Multi-Model Approach to Recommend

Personalized Music Playlist

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Project Proposal Report

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1. DECLARATION

I hereby declare that the work presented in this proposal is entirely my own and has been conducted under my initiative and supervision. This proposal does not incorporate, without proper acknowledgment, any material that has been previously submitted for a degree or diploma in any other university or institute of higher learning. To the best of my knowledge and belief, this proposal does not contain any material that has been previously published or written by another person, except where explicit acknowledgment is made within the text. I take full responsibility for the originality and authenticity of the content presented in this proposal. Any sources, ideas, or contributions from external individuals or works have been appropriately cited and referenced.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

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2. ABSTRACT

The research proposes a music recommendation system that uses real-time weather context to provide personalised music suggestions. The system uses image processing techniques and deep learning(DL) algorithms to analyse photos captured by a device's back camera to identify prevailing weather conditions. Based on these conditions, the system generates customised music playlists that complement the weather scenario, enhancing the overall music listening experience. The feasibility study demonstrates the system's technical feasibility, economic viability, and operational practicality. Technically, the system utilises weather and music datasets, image processing, and deep learning frameworks to implement advanced algorithms for weather classification and music recommendation. The system will also use popular deep learning frameworks like TensorFlow or PyTorch to develop and deploy convolutional neural networks (CNNs) for weather classification. The potential for revenue generation through subscription-based models, in-app purchases, and affiliate marketing with music streaming services indicates a favourable return on investment. Operally, the system aims to enhance the user experience by providing personalised music recommendations based on real-time weather context, aligning with user expectations for convenience and relevance. The system's scalability and integration complexity are addressed, ensuring seamless expansion to accommodate increasing user demand and data volume.

Keywords: music recommendation system, real-time weather context, image processing, deep learning, personalized playlists, feasibility study, CNNs.

Table of Content

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

List of Abbreviations	Description
CNN	Convolutional Neural Network
ML	Machine Learning
DL	Deep learning

3. INTRODUCTION

With the advancement of technology, it is easy to see that music recommendations are debated based on various factors. Personalized experiences will be extremely helpful in improving it [1]. Today's hugely popular Spotify, iTunes, and YouTube social media platforms have more efficient music recommendations based on user preferences and previous music listening.[6] However, it has been realized that these existing systems often ignore the environment and weather conditions, which are critical aspects of the user's experience.[8] The primary focus of the study is environmental factors that influence guest behavior, emotions, and concern for the state of the environment [4]. Previous research seems to have identified that these factors are particularly affected by weather conditions, users' surroundings, mood, and people's music listening habits [8]. For example, a user group survey confirmed that users turned to upbeat music recommendations for a sunny day, while rainy or cloudy weather conditions reflected a majority preference for soft and soothing tunes. The musical methods mentioned above. Primarily playlists are recommended using information provided by the user or previous searches [6]. There it was not difficult to initiate these methods regarding the interaction between music and the environment. The study used the user's current environment processing technology and convolutional neural networks (CNN) technology to simulate weather conditions and environmental conditions for comparison between music and weather.[2] The goal of this system is to use the captured image data to provide personalized music recommendations appropriate for the occasion. Occasional music recommendations are expected to put the user in a more comfortable mood.[3] The music system was created by recognizing real-time information captured by data such as real-time weather and indoor/outdoor data, while these recommendations are personalized and instant recommendations appropriate to the user's current surroundings, not limited to the user's preferences and beyond.[9] State-of-the-art image processing techniques and convolutional neural networks (CNN) model[7] predict the date of data analysis and recommend the best music accordingly[5]. Environmental intelligence focuses on providing a more complete and advanced and usable listening experience than existing systems that focus primarily on the user's surroundings.

3.1 Background

4 The system aims to provide users with a personalized playlist and song recommendations tailored to their preferences and listening preferences, mainly taking into account the user's environment and weather conditions. In recent times, the creation of music recommendation systems has been driven by using machine learning, data analytics, and user interface. [6] . Also, existing recommendation systems recommend songs based on user-supplied information based on prior search data and interactions [8]. It allows the user to select the desired song and has some effectiveness. When this is studied in depth, there is a problem as to whether it is the right song for the occasion because it ignores the environmental conditions and the surrounding situation. Therefore, the research was carried out by paying attention to the user's environment and weather conditions, outdoor/indoor conditions, etc., where the user's emotions and mental health have been affected. Listening to music has been shown to enhance moods with regard to experience and will. [4]. Further studying this research found that most of the users like to listen to music in rainy or cloudy weather conditions. These environmental and weather conditions are entered into the system through a picture frame and the system is prepared to provide song recommendations [5] after analyzing the data. Using image processing and deep learning technologies [1] environmental image frames are inputted into the recommendation process and interact with the environment and other specified data to provide accurate information.[2] CNN has been used to capture the user's location and environment and weather conditions and image classification using VGG19 to identify features has added value to the system. Analyzing the user's needs and wishes [3] This creates

personalized music recommendations based not only on the user's emotions but also on the environment and weather conditions, making environmental conditions an essential factor for innovative music recommendations to increase user satisfaction and improve user satisfaction against presets. Using image processing and deep learning, real-time frames are taken to provide more fun and more personalized music recommendations to suit the current situation and provide a more user friendly experience.[9] It aims to explore and raise awareness of the untapped potential of music recommendation environments through interaction research and collaboration, allowing future researchers to develop new algorithms and techniques for creating music recommendation systems.

3.2 Literature Survey

Music recommendation systems have gained popularity for their ability to offer personalized music suggestions, with various studies exploring methods to improve the effectiveness and relevance of these recommendations.O. Ghosh, R. Sonkusare, S. Kulkarni and S. Laddha This paper presents a music recommendation system based on emotion recognition using image processing and deep networks and analyzes it by interacting image processing and deep learning techniques. The music recommendation system uses a group of users to capture images and analyze the facial expressions of users, the system detects emotional states and correlates them with appropriate music choices. Studies have shown the ability to personalize these music recommendations for framing and improve success by leveraging different intelligences [1]. Music Recommendation System Using CNN Algorithm S. Pesaru, K. Sucharitha, R. Lahari, and P. PrakashPesaru et al. A music recommendation system based on convolutional neural networks (CNNs) has been proposed and shown to use this algorithm for subframes [2]. The system uses CNN to analyze environmental data including weather conditions, time and location extracted from images. By incorporating information into the recommendation process, the system generates personalized music playlists tailored to the user's surroundings, providing a more appropriate and relevant listening experience [2]. Music Recommendation System for Shared Environments J. G. B. Vitório, C. N. Silla The paper introduces a music recommendation system for public spaces that uses collaborative filtering techniques and user feedback to generate consensus-based recommendations. It aims to provide inclusive and enjoyable music experiences in shared settings, considering the social context and preferences of multiple users [3]. Dorochowicz and Kostek's study explores the connection between album cover design and music genres, focusing on how visual cues like color schemes, imagery, and typography convey genre-specific qualities and influence listeners' expectations. They aim to improve user engagement and satisfaction by understanding visual-semiotic aspects of music. [4]. H. S. Angkasa, N. U. Maulidevi Angkasa, and Maulidevi Emotion Classification of User Face Image in a Music Recommender System Propose an emotion-aware music recommendation system that classifies users' facial expressions to infer emotional states. The study highlights the significance of incorporating affective computing techniques into music recommendation systems, which dynamically adjust music recommendations based on users' current moods and emotional needs. [5]. Music Recommender System Using Machine Learning by Verma, Varsha and Marathe, Ninad and Sanghavi, Parth and Nitnaware, Dr. Verma et al. This study provides an in-depth analysis of machine learning-based music recommendation systems, examining various algorithms and approaches like collaborative filtering, content-based filtering, and hybrid methods.. This paper synthesizes existing research findings to offer insights into the challenges and opportunities of creating effective and personalized music recommendation systems. [6]. Emotional Music Recommendation System Using Audio Content and Lyrics by J. H. Lee, S. W. Kim Lee, and Kim propose an emotional music recommendation system that analyzes audio content and lyrics to infer the emotional properties of songs. The system categorizes music into emotional categories based on rhythm, melody, and lyrical content, suggesting suitable tracks based on users' mood preferences.. The study underscores the significance of incorporating multimedia features into music recommendation systems to offer more comprehensive and contextually relevant recommendations. [7]. S. Sasaki, T. Hirai, H. Ohya, and S. Morishima An Affective Music Recommender System Reflecting the Mood of Input Image By Sasaki et al. The proposal proposes a music recommendation system that uses deep learning techniques to analyze visual features from images and correlate them with music tracks that evoke similar emotional responses.. The system introduces a novel method of context-aware music recommendations, utilizing visual cues to understand users' emotional states. [8]. Music Recommendation System Based on Real-Time Sentiment Analysis by B. Zhai, B. Tang, and S. Cao Zhai et al. The system integrates emotion recognition algorithms with streaming to provide personalized music recommendations based on users' emotional states in real-time. Furthermore, Johnson and White (2019) explored the analysis of image texture for scene classification. The research highlights the significance of texture features in image analysis and classification tasks, suggesting that music recommendation systems can use texture analysis techniques to improve weather detection and context analysis.[11]Zhai, Tang, and Cao (2022) proposed a music recommendation system based on real-time emotion analysis. BThe system dynamically adjusts music recommendations based on users' real-time emotional states, ensuring that the music aligns with their mood and emotional context, resulting in a more engaging listening experience.[9]In a similar vein, Sato and Ikeuchi (1995) conducted reflectance analysis under solar illumination, aiming to understand the effects of lighting conditions on image perception.The study, which focuses on computer vision applications like scene analysis and object recognition, suggests that understanding lighting conditions' impact on image perception can enhance the accuracy of weather detection algorithms in music recommendation systems.[10]Future research can develop advanced music recommendation systems that incorporate real-time emotional analysis, environmental context, and image texture features, thereby providing personalized and contextually relevant music recommendations, thereby enhancing the overall music listening experience.

