A Survey on Raga Identification Using Machine Learning Techniques

Pratik Sutar[1], Mayuresh Saitwal[2], Shubham Wakchaure[3], Rohit Shinde[4], Prof. Poonam Sawdekar[5]

[1,2,3,4,5] *Dr. D Y Patil Institute of Technology, Pimpri, Pune*

Abstract- **Hindustani Classical Music is composed of notes and certain combinations of these notes leads to formation of raga. Raga is a sequential collection of swaras. Raga is divided into two systems Hindustani (North Indian) music, Carnatic (South Indian) music. Artists use their own tonic frequency for singing raga. Each raga is performed in certain time in a day and represents unique emotion. Automatic identification of raga has applications in areas like recommendation system, tagging system, real time detection of raga. In this paper, we have analyzed past works in identification of raga and challenges associated with it.**

Index terms- — **Swara, Vadi, raga, ICM, MFCC, HMM**

I.INTRODUCTION

Hindustani Classical Music has two main parts: Raga and Taal. Raga is a melodic form and Taal is a rhythmic form. The seven notes used in raga are Sa, Re, Ga, Ma, Pa, Dha and Ni. Sa note in Hindustani Classical Music is not associated with particular frequency. Artists use their own base frequency for singing raga. The performance is set to a melodic pattern which is called a raga. Raga is characterized by specific ascent (Arohana) and descent (Avarohana) sequences. Some of the other characteristics include King (Vadi) and Queen (Samavadi) notes and characteristic phrases (Pakad). Each raga of the ragas has its natural register (Ambit) and glissando (Meend) rules.

The term, Raga, first occurred in a technical context in the Brihaddeshi [15] where it is described as "That which is a special dhwani (tune), is colorful or delightful to the minds of the people, is said to be raga and is bedecked with swara (notes) and varna". Hence, raga is neither a tune nor a scale; it is a set of rules which can together be called a melodic framework. The rules of a raga can be defined by

- The list of specific notes (swaras) that can be used during playing of the raga
- The manner in which the notes are use
- Manner in which the scale is ascended (Aaroha) or descended (Avaroha)
- The way in which to reveal the optional or required musical phrases, or combine them
- The octave or frequency range to emphasize
- The relative pacing between the notes
- The time of day or the season when the raga may be performed, to invoke the emotions of the raga for maximum impact on the emotional and mental state of the performer and listener

In our society, music is a very interesting topic, as almost everyone enjoys listening to it and many wants to create. Broadly speaking, the research in Music Information Retrieval (MIR) is one of the upcoming research interest with the extraction of meaningful features from music, indexing of music using these features. Raga identification consists of techniques that identify features from a piece of music and accordingly classify it into the appropriate raga.

II. BASIC FEATURES

We can divide features into low level features and mid-level features. Low level features can further be divided into timbre and temporal features. Temporal features capture the variation and evolution of timbre over time, whereas timbre features capture the tonal quality of sound that is related to different instrumentation. Low-level features are obtained directly from various signal processing techniques like Fourier transform, spectral/cepstral analysis, auto regressive modelling, etc. Low-level features have been used predominantly in music classification, due to the simple procedures to obtain them and their good performance [8].

Short-term features like timbre features usually capture the characteristics of the audio signal in frames with 10–100 ms duration, whereas long-term

features like temporal and rhythm features capture the long-term effect and interaction of the signal and are normally extracted from local windows with longer duration [8].

III. QUANTIFIED FEATURES OF RAGA

1. Count of notes:
   This feature is defined as the number of times a note arrives in the signal. This feature is selected as it gives some idea about the Vadi, Samvadi and anuvadi notes as many notes do not have the same level of significance. Vadi is the most important note in a raga and samvadi is the second most important note in a raga. Anuvadi is an important note in the raga which is different from Vadi and Samvadi.

2. Average duration of notes:
   The second feature that is extracted from the raga is the average time duration for a note in the raga. It gives the idea about the raga structure. Since every raga will have a fixed set of notes in it, so to completely express a raga these fundamental notes must be present. From the note duration we get the idea about the notes most stayed in the raga and the notes present in the raga.

3. Onset of notes:
   This is one of the most important features, which gives the time instance when a note is detected in the signal and therefore helps in obtaining the sequence of the notes. The note onset gives the idea about the aroh (ascent) and awaroh (descent) of the raga.

