RECOGNITION OF RAGAS OF HINDUSTANI MUSIC PLAYED ON HARMONION

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Abstract: The paper proposes a technical method for the identification of ragas in an Indian classical harmonion recital. Swaras are musical notes which are produced by pressing any key of the harmonion (an instrument analogous to the piano). Ragas are melodic combinations of swaras which capture different moods and emotions. Raga analysis finds its applications in Music Information Retrieval (MIR) purposes which can help in classification of music pieces from the huge music database. This paper focuses on the technical ways of identification of a raga applying signal processing approaches. The aspects which we deal with here are dataset creation of ragas, pitch detection algorithm, steady state detection for note extraction, tonic extraction from drone, octave adjustments, automatic note transcription and matching input with data set.

I. INTRODUCTION

Classical Indian music is characterised by seven main musical notes (‘pure’ swaras) called the ‘saptak’ viz. Shadja(Sa), Rishab(Re), Gandhar(Ga), Madhyam(Ma), Pancham(Pa), Dhaivat(Dha) and Nishad(Ni) along with five intermediate notes known as altered notes or ‘vikrit swaras’. Further the swaras can be played in three octaves, the first or lower octave starting from 130 Hz; the middle octave starting from 260 Hz; and the upper octave from 520 Hz. A combination of five or more notes upon which a particular melody is based is called a ‘raga’. It can also be characterized by the melodic patterns of the musical notes. Any classical recital always pertains to a particular raga.

This paper proposes a method to identify ragas by extracting the notes used in a particular recorded recital and matching with a dataset. The musical instruments used here are a 36 key Harmonium and a Drone (tanpura) for providing the tonic pitch or the scale (‘Sa’).

II. RELATED WORKS AND OUR APPROACH

Automatic identification of ragas has created a lot of attention among the researchers. We discuss here some recent works.

In one of the recent works, a raga was identified from music excerpts played on different instruments like piano, mandolin, harmonium, etc [1]. The paper suggested analyzing a monophonic signal of an audio excerpt which played the ascending and descending structure of the raga only. Their proposed approach was creating windows of the selected wave file, getting frequencies of the waveform using FFT of each window, finding peak frequencies of each window, removing duplicate consecutive frequencies to get distinct series of frequencies, converting those frequencies to the corresponding notes by matching frequency of the note or the nearest possible note along with the Swara. The raga was identified by matching the retrieved data with a database. This process yielded 80% accuracy. However in actual practice, a raga rendition does not contain the ascending and/or descending structure as a whole. Rather subsets of the structure are played and are subject to improvisations. So in such a case the note sequence does not occur serially.

Another recent work [2] proposed a method for Raga identification in association with Carnatic(South Indian) Classical Music. Taking the audio input from Carnatic Music piece, apart from just the ascendent-descendent patterns, a system was built to identify the Raga associated with it. The audio samples were segmented after filtering of the input in wave format. For each segment a pitch detection algorithm was used to identify the pitch frequency. Knowing the base frequency of the input, the system was designed to calculate the relative frequency to find the notes present in the audio sample. Hence the system calculated the notes and displayed the name of the Raga. Their
methodology comprised of filtering the signal, feature extraction, note identification, classifier, database comparison and raga identification. It reports 80% accuracy for vocal music and 85% accuracy for instrumental music.

In the paper by Trupti Katte [3] a data mining approach was made to identify a raga. The techniques used here are Pitch Class Distribution, Pitch Class Dyad Distribution, LDA model by taking an audio comprising of voice as well as music. But here the tonic note was manually identified. The work in [4] an extensive database of commonly used swara permutations is structured and dynamic programming is used for template matching and hence raga recognition. An objective analysis using a non-cognitive approach of shrutis from the ‘alap’ from different songs of eminent musicians covering different ragas are presented in [5]. In [6], authors followed computational approaches for the understanding of melody in carnatic music,“

In this paper, we concentrate on those ragas which can be identified solely by the set of notes. A signal processing approach is made to devise a method for extraction of information from the audio snippet recorded. The extracted information is matched with the dataset created to identify the raga. Lastly, the results obtained from our proposed system are compared with that of an expert. Here, no prior knowledge regarding the music snippet is required for identification of the raga. The algorithm proposed here fetches all the required information from the audio signal itself. Moreover a real music recital has been taken under consideration thus making it more effective than the existing works. A total of 25 samples belonging to 5 different ragas are analyzed.

