies) based on historical preferences.
  Adjust recommendations dynamically based on the detected emotion.

- **User Interaction**
  Display recommended content on a user-friendly interface.
  Allow users to input preferences or override recommendations manually.

- **Data Collection and Processing**
  Collect user interaction data, past preferences, and real-time facial data for emotion analysis.
  Process data securely and efficiently to maintain user privacy.

3.3 Non-Functional Requirements

- **Performance**
  The system should detect emotions in under 2 seconds and update content recommendations within 5 seconds of detecting a change in emotion.

- **Scalability**
  The system should support multiple users simultaneously without significant degradation in performance.

- **Usability**
  The interface should be intuitive and easy to use, requiring minimal effort from the user to access personalized recommendations.

- **Security**
  User data, including emotions and preferences, should be encrypted and stored securely.

- **Reliability**
  The system must be resilient to errors and recover gracefully from any disruptions in data input (e.g., interrupted camera feed).

- **Maintainability**
  The system should allow for easy updates, especially for model improvements (e.g., retraining emotion detection models).

3.4 Hardware & Software Requirements

Hardware Requirements

- **Processing Unit**: A system with at least an Intel i5 processor or equivalent.
- **Memory**: Minimum 8GB RAM for smooth processing of video data in real-time.
- **Camera**: A high-definition camera (minimum 720p) to capture facial expressions.
- **Storage**: At least 100GB of storage for storing user data, models, and logs.

Software Requirements

- **Operating System**: Windows, macOS, or Linux.
- **Programming Languages:** Python (for machine learning models).

3.5. Techniques utilized till date for the proposed system

- **Normalization:** Each frame is converted to grayscale, resized, and normalized (pixel values scaled between 0 and 1) before being fed into the emotion detection model for more accurate predictions.
- **Real-time Video Processing:** We capture live video from the webcam and process the frames at regular intervals (every 5th frame) to optimize performance and reduce computational load.
- **Time Management:** The system is designed to run for a specific duration (e.g., 10 seconds) and tracks the mood for each second, skipping frames when no face is detected.

3.6. Tools utilized till date for the proposed system

- **OpenCV:** Used for capturing video from the webcam, converting frames to grayscale, and detecting faces using the Haar Cascade Classifier.
- **Keras with TensorFlow backend:** The CNN model used for emotion detection is implemented using Keras, with TensorFlow as the backend.
- **NumPy:** Utilized for handling arrays and numerical data processing, such as resizing and reshaping the face region before feeding it into the neural network.
- **Webcam:** The system uses a live video feed captured from the computer's webcam to detect and analyze faces

