RĀGAWISE: A LIGHTWEIGHT REAL-TIME RĀGA RECOGNITION SYSTEM FOR INDIAN ART MUSIC

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ABSTRACT

We demonstrate a web-based lightweight real-time melodic analysis and visualization system for Indian art music. Our system uses pitch class profiles, pitch transitions and melodic phrases for melodic characterization and rāga recognition. For each rāga we store a dictionary of its svaras (notes), svara transitions, and typical melodic phrases. We process the input vocals in real-time to estimate pitch, and subsequently perform melody transcription. The likelihood of each rāga is updated in real-time based on the transcribed melody. In order to highlight the melodic events that are characteristic of a rāga, we perform a dynamic visualization of the evolution of the likelihood of all the rāgas for the sung melodic excerpt.

1. INTRODUCTION

Rāga is the melodic framework in Indian art music [8] (IAM) based on which the melodies are constructed, organized and retrieved. Recognition of rāgas in IAM is thus an interesting and relevant research problem for both musicologists and Music Information Retrieval (MIR) researchers. Rāgas are characterized by a set of svaras (notes), arohana and avrohana (ascending and descending melodic progressions), and a set of melodic phrases, with different functional and aesthetic roles for each of them [4]. In recent years, a number of approaches have been proposed for automatic rāga recognition that utilize different characterizing aspects of rāgas [1,3,7]. These approaches are relevant and useful for time efficient organization and retrieval of recorded music material in an offline mode. However, they cannot be directly utilized in applications such as building real-time pedagogic tools for exploration and recognition of rāgas.

We here demonstrate a lightweight real-time rāga recognition system for Hindustani music that combines all three characterizing aspects of rāgas for its automatic recognition. The input to the system is a live audio stream of monophonic singing voice, and the output is a dynamic visualization of the evolution of the computed rāga salience. The proposed system is fully functional on modern day web-browsers.

Apart from efficient rāga recognition, with this system, we can further explore musically interesting relationships between rāgas through a gradual unfolding of the svaras. The proposed system would also find its use among advanced students of IAM in music pedagogy.

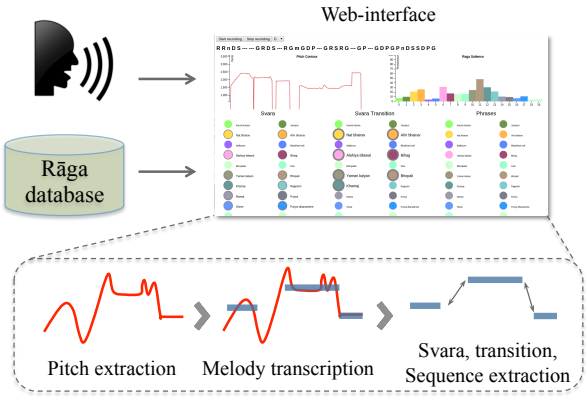

Figure 1. Block diagram of the proposed approach

2. SYSTEM OVERVIEW

The block diagram for our proposed system is shown in Figure 1. The different processing blocks are explained briefly below.

2.1 Pitch estimation

We use the fundamental frequency estimated from the audio signal as the representation for melody. We process the live input audio stream and perform a real-time pitch tracking on a frame-by-frame basis using the YIN algorithm [2]. The algorithm has been implemented in JavaScript [1] to be able to run real-time on a web-browser. The implementation of the algorithm is also made publicly available online [2].

[1] https://en.wikipedia.org/wiki/JavaScript
[2] http://compmusic.upf.edu/node/281

2.2 Melody Transcription

To transcribe the extracted pitch into a sequence of svaras, we use a heuristic based approach proposed in [5, 6]. The transcription process considers only the melodically stable regions and discards the transitory ones. Stable regions are identified based on a musically meaningful and valid threshold around svara positions. To avoid splitting of svaras into multiple fragments due to the presence of melodic ornaments, we perform a svar collating operation based on a duration threshold. We store three main melodic events for further processing: detected svara, the melodic interval from the previous svara, and the sequence of last three/four svaras.

2.3 Rāga salience computation

We have indexed the rāga grammar using a dictionary of svaras, the allowed melodic transitions, and characteristic melodic phrases. For each rāga, its grammar also specifies the weights of the different melodic events in its characterization. The rāga grammar was specified by a professional Hindustani musician who has more than 20 years of formal music training. Using the output of the melodic transcription, the stored dictionary, and the weights for different melodic events, we compute and update the rāga salience every time a svara is detected.

3. WEB-INTERFACE AND VISUALIZATION

The interface of the system has been designed as a web page [3] that can run on all modern day browsers. The visualization components of the interface are written using D3.js [4], a JavaScript library for producing dynamic, interactive data visualizations in web browsers. Apart from loading the rāga dictionaries from a server, the entire processing is performed on the client side for a seamless real-time analysis and visualization. The web interface captures the live audio stream and the user specified tonic pitch class.

The real-time visualization on the web interface has four components: 1. Pitch contour, 2. Transcribed svara sequence, 3. Rāga salience, 4. Rāga space for different melodic events. The pitch contour for the past few seconds of audio is shown in cents, with the sequence of transcribed notes above it. The rāga salience distribution is shown as a bar chart, and updated every time a svara is detected.

The rāga space has separate visualizations for each of the computed melodic events - current svara, the melodic interval from the previous svara, and the occurrence of sequence of three/four svaras. At the onset these melodic events, the rāgas that allow the occurrence of these events are highlighted.

4. SUMMARY AND FUTURE WORK

Our current system performs real-time pitch tracking and melody transcription of singing voice on a web browser, along with dynamic rāga recognition and visualization based on a stored dictionary of rāga grammar. A simple heuristic based transcription is found to be sufficient for Hindustani music, a formal evaluation of which remains to be done in the future. The system is able to capture and highlight the aspects of the sung melody and identify the corresponding rāga. The dynamic visualization also enables the realization of insightful relationships between rāgas using the melodic aspects computed by the system. A computational profiling of the system showed that the entire processing can be done at real-time on a personal computer.

[3] http://compmusic.upf.edu/node/281

[4] http://d3js.org/

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