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Music Recommendation System Using Machine Learning

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Abstract: Music recommendation systems function as personalized assistants that analyze listener preferences and suggest relevant songs or playlists. These systems utilize past user data to generate recommendations that align with individual tastes. However, users often struggle to identify the most suitable songs due to the vast availability of music content. Various techniques have been employed to enhance recommendation accuracy, including collaborative filtering, content-based filtering, and hybrid models. Initially, the system gathers substantial user data, such as listening history and ratings, to create comprehensive listener profiles. Several machine learning algorithms, such as Cosine Similarity, K-Nearest Neighbors (KNN), and the Weighted Product Method, can be implemented for effective recommendations. Advanced hybrid approaches, integrating Singular Value Decomposition and Factorization Machines, further optimize recommendation accuracy. These systems are a specialized application of machine learning, leveraging diverse techniques to analyze user behavior and deliver personalized music recommendations. This paper presents a Music Recommendation System that incorporates multiple advanced technologies to improve accuracy and user experience.
Keywords: Music Recommendation, Collaborative Filtering, Content-Based Filtering, Hybrid Models, Machine Learning

I. INTRODUCTION

An important challenge in the diagnosis of thyroid disease disorders is the correct interpretation and clinical analysis of thyroid disease disorder datasets. Thyroid prediction methodologies will allow us to reduce the number of characteristics used to classify thyroid disorders. As music streaming platforms gain popularity, users can access extensive digital libraries featuring millions of songs across diverse genres, moods, and artists. However, this abundance of choices makes it difficult for users to find music that fits their tastes. To tackle this challenge, advanced music recommendation systems have become crucial, assisting users in discovering songs that align with their listening habits and preferences.

Traditional music recommendation methods, such as manual playlist creation and genre-based sorting, are labor-intensive and restrictive. These strategies often lack personalization and fail to adapt to individual user needs. Consequently, incorporating machine learning and filtering techniques is essential to improve the recommendation process and enhance the user experience.

This paper introduces a Music Recommendation System that integrates multiple technologies which includes Frontend Interface**,** Backend Database and Spotify API. Frontend Interface developed with Streamlit for an engaging and user-friendly experience. Backend Database **p**owered by MongoDB, which stores song metadata, user preferences, and feedback for real-time updates and tailored recommendations. Spotify API **r**etrieves up-to-date song details like artist information, album artwork, tempo, popularity, and mood, enhancing the quality of suggestions.

The system utilizes content-based, collaborative, and hybrid filtering methods to generate precise song recommendations. Additionally, it features a user feedback system, enabling users to rate songs and leave reviews, refining suggestions over time. By leveraging machine learning filtering techniques, real-time feedback integration, and a scalable database, this system significantly enhances music discovery and personalization, ultimately improving user engagement and satisfaction.

II. REVIEW OF LITERATURE

Music recommendation systems have gained considerable attention in recent years due to the rapid expansion of digital music platforms and the growing demand for personalized music experiences. Machine learning (ML) plays a crucial role in modern recommendation systems by leveraging user data, song metadata, and contextual information to deliver tailored music suggestions. This review explores various approaches to music recommendation systems, including collaborative filtering, content-based filtering, hybrid models, and deep learning techniques.

A music recommendation system adopts a user-focused approach by classifying recommendation tasks into three main types: basic music suggestions, lean-in exploration, and lean-back listening. It examines essential recommendation methods, such as content-based filtering, sequential recommendations, and psychology-driven techniques. Furthermore, it addresses challenges like personalization, fairness, evaluation, and managing missing or negative feedback.

The system also emphasizes strategies to enhance recommendations, including diverse recommendation lists, improved user interface design, and the use of open data source [4].

The Music Player relies on facial expressions to analyze and interpret data before generating a playlist based on predefined parameters. To develop an emotion-based music system, the proposed model is designed to recognize human emotions accurately. This study discusses existing techniques used by music players for emotion detection, the specific approach employed in the proposed system, and the most effective way to integrate emotion recognition technology. Additionally, it provides an overview of how the system functions, including emotion classification, playlist generation, and overall operation [3].

