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Michele Della Ventura, *editor*

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Preface

This volume of proceedings from the conference provides an opportunity for readers to engage with a selection of refereed papers that were presented during the International Conference on New Music Concepts and Inspired Education. The reader will sample here reports of research on topics ranging from mathematical models in music to pattern recognition in music; symbolic music processing; music synthesis and transformation; learning and conceptual change; teaching strategies; e-learning and innovative learning. This book is meant to be a *textbook* that is suitable for courses at the advanced undergraduate and beginning master level. By mixing theory and practice, the book provides both profound technological knowledge as well as a comprehensive treatment of music processing applications.
The goals of the Conference are to foster international research collaborations in the fields of Music Studies and Education as well as to provide a forum to present current research results in the forms of technical sessions, round table discussions during the conference period in a relax and enjoyable atmosphere.
36 papers from 16 countries were received. All the submissions were reviewed on the basis of their significance, novelty, technical quality, and practical impact. After careful reviews by at least three experts in the relevant areas for each paper, 12 papers from 10 countries were accepted for presentation or poster display at the conference.

I want to take this opportunity to thank all participants who have worked hard to make this conference a success. Thanks are also due to the staff of "Studio Musica" for their help with producing the proceedings. I am also grateful to all members of Organizing Committee, Local Arrangement Committee and Program Committee as well as all participants who have worked hard to make this conference a success.
Finally I want to appreciate all authors for their excellent papers to this conference.

April 2019 Michele Della Ventura

Contents

Raga classification in Indian Classical music - A generalized approach

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Abstract. Ragas are a fundamental concept to the Indian Classical music which provides immense scope for artists to improvise aesthetically. Classification of ragas have been studied since the inception but even the best models in practice have ambiguities in the classification of certain ragas and this has troubled many musicians and musicologists. We have constructed a new model to classify ragas which adheres to all the existing conventions and resolves these ambiguities.

Keywords. Melakarta, Raga classification, Indian Classical music

1 Introduction

Indian classical system comprises of two systems, the *Hindusthani system* (followed in the Northern regions) and the *Carnatic system* (followed in the southern/Carnatic region) and the concept of *raga* is shared by both. A *raga* is a melodic framework of *svara-s* (notes) for the musician to improvise in a certain scope. Each *raga* (as the term suggests) has its own color in terms of its own "unique melodic personality" [1]. Traditionally a raga comprises of at least 5 *swaras* (notes), although ragas discovered in the recent years may violate this principle [2] [3].

The existence of numerous ragas demands a classification system for analysis and study. Classifications have been done based on *Kampita swara* (embellishment note)*, Nyasa swara* (resting note)*, Graha swara* (beginning note)*, Jiva swara* (sonant note)*, Sancharas* (characteristic phrases)*, Rasas* (mood aroused)*, Gaana Kaala* (melodic time associated with the raga).

Recent classification systems considered the parent-child association of raga-s as the basic criteria of classification. The *Janya raga* (child raga) is associated with one of the *Janaka raga* (parent raga). Exemplary cases of raga include *Varja ragas* (Janya is devoid of some notes), *Upanga ragas* (notes used in the raga is strictly a subset of the Janaka), *Bhashanga raga* (some notes used in the raga are not contained in the Janaka).

Pandit Vishnu Narayan Bhatkhande created the *Thaat* system of classification followed in the Hindusthani system which works based on *Gaana Kaala* and *Rasas* [4]. Venkatamakhin (17th century) proposed the *Melakarta* system as a collection of 72 fundamental

scales in the Carnatic system [5]. These 72 melakarta-s were arranged into 12 *chakras* with each chakra containing 6 scales [6]. Each of these are named based on the *katapayadi system* [7].
Each *sampurna* (7 swaras) melakarta contains S & P and one note (*Madhyama*) from M, m and two notes (*Rishabam* & *Gandharam*) from R, r, G, g and two notes (*Dhaivatam* & *Nishadam*) from D, d, N, n (refer to Table I for swara sthanas and their correspondence in the western system). Here the concept of 16 swara sthanas was used where some frequencies are referred by multiple names.

TABLE I. CARNATIC SWARA STHANAS AND EQUIVALENT IN WESTERN [13]

swara sthanas	S	r	R	g	G	M	m	P	d	D	n	N
western equivalent	C	C#/ D ♭	D	D#/ E ♭	E	F	F#/ G ♭	G	G#/ A ♭	A	A#/ B ♭	B

In this paper, section 2 deals with the drawbacks of the Melakarta system. Section 3 outlines the related work and section 4 explains our approach to solving the problem. Section 5 justifies the correctness of our solution mathematically and demonstrates the same with some examples followed by conclusion in section 6.

