DETECTING INDIAN CLASSICAL VOCAL STYLES FROM MELODIC CONTOURS

Amruta Vidwans
Kaustuv Kanti Ganguli
Preeti Rao

Department of Electrical Engineering
Indian Institute of Technology Bombay

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Outline

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- Database Description
- Listening tests
- Melodic Feature Extraction
- Scatter Plot
- Musically Motivated Feature
- Conclusion

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Introduction

- Style discrimination of Hindustani and Carnatic vocal music on the basis of melody

- Previous work
  - Computational analysis of Indian classical music related to automatic recognition of raga [1, 2]
  - Liu et al. [7] attempted to classify audio signals according to their cultural styles as western or non-western
  - Salamon et al. [8] classified Western genres using melodic features computed from pitch contours extracted from polyphonic audio

Background

- The two styles have evolved under distinctly different historical, geographical and cultural influences
- Hindustani and Carnatic music can be distinguished by instruments used i.e. timbre feature and melodic contour
- However, the two styles can be distinguished by listeners from the vocal music extracted from the alap section of a performance
  - Common perception among listeners is that the Hindustani alaap unfolds “slowly” relative to the corresponding Carnatic alap
  - Carnatic alap on the other hand has more usage of gamakas

Hypothesis:

- The two styles can be distinguished on the basis of melodic contour of alap section

Database Description

- Popular ragas that use the same scale intervals in both the Hindustani and Carnatic styles are selected
- 30 different audio clips of the alap section (duration 70 sec) across 3 raga pairs rendered by 20 different artists of both styles
- Melodic pitch contours are extracted [9]

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
Jaijaiwanti	Dwijavanthi	BageshriAng:N S R G M P, G M D n S’ DesAng: N S R G M P n S’	S’ n D P M G, R g R S

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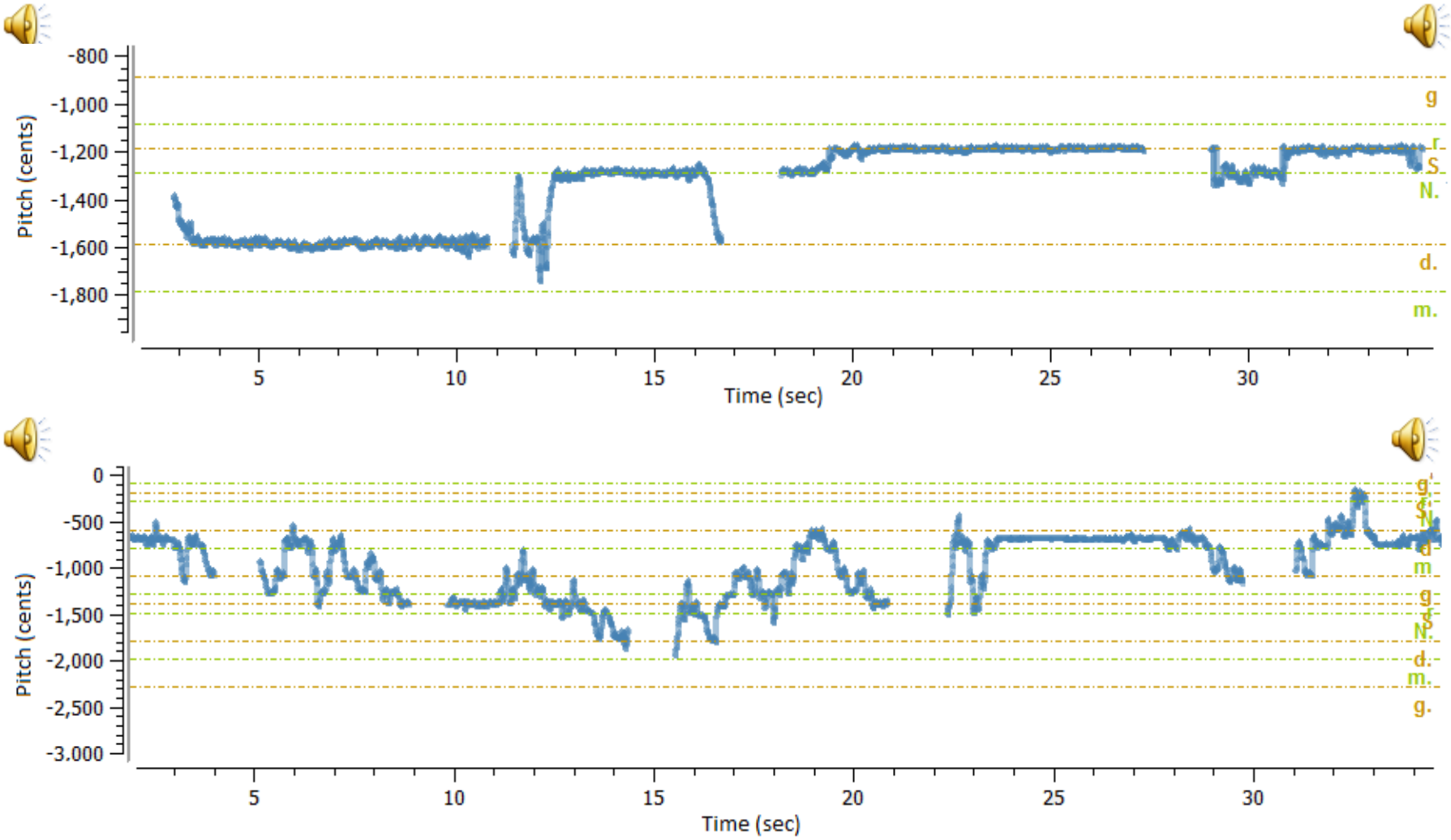
Melodic Pitch Contours



