Identifying Indian Classical Music Styles using Melodic Contours

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Abstract

A prominent categorization of Indian classical music is the Hindustani and Carnatic traditions. The distinction is geographical with the two styles having evolved under distinctly different historical and cultural influences. Both styles are grounded in the melodic and rhythmic framework of raga and tala. The styles differ along dimensions such as structure of a performance, aesthetics, voice production and instrumentation. In this work we explore methods to distinguish the two prominent styles by analysing the extracted melodic contour from audio segments of vocal performances. The assumption that style distinctions are represented in the melodic contour is validated via human listening tests. The presented features can be applied to achieve automatic classification of style.

Keywords – musical styles, Hindustani music, Carnatic music, melodic contour

1. Introduction

Indian Classical music styles span a wide range, a prominent categorization within which is Hindustani and Carnatic. The distinction is geographical with the two styles having evolved under distinctly different historical and cultural influences. Carnatic Music is predominantly performed and studied in the southern states of India viz. Andhra Pradesh, Karnataka, Tamilnadu and Kerala while Hindustani Music is more widely spread in the country. Both styles are grounded in the melodic and rhythmic framework of raga and tala. While the repertoire of commonly performed ragas is different in the two styles, they share the basic scale structure, the use of raga-specific motifs and ornamentation. In both styles due importance is accorded to both compositions and improvisation although the relative weighting tends to differ. The styles differ along dimensions such as structure of a performance, aesthetics, voice production and the use of decorative elements. Additionally, Hindustani and Carnatic styles differ in the musical instruments used.

There has been some past work on the computational analysis of Indian classical music related to automatic recognition of raga [1, 2]. However computational approaches have not been applied to style discrimination. Liu, Xiang, Wang and Cai [3] attempted to classify audio signals according to their cultural styles as Western or non-Western by the use of characteristics like timbre, rhythm and musicology-based features. Hindustani and Carnatic music differ in the nature of the accompanying instrumentation and can potentially be distinguished by acoustic features relating to timbre. However, it may be noted that the two styles can also be reliably distinguished by listeners of the vocal music extracted from the alaap section (i.e. the improvised component) of a performance where the accompanying instrument is restricted to the common drone (tanpura). A common perception among listeners is that the Hindustani alaap unfolds "slowly" relative to the corresponding Carnatic alaap which has complex pitch movements (gamakas) [4]. These observations imply that the melodic contour of the alaap contains sufficient information about style differences. In this work we consider the automatic identification of the style (Hindustani or Carnatic) from the melodic contour. Since transcriptions in the form of symbolic notation are not easy to come by (apart from the absence of standard notation to represent pitch movements), we investigate style recognition from the available recorded audio of vocal performances. Such work can be useful in providing musicological insights as well as in developing tools for music retrieval.

In the next section, the audio database used in this work is described. The repertoire of commonly performed ragas differs in the two styles. In order to minimise any raga-specific influence on the discriminatory characteristics of the melodic contour in the present study, we choose music belonging

to corresponding ragas in the two vocal styles. We examine the assumption that the style distinctions are represented in the melodic contour via listening tests. Next discriminatory features that can be computed from the pitch contour are presented and evaluated for automatic style identification.

2. Database and listening test

Popular ragas that use the same scale intervals (relative to the chosen tonic note) in both the Hindustani and Carnatic styles are selected for the present study. Table 1 shows the two pairs of corresponding ragas, one in each row of the table, along with the ascending and descending scales of each [5,6]. We use the symbols **S**, **R**, **G**, **m**, **P**, **D**, **N** for notating shuddha Sa, Re, Ga, Ma, Pa, Dha, Ni respectively. For notating komal Re, Ga, Dha, Ni we use **r**, **g**, **d**, **n** respectively and **M** for tivra Ma. Characteristc phrases (pakad) of Todi are (.d .N S r g), (d r g~ ^{M}rgr S~), (S r g~ g M d P, M d N S'~), (S' r' N d P, d P M g, ^{M}r g r S) in both Hindustani and Carnatic styles. Identifying phrases of Malkauns are (g m g S), (d n S g m g S), (n S g S), (g m d m), (d n d m) in both the styles. Audio recordings for durations varying from 30 sec up to 3 min from the aalap section of performances of well-known vocalists are selected to represent each style as detailed in Tables 2 and Table 3. It was verified by listening that all the audio clips were in the similar tempo range.

