

# Emotion Based Carnatic Music Recommendation System

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**Abstract**—The project aims to develop an AI-based music recommendation system focused on Melakarta ragas and emotional themes. In the field, previous work has focused on music recommendation systems based on various techniques, but limited research has been conducted specifically on Melakarta ragas and their emotional impact. Therefore, there is a gap to propose a new idea that leverages Melakarta ragas to provide personalized music recommendations aligned with users' emotional states. The objectives include preprocessing the dataset, classifying Melakarta ragas, mapping emotions to ragas, and implementing the recommendation system.

The methodology involves identification of Navarasa (nine emotions) from camera input. Computer vision techniques are employed to analyze facial expressions and detect emotions such as Hasya, Karuna, Shringara, etc. These identified Navarasas are then mapped to corresponding emotional tags associated with Melakarta ragas. The recommendation system is developed to map the detected Navarasa from camera input to emotional tags and provide personalized music recommendations based on the Melakarta ragas associated with those emotions. The simulation tools used include programming languages like Python, machine learning libraries like scikit-learn and computer vision frameworks like OpenCV. The paper concentrates on majorly 6 rasas that maps with all the 72 melakarta ragas.

**Keywords**—Melakarta Raga, Emotion Detection, Navarasa, Music Recommendation.

## I. INTRODUCTION

The project can contribute to the wider appreciation, understanding, and dissemination of Indian classical music, while also serving the specific needs of musicians, learners, and enthusiasts in the digital era. Melakarta ragas are the foundation of the South Indian classical music system (Carnatic music). Such an initiative becomes easier for people to explore and appreciate this rich musical heritage. It can attract new audiences and keep the tradition alive in the digital age. For students and enthusiasts of Carnatic music, it can help users discover new music they might enjoy. This can expand their musical horizons and introduce them to compositions and performances they might not have encountered otherwise. A recommendation system for Melakarta ragas can also facilitate cross-cultural collaborations by providing a common reference framework for musicians from different traditions to understand and explore each other's music.

The problem is to develop an AI-based song recommendation system using melakarta ragas that aligns with users' desired emotions. The system should analyse user input, map emotions to appropriate ragas, and provide

personalized song recommendations to enhance the emotional experience of users.

The project aims to create a music recommendation system based on Melakarta Ragas using machine learning. The recommendations are provided based on the user's emotional state. The user's emotions would be classified as or limited to the Navarasas (nine emotions) out of which 6 being considered based on its relations with Melakarta Ragas. With respect to the ragas, there are numerous of them in Carnatic music, when Janya ragas are also included. However, those are out of this project's scope, and the ragas are limited to the 72 Melakarta Ragas associated with any song or another raga. The project involves data collection, raga identification of songs, emotion detection and music recommendation. The system will suggest compositions based on user preferences (emotion), and is evaluated for accuracy. Deliverables include a functional system and comprehensive documentation.

Objectives of the project include:

- Build a comprehensive dataset of songs and compositions categorized according to their corresponding melakarta ragas and emotional themes.
- Develop an AI algorithm that can accurately analyze the emotional content of user input and map them to relevant melakarta ragas known for evoking suitable emotions.
- Allow users to listen and enjoy personalized recommendations based on melakarta ragas and associated songs.

## II. LITERATURE REVIEW

SentiSpotMusic: a music recommendation system based on sentiment analysis is a paper that talks about developing a music recommendation system called SentiSpotMusic that utilizes sentiment analysis to recommend music to users based on their emotional state. The system aims to enhance user satisfaction and engagement by providing personalized music recommendations that align with the user's emotions. It uses CNN's for sentiment analysis, cosine similarity based music recommendation using Spotify API [1].

Emotion-Based Music Recommendation System Using Deep Neural Networks and User Feedback is a paper that talks about developing an emotion-based music recommendation system that combines deep neural networks and user feedback. The study focuses on leveraging Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks to analyze music features

and user emotion data for generating personalized recommendations [2].

**Deep Emotion-Aware Music Recommendation: Challenges, Approaches, and Future Directions** is a paper that provides a comprehensive review of deep emotion-aware music recommendation systems. It discusses challenges, approaches, and future directions in the field. The study aims to highlight the state-of-the-art techniques and identify gaps and opportunities for further research [3].

**Emotion-Based Music Recommendation Using Deep Learning Techniques** aims to develop an emotion-based music recommendation system using deep learning techniques. It focuses on leveraging Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) to extract emotion features from music and provide personalized recommendations based on user emotions [4].

**Context-Aware Song Recommendation System** explains building a Music recommendation system based on age of the user. This helps understand how songs can be recommended to the users [5].