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Listening Tests

Listeners asked to identify the style through pitch resynthesised clips randomly selected from the dataset

Listening Test Results

No	Raga	Hindustani style			Equivalent Carnatic Raga	Carnatic style		
		Total clips	Correctly identified	Accuracy		Total clips	Correctly identified	Accuracy
1.	Todi	40	32	**80 %**	Subhapanthuvarali	40	36	**90%**
2.	Malkauns	40	28	**70%**	Hindolam	40	30	**75%**
3.	Jaijaiwanti	40	32	**80 %**	Dwijavanthi	40	37	**92%**

Malini Rajurkar (Malkauns)

Veena Sahasrabuddhe (Malkauns)

T N Sheshagopalan (Hindolam)

A R Srinivasan (Hindolam)

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Melodic Feature Extraction

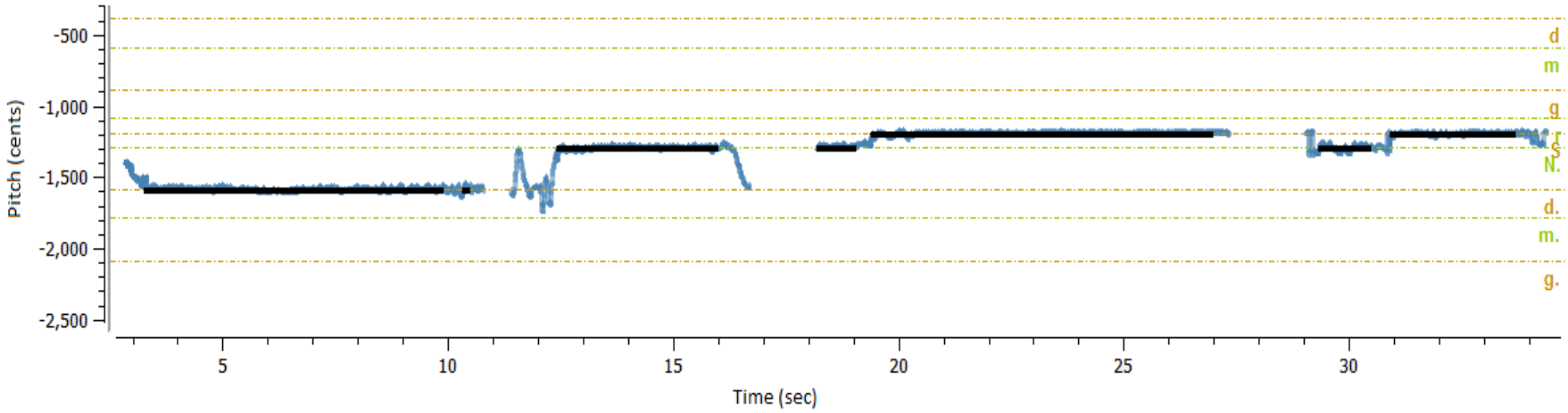
1. Stable Note Measure

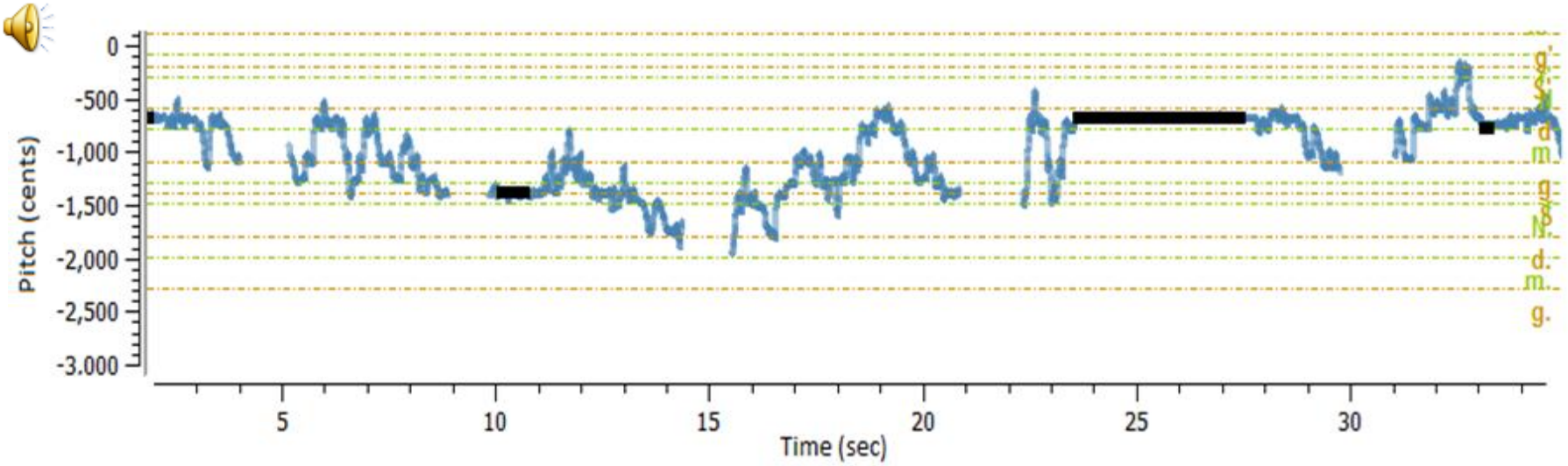