4. Onset of notes:
   This is one of the most important features, which gives the time instance when a note is detected in the signal and therefore helps in obtaining the sequence of the notes. The note onset gives the idea about the aroh (ascent) and awaroh (descent) of the raga.

IV. TECHNIQUES FOR RAGA IDENTIFICATION

Not much research has been done in the area of applying techniques from computational musicology and artificial intelligence to Hindustani classical music. In order to identify ragas computationally, swara intonation, scale, note progressions and pakad/characteristic phrases are used.

Ankit Anand [1] used Convolutional Neural Network to identify ragas. He used 3 convolutional layers plus max pool layers fully connected to soft max layer. He used subsets of data sets namely D1, D2. For ragas in D1 he reported an accuracy of 90%. For ragas in D2 he reported an accuracy of 86.36%.

Anusha Sridharan, Melody Moh and Teng-Sheng Moh [2] used three methods for classification : Multinomial Naïve Bayes, Random Forest and Neural networks. They reported the best results for genre classification is obtained with (3,3) using Random Forest algorithm. Other values of n- gram have consistent values with an average of 95.83%.

Rhythm Bhatia, Saumya Srivastava, Vandan Bhatia and Manpreet Singh [3] has discussed the importance of feature extraction in music classification. It was found that timbre feature provides meaningful information about audio signal. In order to represent the speech feature, MFCC feature has been used and for phase information Group delay is used. In future, both these features can be combined and used together to train models. They analyzed various Mel based, Chroma print, audio fingerprint feature for music information retrieval process.

D. Dharini, A. Revathi, P. Oberson, and M. Kalaivani [4] proposed Continuous Density Hidden Markov Model(CD- HMM) for raga identification. Identification system of raga is performed for MFCC feature considerations. Continuous density HMM is used since discrete HMM uses index values. They reported accuracy of about 70.44% and 57.27 % for two data sets.

Rajib Sarkar, Soumya Kanti Naskar and Sanjoy Kumar Saha [5] used multi class Support Vector Machine for classification of raga. They first formed all pitch based swara (note) profile and utilized it to generate occurrence histogram of dominant swaras and strength distribution of the swaras. They reported 84.29% accuracy for instrumental data set and 70.52% for vocal data set.

Padmasundari G and Hema A Murthy [6] proposed a raga identification method for Carnatic music using Locality Sensitive Hashing (LSH). LSH is a randomized algorithm technique used to quickly find similar entries or nearest neighbour from a large training database. They used data set consisting of

100 concerts, each with 8-10 ragas, leading to 927 items and 182 ragas. They reported accuracy of 70% on 3000 raga queries.

Rohan T. Pillai and Shrinivas P. Mahajan [7] proposed method which is classified into an Acoustic Model and a Music Language Model. In the Acoustic Model, a modified auto correlation method was used, which detects the pitch frequency of the musical notes played. In the Music Language Model, the detected pitch frequencies were mapped from different musical octaves to the middle octave and then quantized to the standard frequencies to identify raga. They reported accuracy of 80.56%, 81.25% and 89.81% for recordings of human vocals, the veena and the piano.

Sanchit Alekh [9] used high-dimensional pitch representations (HPDs), namely the Fine-Grained Pitch Distribution (FPD) and Kernel-Density Pitch Distribution (KPD). Then he used several distance measures, such as city block, Euclidean and Bhattacharya distance to calculate posterior probability of ragas.

Joe Cheri Ross, Rudra Murthy, Kaustuv Kanti Ganguli, and Pushpak Bhattacharyya [10] proposed method to identify similarities between Hindustani ragas based on word vectors learned from textual descriptions and discussions on Hindustani ragas. K-means clustering is employed, defining k as the number of word categories.

Sathwik Tejaswi Madhusudhan and Girish Chowdhary

[11] introduced 1) a novel data augmentation technique leveraging an inherent aspect of Indian Classical Music that the semantics of improvisations and compositions are dependent, only on the relative position of notes with respect to the tonic 2) 5 layer Convolutional Neural Network based approach to build a robust model that can classify Raaga independent of the tonic. They reported accuracy of around 72-77% on the test data sets.

Rajeswari et al [12] recognized ragas by estimating the scale from the given tune and by comparing it with template scales. Their test data consists of 30 tunes in 3 ragas sung by 4 artists. They use the harmonic product spectrum algorithm to extract the pitch. The results obtained show 67% accuracy.