It primarily aims to predict the next likely song a user would want to hear by studying their listening history and choices. This research integrates machine learning with an Android app to ensure accessibility for mobile users. Hybrid ensemble models enhance performance but require large datasets and high computational power for accurate recommendations. Without real-time data like ratings or user engagement, generating personalized suggestions becomes more challenging [10].

This study explores classification techniques for predicting thyroid disease using data from the UCI machine learning repository. It utilizes various machine learning models—such as Decision Tree, Random Forest, KNN, and Naive Bayes—for comparative analysis. The dataset was refined to boost prediction accuracy. PyCaret was employed to implement and evaluate these algorithms. Among the models tested, Naive Bayes achieved the highest accuracy of 95.91% [6].

This research involves classifying thyroid disorders into four distinct categories: hyperthyroid, euthyroid, hypothyroid, and sick. The main goal is to explore how logistic regression can be applied for multiclass classification on a thyroid-related dataset. The model's effectiveness is evaluated using various metrics such as precision, recall, F-measure, ROC, RMS error, and accuracy. The findings show that the One-vs-Rest strategy in logistic regression yields an accuracy of 85%, whereas the multinomial logistic regression approach provides a slightly higher accuracy of 86% [8].

In this study, a sample dataset of songs will be utilized to identify patterns between users and their musical preferences, enabling the recommendation of new songs based on listening history. The implementation will involve Python libraries such as NumPy and Pandas. Cosine similarity and CountVectorizer will be employed to analyze song similarities. Additionally, a Flask-based frontend will be developed to display recommended songs when a particular track is input [9].

This paper presents a Multi-Criteria Recommender System (MCRS) for music, developed to tackle the issue of information overload in the music industry. It integrates K-Nearest Neighbors (KNN) with the Weighted Product Method (WPM) to improve personalized recommendations. Music lyrics are digitized using the NRC Lexicon, and user preferences are factored in through WPM for enhanced relevance. The system utilizes a dataset from Kaggle covering songs from 2000 to 2019. Achieving a high System Usability Scale (SUS) score of 83.65, the system demonstrates strong user satisfaction and usability [5].

This research aims to create a recommendation model that relies on audio signal feature similarity. It employs a Convolutional Recurrent Neural Network (CRNN) for feature extraction and uses similarity measures to compare features, revealing that users favor genre-based suggestions over purely similarity-based ones [1].

This research proposes a music recommendation system using three independent models: topic-based, feature-based, and text-based. The topic-based model focuses on song themes, while the feature-based model finds tracks with similar audio traits. The text-based model utilizes natural language processing to interpret user input. Each model works independently to ensure diverse recommendations. Techniques such as bag-of-words, cosine similarity, and k-nearest neighbors are employed for better accuracy. The system also offers a user-friendly web interface and demonstrates strong performance in delivering personalized music suggestions [7].

This study addresses the issue by analyzing user listening history and demographic data to create a user embedding that reflects individual preferences. Audio embedding's for tracks are generated using Siamese networks and metric learning, based on both liked and disliked songs. Recommendations for new tracks are made by measuring the similarity between the track's audio embedding and user embedding's. The system demonstrates top-tier performance in content-based music recommendation, validated with data from millions of users and tracks. Additionally, the extracted audio embedding's are effective for music genre classification, showcasing their adaptability [2].

III. METHODOLOGY

The research methodology outlined below ensures a systematic approach to building an effective music recommendation system.

A. System Architecture

The proposed music recommendation system is developed using Python, incorporating a robust architecture designed to provide personalized song recommendations. The system integrates multiple technologies for seamless functionality, ensuring accurate and user-friendly interactions. The key components of the system architecture include:

Streamlit: A lightweight web framework that facilitates the development of an interactive user interface. It allows users to interact with the recommendation system through a visually appealing and intuitive layout.

MongoDB: A NoSQL database used for efficiently storing and managing song metadata, user preferences, and feedback data. The flexibility of MongoDB enables quick retrieval and updating of data, making it an ideal choice for handling large music datasets.