→Pitch contour segmented into steady and ornamented regions depending on the detected local temporal variation

→A steady note region is a continuous segment of a specified minimum duration (“N” ms) within which the pitch values exhibit a standard deviation less than a threshold (“J” cents). (N=400ms, J=20cents empirically decided)

$$Stable\ note\ measure = \frac{Duration\ of\ Steady\ Regions \geq 0.5sec}{Total\ Sung\ Duration}$$

Melodic Feature Extraction





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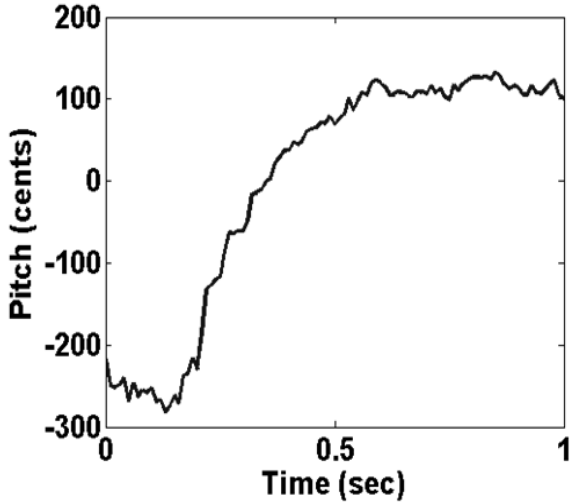
Melodic Feature Extraction

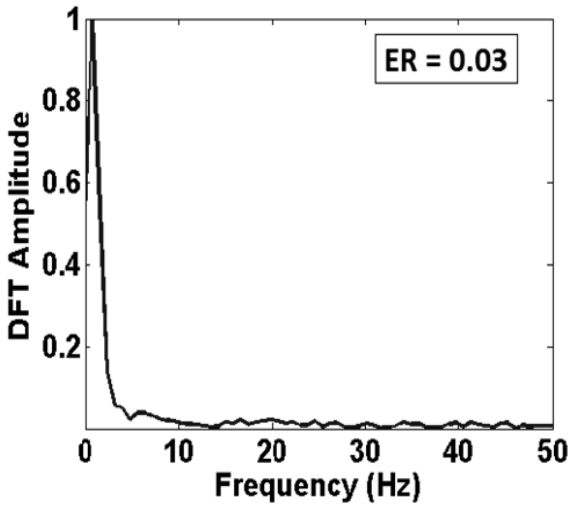
2. Measure of Oscillatory Gamak
   - Between stable notes regions:
     - Carnatic vocalist more engaged in rapid oscillatory movements
     - Hindustani vocalist spends more time gliding between notes, or on lower frequency oscillations
     - Can be captured in Energy Ratio (ER)

