WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Rāga Darśinī - The Rāga Recognizer

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A B S T R A C T :

The intricate art of Indian classical music is characterized by the usage of Raagas, each evoking distinct emotions and moods. This project delves into the development of a robust and efficient model for raaga detection using Python. Leveraging machine learning and signal processing techniques, the system analyzes audio features unique to various raagas. The proposed system demonstrates promising results in accurately identifying 72 raagas from diverse audio samples (with plain notes), paving the way for further advancements in automated music analysis. This research contributes to the growing field of music information retrieval (MIR) and offers a valuable tool for students, music enthusiasts and performing artists. RaagaDarshini is a web app which is created using a python open-source framework called Streamlit.

Keywords: Raaga detection, Music Interval Retrieval, signal processing, Melakartha raaga, audio analysis

1. Introduction

Indian classical music is one of the oldest musical traditions in the world, with roots dating back thousands of years. It is broadly divided into two major systems: Hindustani music (North India) and Carnatic music (South India). Carnatic music, the classical music tradition of South India, places strong emphasis on composition and improvisation. Unlike Hindustani music, which is often more improvisational and performance-oriented. Key features of Carnatic music include:

- Raga: Melodic framework for improvisation and composition.
- Tala: Rhythmic cycle that governs the timing of compositions.
- Gamaka: Ornamentation and nuanced pitch variations that define the beauty and uniqueness of a raga.

1.1 The Concept of Raagas

In Carnatic music, a raaga is a melodic framework that provides a set of rules for building a musical composition or improvisation. Each raaga has a distinct scale, mood (rasa), and a specific set of notes used in ascending (Arohana) and descending (Avarohana) sequences. The two types of ragas are:

- Janaka Raagas (Parent Scales or Melakarta Raagas) – There are 72 Melakarta raagas, which are complete and form the base for other raagas.
- Janya Raagas (Derived Raagas) – These are derived from the Melakarta raagas and often have asymmetric note patterns, skipping certain notes or having unique phrases.

1.2 Project Overview

This model aims at recognizing the 72 Melakarta Raagas (Plain notes) played on a keyboard or other Western instrument when the audio is uploaded. This capability helps students understand the underlying structure of a composition. This project presents a new innovation in the field of Indian Classical music, bridging the gap between Western and Indian genres and serving as cultural preservation through technology. The resulting application, "Raaga Darshini," is a web app created using the Streamlit Python framework. Audio inputs (such as recorded compositions) are analyzed to identify the raagas in real time. This feature not only simplifies raaga identification but also offers a practical tool for musicological research and education.

1.3 Applications of the Project

- *Enhancing Musicological Research*
    - Provide a tool to advance research in Indian Classical Music by automating raaga identification processes.
- *Educational Goals*
    - ***Learning aid for students*** Serve as a practical tool for music students to deepen their knowledge of raagas when they listen to Western music.
    - Simplify the study and appreciation of Indian Classical Music through accessible technology.

1.4 Problem Statement

- Challenge: Automatically detecting Raagas from audio recordings is difficult despite advancements in music analysis.
- Complicating Factors:
    - Variations in tempo (speed).
    - Presence of ornamentation (like gamakas, meend).
- Identified Need: There is a requirement for a dedicated system capable of accurately identifying Raagas, either in real-time or from recordings.

1.5 Brief Introduction to the Raaga Darshini Web Application

The Raaga Darshini web application represents a new innovation in the field of audio development, specifically for Carnatic music.

- The system is designed to accurately recognize 72 Melakarta Raagas, focusing on plain notes played on a keyboard or similar Western instruments.
- Audio inputs (such as recorded compositions) are analyzed to identify the raagas in real time.
- This feature not only simplifies raaga identification but also offers a practical tool for musicological research and education.

2. Litereture Review

To the best of my knowledge, there is no similar kind of project currently available that performs Raaga detection with the specific focus and approach of this work

3. Methodology

The Raaga detection system involves several key stages to analyze audio input and identify the corresponding Raaga. These stages are detailed below:

3.1 Loading the Audio File

- The system provides a user interface that allows users to browse their directories and load the audio file(WAV, MP3, Opus) for analysis

3.2 Onset Detection using STFT

- This process is achieved using the Short-Time Fourier Transform (STFT), which helps detect note transitions by analyzing changes in frequency over time.
- STFT divides the audio signal into small time segments and applies Fourier analysis to identify distinct frequency components.

3.3 Frequency Bin Calculation

- This step involves mapping frequency values to musical notes by analyzing pitch characteristics in the audio signal. Once STFT detects note onsets, the system classifies the frequencies of each note using frequency bins. The pitch information is extracted and matched against a standard note-frequency mapping table.

