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Pitch Based Raag Identification from Monophonic Indian Classical Music

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Abstract

The Indian classical music is one of the oldest forms of music in the world. The Raag is the soul of Indian classical music. The Raag is the logical arrangement of the musical notes i.e. the different pitch of the sound. This system can listen to a sound clip that have the basic structure of the Raag i.e. the Aaroh and Avroh, played by a musical instrument like Musical Keyboard, Mandolin and Harmonium in it and recognize the Raag along with other Raag information. In addition to this the various samples from different musical instruments are analysed and accuracy of the system is calculated. It also shows the performance of the system on various instruments. The overall results of above 80% accuracy shows that the overall performance of the system meets the desired objective.

Keywords: Raag identification, Indian classical music, pitch detection

1. Introduction

Indian classical music is one of the oldest and richest forms of music in the world. It has its roots in ancient religious *vedic* hymns, tribal chants, devotional music, and folk music. Indian classical music is melodic in nature. The most important point is that movements in Indian classical music are one note at a time basis. This progression of sound patterns with time is the most important contributor to the tune and rhythm of the presentation, and so to the melody. [13].

The Swar is the sound generated when a strip or string is vibrated at certain frequency. There are total 12 Swars with 7 names:

Saa	*Re*	*Gaa*	*Maa*	*Paa*	*Dhaa*	*Nee*
ਸਾ	ਰੇ	ਗਾ	ਮਾ	ਪਾ	ਧਾ	ਨੀ

The Re, Gaa, Dhaa and Nee have their one *Komal* Swar each.Maa have 1 *Teevar* Swar. Raag, the soul of Indian classical music, is the logical arrangement of the musical notes. The Ascent and Descent of the Raag is called *Aaroh* and *Avroh* respectively.

As a part of research activity, the approach has been developed to identify the Raag in Indian classical music from the given pattern of Swars (notes) in a sample sound clip. The system is developed by specially focusing the Indian Classical Music. The system has been developed to identify the Raag from the clip recorded with Aaroh and Avroh from various instruments. It has been tested on three instruments The Harmonium, Keyboard and mandolin. The clips recorded in normal environment with any device in mono wave file can be passed through the system to identify the Raag and when the Raag is identified, the all information of the Raag is also displayed. This tool helps the users to identify Raag and retrieve the information of Raag.

2. The Raag Identification

The main tool for Raag Identification is developed in Java. The main idea behind its working is to get the pitch of different notes played in the given sound from their frequencies and identify the note equivalent to that pitch. This data generates a sequence of notes, is then used to match the Raag from the database.

The Redix 2 Cooley Tukey's Fast Fourier Transformation is used to identify the pitch of the sound recorded in mono channel wave file. The list of Raags is stored in Microsoft Access database. Identified series of notes is matched with database, if found then relative Raag information is displayed.

The different samples of Wave files are recorded with the sound of Harmonium, Mandolin and keyboard. From the different samples of sounds with different Raags are tested and corresponding figures are explored.

The main interface contains area where the Swars identified in the selected clip are displayed along with the waveform of the selected clip is, play and stop buttons to play and stop selected clip. The Aaroh, Avroh and other Raag information is displayed if Raag is identified found frequencies.

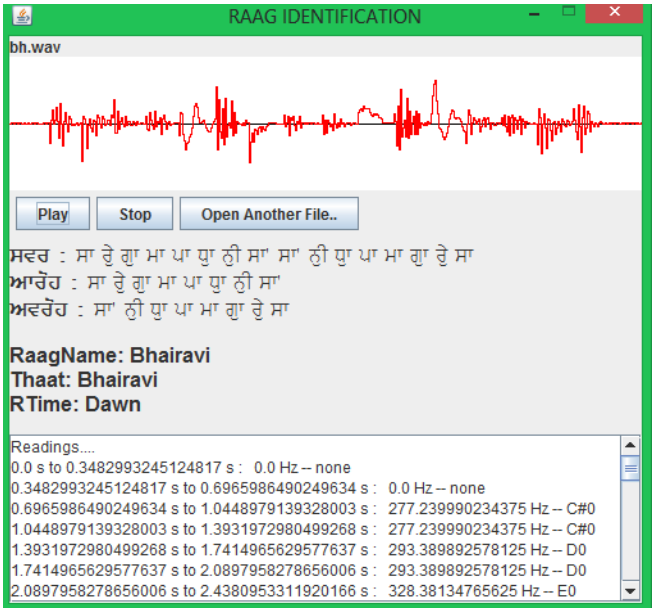

Fig 1: The Main main interface of Raag Identification.