III. PROPOSED DESIGN

The aim of this system is to extract the required information from the recorded audio signal. It will comprise of two phases. They are - creation of a dataset of ragas and raga identification.

3.1. Creating a dataset:

A data set for different ragas was created which contained the note names of the ragas. Here we have used the following notations- Sa: Shadaj, R1: Komal Rishav R2: Sudhh Rishav, G1: Komal Gandhar, G2: Sudhh Gandhar, Pa: Pancham, N1: Komal Nishad, N2: Sudhh Nishad.

Some of the ragas that we have used to create the dataset are shown in the table below

<table>
<thead>
<tr>
<th>Raga Name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nat Bhairav</td>
<td>Sa, R2, G2, M1, Pa, D1,N2</td>
</tr>
<tr>
<td>Malkauns</td>
<td>Sa,G1,M1,D1,N1</td>
</tr>
<tr>
<td>Bairagi</td>
<td>Sa,R1,M1,Pa,N1</td>
</tr>
<tr>
<td>Kirwani</td>
<td>Sa,R2,G1,M1,Pa,D1,N2</td>
</tr>
<tr>
<td>AhirBhairav</td>
<td>Sa,R1,G2,M1,Pa,D2,N1</td>
</tr>
</tbody>
</table>

3.2. Raga identification:

Fig. 1 shows the block diagram of the proposed system.

The following are performed on the signal:

- **F0 estimation:** The recorded audio sample is imported by software called WaveSurfer. Then, using the software, the pitch contour from the audio sample is computed.

- **Steady State detection:** The states of the pitch contour which are considerably steady for a minimum of 60 ms are taken and identified to be the notes which are played in the audio sample. Other regions are discarded.

- **Tonic Extraction:** This is the third module which extracts the ‘Sa’ or the tonic by analyzing the sound of the tanpura (drone). A particular section from the audio signal where the tonic is only played is identified by listening and it is split into a separate audio file. Next, a cepstrum i.e. the Fast Fourier Transform of the log of the magnitude spectrum of that portion is computed. An example of the Cepstrum of the drone portion is shown in Fig 2. Then the frequency corresponding to its highest peak is identified to be the fundamental frequency of the tonic.

\[
\text{Cepstrum}=\text{fft}(|\text{signal}|)\]

\[
\text{Cepstrum}=\text{fft}(\log(\text{fft}))
\]

Where N= No. of samples
**IV. EXPERIMENTAL RESULTS**

The following results shown in Table 1 are obtained by analyzing audio samples of different ragas. The first column in Table 1 provides the name of the different Ragas which were analyzed. For each raga, we have taken 5 samples as shown in column 2. Columns 3 and 4 represent the number of samples identified by our proposed method and that by an expert musician. Obviously, we consider that identification by expert musician is done with 100% accuracy. The last column shows the success rate of our system as an identifier. In overall, our system provides 88% accuracy.

<table>
<thead>
<tr>
<th>Raga analyzed</th>
<th>No of samples</th>
<th>Identification by Proposed System</th>
<th>Identification by Expert Musician</th>
<th>Accuracy (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nat Bhairav</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Charukeshi</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>Bairagi</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>Malkauns</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Kirwani</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>Overall accuracy</td>
<td></td>
<td></td>
<td></td>
<td>88</td>
</tr>
</tbody>
</table>

**V. CONCLUSION**

The proposed system took an one minute excerpt of the alap portion of a music piece played on...
Harmonium as input and identified the underlying Raga by matching the extracted notes from a pre-created dataset. The work was done using 5 ragas, 5 samples were taken for each raga. We used only those ragas which are recognizable solely by the set of notes. The system gives an overall accuracy of 88%. The future work includes incorporation of more ragas using more samples. Obviously, the extension of the work for other instruments and vocal is also an important area of research.

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REFERENCES