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3.3. Research Problem

There are various evolutions in music recommendation systems.. Real-time environmental factors have to be taken into account in order to improve user experience and preferences. While many other systems playlists are based on previous search data and data entered by the user, the user's surroundings. Ignored. Here, the system had to be created by taking into account the environmental factors and the person's surroundings. Considering those circumstances, the user has to get the most suitable personalized combination recommendations. There, data should be entered according to the picture frame, cues from the surroundings should be identified and music suggestions should be provided without interruption and the user's needs and preferences will also have to be taken into account. The aim was to explore the data captured in the frames in real time by studying the latest image processing techniques using technologies such as deep learning. In order to understand the real situation of the users, the opinions of the users have to be asked. Also, the opinions and needs of each user are different and this research has to be done with a group. It will have to adapt to the user's mood by analyzing the interaction between environmental conditions and moods. These research problems involve improving algorithms that can more usefully interpret and leverage environmental cues to generate music recommendations. The system should be able to perceive environmental features and relate to understanding musical cues. The system should adapt and evolve with the times. It should be decided whenever possible based on user preferences. This research aims to revolutionize music recommendation systems by providing users with a personalized, rich listening experience. By leveraging real-time environmental context, the proposed system can create meaningful connections between users' surroundings, emotions, and music preferences. This research happens to create a new generation of recommendation systems that understand users' music tastes and unique contexts, enhancing the overall enjoyment and satisfaction of listening to music.

3.4 Research Gap

This product differs from other existing studies in that it focuses primarily on the user's surroundings. Lack of research suggesting music for existing people and moods, and a lack of song recommendations tailored to real-time environments. This app is organized to support Android platforms. Mainly, it can be achieved by adding ambient weather conditions, indoor-outdoor, environmental color changes etc. Related is user-friendly. This works as a real-time system. It aims to provide personalized music recommendations.

Table 1:Research Gap

Feature	**Research 01**	**Research 02**	**Research 03**	**Research 04**	**Propose System**
Image Processing	✓	✓	✓	✗	✓
Convolutional neural network (CNN)	✗	✓	✗	✓	✓
Capture Weather & indoor or outdoor	✗	✗	✗	✗	✓
Music Recommendation	✓	✓	✓	✓	✓
Mobile Solution	✓	✗	✗	✓	✓
Monitoring by Multiple Users	✓	✓	✓	✓	✓

4. OBJECTIVES

4.1 Main Objective

The main objective of this project is to use image processing techniques and deep learning algorithms to detect weather forecast and indoor-outdoor condition in user's surrounding photo and provide personalized music accordingly. By analyzing the environment captured in the image, such as cloudy weather, sunlight and color door scenes, the system aims to predict the prevailing weather conditions in real time. This analysis was performed using convolutional neural networks (CNNs) trained on a diverse dataset of environmental images labeled with corresponding weather attributes. Once the weather is detected, the system correlates it with appropriate music selections, along with weather attributes that match the user's mood and preferences. . By seamlessly integrating image processing and deep learning technologies, the project provides users with a personalized music listening experience that adapts to their surroundings and improves overall enjoyment and usability.

4.2 Specific Objectives

1. Obtaining Data Sets: Obtaining suitable datasets is crucial for training and testing image analysis and feature recognition models. These datasets should include images of various weather conditions, such as sun, clouds, rain, snow, and indoor-outdoor conditions. Data sources can be publicly available, weather databases. Careful selection and processing of high-quality images ensure model strongly and accuracy.

2. Image Analysis and Context Detection: The study uses image processing techniques and deep learning algorithms to analyze datasets and develop models capable of recognizing indoor-outdoor features, particularly weather conditions. Convolutional neural networks (CNNs) are used to learn hierarchical features from visual data. The trained models can identify patterns and features indicating different weather conditions, allowing them to accurately classify prevailing weather conditions in real time..

3. Validating the Performance of the Developed Models: Validation is crucial for evaluating the performance and efficiency of image analysis and feature recognition models. It involves accuracy, retesting, and evaluation using separate validation data sets. Techniques like validation and comparison with existing methods ensure strongness and generalizability across different scenarios. Continuous optimization based on validation results improves model performance and reliability.

4. Real-time Data Integration: The development and validation of image analysis and context recognition models are being integrated into a real-time system to process user-provided images and generate personalized music recommendations based on weather and indoor-outdoor conditions. This involves creating software components and APIs for communication between the image analysis module and the music recommendation system, ensuring accurate weather prediction recognition and timely music suggestions.

4.3 Solution

The proposed solution is a mobile application that uses image processing to analyze photos captured by the device's back camera and provide personalized music recommendations based on detected weather conditions and indoor-outdoor conditions. The app uses image processing algorithms to extract visual features that indicate weather conditions and a deep learning model to predict the most likely weather conditions. It accesses a database of personalized music playlists created for different weather conditions, ensuring users receive music suggestions that match their surroundings. The system continuously learned and improved over time, tracking user interactions and preferences to refine recommendation algorithms. The user-friendly interface features an intuitive option for a camera and background photo buttons.

5. Feasibility study

5.1. Technical Feasibility:

This project aims to develop a Music Recommendation System using Python and machine learning algorithms. The hardware, including devices for capturing images and audio, should be widely accessible and cost-effective. Proficiency in key technologies like image and voice recognition, programming languages, and libraries like Python, TensorFlow, and PyTorch is necessary for effective implementation. Open-source Python and machine learning libraries like TensorFlow minimize development expenses and provide extensive resources. Skilled developers and experts in machine learning and Python further strengthen the project's technical feasibility. Data for weather classification and music recommendation is readily available from sources like Kaggle and weather APIs. Technological infrastructure, including image processing libraries, deep learning frameworks, and cloud computing platforms, is widely accessible and well-supported. Although image processing and deep learning techniques are complex, established frameworks and libraries make it feasible to implement advanced algorithms for weather classification and music recommendation.

5.2 Economic Feasibility:

The Music Recommendation System has significant economic potential due to its use of open-source technologies like Python and machine learning algorithms. Its economic viability depends on its ability to generate a return on investment (ROI) for music platforms or streaming services. By enhancing user engagement and satisfaction through personalized music recommendations, the system can drive increased user retention and revenue generation. Development costs include personnel expenses for data scientists, software engineers, domain experts, cloud computing resources, and software licenses. Potential revenue can be generated through subscription-based models, in-app purchases for premium features, and affiliate marketing partnerships with music streaming services. The favorable ROI and market demand for personalized music recommendation services make the project economically feasible.

5.3.Operational Feasibility:

The Music Recommendation System is designed to prioritize data privacy and adhere to regulatory standards, ensuring transparency and trust among users. The system aims to enhance user experience by providing personalized music recommendations based on real-time weather predictions. The architecture is designed for scalability, allowing for future expansion to accommodate user demand and data volume. The integration with external APIs for weather data and music streaming services may pose some complexity, but standardized protocols and documentation facilitate seamless integration. This approach ensures compliance with regulations and promotes responsible and ethical usage of the system.

6. Requirements Gathering

6.1 Requirements Gathering and Analysis

The development of a music recommendation system utilized Kaggle, a data source for weather conditions, music genres, and image data. The process involved assessing the quality, relevance, and compatibility of relevant datasets with project requirements. Key insights were extracted from the data, including visual cues related to weather conditions, indoor-outdoor situations for relevant recommendations, metadata collection, user feedback, image processing algorithms, convolutional neural network models, and a recommendation engine for personalized playlists. The research methodology involved a thorough review of existing research and examining similar systems to the proposed system. The study's objectives were established through consultations with music industry professionals, technology experts, and researchers in relevant fields. The research methodology evolved through an extensive requirement-gathering process and information sources. Ethical considerations were crucial during the requirement-gathering phase, including user privacy protection and adhering to ethical guidelines. Data collection for testing and validation involved capturing user interactions within the application, requiring transparent communication, consent forms, and careful selection of recording equipment. By gathering requirements, the research methodology was tailored to address specific objectives, ensuring a comprehensive evaluation of the Music Recommendation System while upholding the highest standards of ethical conduct and research integrity. This approach ensured a comprehensive evaluation of the system while upholding the highest standards of ethical conduct and research integrity.

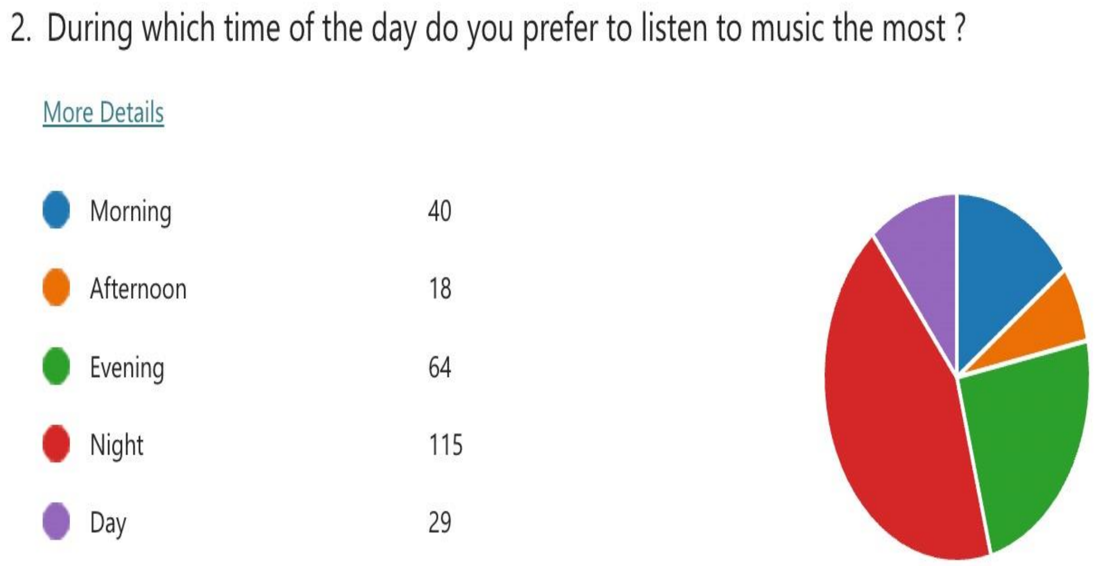

Figure 1:User Responses Result for which time

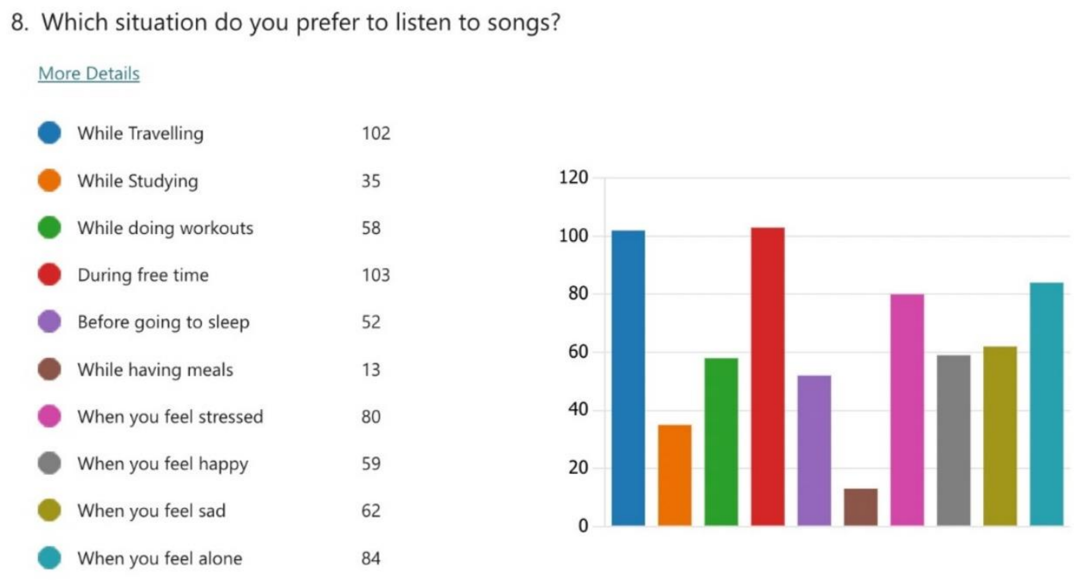

Figure 2:User Responses Result for which situations

6.2 Functionality of the system

Image Capture:

The system interface must incorporate a camera feature enabling users to capture a surrounding image in real time. The captured image should be of sufficient quality to facilitate accurate surrounding recognition and subsequent analysis. Additionally, the interface should provide feedback to ensure users are aware of the image quality requirements.