Spotify API: The system leverages the Spotify API to fetch detailed information about songs, including album covers, artist names, tempo, genre, and popularity. This additional metadata enhances the quality of recommendations by providing users with richer details about suggested songs.

B. Data Processing

The dataset used in this system consists of a collection of Hindi songs stored in MongoDB. The dataset contains crucial attributes that help in building an effective recommendation system, including Song Name, Artist, Mood, Tempo, Popularity, User Ratings. The system follows a structured data processing approach, where raw data is fetched from MongoDB and undergoes multiple preprocessing steps. These steps include:

Data Cleaning – Removing duplicate entries, handling missing values, and standardizing data formats to ensure consistency.

Feature Extraction – Identifying key song attributes that influence user preferences, such as tempo and mood, and structuring the data for further analysis.

Normalization – Standardizing numerical attributes like tempo and popularity scores to ensure fair comparisons between songs.

After preprocessing, the data is stored in a structured format, allowing efficient filtering and recommendation based on various techniques.

C. Authentication and Feedback System

To personalize music recommendations, the system includes a user authentication mechanism. Each user has a unique profile where their listening history, preferences, and feedback are recorded. The authentication system ensures that every user receives tailored song suggestions based on their past interactions.

The system also integrates a feedback mechanism that allows users to rate and comment on recommended songs. These ratings and comments are stored in MongoDB and contribute to refining future recommendations. The iterative nature of the feedback loop ensures continuous improvement in the recommendation quality over time.

D. Filtering Techniques

To generate high-quality music recommendations, the system implements multiple filtering techniques. Each filtering method plays a distinct role in analyzing user preferences and suggesting suitable songs.

1) Content-Based Filtering

Content-based filtering relies on song attributes such as genre, mood, tempo, and lyrics to recommend music. The system analyzes metadata from songs previously liked by a user and identifies tracks with similar characteristics. Key steps in content-based filtering include:

Feature Analysis – It extracts and categorize song attributes.

Similarity Calculation – By using distance-based metrics (e.g., cosine similarity) to compare songs and identify similar tracks.

Recommendation Generation – Selecting the most relevant songs based on the computed similarity scores.

2) Collaborative Filtering

Collaborative filtering is based on user interaction data, such as listening history and ratings. It assumes that users with similar preferences will enjoy the same songs. This approach is divided into two categories:

User-Based Collaborative Filtering – It Finds users with similar music preferences and recommends songs they have liked.

Item-Based Collaborative Filtering – It Identifies relationships between songs based on user ratings and suggests tracks that are frequently enjoyed together.
MongoDB stores historical user data, which is leveraged to enhance collaborative filtering accuracy. This method is particularly useful in recommending songs that the user has not previously discovered.

3) Hybrid Filtering
Hybrid filtering combines both content-based and collaborative filtering techniques to improve recommendation accuracy. This approach ensures that even when user interaction data is sparse (cold-start problem), the system can still generate meaningful recommendations based on song metadata. The hybrid approach enhances overall system performance by utilizing multiple data sources for generating recommendations.

E. Implementation
The recommendation system is implemented in Python using various libraries and APIs for efficient data handling and processing. The primary tools and technologies used are Pandas, Spotify API, PyMongo, Streamlit. Pandas is used for data manipulation and analysis, enabling efficient handling of large datasets.Spotify API fetches additional metadata related to songs, including album covers, artist details, and track popularity.PyMongo facilitates seamless interaction with MongoDB, ensuring quick data retrieval and updates. Streamlit provides a web-based interface, allowing users to interact with the system easily and receive personalized music recommendations.

IV. CONCLUSION
This paper presents a Music Recommendation System that integrates multiple components: a frontend interface built using Streamlit to ensure an interactive and user-friendly experience; a backend powered by MongoDB, which stores song metadata, user preferences, and feedback, enabling real-time updates and personalized recommendations; and the Spotify API, which provides dynamic song details such as artist information, album artwork, tempo, popularity, and mood, enhancing the accuracy and relevance of music suggestions. Future work includes implementing machine learning-based collaborative filtering to provide more personalized recommendations.

