

HOW HARMONIUM ACCOMPANIMENT IN HINDUSTANI MUSIC IS CHANGING THE SCALE SYSTEM

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ABSTRACT

It was middle of 19th century when French-made hand-pumped Harmonium stepped into the arena of Indian music by some missionaries. Apart from the historical evidence it had been a great impact on the basic Hindustani musical genre; Especially on Hindustani vocal music. And within next fifty years it would have been a foremost accompanying musical instrument of Hindustani classical vocal music. In this paper we attempted to find out the influence of harmonium usage in equally tempered scale (ET scale) on the raga renderings in Hindustani music. The pitch period was extracted from 17 renderings of 12 eminent vocalists of Hindustani music, for two different ragas. Only the steady pitch periods were used for analysis. The approach was to study the distribution of steady pitch states against the ratio of each note in an octave. Prominent peaks indicate preferred ratios. Attempt was made to see whether these ratios obey ET scale or Indian 22 sruti intervals. The result shows that most of the vocalists follow a mixture of both systems with a preference of any one depending on the raga.

INTRODUCTION

From one note to three, then five and later seven notes were conceived in the Vedic (*Sumgan*) period in Indian Music, normally called as Hindustani Music (HM) [1]. In *Natyasastra* (about 2nd century A.D.), Bharat portrayed 22 *Srutis* – the ultimate or finest position of a note in a scale or it could be described as micro-tones, in respect of contemporary two *Grams*. *Gram* was a short of scale based on *Sruti* position. For instance, at the time of Bharat there were *Sadja Gram* and *Madhyam Gram*. In *Sadja Gram* the *Sruti* divisions were: 4(Sa) 3(Re) 2(Ga) 4(Ma) 4(Pa) 3(Da) 2(Ni). Whereas in *Madhyam Gram* it were: 4(Sa) 3(Re) 2(Ga) 4(Ma) 3(Pa) 4(Da) 2(Ni). Due to this (22) *Sruti* position *Vadi-Samavadi-Anuvadi* and other related factors used to change [2]. Though many of the musicians still consider the *Sruti* division of *Sadja Gram* but in realistic approach in modern times it is: Sa (tonic) and Pa (fifth note) are fixed note with one *Sruti* and the

other notes are of four *Sruti* each [3]. This was further corroborated by analyzing the renderings of a large number of musicians [7].

Fundamentally, Hindustani music (HM) consists with twelve notes of which seven notes are *Suddha* (natural) and four *Komal* (flat) and one *Tibra* (sharp) note. Although, earlier those were existed but it was first proved on a Vina string (length: 36 inch) by Pandit Ahobal in 17th century followed by Srinivas [4]. Through the ages *Sruti* (in *Sadja Gram*) in respect of note-to-note ratio becomes most vital elements of Indian music.

Noticeably, from 11th to 13th century Indian music had been divided into two major systems: Hindustani music (HM) and Karnataki Music (KM). Vocalists of both systems used Tanpura as drone musical instrument. For accompaniment of vocal music, Sarengi was the only musical instrument other than Tabla or Pakhawaj in Hindustani style. Whereas, instead of Sarengi Vina was the major musical instrument for both vocal accompaniment as well as for solo performances in Karnataki Music (Classical music of South India).

Since the time of British invasion, through British army band, a number of western musical instruments became popular and migrated to the contemporary Indian cultural society. Along with violin, few of those musical instruments were well adopted and had been popularized by the Indian musicians. In comparison with the other parts of India, violin was much nourished and later Indianised by the brilliance of some Karnataki Musical exponents and gradually it had become a part and parcel for the Karnataki vocal accompaniment.

On the contrary, due to some reasons Sarengi was slowly decreasing its demand to the Hindustani vocalists. Moreover, about the middle of 19th century Harmonium was introduced to Hindustani music and due to its easy playing technique subsequently it became popular and well accepted by both musicians (especially vocalists) as well as to the music lovers. In the eastern part of India, this migrated musical instrument was nurtured, improvised by means of modification and of course Indianised by Mr. Dwarkanath Ghosh (founder-owner of the harmonium making shop – Dwarkin)[5].

As we earlier mentioned that – *Sruti* and note-to-note ratio are the most fundamental elements of Hindustani music; along with *Sadja-Madham* (1st and 4th note) and *Sadja-Pancham* (1st and 5th note) relations. There is no fixed scale in HM like western music. Usually in Hindustani music, vocalists (also instrumentalists), as per their voice comfort used any sound or *Swara* as tonic (*Sadja* or Sa) note and with the help of note ratio, individual feeling and *talim* (intense training)

used to make the whole structure of any raga (in a nutshell – musical scale). This is one of the uniqueness of Indian music and so it has been highly esteemed by the rest of the world.

