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An Overview of Raga Identification in Indian Classical Music

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Abstract

Ragas are the heart of Indian classical music. Indian music has adequate history and slowly it is becoming an international phenomenon. This has opened a wide opportunity for an Indian music discovery system which can suggest music based either on known artists or on sample descriptive terms. Hence researchers from various domains such as music processing, computer engineering and artificial intelligence etc. are contributing more towards Indian music processing. After studied the major features are Note transcription, *Pakad*, Annotation, Pitch-Class Distribution (PCDs), Pitch-Class Dyad Distribution (PCDDs), Signal frequency component offset and onset and *swar* intonation. Some methods like Hidden Markav Model (HMM), Neural Network (NN), Self Organizing Map (SOMs), Signal Separation, Segmentation and String matching with accuracies are used[1].

This paper presents an overview of previous works on *Raga* Identification in Indian Classical music.

Introduction

Ragas are the central structure of Indian Classical Music, each consisting of a unique set of complex melodic gestures. The gestures are sequence of notes that are often inflected with various micro-pitch alterations and articulated with an expressive sense of timing. *Raga* Identification is a process of listening to a piece of music, synthesizing it in to sequence of notes and analyzing the sequence of notes for identifying the *raga* it follows. Each raga has a *swaroopam* and the *gamakas* given to these *swaras* is termed as the *raga laksanam* which contains the *arohanam* (ascending passages i.e. pitch goes up), *avarohanam* (descent i.e pitch goes down).Indian Music is based on *Raga* and *Tala* equivalent to melody and rhythm in western music. *Raga* is more complex than melody and scale in western music [1]. *Raga* invokes the emotion of song. A *raga* is classified in to *melakarta raga* (parent) and *janya raga* (child).The basic notes or *swaras* are Sa, Re, Ga, Ma, Pa, Da and Ni [2].

Raga Identification

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

Sinith and Rajeev [3] suggested an efficient method for recognizing isolated musical patterns in a monophonic environment. They propose a new method, in which first tempo tracking is done to find the transition points of each of the pitches in the music piece, which is consequently used to find the window width adaptively. The fundamental frequency in each of these windows is calculated using the method suggested in Schroeder's histogram, but with a slight modification that the fundamental frequency is tracked using Greatest Common Divisor method in the specified window. This method can be used for perfect fundamental frequency tracking when the fundamental frequency component is either missing or have very simple value in the Fast Fourier Transform. Perfect recognition has been obtained for all in nine typical music patterns (ragas).

Chordia and Rae [4] described the results of the first large-scale *raga* recognition experiment. *Raga* are the central structure of Indian classical music, each consisting of a unique set of complex melodic gestures. They have constructed a system to recognize *ragas* based on pitch-class distributions(PCDs) and pitch-class dyad distribution (PCDDs) calculated directly from the audio signal. A large, diverse database consisting of 20 hours of recorded performances in 31 different *ragas* by 19 different performers was assembled to train and test the system. Classification was performed using support vector

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machines, maximum a posterior (MAP) rule using a multivariate likelihood model (MVN), and Random Forests. When classification was done on 60s segments, a maximum classification accuracy of 99.0% was attained in a cross-validation experiment. In a more difficult unseen generalization experiment, accuracy was 75%.

Chordia and Rae [5] described a system that can listen to a performance of Indian music and recognize the *raga*, the fundamental melodic framework that Indian classical musicians improvise within. In addition to determining the most likely *raga* being performed, the system displays the estimated the likelihood of each of the other possible *ragas*, visualizing the changes over time. The system computes the PCD and employs Bayesian decision rule to classify the obtained twelve dimensional feature vector, where each feature represents the relative use of each pitch class. First evaluation of the system involved a trained Indian classical musician, performing twelve of the thirty-one *ragas* for several minutes each on sarod. A second evaluation used eight vocal recordings, of an average length of ten minutes, from the *raga* database. Authors demonstrated real-time *raga* recognition possibility in realistic performance situations with minimal adjustments needed for different performers.

Sridhar and Geetha [6] 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. Using their proposed singer identification algorithm they determined the singer with the help of the fundamental frequency of the singer. The frequency components of the signal were then determined and these frequency components, mapped into the *swara* sequence thereby determining the *Raga* of the particular song. This method could be used to index the songs and further for retrieval based on the *Raga.*

Belle, Joshi and Rao [7] 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*. The authors looked at two approaches by other authors that exploit some of these characteristics. Then they review musicological studies that mention intonation variability of *swaras* across *ragas*, providing them a basis for using *swara* intonation information in *raga* recognition. They described an experiment that compares the intonation characteristics for distinct *ragas* with the same set of *swaras*. Features derived from *swara* intonation were used a statistical classification framework to classify audio segments corresponding to different ragas with the same *swaras.*

Sudha, Kathirvel and Sundaram [2] 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 (*arohanam* i.e Increasing order of Music Pitch, *avarohanam* Descreasing order of Music Pitch) of the signal are then determined and they map these frequency in to *swara* sequence and thereby determine the *raga* of the particular song. They provided the identification with string type Instruments of 1 or 2 Instruments mixture(violin /sitar/both). Musical note transcription has been done for polyphonic song(audio signal).The feature extraction is done for 90 songs of 50 *ragas* out of which the feature of 70 songs are used to train the network. The remaining 20 songs are used to testing purpose which result in 95% accuracy.