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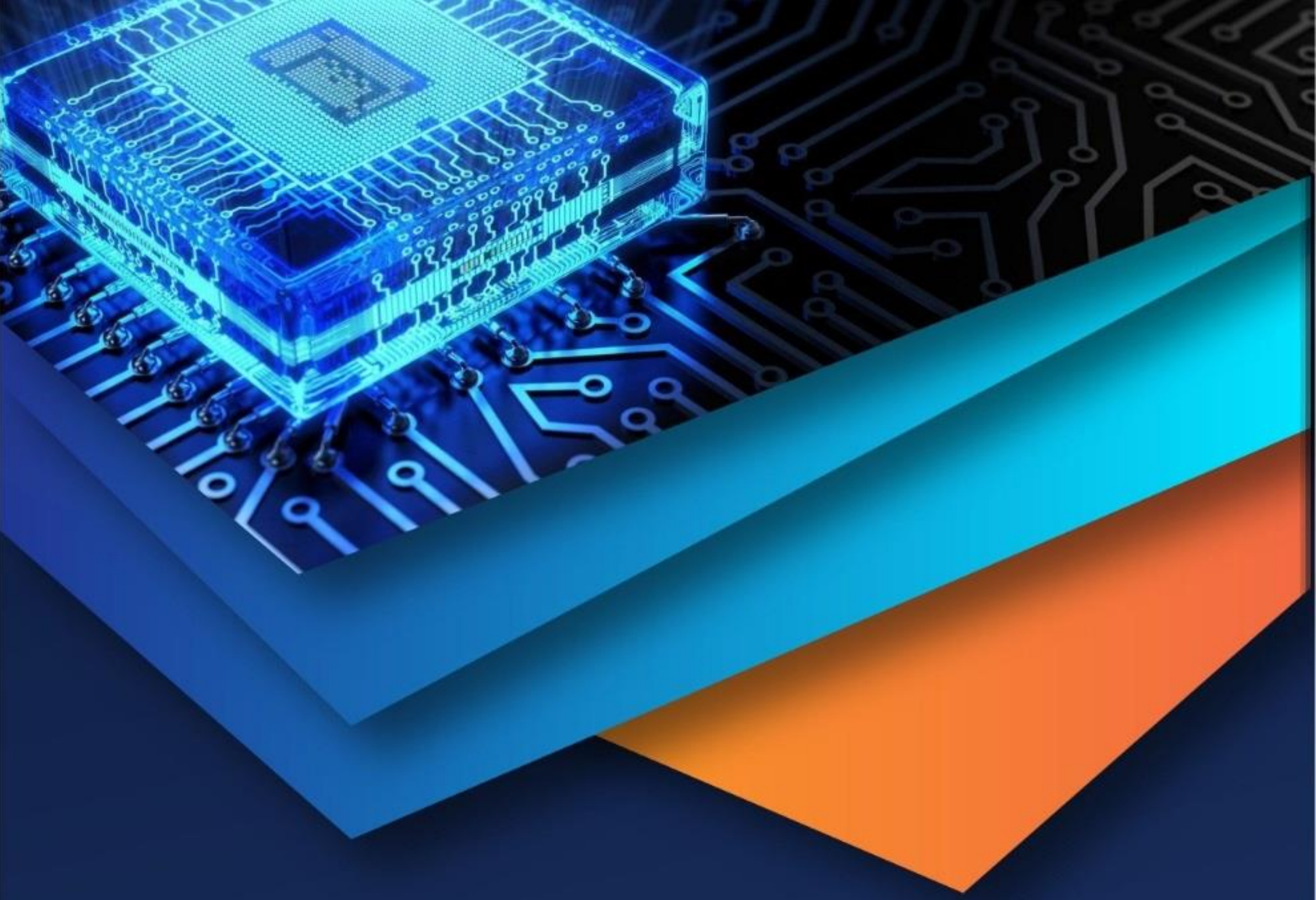

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