Exploring Data Analysis in Music using tool praat

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Abstract

Music or audio data digitally sampled contains information about musical clip such as pitch, amplitude etc at multiple points along timeline. This huge data needs to be understood in the form of musical notations for the musicians. Praat is a tool used for acoustic analyses by audio researchers. We have processed the data produced by Praat using our own program to find useful information. We have focused on finding notation, duration of note and amplitude in a flute clip of Hindustani classical music. The clip was an alap clip in which there is no rhythm accompaniment to flute. Our attempt has given us encouraging preliminary results

Key words- Data analysis, audio, Praat, music notation.

1. Introduction.

Music analysis or audio data analysis using software tool is not a novel phenomenon. Music analysis can be done in several ways with different objectives such as compositional analysis, perceptual analysis, and imminent structure analysis etc. An analysis can be done on single piece of music or a portion of a piece or clip. Most of work is done by researchers with respect to Western Music.

We have selected Hindustani Classical Music (HCM) clip for our analysis. HCM is sung or played on instrument with background of drone. Drone is a reference against which all notes are sung or played. Raga music is mainly based on notes and patterns of notes.

We have attempted to do analysis of notes played on flute using data produced by Praat post-processed through our own software to find possible notations and amplitude variations and present the data in notation form which can be understood by musicians.

2. Audio Data.

Audio files in different formats contain huge amount of digital data, consisting of samples sampled at a fixed sampling frequency. Typical sampling frequency of 44.1 KHz with 16 bit samples will require 44100 X 16 bit raw data to be stored per second for mono audio file. This encoded data in different formats are decoded by audio players to play a particular audio file.

Any Musical note or swar has generally 3 basic characteristics as timbre, pitch and amplitude. Timbre is the way it sounds and we can recognize voice of different people or instruments due to timbre. Pitch represents the frequency of note in Hz. This is one of most important characteristic of musical note. Women generally have higher pitch range in octave as compare to men in singing. Amplitude is volume information generally presented in Db or decibels. It represents loudness of a particular note at specific time.

3. Pitch Estimation.

Pitch estimation can be done in time domain and frequency domain. Time domain methods includes zero crossings, autocorrelation etc. and frequency domain methods include spectrum analysis, maximum likelihood etc.

Most of pitch estimation algorithms do not give satisfactory results for lower frequencies (less than 60 Hz) and higher frequencies (more than 600 Hz). In case of HCM, algorithm can give undesirable results during rapid variation of notes or rhythm strokes during notes played. Background drone music is also rich in harmonics and can mislead the pitch estimation of voice or instrument in the presence of drone background music.

4. Working with Praat.

Praat is an open software tool used by many audio researchers for various acoustic analyses. It is free and available for many platforms. Praat supports audio files with .wav extensions.

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We worked with praat on one portion of flute clip alap in HCM. The selected clip does not have rhythm accompaniment. We selected alap clip for our initial analysis as strokes of rhythm are absent during note play and generally notes are not played in fast succession during alap. These factors could have adverse impact on pitch estimation. We sampled audio information at the sample rate of 100 samples per second using praat. We got pitch and amplitude information of these samples. This information is taken as an input to our program.

5. Our selection of parameters.

We have attempted to estimate pitch information, pauses and amplitude variation of the notes. We needed to take some decisions regarding different parameters and the logic to be used for pitch estimation.
We discussed with some musicians and researchers working in this field to finalize the decisions about different parameters.
First decision was about samples per second to be considered. We decided to have samples after every 10 ms for our initial analysis. This enabled us to observe 5 samples in 50 ms considering minimum time of note played in HCM as per input received from other music researchers.
Second decision was to find mean frequency how many samples needs to be considered? We decided to average 5 successive samples considering 50 ms time frame. We shifted window size of 50 ms by 2 samples every time i.e. 20 ms to estimate next mean frequency information. This was done because we do not know the beginning of small duration note and the information about 50 ms note duration should be recognized by program.
For pitch estimation, we found that successive notes are about 6% apart from each other in the tempered scale and we decided to consider ± 3 % range about note frequency as the frequency of note for our initial estimation. We can change this parameter for fine tuning as we progress.
Another decision was about loudness or amplitude information. We observed and found that for any clip; maximum amplitude information can be used to find pauses or silence. In the clip of flute maximum amplitude was 83 Db and clip portion with less than 55 Db were pauses. We have estimated about 28 Db from the maximum amplitude can be considered as a perceived audio range and all values below that can be considered as pauses or silence.

6. Sample output.

For presenting this information about pitch and amplitude, we have studied the notations used. In HCM notations amplitude information is absent and in case of western notation it is shown on the scale. We decided to show amplitude information on the 7 point scale with each mark representing 4 Db range. It is represented in increasing order of amplitude as (ppp, pp,p, [no mark], f,ff,fff).
We have presented the information on time scale with 50 milliseconds as a unit separated by bar to present alap notations as maximum 20 notes per second and display time at the end of each second. Lower octave notes were presented with underline and upper octave notes with symbol ‘ followed by note. Middle octave notes presented normally without any specific symbol.
Sample output
|Sa p| 3 |Ni p|Ni |Ni |Ni |Ni |ni p|ni p|Dh p|

In this sample output Sa, Ni, ni Dh are the musical notes, 3 represent end of 3rd second and p or no mark (neutral) represents amplitudes.

7. Applications.

The tool can be useful for music learners to check their notes played for the accuracy. HCM Learners can also observe the fine patterns of the stalwarts playing particular raga music.
Tool pitch estimation parameters can be adjusted according to the need of musical instrument manufactures. They can use the tool for fine tuning of the instruments.

8. Future Work.

We can work on the tool to present the information in better way considering HCM notations. We need to verify the accuracy of the tool for clips in presence of rhythm and fast succession of notes. We may require adjusting some parameters to produce proper estimated notations.

9. References.

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