Ranjani, H.G, Arthi,S. and T.V. Sreenivas [8] analysed the *AlApana* of a Carnatic music piece without the prior knowledge of the singer or the *raga. AlApana* is a means to communicate to the audience, the flavour or the *bhAva* of the *raga* through the permitted notes and its phrases. The input to their analysis is a recording of the vocal *AlApana* along with the accompanying instrument. The *AdhAra shadja* (base note) of the singer for that *AlApana* is estimated through a stochastic model of note frequencies. Based on the *shadja*, the authors have identified the notes *(swaras*) used in the *AlApana* using a semi-continuous GMM. Using the probabilities of each note interval, *swaras* of the *AlApana* have been recognized. For *sampurNa ragas*, identification of the possible *raga* is based on the *swaras*. The authors have been able to achieve correct *shadja* identification, which is crucial to all further steps, in 88.8% of 55 *AlApanas* (48 *AlApanas* of 7 *ragas*), 91.5% correct *swara* identification and 62.13% correct *raga* accuracy.

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Prashanth T R, Radhika Venugopalan [9] have described a note identification technique which is mainly Raga Identification in Music. *Raga* refers to melodic modes and modes is a series of five or more musical notes. Characterisation of a note in Carnatic Music is challenging due to the extensive use of Gamakas. 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. A Test data of around 15 *raga AlApanas* was used. The renditions ranged from 3-8 minute clips of various artistes, both male and female. The System performs with an accuracy of 90%

Debashis De and Samarjit Roy [10] discussed about polymorphism in Indian Classical Music. Polymorphism is a property of the object-oriented technology and design. The polymorphism generally provides the designing of a generic interface which embraces a set of related activities. In Indian Classical Music (ICM), there are several features by which the unique features are classified into the Super-Class and a set of Sub-classes using the object-oriented programming and analysis methodology. The authors have used a simple polymorphic approach to represent using the concept of *'Taal'. Taal* is a sole feature which is abbreviated in ICM to define as the exact rhythm of the music. The soul of the music, the *Taal* and its variations (known as 'lay') are represented into the several Super-class and Sub-classes.

Preeti Rao [11] has consider audio metadata in the context of Hindustani classical music. To make the vast digital archives of music more easily accessible, it is necessary to have searchable music descriptors, or metadata, that are meaningful and robust. While metadata conventionally covers factual information that accompanies the music on a CD such as genre, composer, artist, it could also include community-contributed semantic labels such as mood or other culture-specific tags. On the other hand, signal processing methods can be used to extract specific musical knowledge from audio signals such as descriptors related to the melody or rhythm which, in turn, depend to a great extent upon the particular music tradition. Audio signal processing methods and data representations are discussed for specific retrieval tasks within the musicological basis of the tradition.

K.K.Ganguli and P.Rao [12] have described discrimination of melodic patterns in Indian Classical Music. The melodic phrases of a raga are an important cue to its identity. Artists, however, incorporate considerable creative variation within a raga phrase during performance while still preserving its identity in the ears of the listeners. It is of interest therefore to explore the boundaries of this categorizationof phrase identity, given the space of musical variations in the tonal interval and duration dimensions. Such an endeavor canhelp better model musical similarity for music retrieval and pedagogy applications. In this work, they carry out melodic shape manipulations on a selected prominent phrase of raga Deshkar to study the subjective responses of musicians in comparison with non-musicians in terms of perceived discrimination of the controlled variations. A method is presented for deriving musically consistent synthetic stimuli for listening. Subjective responses on the discrimination and identification tasks are presented alongwith a discussion on possible perceptual mechanisms at play.

Prateek Verma,Vinutha T.P, Parthe Pandit,Preeti Rao [13] have analysed 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. Tempo features are effectively combined with energy and chroma features motivated by musicological knowledge and acoustic observations. Posterior probability features from unsupervised model fitting of the frame-level acoustic features are shown to significantly improve robustness to local acoustic variations. Finally, two diverse change detection criteria are combined to obtain a superior segmentation system.

Conclusion

A brief but comprehensive introduction to the *Raga* and its Identification is presented. Previous *Raga* recognition techniques are surveyed with a focus on their approach and contribution. Each component provides different accuracies and all research results suggest that there is amble scope for improvement.

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