Analysing the captured image:

The system uses deep learning models, specifically convolutional neural networks (CNNs), to predict and identify the current weather conditions in the captured image. Following image capture, the system must employ image processing techniques to isolate and extract the users surroundings from the captured image

Weather Detection:

Based on the classified surrounding details, the system should predict and construct user surroundings. This surrounding information and serves as the basis for generating personalized music recommendations..

Playlist Generation:
Leveraging the user surrounding and other contextual information, such as time of day or user activity, the system should generate a personalized music playlist tailored to the individual user's preferences and mood. This playlist may include recommendations based on music genre, artist preferences, and past listening history.

software application:
The system interface should provide users with the ability to access and listen to the generated personalized playlist directly within the software application. This functionality enhances user experience by providing seamless access to recommended music content.

Listening Experience: The application should provide users with the option to listen to the recommended playlist through built-in media player functionality.

Real-time Processing: The application processes all processing in real-time, from image capture to music recommendation, allowing users to access personalized playlists based on their current environment.

6.3. Non-Functional Requirements

Non-functional requirements are a critical aspect of software development because they define how a software application operates and performs, rather than just its functional features. These requirements focus on aspects such as performance, security, usability, scalability, and other qualities that contribute to the overall user experience and system effectiveness. The success of the product is dependent on these non-functional requirements.

Privacy and Security:

The system should prioritize user privacy by handling user data securely and not sharing it with unauthorized parties. Transparent information about data collection, processing, and storage practices should be provided to build trust. Robust security measures like encryption, authentication, and access control mechanisms should be used to prevent unauthorized access, data breaches, and malicious attacks.

- Data Encryption: Sensitive user data should be encrypted during transmission and storage to protect against unauthorized access and data breaches.
- Authentication and Authorization: The system should implement robust authentication and authorization mechanisms to ensure that only authorized users can access and modify data.
- Compliance: Developers should adhere to data privacy regulations such as GDPR (General Data Protection Regulation) or CCPA (California Consumer Privacy Act) to safeguard user privacy and comply with legal requirements.

Performance Efficiency:

The system should efficiently process images and provide music recommendations, prioritizing performance optimization to minimize processing delays and ensure a smooth user experience, especially in real-time scenarios where prompt responses are expected.

- Response Time: The system should respond promptly to user interactions, with minimal delay between input and output.
- Loading Time: Application and content loading times should be optimized to provide a seamless user experience.
- Resource Utilization: The system should efficiently utilize resources such as CPU, memory, and network bandwidth to minimize resource wastage and maximize performance.

- **User Interface and User Experience (UI/UX):**

➢ Intuitive Design: The user interface should be intuitive and easy to navigate, allowing users to perform tasks efficiently without unnecessary cognitive load.

➢ Visual Appeal: The interface should adhere to modern design standards, with visually appealing layouts, colors, and typography.

➢ Accessibility: The application should be accessible to users with disabilities, following accessibility guidelines such as WCAG (Web Content Accessibility Guidelines) to ensure inclusivity.

- **Scalability:**

➢ Database Scalability: The system architecture should support horizontal scaling of databases to accommodate growing data volumes and user traffic.

➢ Server Scalability: Server infrastructure should be designed to scale dynamically based on demand, ensuring consistent performance under varying loads

Reliability and Availability:

The system, which provides accurate weather predictions and personalized music recommendations, must prioritize reliability and availability, ensuring uninterrupted service and minimizing disruptions. This requires robust fault-tolerant mechanisms, redundancy measures, and proactive monitoring to detect and address potential issues.

➢ System Uptime: The system should strive for high availability, minimizing downtime for maintenance and updates.

- Fault Tolerance: The system should be resilient to failures and errors, with mechanisms in place to handle exceptions gracefully and prevent service disruptions.
- Disaster Recovery: Procedures and mechanisms should be in place to recover data and restore service in the event of a catastrophic failure or disaster.

6.4 System Requirements

The system requirements for implementing the proposed solution include:

- **Laptop/Desktop:**

A laptop or desktop computer serves as the primary hardware platform for developing and deploying the system. It should meet the minimum hardware specifications required to run the necessary software tools and libraries.

- **Cameras and Audio Recorders:**

High-quality cameras and audio recorders are essential for capturing user selfies, surrounding images, and voice inputs. These devices should be capable of producing clear and detailed images and audio recordings, ensuring accurate analysis and processing.

- **Internet Connection:**

A stable internet connection is necessary for accessing online resources, such as cloud-based development platforms, datasets, and APIs. Additionally, internet connectivity enables seamless communication between components of the system and facilitates real-time updates and data synchronization.

- **Mobile Phone:**

A mobile phone serves as the endpoint for delivering personalized music recommendations to the user. It should be compatible with the mobile application developed as part of the system. The mobile phone provides users with access to their personalized playlists and allows them to interact with the recommendation system on the go.

7. Methodology

7.1 Tools and technologies.

- **Programming language - Python**

We selected Python and Google Colaboratory as our primary tools for developing machine learning models due to several compelling reasons. Python is widely recognized for its simplicity, versatility, and extensive ecosystem of libraries, making it an ideal choice for machine learning tasks. By leveraging libraries like NumPy, pandas, TensorFlow, and PyTorch, we could efficiently build, train, and evaluate our models with ease.

- **Google Colaboratory**

Google Colaboratory offered several advantages that aligned perfectly with our project requirements. Its provision of free access to GPU and CPU resources allowed us to accelerate model training without incurring additional costs. Additionally, Colab's seamless integration with Python and built-in support for data preprocessing, analysis, and visualization facilitated collaborative development and streamlined our workflow. The platform's ability to visualize metrics such as loss and accuracy enabled us to evaluate and optimize our models effectively.

- **Kaggle**

We went for Kaggle as our data source platform due to its extensive collection of datasets and educational resources tailored to data science and machine learning projects.

Leveraging Kaggle's datasets allowed us to access diverse data sources relevant to our machine learning tasks, ranging from weather prediction to age, gender, and voice emotion recognition. The mentioned datasets were taken from the Kaggle for the use of ML model.

Weather-prediction

- https://www.kaggle.com/datasets/vijaygiitk/multiclass- weather-dataset/

Age prediction

- https://susanqq.github.io/UTKFace/

Gender prediction

- https://susanqq.github.io/UTKFace/

Voice emotion recognition

- https://www.kaggle.com/datasets/ejlok1/toronto- emotional-speech-set-tess
- https://www.kaggle.com/datasets/ejlok1/cremad/data
- https://www.kaggle.com/datasets/uwrfkaggler/ravdess-emotional-speech-audio
- https://www.kaggle.com/datasets/ejlok1/surrey-
- audiovisual-expressed-emotion-savee

- **TensorFlow**

TensorFlow emerged as our preferred machine learning framework due to its robustness, scalability, and comprehensive toolset for building deep learning models. With TensorFlow, we could harness state-of-the-art algorithms and techniques to develop powerful machine learning models tailored to our project requirements.

- **Flutter, Visual Studio Code, and Firebase**

Flutter, Visual Studio Code, and Firebase were chosen for their respective roles in developing our mobile application. Flutter's cross-platform capabilities enabled us to build a single codebase for multiple platforms, ensuring compatibility and consistency across devices. Visual Studio Code provided a feature-rich development environment with seamless integration for writing, debugging, and deploying code. Meanwhile, Firebase offered backend services such as authentication, database management, and cloud storage, facilitating the seamless integration of our machine learning models with our mobile application while ensuring scalability, security, and real-time data synchronization.

- **Swagger**:

Swagger is an open-source software framework that allows developers to design, build, document, and consume RESTful web services. We integrated Swagger into our development process to streamline API documentation and facilitate communication between frontend and backend teams. With Swagger, we could efficiently document and test our APIs, ensuring consistency and reliability across our application ecosystem.

Overall, the combination of Python, Google Colaboratory, Kaggle, TensorFlow, Flutter, Visual Studio Code, and Firebase provided us with a robust and versatile toolkit to effectively develop, deploy, and integrate machine learning models into our mobile application, thereby fulfilling our project requirements with efficiency and efficacy.

7.2 Introduction

Melowave is a mobile application that uses machine learning and artificial intelligence to provide personalized music recommendations. The app uses real-time data, including weather conditions and indoor-outdoor factors, to understand each user's environment. Melowave aims to create playlists tailored to each user's needs. To ensure the system's effectiveness, a thorough evaluation process was conducted to identify key factors influencing music preferences. A survey was conducted to understand the user experience of the environment. Results showed that music consumption varies by category of weather conditions, with more users preferring night time cloudy time(). The study also revealed that preferences have changed based on indoor-outdoor situations we found the most users are impress the outdoor situation(3). These findings helped develop the machine learning model, enabling better categorization of users and providing more accurate music recommendations. Overall, Melowave aims to revolutionize the music listening experience through personalized recommendations.