2.1 The Main working Algorithm

1. Create windows of the selected wave file, get Frequencies of the waveform using FFT of each window and draw waveform.
2. Find peak frequencies of each window.
3. Remove duplicate consecutive frequencies to get distinct series of frequencies.
4. Convert those frequencies to the corresponding notes by matching frequency of the note or the nearest possible note along with the Swar.
5. Make further corrections and adjustments.
6. Match found series of notes with database.
7. Display information if match found.

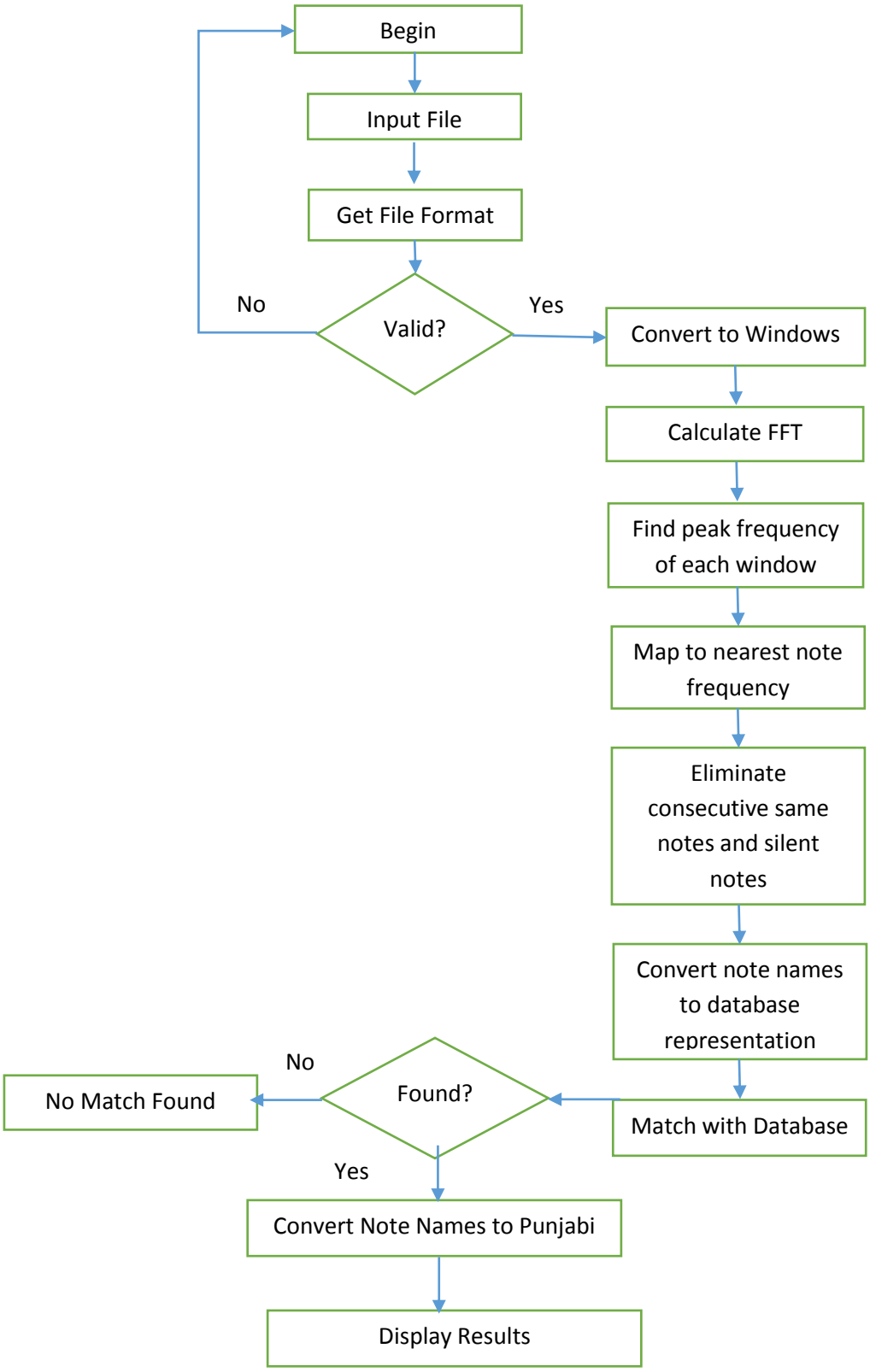

Fig. 2: The flowchart of the main working algorithm of the source code.