In HM, swara (note) is conceived not merely as a sound of fixed pitch position, but as the entire tonal range between itself and its previous swara. Though this interval can be theoretically divided into infinitesimal parts, the ancient musicologists believed that only a limited number, not exceeding four, sounds could be distinctly cognized by the ear in a swara-interval. These cognizable sounds are known as *Srutis* and the interval, which separated one swara from the next, was measured in terms of *Srutis*. *Sruti* was thought of both as the least audible interval between two sounds, as well as the sounds themselves, which were separated, by such an interval. The total number of *Srutis* was fixed unambiguously at 22 in ancient, musical treatises [6]. The tradition of teaching HM is an oral one. It is taught directly by the guru to the disciple, without the use of textual material. The basics starting from voice culture to the understanding of notes and *Srutis* are taught through direct oral communication accompanying with only *tanpura*. It was showed that the use of *Srutis* varies with *gharanas* as well as with the *ragas* and has also a student- teacher relationship [7]. It is likely that each *gharana* may have its own sense of aesthetic satisfaction of a *raga* and the use of *Sruti* may reflect these. It is also known that musicians feel that a particular note sounds better when placed relatively low for a particular *raga* while it may have to be raised much higher for some other *raga*. For example some say that *komal re* needs to be placed high in Todi but low in Bhairav. By the name it is clear that harmonium is related to harmony not melody. Though it is said, Indianised harmonium can produce some melody with its bellow. But the fact is – free from frequent tuning hazard and easy playability, the introduction of harmonium subconsciously turned our melodic musical attitude, at least to some extent, towards harmony. Because, harmonium is based on equally tempered scale(ET scale) which can play only 12 notes not 22 *Srutis*. So, *Ati-komal* (moreflat), *Chori-komal* (sharper than flat) is same ‘flat’ one key.

This paper presents the *Sruti* position as revealed from the performances of contemporary and older generation singers. Regarding the use of *Srutis* by the singers, substantive and distinctive preferences to different *Srutis* in two different ragas (Bhairav and Todi) are studied particularly in the context of the usage of Harmonium (ET scale).

EXPERIMENTAL DETAILS

17 renderings on two *ragas* namely Bhairav and Todi, sung by 12 singers from different *gharanas* of Hindustani music, collected from different archives, were taken for the study. For our analysis only slow tempo parts (mostly *Vilambit Vistar*) of each sample was selected from each *raga*. The digitization of the signal is done at the rate of 44100 samples/sec (16 bits/sample) in mono channel. Signal files, stored as 'wav files', are thus selected for analysis, which constitute the database. Pitch was extracted at 10 milliseconds interval using open source software Wavesurfer of KTH, Stockholm. Extraction of notes from the pitch profile needs the knowledge of the tonic used by the player. A skilled musician was requested to listen to the signal files one after another to detect the position of tonic Sa in the signal file. Cool edit software of Syntrellium corporation was used for further signal processing. The finding of the ratio-intervals is done by first dividing the smoothed pitch values for each song by the pitch value of the 'Sa', tonic of that raga rendering. This gives the frequency ratios for each pitch data. From the ratio data, steady state sequences are created with all consecutive pitch in a sequence, which is terminated when $|x_{i+1} - M| > M/30$ where $M = (1/i) \sum x_i$. If the duration of any sequence were less than that of a certain minimum value (60 milliseconds for this experiment) then the sequence is rejected. Elements of these sequences are considered as suitable candidate data for this analysis [4]. Whenever the ratio is less than 1 it is multiplied by a factor of 2 and when it is greater than 2 it is divided by 2. This effectively folds all pitch data into the middle octave. These are now distributed in 1200 bins of one-cent width each. The peaks of these distributions for each song are purported to be indicative of the Sruti positions for that raga rendering.

RESULT AND DISCUSSION

Aim of this study is to examine closely the calculated Sruti intervals [5] for individual performers, which reveals discreet well-defined finer structures of their Sruti position. It also reveals that the sounds having two different pitches in the same *Sruti*-interval have the same note value and are identical in this perceptual sense. However in terms of consonance with another sound, these two may behave quite differently. One may be in consonance while the other may not. In this sense they are perceptually differentiable. This differentiability demands cognizance at least in modal music [6].

A Euclidean distance measurement technique (eqn. 1) is used to find the nearest neighbour of 22 Sruti intervals from that of ET scale.

$$d(p, q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + \dots + (p_i - q_i)^2 + \dots + (p_n - q_n)^2} \dots (1)$$

As per the calculated minimum distance i.e. the nearest neighbour, values closer to 22 Srutis are marked in italics in Table 1 and 2 while values closer to ET scale are in normal font.

