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Process of Recognition of Raag Using Frequency domain: An Overview

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Abstract: *A Raag is a core of Indian Classical music and is a fundamental concept. It plays an important role in Indian Classical Music. The Raag is formed from a unique sequence of Swars. The Swar is a sound generated at certain frequency by a musical Instrument. The computational System identifies the sequence of frequencies from a sequence of Swars. This paper illustrates the process of this system of Raag identification.*

Keywords: *Computer Music, Raag Identification,*

1. INTRODUCTION

The Indian classical music is one of the richest and of course the oldest form of music in the world. Its existence can be found in ancient vedic hymns and folk music.

The Raag is the most important concept of Indian Classical Music. It is formed from unique sequence of 5,6 or 7 Swars. The swars are the sounds generated at a particular frequency. There are seven basic swars as follows:

Sa Re Ga Ma Pa Dha Ni

Swara	Sanskrit
Sa	Shadja
Re	Rishaba
Ga	Gandhara
Ma	Madhyama
Pa	Panchama
Dha	Dhaivata
Ni	Nishadam

Table 1 The Sanskrit full names of Swars

There are total 12 swars with these seven names. Re, Ga, Dha and Ni Swars have one 'Komal' Swar each also and Ma have one *Teevar* Swar too. The Raag is formed from sequence of Swars going upward called '*Aaroh*' and going downward called '*Avroh*'. A Raag must have both. It can have Aaroh and Avroh same or different. A Raag is described by a number of characteristics, like its 'Vaadi'-'Sanvaadi','Aaroh'-'Avroh' etc. They are Swars. The most major Swar in a Raag is called *Vaadi*. The second major Swar is called the *Sanvadi*. The swars other than Vaadi and Sanvadi which constitute the raag are called *Anuvaadi* swars.

Fig.1 Swars on Harmonium

According to Indian classical music there are total 10 *Thaats.* The Thaat is a class of Raags. There are number of Raags and each Raag belong to one of these 10 Thaats. There is one more issue, i.e. the scale. According to the voice pitch of any individual the one can consider any swar as his *Sa* and proceed the same sequence.

To identify the Raag in a computerized system, a sound track is needed that need to have a monophonic sound, that is generated by an instrument. The sound generated by an instrument will be analog of course. So the file format will be wave.

2. THE PROCESS

The first step is to get a sound that will used to identify the Raag. The sequence of swars played by an instrument is recorded in a wave file. In the second step we need a computational system which converts the analog sound to set of frequencies, I.e. the frequency numerical values. Now at third step the frequencies need to be converted to note names (swars).The standard frequencies are pre-defined for each Swars, for example the 'A' (a western music note equivalent to *Dha(Komal)*) note has 440Hz value of frequency. It has a formula :

$$\mathbf{440*2^{i/12}}$$

Where i= octave*12+[current note]

The musical instruments have number of octaves and an octave have 12 ‘Swars’. Now the duplicate consecutive swars/frequencies needs to be eliminated because sometimes the long press of ‘Swar’ repeats the frequency windows, that repeats the ‘Swars’.

The Next step is to match the calculated sequence with the database that has been prepared with the collection of Raags and their a;; needed information. The database can be maintained with any desired database. The database needs to have all needed information related to Raag i.e. the Raag name, Aaroh, Avroh, Pakad, time etc.

3. THE CONVERSION

There are number of techniques to convert sound to frequency values i.e. from time domain to frequency domain. The most common and most used method if Fast Fourier Transformation (FFT). In this the mathematical fourier transformations are applied to the complex numbers acquired to convert time domain sound sample to frequency domain values. There are few sub types of FFT like Radix 2 Cooley Tukey Algorithm and is the most efficient FFT technique.

In this technique the sound clip data is divided into windows of small size separated in odd and even, which gives the best results. Now the Fast Fourier Transformation(FFT) is applied to the converted complex numbers. That gives the set of frequencies. After this the windows are merged back to get the final set. The main idea behind this is to get sound from time domain and convert its sine and cosine complex value numbers to frequency values using this algorithm.