$$ER = \frac{\sum_{k=k_{3Hz}}^{k_{7.5Hz}} |Z(k)|^2}{\sum_{k=k_{1Hz}}^{k_{20Hz}} |Z(k)|^2}$$

$$Gamak\ measure = \frac{Number\ of\ ER>0.3}{Total\ Number\ of\ ER}$$

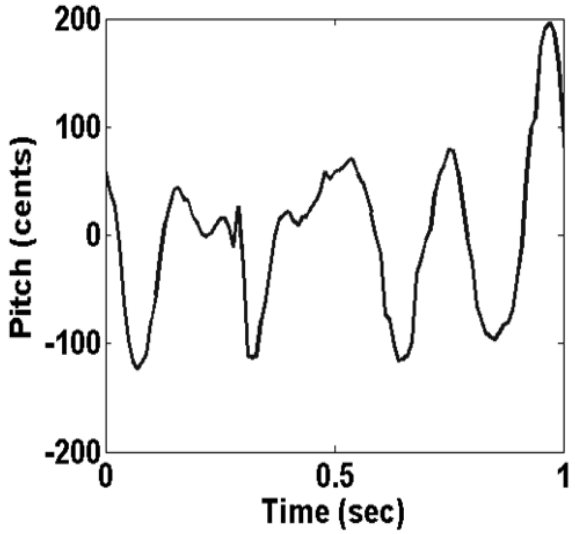
Melodic Feature Extraction

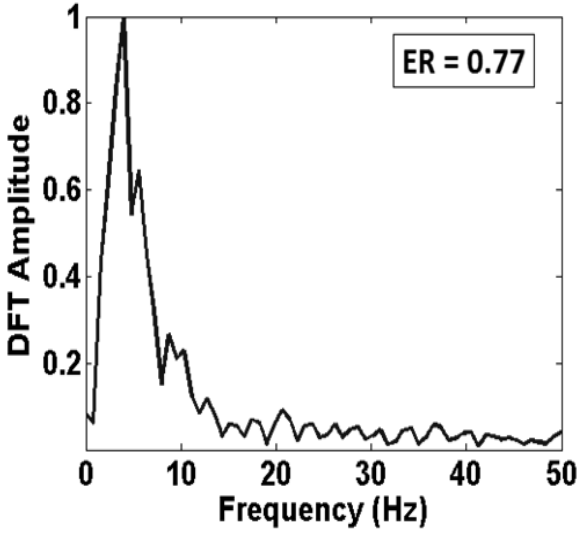




Rashid Khan

Raga – Miyan ki Todi





Sudha Raghunathan

Raga – Subhapanthuvarali

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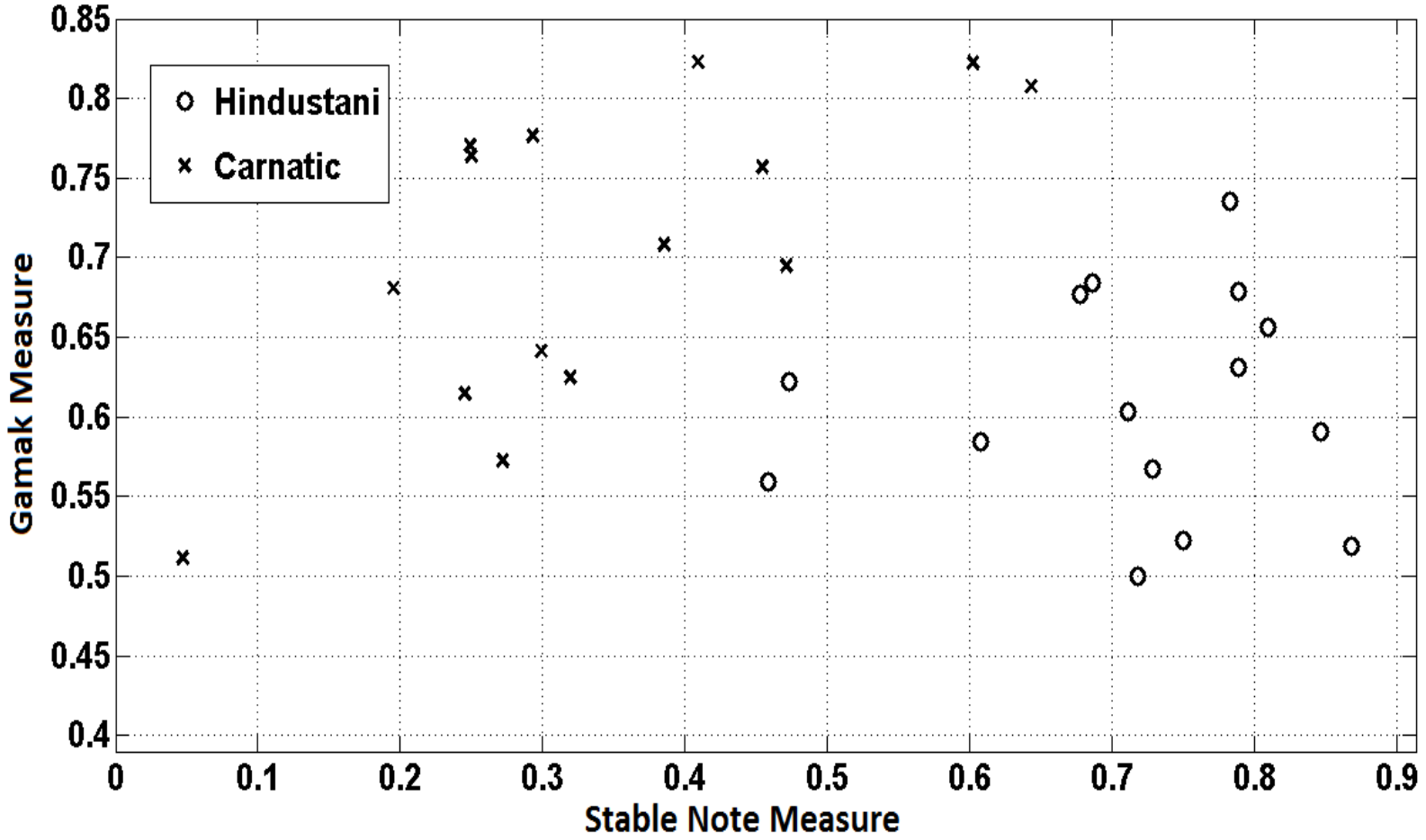