Table 1. *Sruti* positions obtained from raga Todi for nine artists

Ratio (22)	Artist a	Artist c	Artist d	Artist f	Artist g	Artist w	Artist x	Artist y	Artist z
sa	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
r1			<i>1.051</i>					<i>1.050</i>	
r2	1.059	1.061		1.050	1.059	1.060	1.061		1.061
r3									
r4			<i>1.158</i>			1.123		<i>1.136</i>	
g1	1.186			1.185	1.189		1.185		<i>1.179</i>
g2		<i>1.200</i>							
g3									
g4						<i>1.262</i>		<i>1.256</i>	
m1									
m2								1.333	1.338
m3		<i>1.413</i>	1.417			<i>1.412</i>	1.420	1.416	<i>1.401</i>
m4	1.428			1.427	1.431				
pa	1.497	1.498	1.501	<i>1.508</i>	<i>1.514</i>	<i>1.509</i>	1.488	<i>1.506</i>	<i>1.507</i>
d1					1.575				
d2	1.582	<i>1.597</i>	1.591	1.583			1.586		<i>1.597</i>
d3									
d4						1.681			
n1									
n2									
n3								<i>1.819</i>	
n4	1.910	1.903	1.893	1.903	<i>1.926</i>	<i>1.920</i>	1.890	1.888	<i>1.920</i>

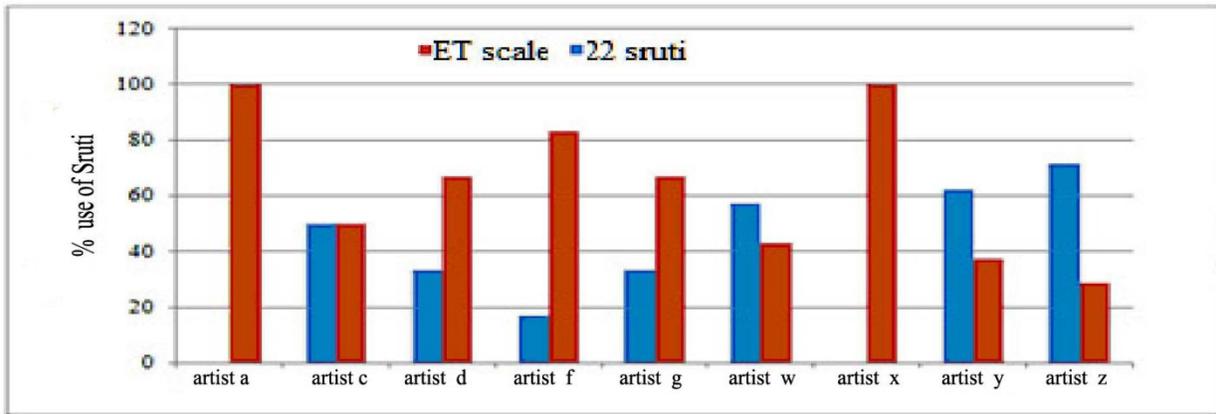


Figure 1: Usage of Sruti by nine artists in raga Todi

Usage of 22 Srutis (microtonal intervals) are perceptually distinguishable than that use of ET scale. And according to some people 22 Srutis are more pleasant to listen. Possibly the frequent use of harmonium as an accompaniment for some artists make their ratios mostly matched with the ET scale.

Table 2. *Sruti* positions obtained from raga Bhairav for eight artists

Ratio (22)	artist a	artist c	artist d	artist f	artist g	artist h	artist i	artist j
sa	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
r1		1.043			1.047	1.053	1.043	1.049
r2	1.061		1.058	1.059			1.078	
r3								
r4								
g1								
g2		1.209						
g3								
g4	1.265		1.263	1.263	1.266	1.258	1.263	1.261
m1		1.313					1.327	
m2	1.334		1.336	1.335	1.333	1.330		1.332
m3						1.411		
m4								
pa	1.506	1.498	1.512	1.517	1.510		1.494	1.497
d1		1.562				1.583		1.571
d2	1.593		1.596	1.601	1.586		1.588	
d3								
d4								
n1								1.709
n2					1.764			
n3			1.795					
n4	1.906	1.869	1.906	1.914	1.875	1.896	1.896	1.886