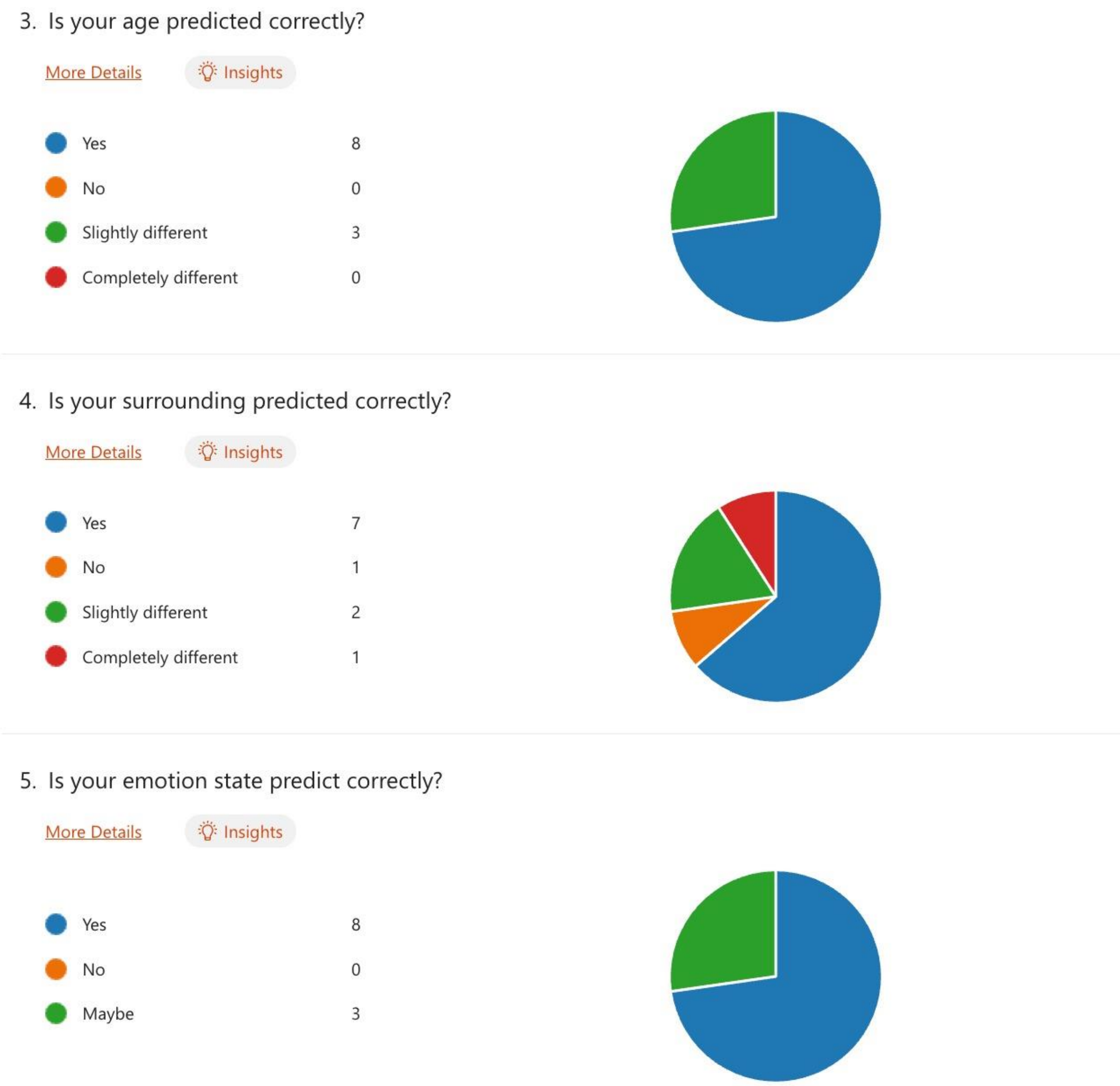

Figure 3:Survey results of Surrounding

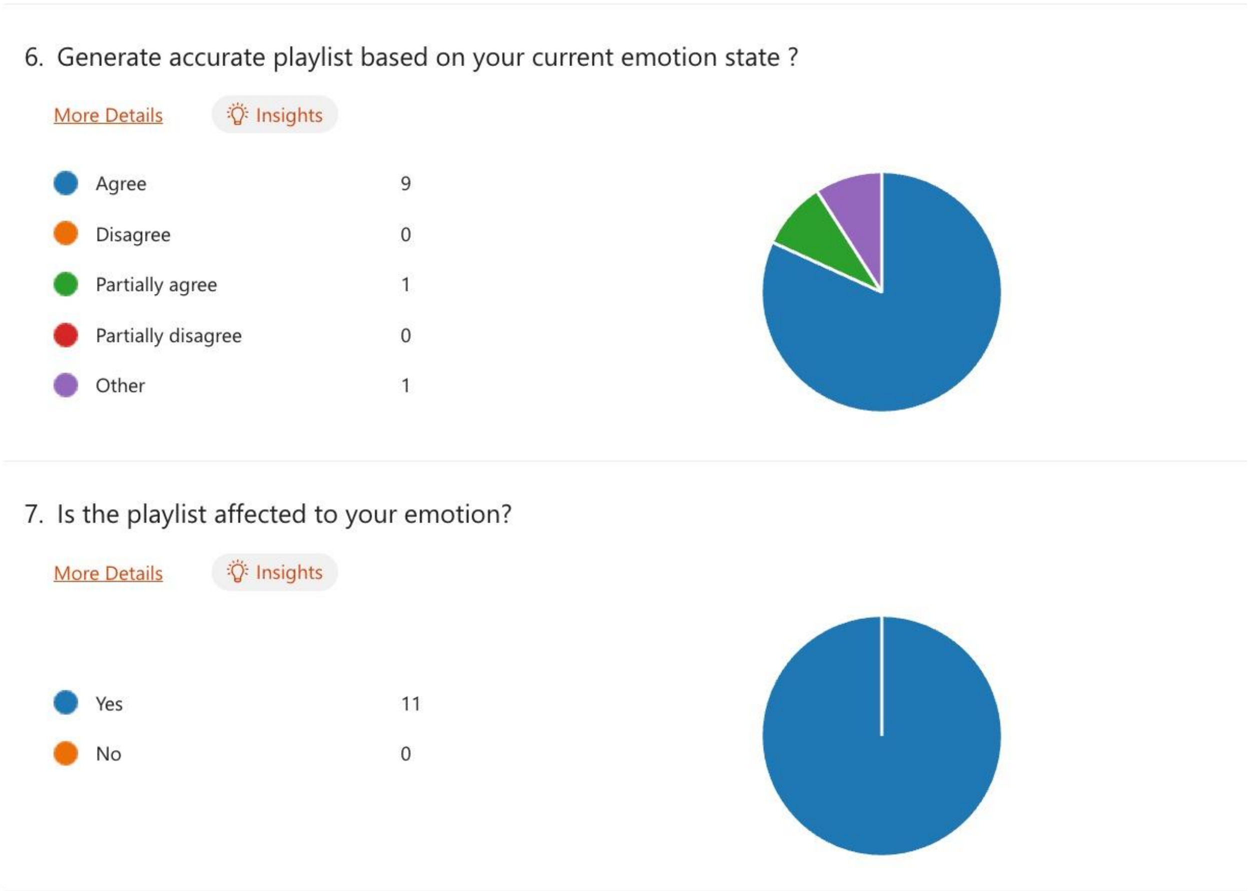

Figure 4:Survey results of play list

7.3 Overall System Diagram

In the proposed solution for a multi-model music recommendation system, we have identified four main sub- components. The System overall Diagram is illustrated below

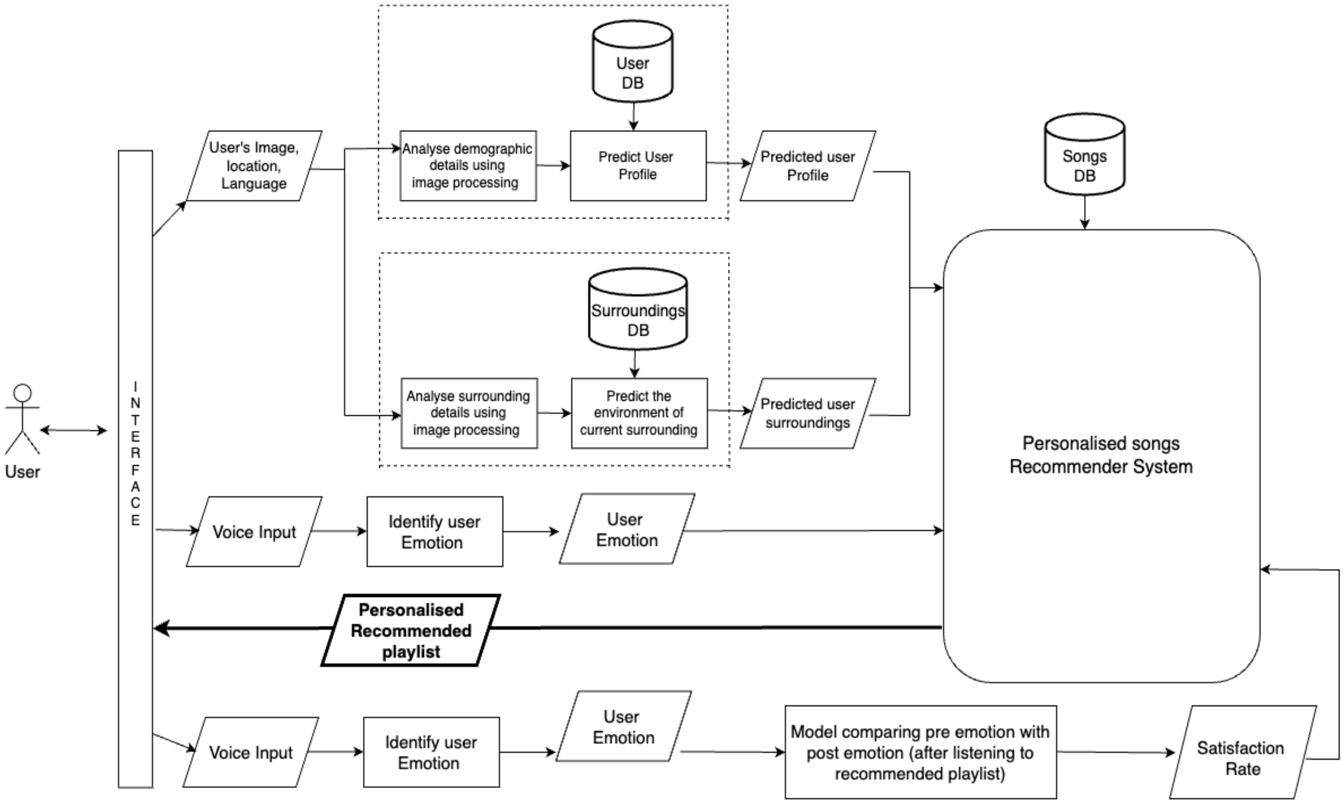

Figure 5:Overall System Diagram

As depicted in, our proposed system comprises four main sub-components designed to achieve optimal functionality. The first component involves retrieving an image of the user for analysis, with a focus on extracting essential user details such as age and gender. This information serves as crucial input for the recommender system, enabling personalized music recommendations tailored to the user's demographic profile.