Table 1. Swaras that are present in Aroha-Avaroha of Todi and Malkauns

Hindustani Raga	Carnatic Raga	Swara Present while ascending (Aroha)	Swara Present while descending (Avaroha)
Todi	Subhapanthuvarali	S r g M d N S'	S' N d P M g r S
Malkauns	Hindolam	n S g m d n S'	S' n d m, g m g S

Table 2. Database description of Aalap section for Todi

No.	Hindustani Artist	Carnatic Artist
1.	Pandit Bhimsen Joshi	Sudha Raghunathan
2.	Pandit Jasraj	Vellore A. R. Srinivasan
3.	Kishori Amonkar	Megha Ranganathan
4.	Malini Rajurkar	Nagavalli Nagaraj
5.	Ustad Rashid Khan	Sandeep Narayan

Table 3. Database description of Aalap section for Malkauns

No.	Hindustani Artist	Carnatic Artist
1.	Pandit Bhimsen Joshi	M. D. Ramanathan
2.	Girija Devi	Vellore A. R. Srinivasan
3.	Veena Sahastrabuddhe	T. N. Sheshagopalan
4.	Malini Rajurkar	Nagavalli Nagaraj
5.	Ustad Rashid Khan	M. S. Subbulaxmi

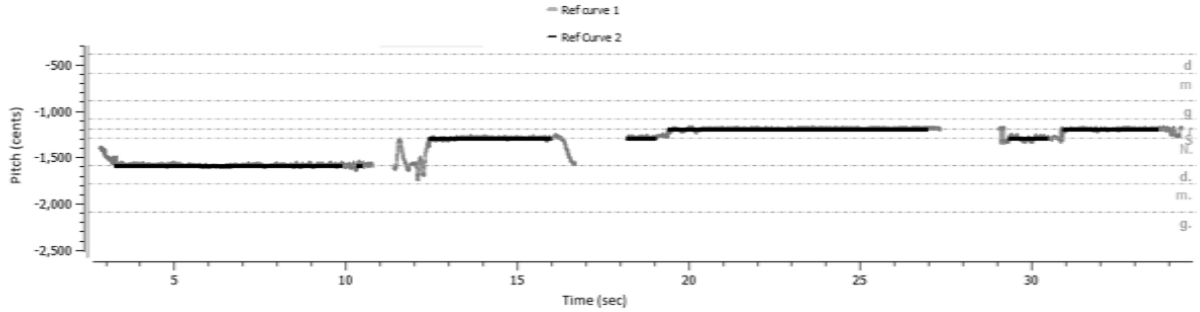
We examine the assumption that the style distinctions are captured by the melodic contour via listening tests. The audio clips are processed by a polyphonic pitch detector [7] to obtain the melodic contour (continuous variation of pitch in time across all vocal segments of the audio signal). The pitch is detected at 10 ms intervals throughout the sung regions of the audio track using short-term analysis coupled with dynamic programming based smoothing. Figure 1 depicts the extracted high-resolution continuous pitch contour of examples of each style by gray lines. To suppress the effects of voice quality and pronunciation in the listeners' discrimination task, the melodic contour is re-synthesized using a uniform timbre vowel-like sound before being presented to listeners. The amplitude of the resynthesized tone however follows that of the singer's voice. Thus the volume dynamics are retained since they play a role in melody perception.