Scatter Plot



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Further work: Musician validation of empirical parameters

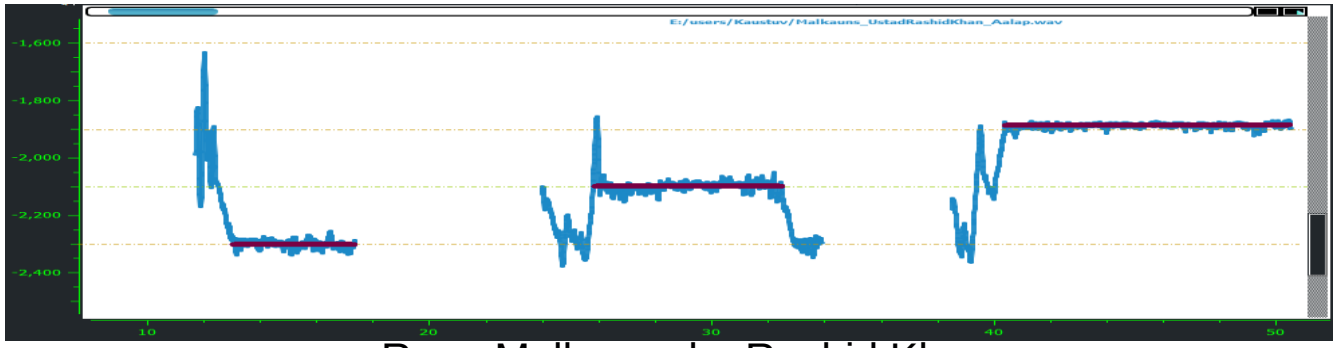
- Parameters (N and J) in current work are empirically set as stable note parameters
- The musical concept of "Khada Swar" (standing note) can help to find musically better grounded parameter settings