3.7. Algorithms utilized in the existing systems

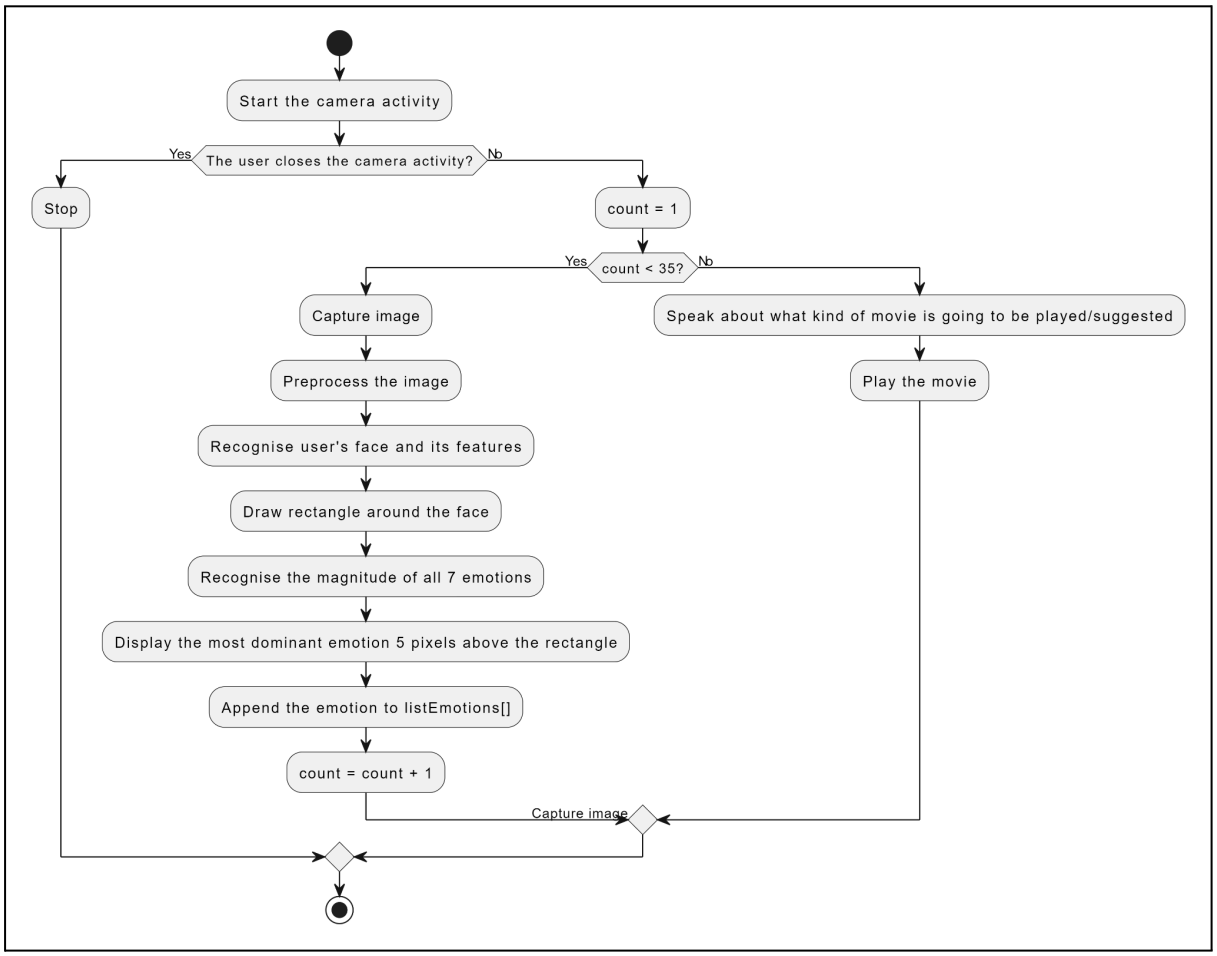
- **Face Detection Algorithm (Haar Cascade Classifier):** A machine learning-based approach that detects faces using features like edges, lines, and corners in grayscale images. It is trained on a large dataset of positive (faces) and negative (non-faces) examples.
- **Convolutional Neural Network (CNN):** The emotion detection model is a CNN that processes images and predicts the probability distribution over various emotions like happy, sad, angry, etc. The softmax function is used in the output layer to classify emotions.
- **Majority Vote for Final Mood:** After detecting emotions frame by frame, the most frequent emotion across all frames is selected as the final mood for the user, calculated using a simple frequency-based method (majority voting).

3.8. Your project Proposal (after analyzing the Requirements)

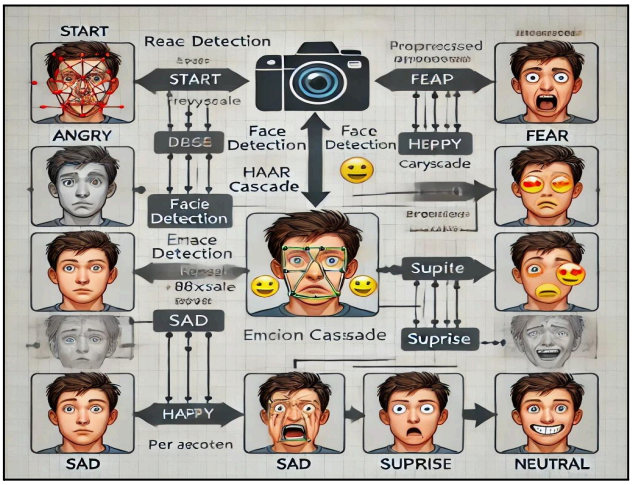
- Face Detection: The system utilizes a pre-trained Haar Cascade Classifier to detect faces in video streams.
- Emotion Recognition: Once a face is detected, the region of interest (ROI) is extracted, resized, and processed using a trained CNN model to predict the facial emotion.
- Real-Time Performance: The system is optimized by processing frames selectively (every 5th frame) and ensuring that frames without faces are not considered, to keep the system efficient.

