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Computational Approaches for the Identification of Indian Classical Music

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***Abstract*—Music is an interaction of melody, harmony and rhythm. Indian classical music has very distinct characteristics. It has distinctive characteristics like swar, saptak, thaat, raga and taal, Raga is the base. Various approaches for music information retrieval have been proposed. Indian classical music offers an excellent ground for the same. In this paper, we focus on the Indian classical music system, especially on its characteristics from the point of view of music information research. We overview the theoretical aspects that are relevant for music information research and discuss the scarce computational approaches. We put emphasis on the limitations of the current methodologies.**

***Index Terms*— Indian Classical Music, computational approaches, music information retrieval**

I. INTRODUCTION

There are certain features every music tradition has, which can be used to identify, classify and differentiate from others. The western music has its own traditions and characteristics. The use of information technology has aimed on this processing of this genre of music mainly. To process Indian classical music, we need to develop such technologies which can exploit the science of our rich music. The need is to study the uniqueness of Indian classical music with other world music traditions so that better versatile computational approaches can be developed.

The music of India is said to be one of the oldest unbroken musical traditions in the world. It is said that the origins of this system go back to the Vedas. Many different legends have grown up concerning the origins and development of Indian classical music. Indian classical music has a very important role in defining Indian culture. Indian Classical Music is based on melody (raga) and rhythm (taal).

Ragas form a very important concept in Indian classical music and capture the mood and emotion of performances. One combination embodies a special mood of expressing the emotions and gestures. A raga is most easily explained as a collection of melodic gestures and a technique for developing them. The gestures are sequences of notes that are often inflected with various micro-pitch alterations and articulated with an expressive sense of timing.

The time of playing or singing any raga is also defined. There are three main vocal genres of Indian Classical Music are: dhrupad, khayal and thumri. These terms designate both, the composition as such and the genre as a whole. Whilst dhrupad is considered to be the oldest and the most disciplined (in terms of the purity of raga and rigidity of the composition structure) of the Indian genres heard today. Thumri is the lightest and the most ornamented genre, Khayal stands in between these two extremes.

II. INDIAN CLASSICAL MUSIC

The computational study of Indian Classical music offers a number of problems that require new research approaches. The concepts of raga and taala are completely different to the western concepts used to describe melody and rhythm. A raga is described by several characteristics, like its Vaadi-Samvaadi, Aaroh-Avroh. They are swaras, a swara is a note in the raga system. The most prominent swara in a raga is called Vadi. The second important is called the Samvadi. The swaras other than vadi and samvadi which constitute the raga are called anuvadi swaras.

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

Every raga is a melodious combinations of these swaras. There are three saptakas as they are called, depending upon the frequency a swara is used. Namely, mandra, madhya and taar saptakas. The swara 'Sa' is used as the base for the rest of the sequence.

Indian Classical Music mainly focuses on the melody. Rhythm is not ignored, it actually is an essential ingredient to the performance. Tanpura is used as a basic instrument to generate a harmonic environment. In the words of Pandit Ravi Shankar, the Sitar Legend, "The reason is that there is never any modulation between keys in a raga; the key always stays the same. The tanpura maintains, continuously, the drone of the tonic note. In Western music, the equivalent is sometimes called a pedal point, as if an organist is holding one foot on one pedal all the way through. Everything that happens melodically on top of that occurs in relation to that single note."

III. COMPUTATIONAL APPROACHES

Several research works focused on the Raga Identification and analyses have been published from different viewpoints. This section presents an overview of previous works found in the literature which concentrate on Raga Identification.

Sridhar and Geetha [27] propose a method to identify the raga of Carnatic music signal. The main motive behind Raga identification is that it can be used as a good basis for Music Information Retrieval of Carnatic music songs or Film songs based on Carnatic music. The input polyphonic music signal was analyzed and made to pass through a signal separation algorithm to separate the instrument and the vocal signal.

Belle, Joshi and Rao [28] investigated information pertaining to the intonation of swaras (scale-degree) in Hindustani Classical Music for automatically identifying ragas. They briefly explain why raga identification is an interesting problem and the various attributes that characterize a raga.

Sudha, Kathirvel and Sundaram [26] described a system where the input polyphonic music signal is analyzed and made to pass through a signal separation algorithm to separate the instrument and the vocal signal. The frequency components of the signal are then determined and they map these frequency in to swara sequence and thereby determine the raga of the particular song.