The second component of our system entails capturing an image of the user's surroundings to identify current weather conditions. This data is then extracted and forwarded to the recommender system as additional input. By incorporating weather information, our system enhances the relevance of music recommendations, aligning them with the prevailing atmospheric conditions and user preferences.

Moving on to the third component, we gather voice input from the user to extract their current emotional state. This emotional data provides valuable insight into the user's mood, allowing the recommender system to curate music selections that resonate with their feelings and emotions at that moment.

Once all the relevant inputs are collected, our music recommendation models spring into action, generating a tailored playlist designed to enhance the user's entertainment experience. By leveraging advanced machine learning algorithms, our system ensures that each recommendation is finely tuned to the user's preferences, demographics, weather conditions, and emotional state.

Furthermore, our system includes an evaluation mechanism to assess the post-listening emotions of the user. This feedback loop enables continuous refinement and improvement of the music recommendation process, ensuring that future recommendations are even more aligned with the user's evolving tastes and emotional responses. Overall, our comprehensive approach aims to deliver a truly personalized and immersive music listening experience for every user..

7.4 Component Overview Diagram

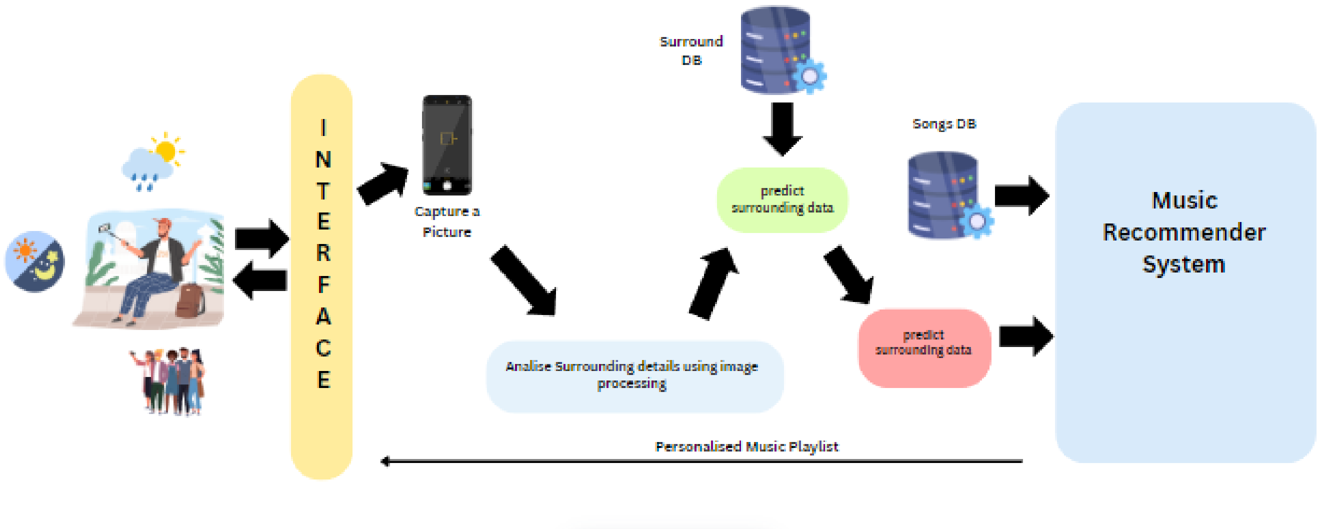

Figure 6:Individual System Diagram

The initial step of this component is to capture a high-quality image of the surroundings, which serves as the basic input for further analysis. Once the image is acquired, the system proceeds to extract details of the indoor-outdoor condition to the outdoor weather conditions using advanced image processing techniques. This includes identifying weather conditions such as cloudy, rainy, sunny, foggy, indoor outdoor descriptions in the environment. Then, the system uses machine learning algorithms to predict the user's weather conditions based on the extracted surroundings details. These predictions are then aggregated to create a comprehensive user profile that captures the contextual information essential for personalized recommendations. , which is seamlessly integrated into the recommendation system as input data. Using this information, the recommender system curates a personalized playlist tailored to the user's weather conditions and indoor-outdoor situation preferences. Finally, the personalized playlist is delivered to the mobile app, where the user can access and enjoy music content tailored specifically to their surroundings and preferences.

7.5 User interfaces of the Mobile application

From the user's perspective, the "Melowave" mobile application begins with a login window prompting the user to sign in with their Google account ***(Error! Reference source not found.)***.

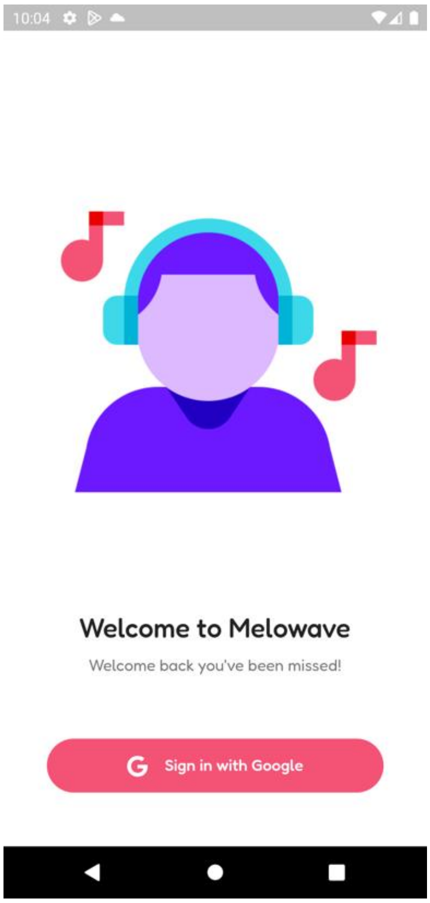

Figure 7:Login UI of Mobile app

Once logged in, the application guides As the first step, a consent will be prompt for permission to use the camera, gallery, and microphone of the user's mobile phone. The next step is to take a picture with the device's back camera, capturing the user through a capture a picture of the surroundings using a back cam features for analysis (Figure 10).

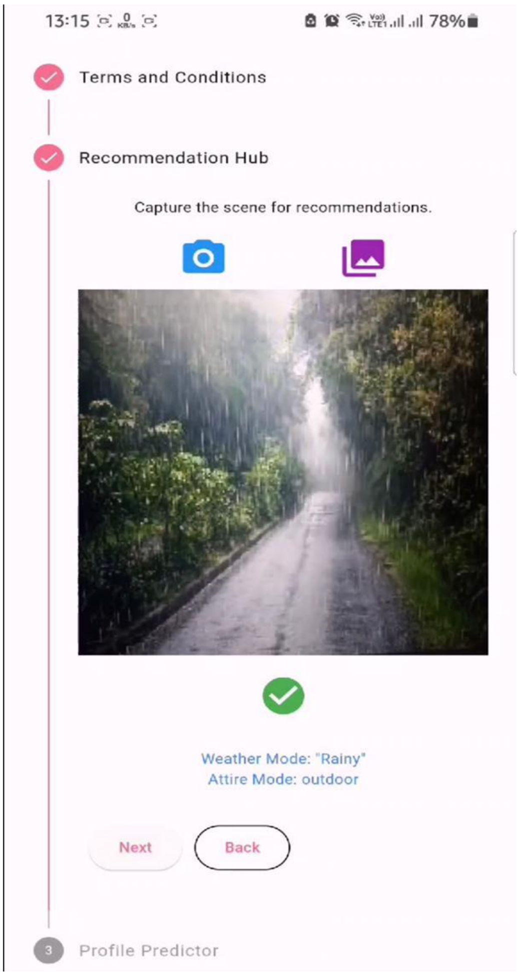

Figure 8:Image weather Predictor UI

The application uses the camera to capture user profile details, gathering facial features data. In the third step, the user is asked to record a voice clip using the microphone, allowing the system to analyze their emotional state.

The machine learning models, including age, gender, weather, and emotion prediction models, are deployed after clicking the "next" button, analyzing collected data to generate outputs like user's age, gender, current weather conditions, and emotional state. The music recommender model creates a personalized playlist based on user's age, gender, weather, and emotional state. If the user is dissatisfied or mood doesn't improve, the post-emotion classification model intervenes.

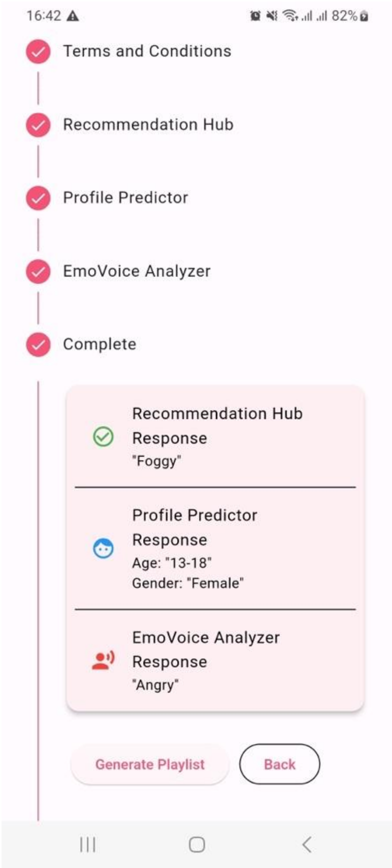

Figure 10:Individual System Diagra

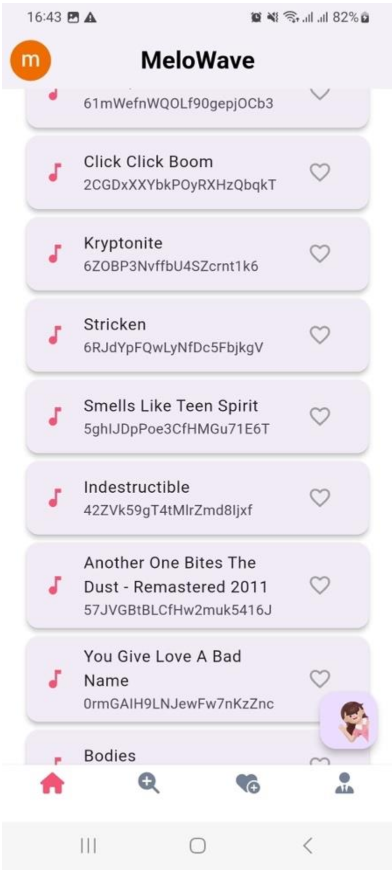

Figure 9:Individual System Diagra

7.6 Machine leaning models and accuracy levels.

1) Surrounding identification through image processing:

As the first component extracting user sirroundings, we have used the CNN algorithm, and weather conditions and image classification using VGG19 to identify features has added value to the system image processing, deep learning methods, and the pre-trained model – "VGG19 " from the Kaggle to develop the weather prediction machine learning model. After training the model with modifications, I could achieve accuracy level of 0.88. The following images convey the accuracy levels of the weather Classification model after evaluation (Figure 12).*)*.