Now the database is maintained with the key names (Swars), so the frequencies are need to be given names according to the corresponding frequencies. For example the First black i.e. on middle octave on harmonium which is Sa or C# in western have standard frequency of 277 Hz and ‘A’ note (Dha Komal) have 440 Hz frequency. The frequencies of other Swars in any octave(Saptak) can be calculated by using the formula $\mathbf{440*2^{i/12}}$, Where i= octave*12+[current note].

.Fig.2 The process of Raag Recognition

4. MATCHING WITH DATABASE

Finally we have sequence of swars those can be matched with the database. This can also be done with HMM(Hidden Markov Model) for complex sequences when we have Pakad of Raag instead of Aaroh and Avroh. The complex Pakads and compositions are identified by using Pitch Class Distribution(PCD) which calculated using Histograms of Pitch tracks and Pitch Class Dyad Distribution(PCDD), which uses pitch labels into notes instead of histograms.

Chordia,Rae [3] used pitch class distribution and pitch class dyad distribution for the identification of raag. They tested data containing of 20 hrs of recorded performance in 31 raags by 19 different accompanists. The individual recordings were segmented into 30 seconds and 60 seconds pieces. Classification of raag is prepared by using Support Vector Machine(SVM), Maximum A Posteriori (MAP) rule by using Random Forests and Multivariate likely-hood model (MVM). Initially explanation is done by using labeling each raag sample with the frequency value. Then pitch detection is implemented on sample chunk using Harmonic Product Spectrum algorithm. ThreshHolding complex Detection Function (DF) on each segment, note onsets are determined.

Pitch class distribution(PCD):

It is calculated bytaking histogram of the pitch tracks. For each notes of chromatic scale the bins associated segment is found out and bins are centered about the tonic for segment.The five octaves then folded into one and their values are normalized to create a pitch class distribution.

Pitch class dyad distribution (PCDD):

The note onset is used to segment pitch tracks into notes instead that of histogram for pitch tracks. Each note is labeled with a pitch class label. The octaves for notes were folded into one. The pitch classes then arranged in group of two (bigrams), or in musical term it is called as dyads, which creates pitch class dyad distribution.

5. CONCLUSION

There are two major issues in this process, one is to efficiently convert sound to frequencies to get each note accurately and second is to get exact sequence of Swars to match with the database. For converting the sound from time domain to frequency domain, there are some techniques available like Fast Fourier Transformation. These techniques accurately identifies the note frequency if the sound is clear and the recording in monophonic i.e. there is only one instrument played without any other interference. But if there is a polyphonic sound i.e. the number of instruments being played together, then the frequencies overlaps and the note is misidentified. For this the more accurate filters and algorithms are required. The other thing is the algorithm which identifies the notes from a composition and put them in such a sequence that can be properly matched with the Pakad or Aaroh-Avroh presentin the database.

This Field is not much old and is on rise. It requires lots of research. The monophonic sound can be easily identified but polyphonic analog sounds are hard to identify or the sounds with disturbance are also hard to identify the corret frequency. The sounds with Aroh and Avroh or Pakad can be identified but the compositions are too complex to identify the exact Raag. This topic is a rising research topic. This Field have lots to work with and interesting too. But the researcher need to have the knowledge of both computer technology as well as music. The techniques to find the accurate frequencies, to search database and to match with exact Raag, all have lots of room to improvement.

- ## Future Scope

This field has lots to work with. There are two main sub fields in this i.e. Raag and Taal. The Raag is as described above and the Taal is the rhythm. The work can be done to identify Raag from a complete composition with either monophonic instrument or the multiple instruments even when the sound is not properly clear. The algorithms and filters can be developed to increase the accuracy. The second field is the rhythm. The number of beats can also be identified. By this the Taal played in a composition can be identified. There are lots of researchers who have worked on the field and working on it.

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