**Personalized Reason Generation for Explainable Song Recommendation** builds a system that aims at learning from features extracted from the feedback given by the user. Features like fact and opinion, emotion and experience are extracted [6].

**Emotion-Based Music Recommendation Using Convolutional Neural Networks** proposes a deep learning approach using convolutional neural networks (CNNs) for emotion-based music recommendation. Extract emotional features from audio and train a CNN model for accurate emotion classification and recommendation [7].

### III. EXPERIMENTAL SETUP

This section, provides a detailed account of the experimental setup employed for the implementation of Emotion Based Carnatic Music Recommendation System. The setup involved a combination of hardware and software requirements, including the necessary tools and frameworks.

#### Software Requirements

- Programming Language: Python 3.8 or above
- Machine Learning Libraries: Frameworks to develop the emotion classification model, skimage, joblib, and scikit-learn
- Emotion Recognition Model: A pre-trained model to recognize emotions from user input
- Development Tools: Integrated Development Environment (IDE) like VSCode or command-line editors for coding and also based on users will, Google Colab can be used

#### Hardware Requirements

- CPU: A multi-core CPU is essential, to handle a large number of simultaneous users and real-time processing.

- GPU (Graphics Processing Unit) (Optional): For training the emotion recognition model, a powerful GPU can significantly speed up the process.
- RAM: Sufficient RAM (minimum 4GB) is required to store and process large datasets
- Storage: the size of the overall project accounts to about 250 MB of space and about 500MB of space is preferred.
- Network: A stable and fast internet connection is necessary, particularly to fetch and stream music to users efficiently.

### IV. ARCHITECTURE OF THE SYSTEM

High Level Design of the System:

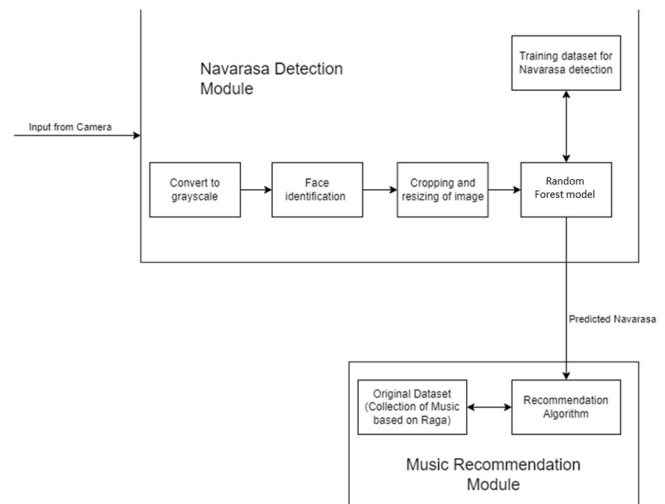


Fig. 1. Integrated Emotion-Based Music Recommendation System with Navarasa Detection

Fig1. Shows that the complete project involves 2 major modules:

#### 1. Navarasa Detection Module:

- Collects video input containing facial expressions for Navarasa detection.
- Preprocesses the video frames by converting them to grayscale to simplify processing.
- Applies face detection and recognition techniques to extract and isolate faces from the frames.
- Utilizes Random Forest (RF) Classification algorithm to analyze the preprocessed face images and detect Navarasa (emotions).
- The RF model uses a labeled dataset of facial expressions corresponding to each Navarasa.
- Extracts relevant features from the face images, such as facial landmarks or texture descriptors, and feeds them into the RF model for classification.

#### 2. Music Recommendation Module:

- Developed a separate recommendation model that interacts with a dataset of songs and compositions associated with Melakarta ragas.

- b. Based on the detected Navarasa, it maps the Navarasa to emotional tags or labels associated with Melakarta ragas.
- c. A machine learning algorithm is used to find songs in the dataset that correspond to the identified emotional tags.