2.2 The Redix 2 Cooley Tukey Algorithm and The calculation of FFT

For this firstly the data is divided in parts, separating in even and odd gives best result, so is done. Using FFT the data from time domain to frequency domain is converted and then again even and odd parts are merged back. Before applying this the windows are created one by one of the given sample to calculate FFT. The windows are the small portion of the sample sound on which the note will be identified one by one. The window size is kept 2048.

2.3 The Audio File

The Wave File (.Wav) samples are used with configuration 44100Hz, 16bit and mono channel. These files are recorded from different sources like harmonium, Keyboard and mandolin in normal but least noisy environment. These files contains different samples of different Raags to be identified.

2.4 Conversion to Notes from Frequencies

The standard A note frequency is 440.The octaves are considered to be 6. From note A the frequency is gathered by the formula $\mathbf{440*2^{i/12}}$, Where i =octave*12+[current note]. So corresponding to the frequency the note with the minimum distance from the calculated frequency in matched.

2.5 Matching Raag from the Database

The Access Database contains the Raag information according to Aaroh Avroh of the Raag and other necessary information. The notes found from frequencies are in western nomenclature, now needs to be converted in Indian classical form and also in Punjabi. The notes are represented in western, database, English Notation and Punjabi representation of notes respectively are shown below:

3. Tests and Results

The system finally is tested with the three instruments the Harmonium, Mandolin and Musical Keyboard. The various samples from all the systems are tested on the system. If the system identifies all the notes if the sample, it leads to identification of correct Raag, otherwise the Raag will not be identified if even one note is incorrectly identified. In the table below random 15 samples of each instrument are tested on the system:

Instrument	**Total Clips**	**Fully Identified**	**Partly Identified**	**Poorly Identified**	**Accuracy (%)**
Keyboard	15	14	1	0	93
Mandolin	15	11	3	1	73
Harmonium	15	10	3	2	66

Table 1: Results of the random samples.

The keyboard gives the maximum full identification accuracy because it was recorded by using direct cable without any external disturbance. Harmonium gives lesser accuracy as compared to others. Because the harmonium has two reads of Swars in it. These reads sometimes becomes mismatched and up or down from standard range of Swars by usage and is not easy to retune it and even recognize it. This problem leads to little less accuracy of the system from Harmonium as compared to other systems. Another reason is the external disturbance if recorded in normal environment and the sound of wooden keys (very rare).

All the samples by all the three instruments are played at almost the same tempo. All the samples are recorded in normal indoor environment without any sound proofing. To calculate overall accuracy of the each instrument, the accuracy is calculated per note. The Total number of notes tested are **224** per instrument as the

10 of the samples contained 16 notes, 3 had 12 and 2 played 14 notes. The difference is because the Raags have different *Jaatis*, so have different number of notes. The table below represents the number of notes identified correctly combining all three categories fully identified, partly identified and poorly identified, and their percentage from the all 224 notes for each instrument separately.

Instrument	Total notes played	Notes identified	Percentage
Keyboard	224	205	91.5
Mandolin	224	182	81.3
Harmonium	224	175	78.1

Table 2: Accuracy on the basis of number of notes of the individual instruments.

The overall accuracy of the system leads to: (91.5+81.3+78.1)/3 = **83.63%**

The overall calculated accuracy tells that it provides over 80% overall accuracy when tested on all three instruments. The figures are quite good on the random samples recorded in the normal environment.

4. Conclusion

The system presented here is totally focusing on Indian classical music, recognizes the Raag from the clip containing Aaroh and Avroh of the Raag using FFT. The system demonstrate that the Raag recognition is possible with the real time instruments recorded in sample clips. The facts and figures shows that the system is good enough for this level of work. There are many difficulties in implementing and working with real time clips which are in wave form. Because the clip is wav not the midi so if there is some other noise along with the music been recorded, means unnecessary sound from environment, results to inaccurate results. So the noise free environment is required while recording the clip to produce accurate results. This system recognize Raag only when the Aaroh and Avroh is played in the clip continuously. In the future the system can be extended to recognize the Raag from the 'Pakad' of the Raag, partly played Raag or even from the composition. Another extension of the system can be to increase the accuracy of the system by recognizing and eliminating the external disturbance.

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