Khada Swar: Musically Motivated Feature

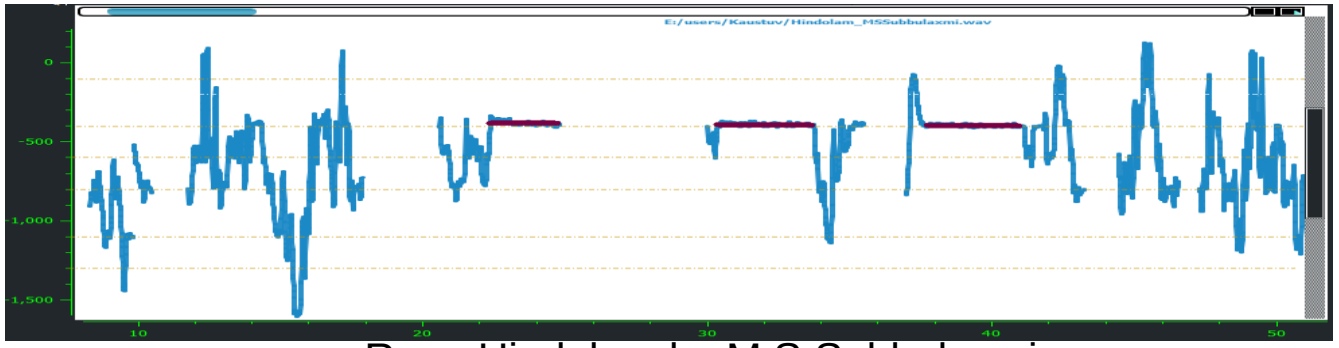
- The position of the stable notes with exact boundaries were marked independently by two trained musicians on a subset of the audio database
- The duration of Khada Swar, its mean, maximum, minimum and standard deviation in cents were calculated

Raga	Hindustani Artiste	Carnatic Artiste
Malkauns / Hindolam	Rashid Khan Bhimsen Joshi	M D Ramanathan M S Subhalaxmi
Jaijaiwanti / Dwijavanti	Rashid Khan Bhimsen Joshi	M Balamuralikrishna Semmangudi Iyer

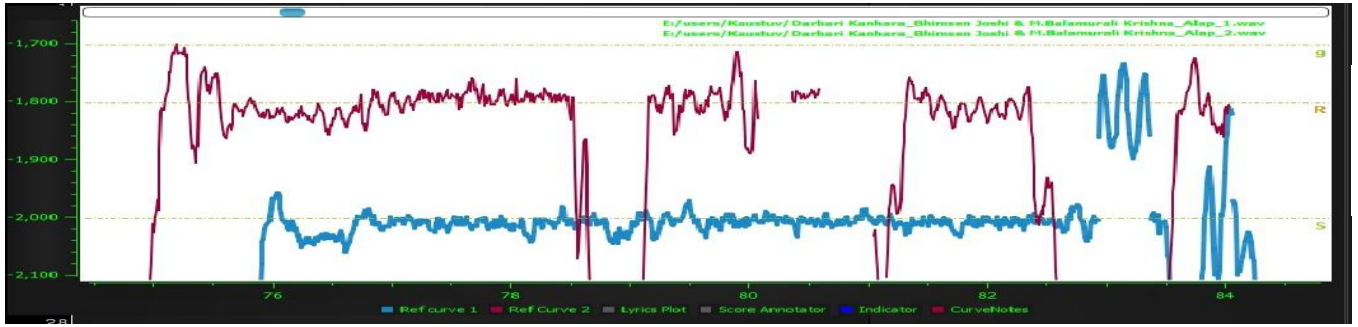
Khada Swar: Pitch Contours



Raag Malkauns by Rashid Khan



Raag Hindolam by M.S.Subbalaxmi



Duet performance in Raag Darbari by Bhimsen Joshi & M.Balamuralikrishna

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Khada Swar: Observations

- The perception of the Khada Swar marking is purely based on the Hindustani concept
- The minimum value of standard deviation was observed for the tonic ‘S’, and for ‘P’
- The average duration of the Khada Swar is found to be comparatively less in Carnatic clips, whereas the standard deviation is higher

Parameter	Hindustani	Carnatic
Minimum Duration (‘N’ ms)	760	750
Maximum Std. Dev. (‘J’ cents)	36	45

Conclusion and Future Work

- Listening tests using resynthesized melodic contours confirmed that pitch variation provides sufficient cues to the underlying style

- Separation of the clusters corresponding to each style suggests that automatic classification of style from alap section using the proposed features is promising

- The present study will be extended to other sections of the concert such as the metered composition and to a study of vocal style differences across the distinct schools (gharanas) of Hindustani music

- Classification performance using the musician's interpretation of stable note will be compared with that from the data-driven approach

References

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