2 Drawbacks of the Melakarta system

As introduced earlier, the drawback with the Melakarta system lies in its inability to classify the Upanga and the Bhashanga ragas appropriately. *Hamsadhvani* and *Hamir Kalyani* are the respective examples considered throughout the paper.
Aarohanam (ascent) & the *Avarohanam* (descent) of the ragas [8]-
Hamsadhvani - SRGPNṠ & ṠNPGRS
Melakarta system is strictly based on the swara sthanas and is considered by far the most logical and scalable system for raga classification in Carnatic music. On the contrary to its efficiency in classifying Janya ragas, classification of Upanga and Bhashanga ragas is still ambiguous.
Haamir Kalyani - SPmPDNṠ & ṠNDPmMGPMRS [9] Haamir Kalyani is classified onto *65th Melakarta Mecha Kalyani* (SRGmPDNṠ) and Hamsadhvani is classified onto *29th Melakarta Dheera Shankarabharanam* (SRGMPDNṠ) [10].
Hamsadhvani's swaras are also a subset of Mecha Kalyani (SRGPN $\subset$ SRGmPDN). Haamir Kalyani also contains M which is not present in Mecha Kalyani (M $\notin$ SRGmPDN) and hence considering only *saptaswaras* Dheera Shankarabharanam (m $\notin$ SRGMPDN) could also be used as the Janaka raga.
Thus the classification of Hamsadhvani and Haamir Kalyani to 29th and 65th Melakarta is ambiguous and not justified.

3 Related work

On the contrary of being bothered by some ambiguity with the Melakarta system, musicians and musicologists have predominantly accepted the convention of raga classification (like Hamsadhvani is conventionally classified under Dheera Shankarabharanam). S. Kalyanaraman (SKR) on the other hand, ventured deeper into scales and came up with *Dwi-Madhyama Panchama Varja Ragas* by including 36 *vikritha panchama melas* [11]. Here the raga contains both the Madhyams (M & m) but is devoid of Pancham (P) (the ragas are obtained by replacing P with m in the first 36 Melakarta and the nomenclature involves *"Sri"* as a suffix).

Consider the raga Rohini (SrGMmDNṠ & ṠNDmMGrS) which is classified onto *17th Melakarta Sooryakāntam* (SrGMPDNṠ) [10]. This also holds an ambiguous spot in classification since m ∉ SrGMPDNṠ and this ambiguity is resolved by classifying Rohini as/under *Suryasri* (SrGMmDNṠ) proposed by the *Dwi-Madhyama Panchama Varja* extension for the already existing 72 Melakarta to 108 ragas. This system is the only practically accepted extension to the Melakarta system but still fails to clear the ambiguity we initially wanted to address about Hamsadhvani and Hamir Kalyani

Our approach

The traditional (Dwi-Madhyam Panchama Varja) Melakarta only considers Sampurna (7 notes) scales to be classified as Melakartas (Janakas). This method may fail to scale and support the modern experimentations and discoveries of newer ragas.

Current approach.

I. 2 notes from r, R, g, G occur and are referred to as Rishabham & Gandharam
II. 2 notes from M, m, P occur (extension from Dwi-Madhyam Panchama Varja)
III. 2 notes from d, D, n, N occur and are referred to as Dhaivatam & Nishadam

Our approach releases these constraints and allows every note's individual existence. We fix only the *Shadjam* of the 12 swara sthanas and allow all the other 11 swara sthanas to (not)occur depending on the raga. Refer to table IV for the contrast between the existing models and our approach.

The swara sthanas so chosen will form a scale onto which many Janya ragas would be classified. We shift from the Janaka raga paradigm to Janaka scale paradigm where the Janaka provides the scale and structure for classification of the Janyas.

For easier analysis, we group the following-

I. RGset - notes occurring from r, R, g, G. (#RG)
II. MPset - notes occurring from M, m, P. (#MP)
III. DNset - notes occurring from d, D, n, N. (#DN)

Table II gives the details of the numbering of each set based on the occurrence of swara sthanas.

The final numbering for the raga is obtained as

"*(#MP - 1) * 256 + (#RG - 1) * 16 + #DN"*.