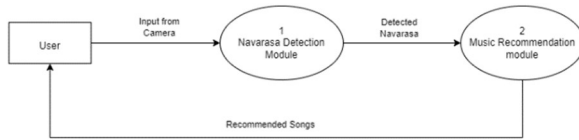


Fig. 2. Data Flow Diagram Level-0

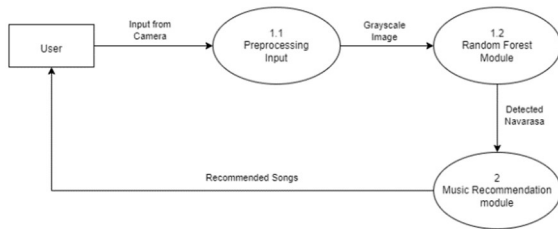


Fig. 3. Data Flow Diagram Level-1

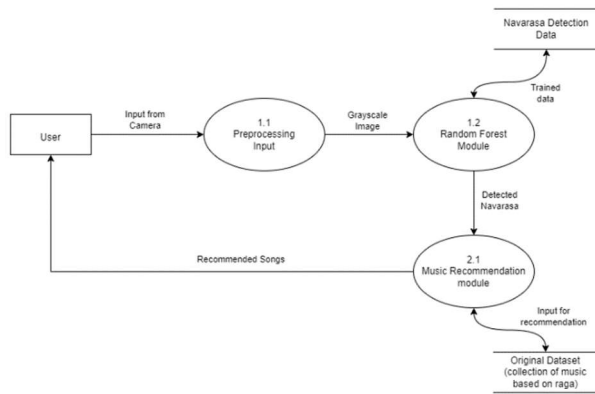


Fig. 4. Data Flow Diagram Level-2

## V. METHODOLOGY

For Building an Emotion Based Carnatic Music recommendation system the following steps are included:

- **Data Collection** - Gather a large dataset of songs and their associated metadata, including information about their category and raga associated. Also, gather data for emotion detection of users.
- **Data Preprocessing** - Clean and preprocess the dataset by handling missing values, duplicates, and applying text preprocessing techniques for further analysis.
- **Emotion Tagging/Mapping** - Establish a mapping between Melakarta ragas and emotional tags, assigning characteristic emotional themes to each raga. Create or use an existing emotion tagging system where users can assign specific emotion labels (e.g., sorrow, anger, laughter and so on, based on the Navarasas) to the ragas and in turn to songs. This could be done manually by users or extracted from existing sources like social media or user playlists.

- **Feature Extraction** - Extract relevant features from the input that can capture the emotional content.
- **Emotion Model** - Develop an emotion classification model that can predict the emotions associated with the songs. Machine learning techniques like deep learning (e.g., CNN, LSTM) or traditional classifiers (e.g., SVM, Random Forest) are to be explored for this task. Train the model using the emotion-tagged dataset.
- **User Emotion Input** - Allow users to input their current emotional state (based on Navarasas) into the recommendation system. This could be done or detected directly through the camera input using a webcam.
- **Recommendation Algorithm** - Design a recommendation algorithm that combines the emotion predictions from the model and other factors as applicable, if any, and provides music recommendations as required.
- **Evaluation**: Evaluate the recommendation system's performance using metrics like accuracy, R2-score etc. Additionally, conduct user testing and gather feedback to ensure the system provides relevant and satisfying recommendations.

The modules included in the Emotion Based Carnatic Music Recommendation System are as follows:

1. **Main Module:**
  - Responsible for coordinating and managing the overall flow of operations within the system.
  - Calls the Navarasa Detection Module and Song Recommendation Module in the appropriate sequence.
  - Handles communication between modules and ensures proper execution of the system.
2. **Navarasa Detection Module:**
  - Performs Navarasa detection using the RF algorithm.
  - Receives video input and performs preprocessing techniques like grayscale conversion, face detection, and recognition.
  - Utilizes the trained RF model to classify the extracted faces and detect the prevalent Navarasa (emotion).
  - Returns the detected Navarasa to the Main Module for further processing.
3. **Music Recommendation Module:**
  - Handles the music recommendation process based on the detected Navarasa.
  - Accesses the song dataset that contains songs and compositions associated with Melakarta ragas.
  - Maps the detected Navarasa to emotional tags or labels associated with Melakarta ragas.
  - Implements a matching algorithm to identify songs in the dataset that correspond to the emotional tags.
  - Returns a list of recommended songs to the Main Module for display.

## VI. RESULTS AND ANALYSIS

The evaluation metric for the Emotion-based music recommendation system that maps Navarasa (the nine emotions in Indian classical art) to the associated raga involves a two-fold process. Firstly, the system's accuracy in correctly identifying the predominant emotion expressed in a

given piece of music is measured. This is done by comparing the system's predicted emotion with the ground truth emotion label, which is determined through human evaluation.

The accuracy metric calculates the percentage of correct predictions made by the system.

Algo Used	Plot	Accuracy	Observation
SVC		60.49%	<p>The algorithm didn't work as images account for a lot of feature variables and fitting a hyperplane would be difficult.</p> <p>Decision tree approach was taken as it works better for image data.</p>
Decision tree		69.40%	<p>A single tree could take into account all the features and hence the algorithm could not succeed to that extent.</p> <p>Random forest algorithm brings in more.</p>
Random Forest		84.41%	<p>Helps achieve good accuracy.</p>

**Table 1.** Different approaches taken

The accuracy is displayed in Table 1. to provide a comprehensive overview of the emotion detection module's performance, illustrating its efficacy in accurately recognizing emotions within the recommended music. The RF model that is trained has a test accuracy of 80% with respect to the six Navarasas that are mapped.

