CHANGE YOUR TUNE: A SYSTEMATIC EXPLORATION OF TONIC SHIFT IN CARNATIC MUSIC

Vidya Rangasayee
Department of Computer Science, San Jose State University, USA
vidya.rangasayee@sjsu.edu

ABSTRACT

In Carnatic (South Indian Classical) music, Ragas (similar to western scales) can be produced by a change of the Adhara Sruthi i.e., tonic, This can be performed on Melakartha ragas (full scales) as well as Janya or derivative ragas. Complete tonic shifts is a well-known technique employed by several musicians in order to bring a change in mood in a piece. This paper presents TonicTunes - a system that systematically explores all possible tonic shifts of a given scale. In addition it uses decision trees to identify valid tonic shifts based on established rules of Carnatic Music. The system also allows users to enter any arbitrary phrase in a given raga, to generate equivalent phrases in other ragas that can be produced by a simple tonic shift. We further explore the realm of partial tonic shifts where, by omitting notes during improvisation, we can explore related ragas which was hitherto unexplored in conventional graha bedham.

1. INTRODUCTION

Graha bedham or tonic shift is used as an improvisation technique in Carnatic Music to bring out the mood changes and increase audience engagement. This has predominantly been up to the knowledge, musical maturity and discretion of the musician to employ graha bedham in their concerts. Rendering a tonic shift involves non-trivial mental mathematical calculations, impeccable pitch perfection, astute knowledge of ragas and their gamakas and the ability to combine the them in realtime. It is easy to implement the theoretical foundations of this computationally. It allows us to explore a wider variety of tonic shifts that were not available to the average musician until now. While several attempts have been made at implementing this in some form or the other, all of it were done recreationally. A formal proposal for building a system for systematically exploring tonic shifts has not been presented yet to the best of our knowledge.

2. BACKGROUND

Carnatic Music, unlike the fixed Western notes, is pivoted on adhara sruthi or tonic. The scale is then calculated as a system of ratios from the adhara sruthi. Based on the 12 sruthis (semitones) [1] and a set of rules governing what constitutes a Sampurna Raga (or full scale), a system of 72 Melakartha ragas are defined. Several Janya Raga (or partial scale) are generated out of the 72 Melakartha ragas. Based on the adhara shadja, we can then proceed to identify the frequency of the notes in a scale. For ex, with a Adhara sruthi of C4, the notes C4, D4, E4, F4, G4, A4, B4 form the raga Shankarabharanam which is the 29th Melakartha. By omitting F4 (M1), and A4 (D2), we arrive at Hamsadhwani which is a partial scale (janya) of Shankarabharanam. While there are only a total of 72 full scales, they can give rise to countably infinite janya ragas.

3. IMPLEMENTATION

3.1 Algorithm

A tonic shift occurs when notes of the scale are retained but the tonic is shifted to a different position. Take for example the 12 semitones and notes in HanumaTodi $(SR_1G_2M_1PD_1N_2)$. Replacing with note numbers (see Table 1) we have [0,1,3,5,7,8,10]. Calculating successive differences in the scale (and including the shadja in the next octave) we have [1,2,2,2,1,2,2]. A tonic shift can be thought of as a circular permutation of these differences. Since the notes are retained and only the starting note is shifted, it is equivalent to having the same set of differences but starting at a different index and wrapping around. If, say we start at index 5 (0-based), the differences become [2,2,1,2,2,2,1] and calculating backwards this is [0,2,4,5,7,9,11] which gives $(SR_2G_3M_1PD_2N_3S)$ or Shankarabharanam (29th Melakartha). Note that the note frequencies are unchanged but by simply shifting the shadja, the perception of a new raga is created.