Note: Considering the *vivadi* swara sthanas in the Melakarta system (leading to 16 swara sthanas), we propose a method to stay consistent with the convention in Table III [12]. This table is relevant to fit in the *Vivadi* ragas [14].

TABLE II: NOMENCLATURE/NUMBERING OF EACH SET

Numbering	RGset (rRgG)
1	----
2	r---
3	-R--
4	--g-
5	---G
6	rR--
7	r-g-
8	r--G
9	-Rg-
10	-R-G
11	--gG
12	rRg-
13	rR-G
14	r-gG
15	-RgG
16	rRgG

Numbering	MPset (MmP)
1	---
2	M--
3	-m-
4	--P
5	Mm-
6	M-P
7	-mP
8	Mmp

Numbering	DNset (dDnN)
1	----
2	d---
3	-D--
4	--n-
5	---N
6	dD--
7	d-n-
8	d--N
9	-Dn-
10	-D-N
11	--nN
12	dDn-
13	dD-N
14	d-nN
15	-DnN
16	dDnN

TABLE III: CONVENTION ON VERBAL SOUND UTTERED WITH SWARA STHANAS

Swara sthanas	*Bol* (verbally uttered sound)
rR--	Rishabam (R), Gandharam (G)
--gG	Rishabam (R), Gandharam (G)
dD--	Dhaivatam (D), Nishadam (N)
--nN	Dhaivatam (D), Nishadam (N)

TABLE IV: DIFFERENT SYSTEMS AND THE NUMBER OF SWARAS TO OCCUR FROM THE DIFFERENT SWARA STHANAS.

#notes	S	r	R	g	G	M	m	P	d	D	n	N
MK	1	2				1		1	2			
DMPV	1	2				2			2			
OA	1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Key:
MK - Melakarta
DMPV - Dwi-Madhyama Panchama Varja
OA - Our Approach

4 Correctness and Examples

Consider a raga (R) with a moorchana M and define SS_R as the set of all swara sthanas in R. Let the Janaka (J_R) of this raga in our system be SS_{JR}.
$SS_R = \{X|X \in M\}$

Janaka contains all the notes present in R and amounts to no ambiguity: $SS_{JR} = SS_R$ (unique J_R is assigned). Also, no two Janaka ragas would be the same (they'd differ in at least one of the RGset, MP set or DNset) and hence offers a unique numbering to each raga.
Proof for the nomenclature:
MPset: for every mp∈MPset, there are 16*16 combinations for #RG & #DN. **256*

RGset: for every rg∈RGset, there are 16 combinations for #DN. **16*

DNset: the #DN with the #MP & #RG gives a unique numbering. **1*

Verifying the solution to the problem with initial ambiguity examples:
Hamsadhvani - SS_R = {SRGPN}
RGset = {RG} → 10
MPset = {P} → 4
DNset = {N} → 5
Hence unique Janaka's numbering: 256*(4-1)+16*(10-1)+5 = *917*.

Hamir Kalyani - SS_R = {SRGMmPDN}
RGset = {RG} → 10
MPset = {MmP} → 8

DNset = {DN} → 10
Hence unique Janaka's numbering: 256*(8-1)+16*(10-1)+10 = *1946*.

Hence both Upanga and Bhashanga ragas are given a unique Janaka resolving the ambiguity.

5 Conclusion

Since the existence of Indian classical music, several attempts have been made in clustering and analyzing ragas based on a certain property. Melakarta system definitely surpasses the other systems through its logical methods of classification which can work at scale but fails to provide justification for Upanga and Bhashanga ragas.
Our approach is a proposal to classify ragas into unique Janakas and remove the ambiguity in the classification of Upanga and Bhashanga ragas. This approach is consistent with the existing conventions of the classical Indian music including the 16 swara sthanas. Nomenclature is shifted from the Katapayadi system to formal numbering. This model covers all ragas presently practiced in the system and is also scalable to accommodate newer ragas which may be discovered with time. We also propose the shift from the Janaka being a parent raga to Janaka being a parent scale (in accordance with Hindusthani Thaat's conventions).

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This book presents a collection of selected papers that present the current variety of all aspect of music research, development and education, at a high level. The respective chapters address a diverse range of theoretical, empirical and practical aspects underpinning the music science and teaching and learning, as well as their pedagogical implications. The book meets the growing demand of practitioners, researchers, scientists, educators and students for a comprehensive introduction to key topics in these fields. The volume focuses on easy-to-understand examples and a guide to additional literature.

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