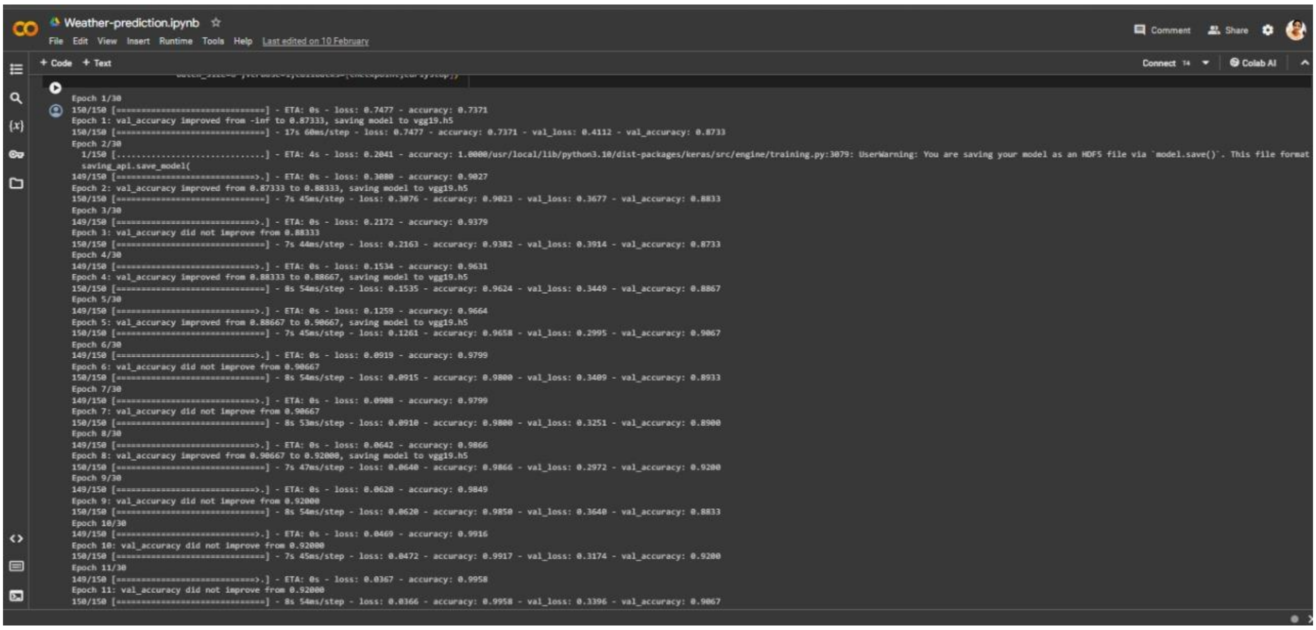

Figure 11:Train Modle

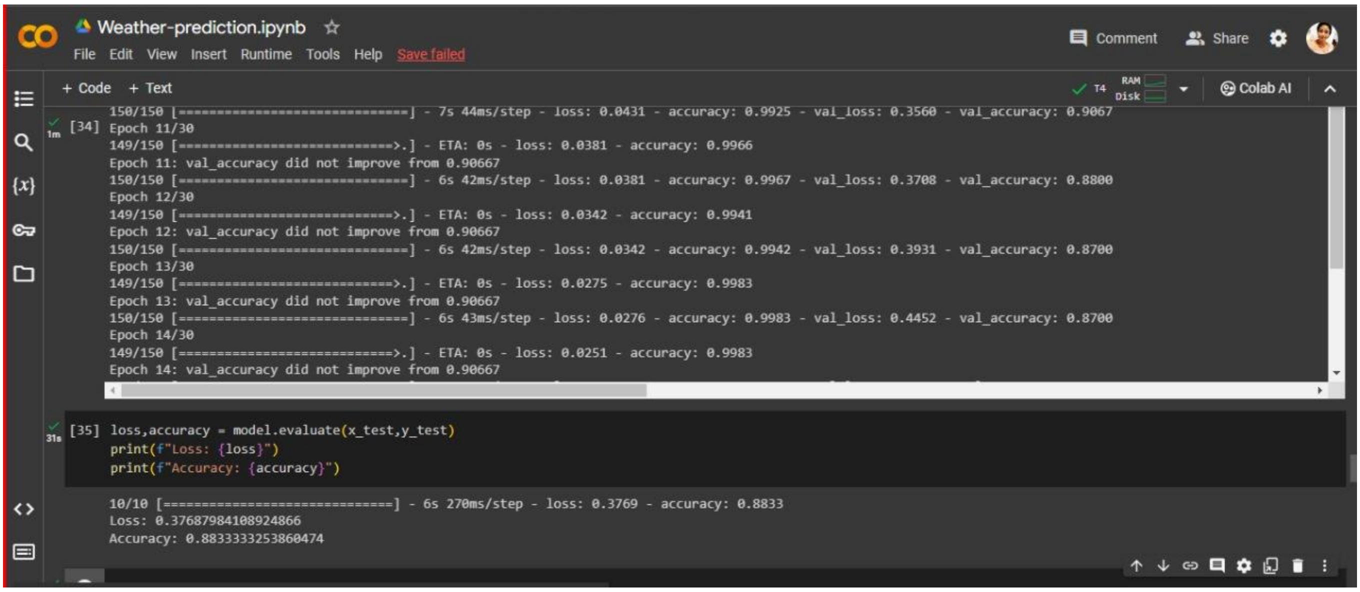

Figure 12:Accuracy and loss of the weather prediction modle

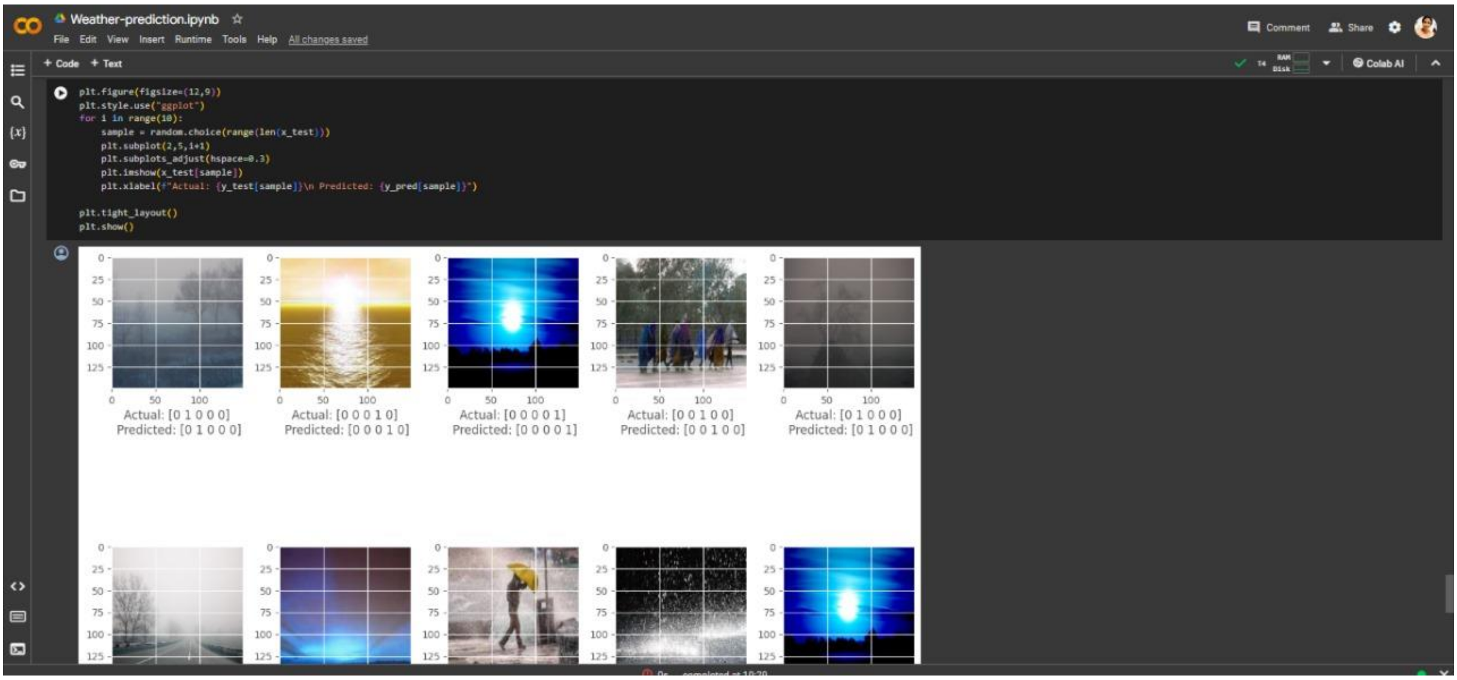

Figure 13: Predict Model

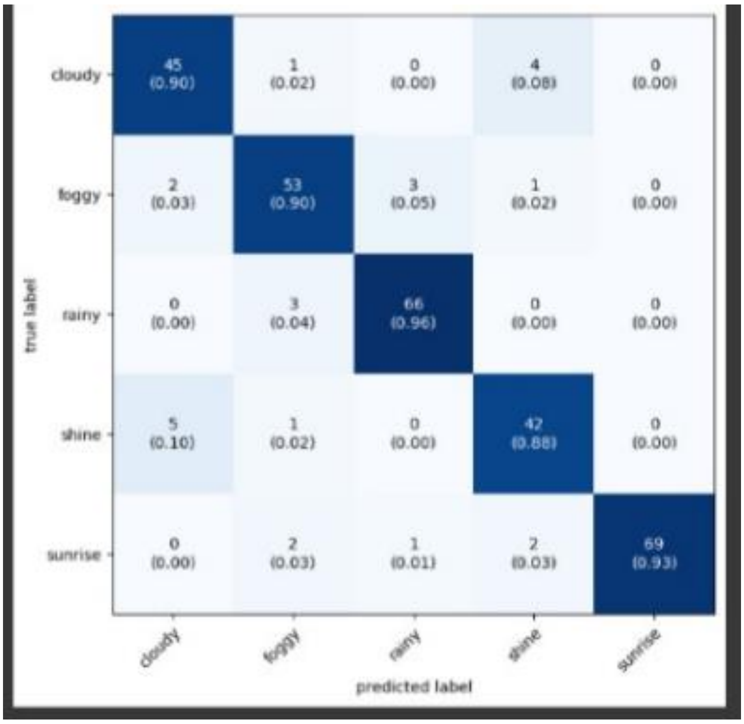

Figure 14:confusion Metrix of the weather prediction model

7.7 Field visits and Feedbacks

After implementing the mobile application and after integrating, as always user feedbacks were needed to test and to make changes. Considering field visits and feedbacks, it plays a crucial role in ensuring the success of our mobile application. By conducting field visits, we can directly engage with our target users and observe their behaviors, preferences, and pain points in real-world settings. This firsthand experience allows us to gain valuable insights into how our application is being used and how it can be improved to better meet user needs. Additionally, collecting feedback from users enables us to gather direct input on their experiences, likes, dislikes, and suggestions for enhancements. Incorporating this feedback into the development process enables us to iteratively