Listeners were asked to identify the style through 30 sec clips randomly selected, but representing all the artists, from the dataset. As mentioned earlier, the clips presented to the listeners were simply the resynthesized pitch contours extracted from the original audio and thus contained no strong cues to artist identity. Among the five listeners of the subjective test for Todi, one participant was trained in Hindustani, one in Carnatic and the remaining were untrained listeners. Ten clips in random order were presented to each listener, consisting of 5 clips of raga Todi of Hindustani and 5 clips of its equivalent raga Subhapanthuvarali of Carnatic style. In listening test for Malkauns, one listener trained in Carnatic and two untrained participants were given 5 clips of each style randomly selected from the dataset.

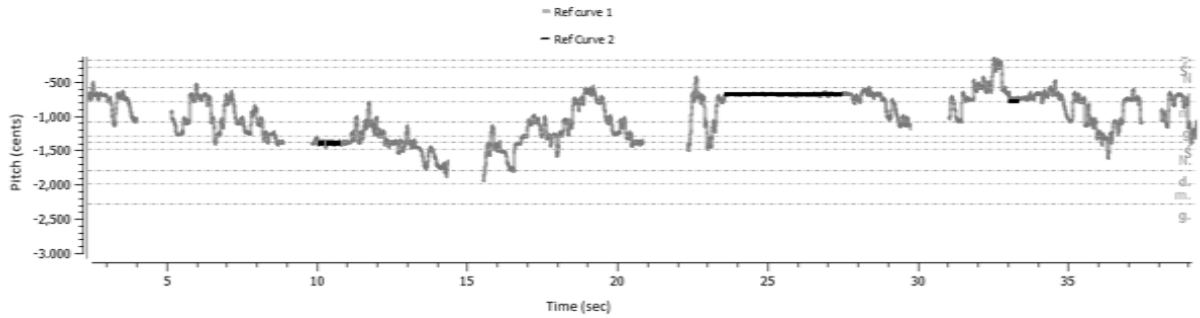
The listening test results reveal that listeners are able to identify the style at levels well above chance as can be seen from Table 4. This is particularly true of Todi raga and less so in the case of Malkauns. It may be speculated that this is due to the solemn (gambhir) nature of the raga. Raag Malkauns is known for its gamak such as the initial swaras in the phrases **dd**SnS, **dd**mgm, **SS**ndn.

Table 4. Listening Test Results

Sr. No.	Raga	Hindustani style			Equivalent Carnatic Raga	Carnatic style		
		Total clips	Correctly identified	Accuracy		Total clips	Correctly identified	Accuracy
1.	Todi	25	20	80 %	Subhapanthuvarali	25	23	92%
2.	Malkauns	15	8	53 %	Hindolam	15	10	67%



(a)



(b)

Figure 1. Pitch contour of alaap segments of (a) Hindustani vocalist Malini Rajurkar for raag Todi (b) Carnatic vocalist Nagavalli Nagaraj for raag Subhapanthuvarali. The steady note pitch contour (black) is superimposed on original contour (gray) with the swaras corresponding to horizontal lines labelled on the right. The y-axis denotes the pitch in cents with respect to the A-440Hz.

3. Automatic Identification

Differences in the two melodic styles are observed by the visual comparison of the pitch contour segments of Figure 1. The tonic is detected in each piece by a musician expert. The detected pitches obtained at 10 ms intervals are converted to the musical cents scale with the tonic corresponding to 0 cents. We note the presence of long held notes in the Hindustani segment versus the short and more ornamented notes of the Carnatic segment rendered in the same raga. Finely binned (such as 5 cent bin width) pitch histograms derived from extracted pitch contours tend to show clustering about the swara locations, with the Carnatic music distributions being more diffuse compared to the relatively concentrated peaks typical of Hindustani music [8, 1].