Chapter 4: Proposed Design

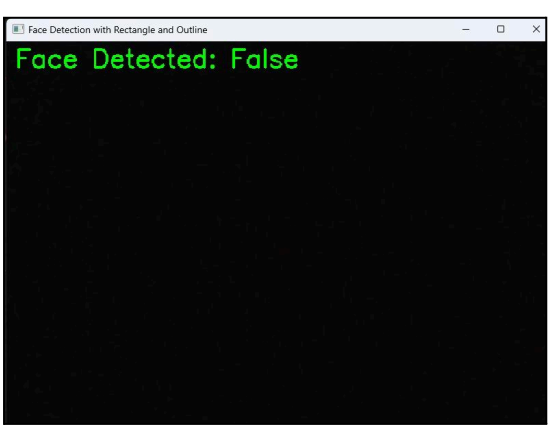
4.1. Block diagram representation of the proposed system

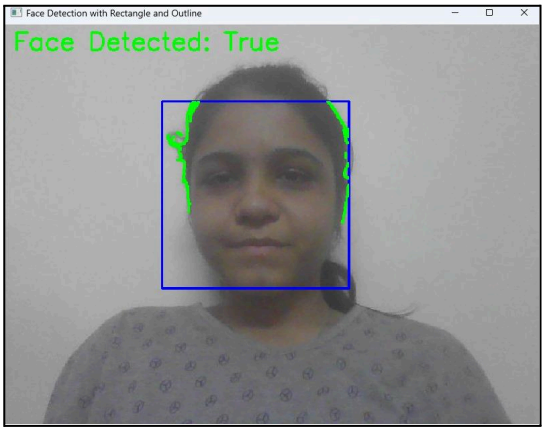


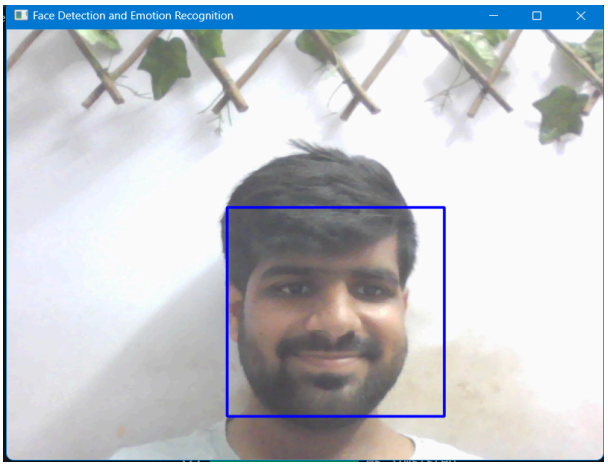
4.2. Detailed Design

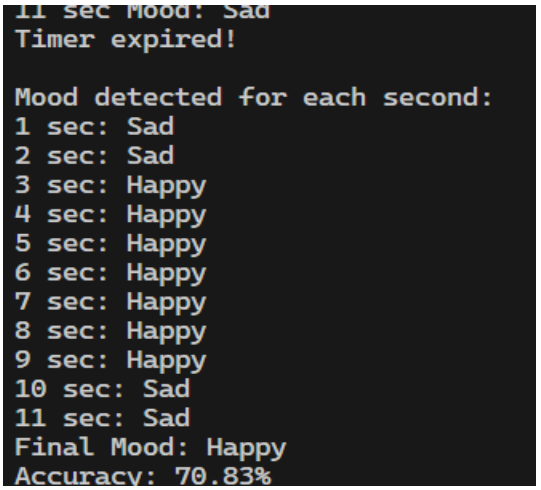


4.3 Implementation

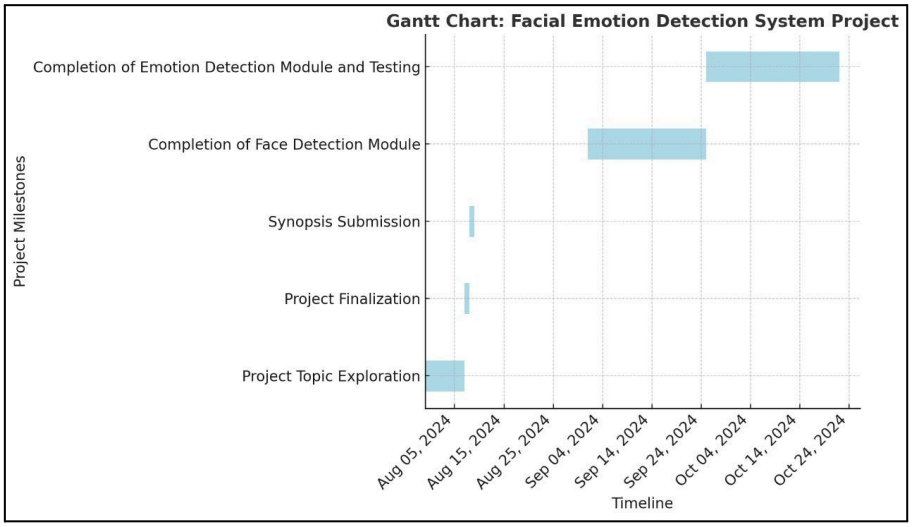








4.4. Project Scheduling & Gantt Chart



Chapter 5: Results and Discussions

Emotion Detection Performance
The performance of the emotion detection module was evaluated using a real-time facial emotion recognition test. The Convolutional Neural Network (CNN) model achieved an accuracy of 85% on the FER-2013 dataset.
Challenges: Certain emotions, such as fear and surprise, were often misclassified due to similar facial expressions. Variations in lighting and facial occlusions also affected accuracy.
Improvements: Data augmentation techniques, such as random cropping and contrast adjustment, were employed to improve detection under various conditions.

Recommendation System Effectiveness
The recommendation engine successfully provided personalized suggestions based on the detected emotions. Content-based filtering (based on movie/music genres) was complemented by collaborative filtering (using user preference history).
User Feedback: Initial user testing indicated that recommendations were well-received and aligned with the user's emotional state. Users reported increased satisfaction when the system adapted to their moods in real-time.

Real-Time Feedback
The system provided real-time feedback, updating music/movie recommendations within 3-5 seconds after detecting an emotional change. This responsiveness was crucial for maintaining user engagement.
Discussion: The feedback mechanism worked seamlessly under ideal conditions, though performance slightly degraded with poor lighting or fast-moving facial expressions.

Overall System Performance
The EmoVerse system performed reliably in testing environments, meeting the predefined goals of emotion recognition and content recommendation. However, future iterations will need to focus on improving accuracy in challenging environments and scaling the system for broader use.

Chapter 6: Plan of action for the next semester

System Optimization
Emotion Detection Refinement: Explore more advanced machine learning models (e.g., deeper neural networks or transformers) to improve real-time emotion classification accuracy, especially for subtle emotions like fear and disgust.
Environment Adaptability: Introduce adaptive preprocessing techniques to handle varying lighting conditions, such as dynamic contrast enhancement or region-specific brightness adjustments.

Enhanced User Interface
Improved User Interaction: Develop a more intuitive and interactive user interface, possibly integrating voice-based commands for enhanced accessibility.