Prashanth T R, Radhika Venugopalan [29] has described a note identification technique which is mainly Raga Identification in Music. They proposed a system that takes a 'wav' file as input, analyses the frequency characteristics and performs note mapping. The prominent notes in the Raga are selected by a Statistical T Test based on the duration of occurrence of a note.

Prateek Verma, Vinutha T.P, Parthe Pandit,Preeti Rao [30] have analyzed Structural segmentation of music involves identifying boundaries between homogenous regions where the homogeneity involves one or more musical dimensions, and therefore depends on the musical genre. In this work, they address the segmentation of Hindustani instrumental concert recordings at the highest time-scale, that is, concert sections marked by prominent changes in rhythmic structure.

We wish to create a comprehensive framework for the problem undertaken. Our approach to raga identification relies heavily on the theory of Indian Classical Musical Theory. The approach does not treat the raga dataset as a type of audio to be analyzed, modeled and classified using standard techniques. Instead, it employs the knowledge of various components of musical theory.

Some of the major features of the approach are as follows:

Use of Vaadi Swaras for identification: A swara is the basic unit of our dataset. With the knowledge of the vaadi-samvaadi swaras for any raga and signal processing of the music piece, the swaras for the ragas are extracted.

Identifying Aaroh and Avroh: An earlier approach looks for arohan and avrohan through finite automatons. The basic notes of the raga are used to write the composition on paper and useful for the learners. Capturing aaroh and avroh from a live performance of any raga is very difficult as these combined in the structure of the raga. A generic approach is attempted. Numbers of recordings are considered where artists performing the same raga, and the sequences of swaras are read and stored. These sequences are extracted manually with the help of persons who are quite knowledgeable in the identifying ragas. These sequences are long enough to identifying the raga.

Swara Frequencies/Histograms: All the swaras used in any raga are fixed. They are used to identify a raga. This is a predefined structure which is followed by the performers, although they do improvisation in their performances with their personal touch.

*Robust and Scale Independent Raga Recognition***:** Earlier approaches have used the audio samples of instrumental performances in a specific setup. We have a mix of vocal as well as instrumental performances in our dataset, which makes sense as we attempt to identify raga on the basis of sequence of swaras and no the tonal frequency used in any performance.

IV. DATASET AND FEATURE EXTRACTION

Raga Dataset: The database used for raga identification has been taken from Swara Sudha, Jodhpur. Swara Sudha has an extensive collection of video/audio recordings of raga performances by various artists over the years. The recordings include both vocal and instrumental performances by artists. In terms of quality, the relatively newer raga performances whose digital recordings are available have cleaner audio tracks on Swara Sudha. The details of the dataset we have used are as follows:

Dataset	Recordings	Male	Female	Instrument	Duration
DS1	48	12	20	16	Concert
DS2	78	25	23	30	3-5 Mins

Sridhar and Geetha [3] tested on 3 ragas sung by 4 artists, where the tonic frequency was manually fed. The Tansen framwork by Pandey et al [14] used 2 ragas Yaman and Bhupali which were taken to be performed around the same tonic. The dataset used by Chordia et al. [20] consists of 72 minutes of monophonic instrumental (sarod) data in 17 ragas performed by a single artist. Belle et al [5] evaluate their system on 10 tunes, with 4 ragas evenly distributed in 2 distinct scale groups.

*Feature Extraction***:** Any audio related classification problem involves features that can capture the time and frequency) qualities of the audio signal. Features like MFCC (Melcepstral cofficients), spectrogram, LPC are widely used for speech recognition. We have tried to work on the feature of swara sequences used in a raga, we have used the arrangement of swaras in a raga to define it. We use the chromagram as our source of feature extraction as it is a very good representation for musical information. Chroma features are 12-dimensional framewise features which, for each frame of audio, represent the content of energy in the 12 western notes. Vector sequences of the chorma features are used for representing the swaras. From chromagram, we extract the semitone with maximum energy in each frame and get a sequence of semitones for the raga. Though these

sequences of semitones might have some identifying information about the raga, using them for raga identification is not suggested because ragas are defined over patterns of swaras which in turn might get associated with different semitones depending on the tonic frequency selected by the artist for a particular performance.

V. CONCLUSION AND FUTURE WORK

A brief introduction to the Raga and its Identification is presented. Techniques used in previous researches are surveyed keeping in view of their approach and contribution. Different features suggest different angle to think about the problem, all outcomes of the various researches suggest that there is ample scope for improvement.

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