3.4 Shruthi Input

- Shruthi, referring to the base pitch against which all musical notes are measured in Indian classical music, is provided as an input to the system.

3.5 Loading of Raaga Dataset

- A CSV file dataset is loaded into the system, containing all 72 Melakarta Ragas with their Arohana Swaras.

3.6 Mapping Notes with Raagas

- The system compares the extracted frequencies, matched with swaras, against the Raaga dataset to identify any matching Raagas.
- If a match is found, the system displays the Raaga name and the corresponding Melakarta Raga number.

3.7 Python Libraries Used

The python libraries used for this project are Librosa, NumPy, Matplotlib, re (Regular Expression), Collections, Pandas

4. Results

Figure 1: Welcome text and user input option

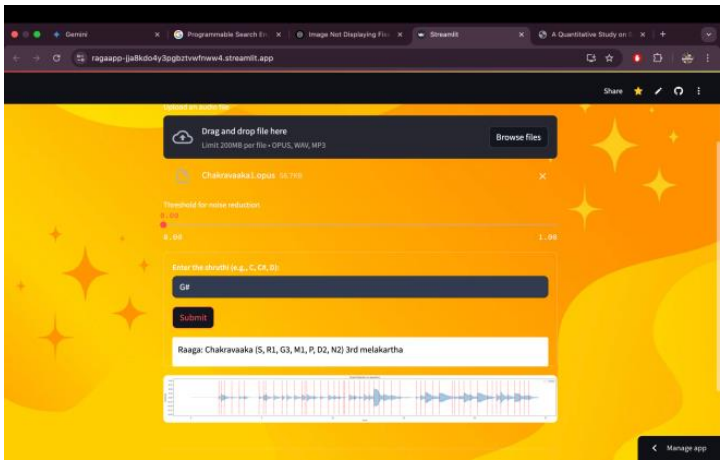
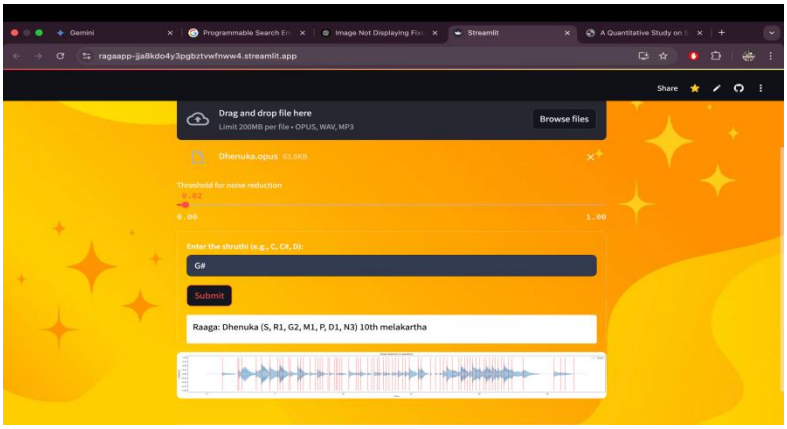


Figure 2: Entering the Shruthi and display of raaga

Figure 3: Use of threshold slider



5. Limitations

- Presently it can only detect the 72 ragas.
- It does not have the option of using the real time audio directly through built in microphone of the device.
- It can only recognize the raaga if the audio is of plain note and not with gamakas.

Conclusion

The *Rāga Darśinī - Raaga Detection System* represents a significant step forward in blending technology with the rich tradition of Indian classical music. By leveraging advanced signal processing techniques, such as Short-Time Fourier Transform (STFT), Mel-Frequency Cepstral Coefficients (MFCC), chroma features, and spectral contrast, the system provides an innovative approach to identifying *72 Melkarta Raagas* from keyboard or instrument-based audio inputs. This project bridges the gap between Western musical systems and Indian classical music, making raaga recognition more accessible to students, enthusiasts, and musicians.

Acknowledgements

I convey my sincere gratitude to **Dr. Pankaj Choudhary, Principal,**
BMS College of Commerce and Management for providing all the facilities
needed for the successful completion of the project.

I am grateful to our respected Head of Department (BCA), **Mr. Kiran Kumar**
M N whose support and permission were instrumental in enabling me to embark
on this dissertation journey and guiding us through its completion.

Above all, I would like to thank my parents and Prashanth Raghu, founder of Gonagoor technologies for their
valuable help and support throughout the course of the project. Special thanks to my dear friend Vidwan Sanath Kumar Naibhi, a violinist for his valuable guidance on the raaaga and shruthi system.

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