3.2 Well known full scale tonic shift

This is the most popular and has the most ragas generated by a single pattern of differences. [2, 3]

[1] There is disagreement among carnaic musicians on on whether there are 12 or 22 sruthis but the popular system uses only 12

[2] The Greek modes assume that the adhara shadja is at C for Shankarabharanam

[3] Locrian gives rise to a full scale with two Madhyamas called Hanumasri. See Section 6

S	R_1	R_2	G_2	G_3	M_1	M_2	P	D_1	D_2	N_2	N_3
–	-	G1	-	-	-	-	-	-	N1	-	-
0	1	2	3	4	5	6	7	8	9	10	11

Table 1. The 12 semitones

Result: Complete set of Full scale tonic shifts
i = 1;
while *i* $\leq$ 72 **do**
  Generate the notes for ith Melakartha;
  Compute the difference between successive notes;
  for *every circular permutation of differences* **do**
    compute the new notes from the differences;
    if *new notes form a raga* **then**
      Print the Start Raga, New Raga and the shift amount
    else
  end
end

Algorithm 1: Generating Full Tonic shifts

Raga	Mela	Pattern	Greek Mode
Shankarabharanam	29	2212221	C-major
Kharaharapriya	22	2122212	Dorian
Hanumattodi	8	1222122	Phrygian
Mechakalyani	65	2221221	Lydian
Harikhamboji	28	2212212	Mixolydian
Natabhairavi	20	2122122	Aeolian

Table 2. Highest number of ragas from tonic shift

3.3 Lesser known full scale tonic shifts

There are several lesser known tonic shifts among ragas that have fewer compositions

Raga	Mela	Diff Pattern
Kantamani	61	2221212
Manavati	5	2212122

Table 3. Lesser known full scale tonic shifts

3.4 Popular tonic shifts in Janya raga

See Table 4

4. PARTIAL TONIC SHIFTS

Partial tonic shifts occur when certain notes are omitted in the rendering of one raga in order to perform tonic shift to another raga.

4.1 Full scale to Janya Raga tonic shift

Consider the Shanmukhapriya full scale: $SR_2G_2M_2PD_1N_2S$ (2131122) and Kanada Janya raga: $SR_2G_2M_1D_2N_2S$ (212412). When you omit M2 of the full scale, you get a pattern 214122. This, however is not a circular permutation of the Janya. By omitting the S of the janya we get a pattern of 14124 which can be formed by the full scale. Work is in progress to generate all such variations.

Raga	Notes	Diff Pattern
Mohanam	$SR_2G_3PD_2S$	22323
Madhyamavati	$SR_2M_1PN_2S$	23232
Hindolam	$SG_2M_1D_1N_2S$	32322
Suddha Saveri	$SR_2M_1PD_2S$	23223
Suddha Dhanyasi	$SG_2M_1PN_2S$	32232

Table 4. Highest number of ragas from tonic shift

5. RAGAS WITH TWO MADHYAMAS

Tonic shifts produce a large number of permutations that involve ragas with two madhyamas M_1 and M_2. These are usually omitted since a full scale can only contain seven notes and only one of each. If we omit the P and include both M's, this gives rise to 36 additional ragas which are called Panchama Varja Dwi Madhyama ragas as defined in the Ashtotharasata or 108 melakartha system. The system generates these tonic shifts.

6. CURRENT STATUS AND FUTURE WORK

TonicTunes currently generates full and partial tonic shifts for both Melakartha and Janya ragas. It also allows the user to enter a series of notes in a selected scale and get a list of suggestions for tonic shifts to other ragas. Work is in progress to synthesize the notes produced. The system can be extended to learn from existing renderings to generate newer swara prastharas and explore tonic shifts of these generated notes. This can be used a pedagogical tool for students of carnatic music to both learn and explore graha bedham at different levels.

7. REFERENCES

[1] Ranjani Gayathri. Lecture demonstration on gruha bedham. https://www.youtube.com/watch?v=KPNCwCO3lhI, January 2016.

[2] Raja Ramanna. *The structure of music in raga and western systems*. Bharatiya Vidya Bhavan, 1993.

[3] Ramesh Subrahmanyan. Analysis of raga and gruha bedham. Private correspondence.