Secondly, the system's effectiveness in recommending songs based on the identified emotion and mapped raga is evaluated. A recommendation is considered successful

if the recommended song's emotional content aligns with the emotion of the user. This evaluation can be done through user feedback or through an evaluation panel of music experts who assess the appropriateness of the recommendations.

Ultimately, the combined assessment of the recommendation system's ability to map Navarasa to raga and its emotion detection module's performance ensures that the system delivers accurate and relevant

music recommendations that resonate with users' emotion and preferences.

### Experimental Dataset:

The emotion detection module of the music recommendation system utilizes a unique dataset sourced from Kaggle, which consists of images representing the nine different Navarasas in Indian classical art. Each image represents a specific emotional expression, capturing the essence of the corresponding Navarasa.

The dataset is divided into training and testing sets, with the training data used to develop a deep learning model capable of recognizing and classifying emotions accurately. The images in the dataset act as visual representations of emotions, enabling the model to learn the visual patterns associated with each Navarasa. Fig 5. gives a small sample of images that are used to train the emotion detection module.



Fig. 5. Sample dataset for the Emotion Detection Module

On the other hand, for the music recommendation module, we have taken a more hands-on approach. We collected information and insights from classical music books and collaborated with domain experts proficient in Carnatic music. Through these efforts, we curated an original dataset comprising classical musical compositions, their associated Ragas, and the corresponding emotions they evoke. This dataset provides the foundation for the music recommendation algorithm, as it encapsulates the rich emotional nuances embedded in Carnatic music. Table 2. has a small sample of data collected for the music recommendation module.

**Table 2.** Sample dataset for the Music Recommendation Module

Song Name	Raga	URL	Mood associated
Gaanamurt he	Ganamurti	<a href="https://youtu.be/X2UORRf8xoU">https://youtu.be/X2UORRf8xoU</a>	BHAYA NAKA
Pariyachak ama	Vanaspati	<a href="https://youtu.be/cBAJjCBDIqY">https://youtu.be/cBAJjCBDIqY</a>	KARUN A
Naadamaya a	Hanumatodi	<a href="https://youtu.be/EkPOkT_a2U0">https://youtu.be/EkPOkT_a2U0</a>	BHAYA NAKA
Intha Chowka	Dhirasankarabharanam	<a href="https://youtu.be/YtnoHna_ZpA">https://youtu.be/YtnoHna_ZpA</a>	HASYA
Sharadhe Daya Thoride	Chakravakam	<a href="https://youtu.be/gz2SAwiHR90">https://youtu.be/gz2SAwiHR90</a>	ADBHUTA
Ottagathai Kattiko	Dharmavathi	<a href="https://youtu.be/yvZ8ErJbaFE">https://youtu.be/yvZ8ErJbaFE</a>	SHRINGARA

By combining the Kaggle dataset of Navarasa images with our expert-curated dataset of classical music and emotions, our music recommendation system aspires to provide users with a holistic and immersive experience. The emotion detection module's deep learning capabilities allow it to understand emotional cues from the Navarasa images, while the curated dataset ensures that the recommended songs align harmoniously with the identified emotions and the specific Ragas associated with them. The synergy between the datasets enables our system to deliver culturally enriched and emotionally resonant music recommendations, catering to the unique preferences of each user.

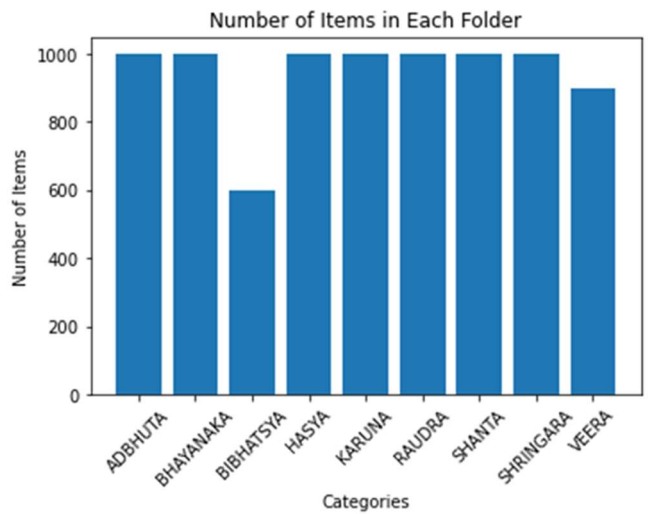


Fig. 6. Dataset distribution details

Fig. 6. Gives details of distribution of the training data. As the data is equally distributed it can be inferred that there will not be a lot of variance or bias into the system.