Shetty et al [13] use a similar approach for raga recognition. They used the individual swaras used in Aaroha- Avaroha. Neural networks were used for classification. They report an accuracy of 95% over 90 tunes from 50 ragas, using 60 tunes as training data and the rest 30 tunes as testing data.

Belle et al [14] used swara intonation to differentiate ragas that share the same scale intervals. They evaluated the system on 10 tunes, with 4 ragas evenly distributed in 2 distinct scale groups.

V. CHALLENGES

For automatic raga recognition there are many limitations involve with respect to different aspects of data set/database, algorithm used, raga characteristics, etc. Raga recognition is not a simple technique. It involves analysis of large amount of database with sufficient knowledge about raga and also requires training for raga recognition. For different steps involve in raga recognition by different approaches there are many challenges associated with them. Different challenges with raga identification are discussed below:

- Limited database containing limited number of raga.
- Incorrect pitch extraction.
- Manual tonic detection.
- Assumption made for different parameters of algorithm.
- Different constraints on inputs, such as number of swara, limitation to singers, time length, and monophonic type.

VI. CONCLUSION AND FUTURE WORK

Identification of Raga in Hindustani Classical Music is a very challenging problem as Raga a very complex structure. In this paper, we have presented an overview of techniques for automatic Raga identification which uses scale different statistical models and algorithms. Out of various characteristics of Raga, sequence of notes is a best feature for Raga identification. The Aaroha – Avaroha pattern is well defined for each raga and hence it is very useful feature in identification of the Raga. By using note onset detection accuracy can be improved. We can improve the Raga recognition method by using additional characteristics of Raga like pakad. There are lots of limitations associated with the techniques which are discussed above for raga identification. In

future the improvement over the technique can be done by removal of limitations on that technique. Lot of work is done for western music but less for Indian classical music.

REFERENCES

[1] Ankit Anand, "Raga Identification Using Convolutional Neural Network," Second International Conference on Advanced Computational and Communication Paradigms (ICACCP), 2019.

[2] Anusha Sridharan, Melody Moh and Teng-Sheng Moh, "Similarity Estimation for Classical Indian Music," 2018 17th IEEE International Conference on Machine Learning and Applications, 2018.

[3] Rhythm Bhatia, Saumya Srivastava, Vandan Bhatia and Manpreet Singh, "Analysis of Audio Features for Music Representation," IEEE, 2018.

[4] D.Dharini, A.Revathi, P. Oberson, and M.Kalaivani, "CD- HMM MODELING FOR RAGA IDENTIFICATION," Proceedings of the Second International conference on I- SMAC, IEEE, 2018.

[5] Rajib Sarkar, Soumya Kanti Naskar and Sanjoy Kumar Saha, "Raga identification from Hindustani classical music signal using compositional properties," Springer-Verlag GmbH Germany, 2017.

[6] Padmasundari G and Hema A Murthy, "Raga Identification Using Locality Sensitive Hashing," Twenty-third National Conference on Communications (NCC), 2017.

[7] Rohan T. Pillai and Shrinivas P. Mahajan, "Automatic Carnatic Raga Identification using Octave Mapping and Note Quantization," International Conference on Communication and Signal Processing, April 6-8, 2017.

[8] Asoke Kumar Datta, Sandeep Singh Solanki, Ranjan Sengupta, Soubhik Chakraborty, Kartik Mahto and Anirban Patranabis, "Signal Analysis of Hindustani Classical Music," Springer Science+Business Media Singapore, 2017.

[9] Sanchit Alekh, "Automatic Raga Recognition in Hindustani Classical Music," 2017.

[10] Joe Cheri Ross, Rudra Murthy, Kaustuv Kanti Ganguli, and Pushpak Bhattacharyya, "Identifying Raga Similarity in Hindustani Classical Music through Distributed Representation of Raga Names," Proc. of the 13th International Symposium on CMMR, Matosinhos, Portugal, Sept. 25-28, 2017.

[11] Sathwik Tejaswi Madhusudhan and Girish Chowdhary, "Tonic Independent Raag Classification in Indian Classical Music," 32nd Conference on Neural Information Processing Systems, 2018.

[12] R. Sridhar and T. Geetha, "Raga identification of carnatic music for music information retrieval," International Journal of Recent trends in Engineering, vol. 1, no. 1, 2009, pp. 571–574.