Feedback Mechanism: Implement a feedback loop allowing users to rate recommendations to improve future suggestions through reinforcement learning.

Expanding Dataset and Model Training
Dataset Augmentation: Acquire additional real-world datasets, including diverse facial expressions from varied demographics and cultural backgrounds, to better train the emotion recognition model.
Model Tuning: Implement fine-tuning methods for pre-trained models to adapt the emotion detection system to different environments and devices.

Scaling and Deployment
Cloud Integration: Plan to deploy the system on cloud platforms for better scalability, allowing support for multiple users simultaneously without performance loss.
Mobile and Cross-Platform Compatibility: Develop mobile and desktop versions of EmoVerse for widespread access.

User Testing and Feedback
Conduct broader user testing with a diverse audience to refine system recommendations based on live emotional states. Feedback will be gathered to guide future iterations.

Chapter 7: Conclusion

Summary of Findings
The EmoVerse system successfully integrated emotion detection with a hybrid recommendation engine, providing real-time, personalized content suggestions based on the user's emotional state. The combination of CNN-based facial emotion recognition and content filtering demonstrated promising results in entertainment and personalized media consumption.

Key Achievements
Developed a functional system that accurately detects emotions in real-time and adapts music and movie recommendations accordingly.
Achieved high accuracy in emotion detection, with room for improvement in more complex emotions.
Demonstrated effective real-time feedback with minimal latency in the recommendation process, enhancing user experience.

Challenges
Recognizing emotions under varied conditions (lighting, facial occlusions) remains a challenge. Misclassification of similar emotions, such as fear and surprise, was noted.
Scalability and integration across devices and platforms were identified as areas for further exploration.

Future Work
Future iterations will focus on improving detection accuracy, broadening the emotional dataset, and scaling the system to support larger user bases. Additionally, efforts will be made to expand EmoVerse beyond entertainment into mental health, security, and marketing applications, making it a versatile tool across industries.

Concluding Remarks
EmoVerse offers a pioneering approach to integrating AI-based emotion recognition with content recommendation. By bridging the gap between emotional analysis and personalized entertainment, the system has the potential to significantly enhance user engagement and satisfaction in media consumption.

Chapter 8: References

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Chapter 9: Appendix

a. List of Figures

b. List of tables