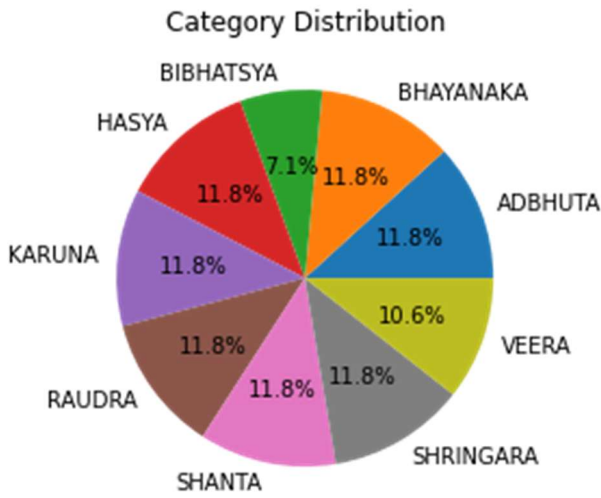


Fig. 7. Total Testing and Training Details

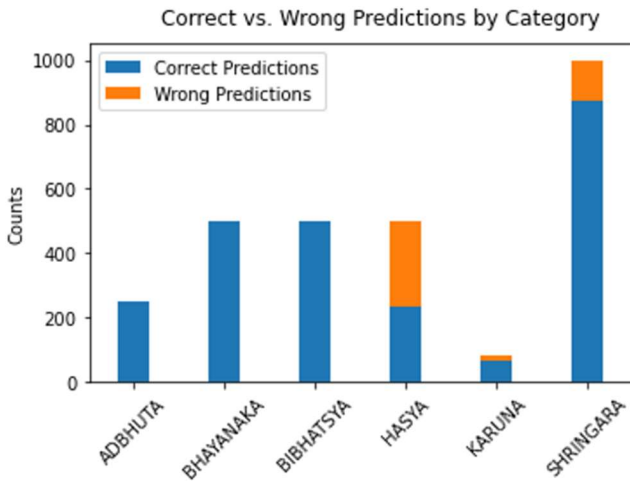


Fig. 8. Testing Data Prediction Details

The above diagrams Fig 7. and Fig 8. explain the working of the model in detail. This can help us further fine tune the model.

## VII. CONCLUSION AND FUTURE SCOPE

In conclusion the Emotion based carnatic music recommendation system is an innovative project that employs a Random Forest algorithm for emotion detection, surpassing the accuracy achieved by existing Convolutional Neural Networks (CNN). The system's foundation lies in a dataset containing images representing the nine Navarasas, sourced from Kaggle. Using Random Forest, the emotion detection module can recognize emotional cues from the Navarasa images with an impressive accuracy of 80%, outperforming the traditional CNN, which obtained 65% accuracy. This higher accuracy allows for a more precise understanding of the emotional content in music, catering to a broader range of musical genres and styles.

In parallel, the music recommendation module utilizes domain experts' knowledge of Carnatic music to map emotions to specific Ragas, ensuring culturally enriched and harmonious music suggestions. By integrating user feedback and continuously updating the recommendation algorithms, the system aims to provide a dynamic and personalized music listening experience, deepening users' appreciation for Carnatic music and emotional expression in music. The project's success in achieving superior accuracy with Random Forest underscores its commitment to delivering more relevant and emotionally resonant music recommendations, fostering a stronger emotional connection between the listener and the music they enjoy.

Some elements that could be touched upon in the future are:

- **User Interaction and Feedback:** Implement a user feedback mechanism to gather direct inputs from users regarding the accuracy and relevance of the recommended songs. This feedback loop can help refine the recommendation algorithms over time and adapt to individual users' preferences.
- **Multi-modal Data Integration:** Explore the integration of other modalities, such as lyrics, music annotations, and user-generated content, to enrich the dataset and improve the emotion detection module's performance. Combining textual and acoustic features can provide a more comprehensive understanding of the emotional content of songs.
- **Cross-cultural Recommendations:** Extend the recommendation system to encompass a broader range of musical genres and cultural styles, allowing users from different backgrounds to discover and appreciate music from various traditions.
- **Implementing fuzzy logic:** Extend the emotion detection to capture the inherent ambiguity and subjectivity of human emotions. Unlike traditional binary classification methods that categorize emotions as discrete labels, fuzzy logic allows for the representation of emotions as fuzzy sets with varying degrees of membership.

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