In the present work, we examine the temporal nature of the pitch contour, or melodic contour (rather than the pitch histograms) for distinctive characteristics of the two styles. The pitch contour is segmented into steady and ornamented regions depending on the detected local temporal variation. Steady, or relatively flat, pitch regions are expected to correspond to the *swaras* (notes) of the underlying raga. A steady note region is defined as a continuous segment of a specified minimum duration ("N" ms) within which the pitch values exhibit a standard deviation less than a specified threshold ("J" cents) from the computed mean of the segment. We set N= 400 ms while J was varied to accommodate various definitions of steady note. It was found that J=20 worked best in the current task. Figure 1 depicts the detected steady note segments as dark lines superposed on the continuous pitch contours. The gamakas, or complex pitch movements, are left untouched. We observe that the long held notes coincide with the swara locations of the raga. Traditionally, the ornamented regions too are transcribed to a sequence of raga notes. However the correspondence between the complex pitch movements and sequence of notes is not obvious from the continuous pitch contour, and depends on the raga and on the immediate melodic context and possibly on the style as well.

A visible difference between the Hindustani and Carnatic pitch contours in Figure 1 is the proportion of steady note regions in the segment. We study this feature for style discrimination via the scatter plots of Figure 2. The ratio of detected steady note regions to overall vocal duration in a 70 sec clip of each of the performances listed in Tables 2 and 3 is plotted in Figure 2. We observe an overall separation of the clusters corresponding to each style (vertical distribution). This suggests that the ratio can be a useful feature in the automatic classification of style from a sufficiently long audio segment.

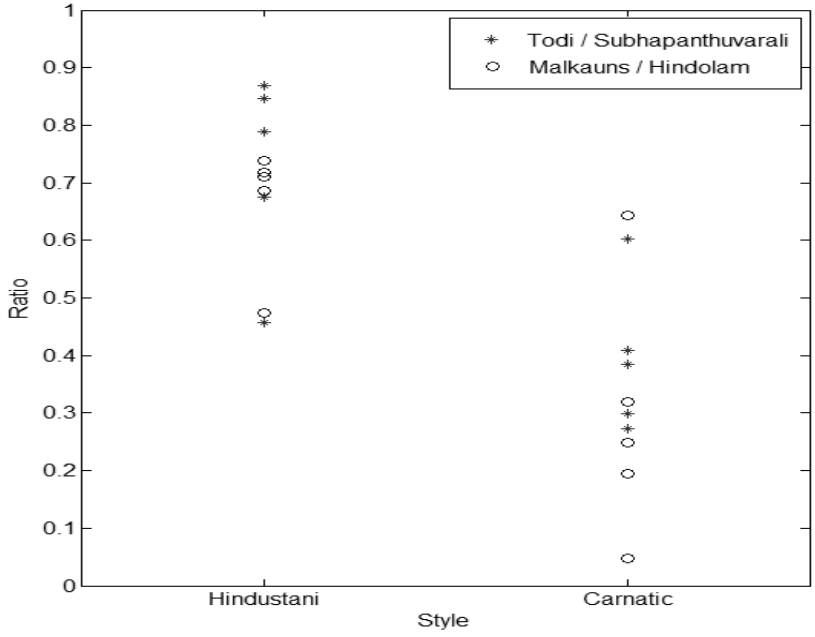


Figure 2. Ratio of detected steady note regions to overall vocal duration in 70 sec audio clips (one from each performance).

4. Conclusion

The observation that listeners can usually identify the style from unaccompanied vocal music corresponding to alaap sections of Hindustani or Carnatic traditions provided the motivation for an investigation of melodic features for automatic classification. Listening tests using resynthesized melodic contours were used to confirm that pitch variation provides sufficient cues to the underlying style. A method to detect steady notes is applied to derive a feature based on the ratio of steady note region to overall duration. The feature separates the two styles to a large extent as seen on a database of alaap sections drawn from various artists' performances of pairs of corresponding ragas. Classification accuracy can be further improved by features derived from gamak characteristics. Similar raga phrases across the two styles can be compared to reveal differences that may be useful to style identification. These could include differences in the nature of note transitions and the specific intonation patterns of corresponding phrases as obtained from musicians' transcriptions of the audio recordings.

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