refine and optimize our mobile application, ensuring that it remains relevant, useful, and user-friendly. Ultimately, field visits and feedback serve as essential tools for understanding user requirements, validating design decisions, and ultimately delivering a mobile application that truly resonates with its intended audience. We could identify many mistakes and points to improve during our field visit ***(Error! Reference source not found.)***.

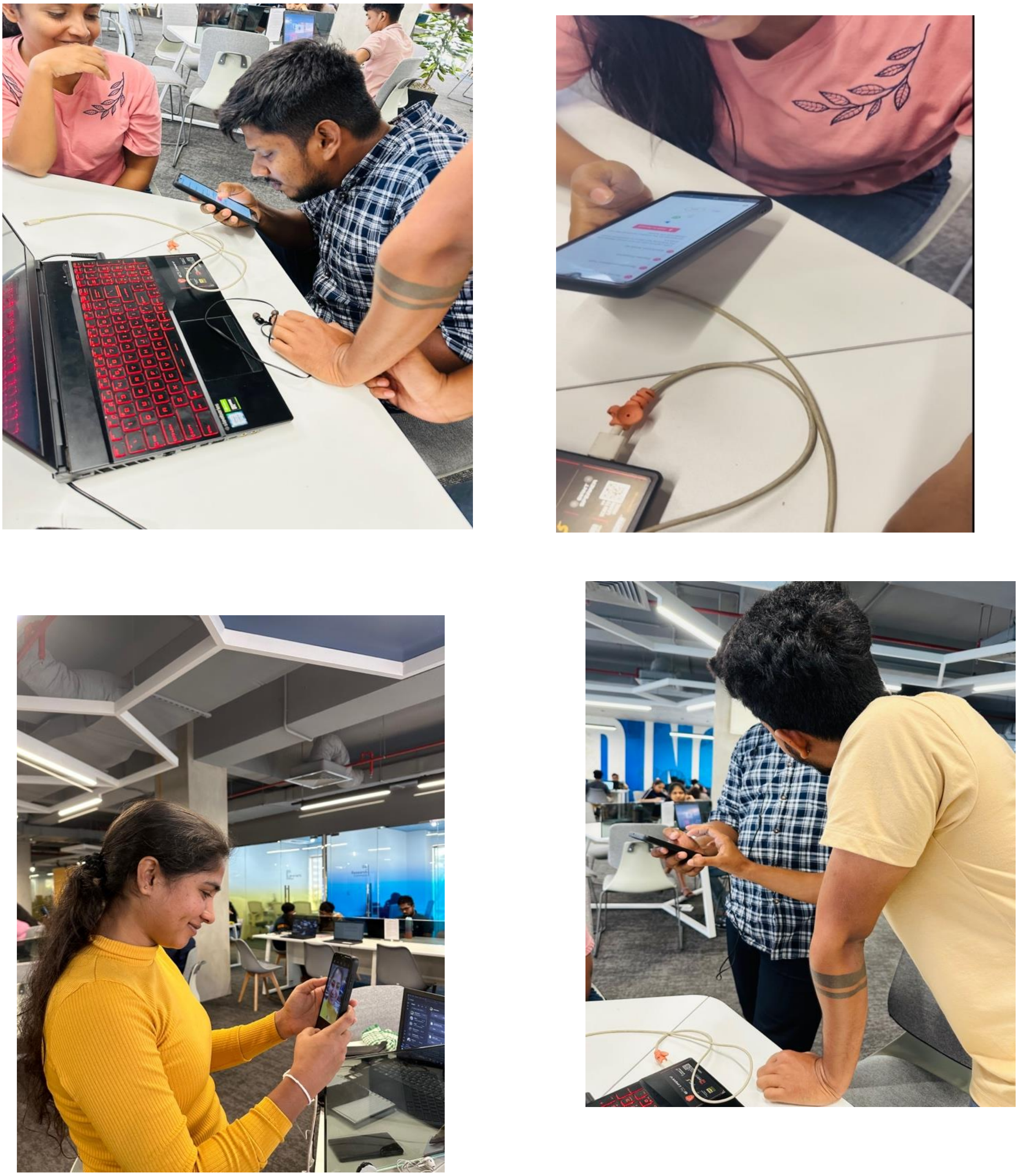

Figure 15:Field visit and Testing

Feedback indispensable for the success of our mobile application as it provides essential insights into user experiences, preferences, and areas for improvement. By actively soliciting and responding to user feedback, we can enhance the overall user experience, identify, and address bugs and technical issues promptly, validate features and functionality, tailor music recommendations to user preferences, and foster user engagement and loyalty. Utilizing feedback as a guiding force enables us to continuously refine and improve our application, driving user satisfaction and contributing to its long-term success in the market.