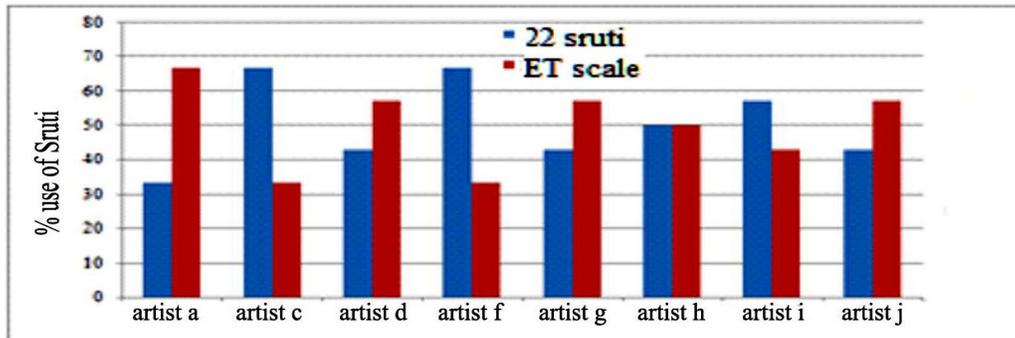
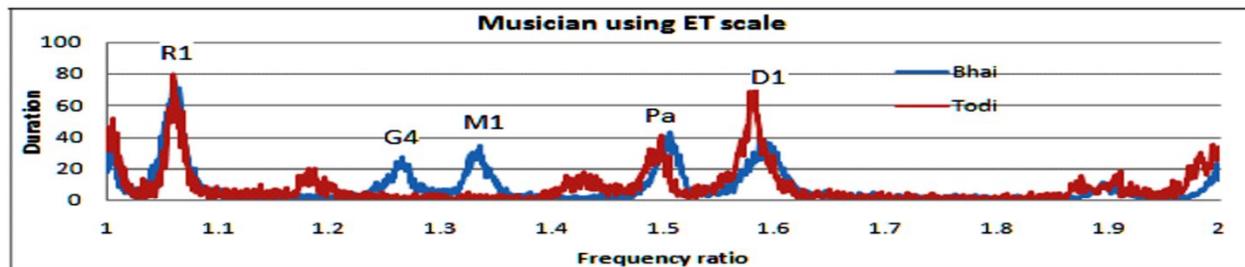


Figure 2: Usage of sruti by eight artists in raga Bhairav

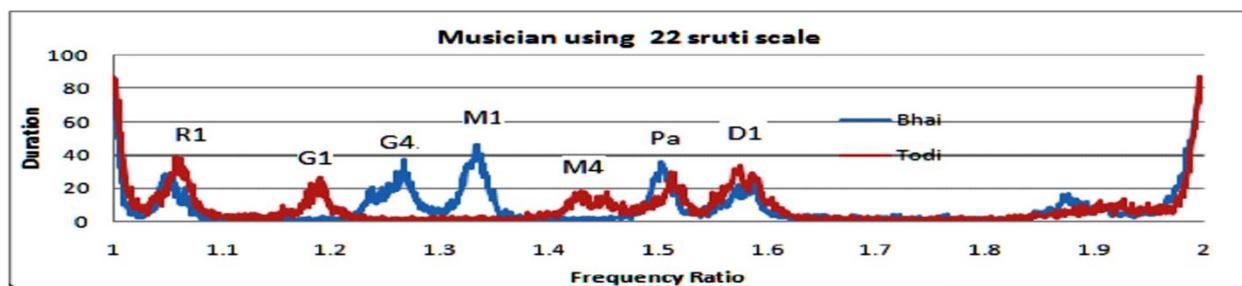
It is being observed from the tables and figures 1 and 2 that some musicians are using ET scale ratios and some musicians are using mixed ratios both 22 srutis and ET scale.

Presently this trend is increasing in HM and a recent survey on the assessment of tuning in HM shows the predominance of the use of ET scale [7]. Such inclination of HM towards equal-tempered scales will gradually lose the significance of *shrutis* due to the influence of foreign musical elements like harmonium. This might lose the cognitive influence of HM regarding many

musical qualities such as mood, consonance or timbre particularly the ‘feelings’, which is the heart of HM.



(a)



(b)

Figure 3 (a and b). Frequency distribution of two renderings of *raga* Bhairav and Todi spread over 1200 bins of 1-cent interval. The peaks can be easily identified with the ratios, which correspond to different *Sruti* positions utilized by the artist in the rendering.

Figure 3 (a and b) shows the frequency of occurrence of the duration of ratio of the steady pitch periods and Sa (tonic) folded to middle octave and distributed over 100bins of one cent interval. Thus each peak corresponds to a note utilized by the artist in the raga. The height of the peak gives the number of times the note is sung in the processed signal. It is being observed from the distributions that the singer (a) uses ET scale mostly and the singer (b) uses the Indian *Sruti* system.

CONCLUSION

Influence of harmonium have enabled the vocalists of HM to deviate from the older 22 *Sruti* interval system and at present most of the musicians either follow a mixed system of ET and 22 *Sruti* intervals or purely ET scale. There is also a preference of the system on the raga.

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