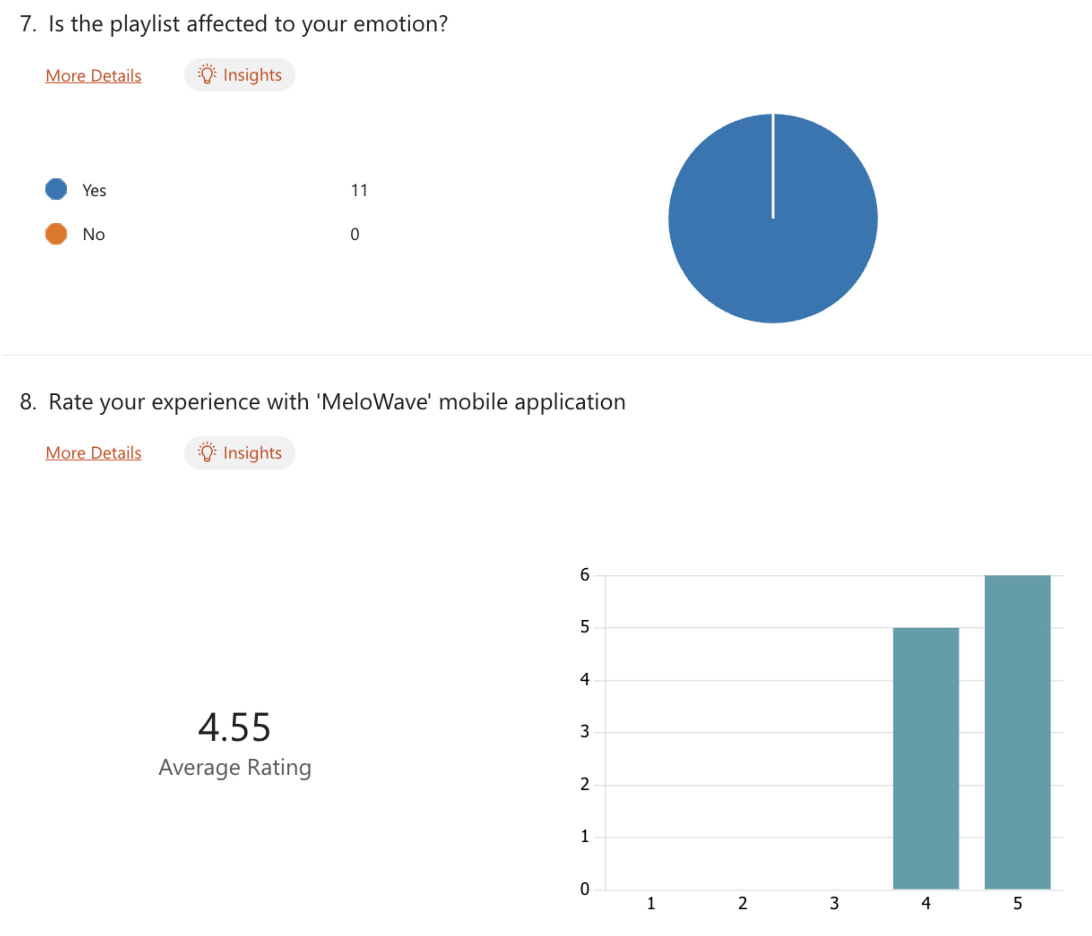

Figure 16:User Feedback

7.8 Gantt Chart

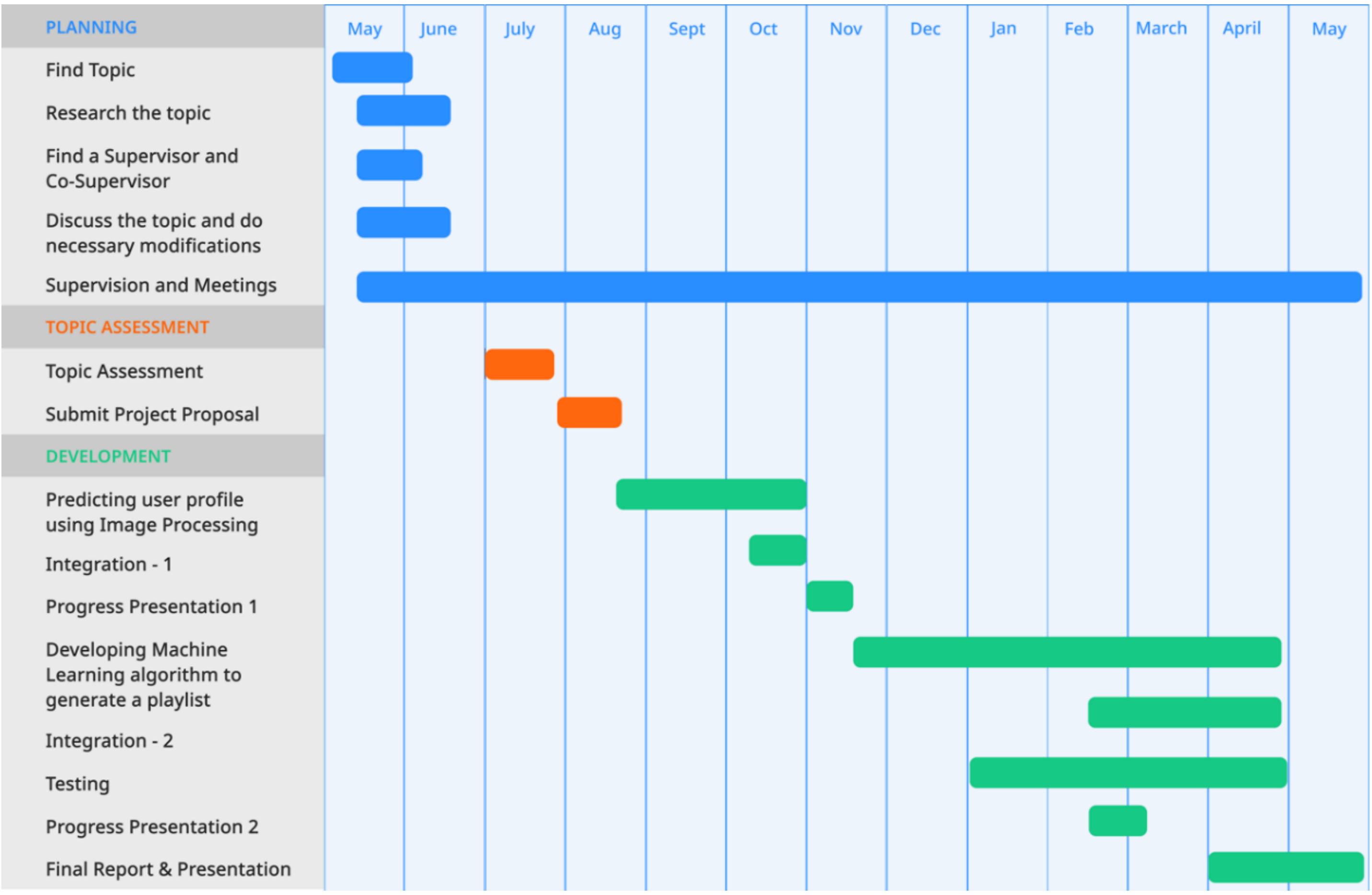

Figure 17:Gantt Chart

7.9 Work Breakdown Chart

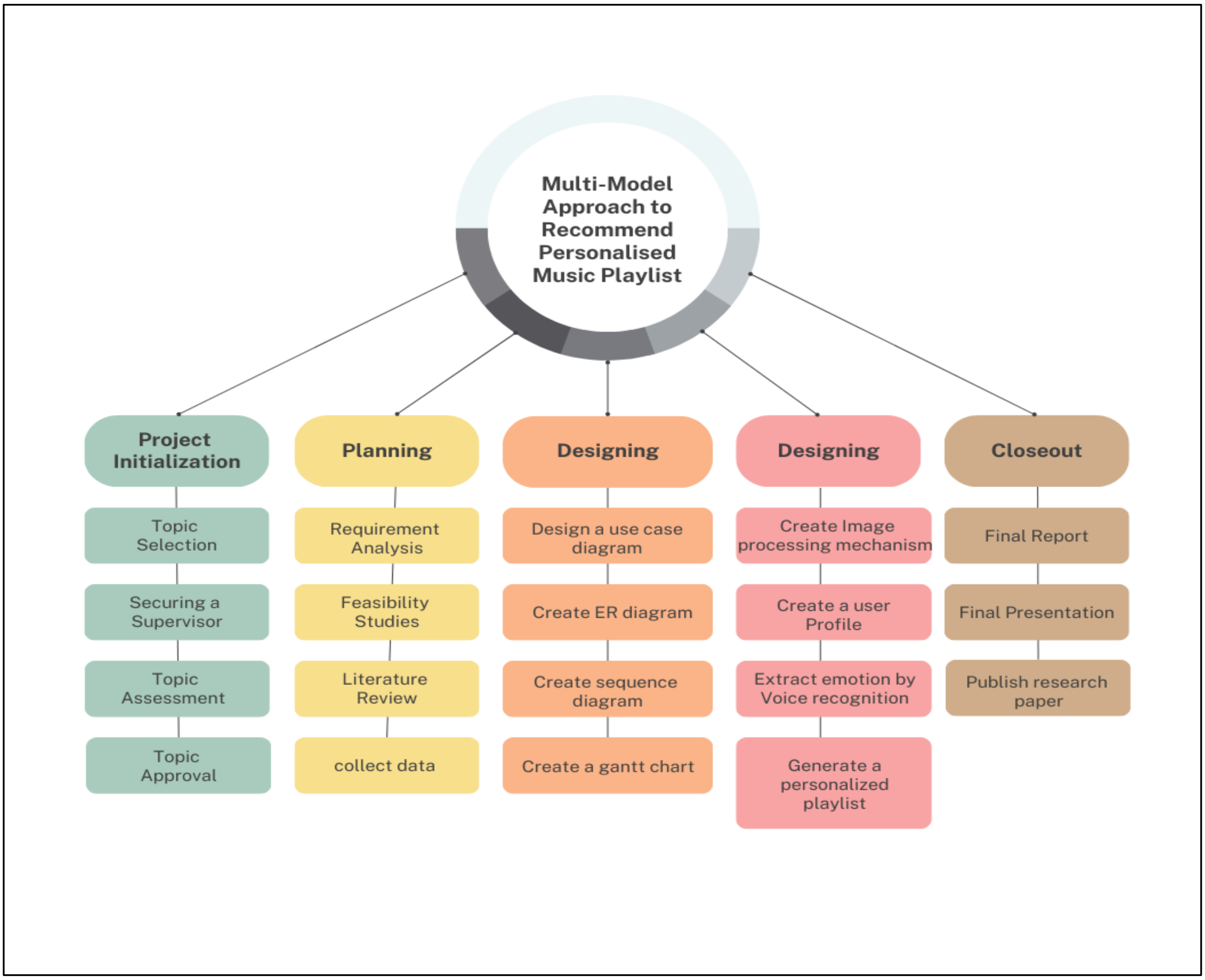

Figure 18:Work breakdown chart

8. Limitations and Challenges

The research presents an innovative method for personalizing music recommendations without lengthy forms, but it faces several limitations and challenges in implementing this solution.

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- **Privacy Concerns**

The challenge lies in gathering user images due to privacy concerns, as users may feel uncomfortable and unwilling to share their personal information.

- **Biases in Data**

The recommender model's accuracy is significantly influenced by the diversity of the training data, as biased data may lead to inaccurate predictions for specific surroundings details.

- **User Acceptance**

The proposed system, which uses weather condition images to forecast the environment, may face resistance from users, particularly in third world countries like Sri Lanka, which has low adoption rates for new technology.

- **Technical Complexity**

The implementation of a convolutional neural network (CNN) for ambient image classification is complex, requiring technical expertise to ensure efficiency and accuracy.

- **User Experience**

The primary objective is to minimize outdated forms, but some users may find sharing environmental quality weather images more intrusive or uncomfortable than filling out forms.

- **Accuracy and Reliability**

Ambient image classification models' accuracy depends on image quality, lighting conditions, and weather changes, making it crucial to assess their reliability for forecasting indoor and outdoor weather conditions.

9. TEST PLAN

MeloWave Music mobile app testing includes several phases to ensure early bug detection and resolution, improving system robustness and usability. Music recommendations are based on the user's environment.

9.1 Unit Testing

Researchers will conduct unit tests for image classification and music recommendation models, identifying and correcting errors in each component. Focused on two main areas.

a) Performance testing of the component.

- Evaluated the processing time of the image classification model across different image sizes.

b) Accuracy testing of the component.

- The verification model correctly classifies images within an acceptable time frame.

9.2 Integration Testing

This research project focuses on the integration of components, testing them individually and simultaneously to prevent system errors and ensure system stability.

9.3 Final Examination

Final testing ensured problem-free system operation using various test scenarios and sample data. In the second phase, users provided feedback on the mobile app. The user experience was measured, and the researchers refined the application's interface to improve the end-user experience.

10. BUDGET AND COMMERCIALIZATION

Considering the widespread use of music players in people's daily lives, this project has significant potential for commercial success. Individuals are willing to invest in an improved music player experience, indicating substantial commercial value. However, with established market leaders like Spotify, iTunes, and Deezer already in place, it's crucial to devise a competitive and fair pricing strategy for the music player. While popular subscription models like those of Spotify, Apple Music, and Deezer typically charge around $10 per month, some users find this pricing too high for the perceived value. Hence, a different subscription model is proposed to drive the commercialization of this mobile app.

Table 2:Subscription Type

	Free version	**Paid version (<$10/month)**
Advertisements	Yes Advertisement networks such as Google Adsense /Admob will run on this version of the mobile app	No No advertisements will be displayed in the mobile app
Monthly charges for the users.	No Revenue will be generated from the advertisements shown to the user while the user is using the mobile application.	Yes Revenue will be generated from the monthly charges paid by the user.
Features	All features	All features

The final mobile application will be focused on different user groups; therefore, it will be marketed to each user group using different methods.

1. Young People – social media, gaming advertisements
2. Adults – worldwide news
3. Tech People – in-depth technical advertisements, new technologies, new trending applications.

Below is the budget that has been planned for the project. Charges will be changed from time to time, and final charges will be based on the consumption of the resources used in the cloud environment.

Table 3:Budget Plan

Description	**Amount (USD)**
1. AWS Cloud database (S3) for facial images • To store user images collected through the mobile app.	0.023 per GB / Month
2. AWS Cloud database (EFS) for user demographic data. • To store the demographic data of the users.	0.30 per GB / Month
3. AWS Glacier to store User logging from the mobile application.	Storing = $0.004 per GB / Month Retrieving = $0.01 per GB
4. Paper Publications and Documentation.	50 - 100

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