Harmonic Nature of Maddalam – A Study

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Abstract

The sound samples of different strokes of maddalam are analysed using MIR toolbox. The frequency spectrum, attack and decay parameters are studied. The reasons for the harmonic nature of maddalam are identified.

Keywords: Frequency Spectrum, MIR Toolbox, Maddalam

Introduction

The one among the many drums commonly played in the art forms and the temple rituals in Kerala is Maddalam. The description about the instrument can be seen in Mahabharata- the Indian epic written by Veda Vyasa, Sangeetharatnakara by Sarngadeva and Sangeetha Damodara by Subhangara (Rajagopalan et al., 2010). The strokes of many musical instruments have been studied and reported in different literature (Anantapadmanabhan et al., 2013; Chordia, 2005). In a paper by Dighe et al. the Indian classical ragas have been identified using the feature extraction of ragas, plotting chromagram and the corresponding swara histograms (Dighe et al., 2013). Feature extraction is also used in the classification of the Indian ragas using different classifiers (Dandawate et al., 2015). Different features extracted using MIR toolbox has been used by (Vallabha Hampiholi, 2012) in the classification of Bollywood songs. Here in this paper, different strokes of the maddalam are analysed. For this we used MIR toolbox (Lartillot et al., 2008). For the drums, the study of frequency ratio of peaks in the spectra of strokes gives a better insight of the harmonic nature and helps in the study of the membrane vibration.

Acoustics of Maddalam

Maddalam is a 28 inch long drum made with jackwood. The diameter of the left head is about 7 inch and that of right head is about 8-9 inch. Different layers of buffalo skin are used to make the drum heads and on the right head cow skin is used at the center. In this head a black paste made with a mix of flour, water and powder of puranakeedam stone, which is locally available with the instrument makers of Kerala, is carefully pasted at the center. The picture of loaded head and the construction of maddalam are shown in Fig 1.

(a) Loaded head

(b) Construction

Figure 1 : The maddalam and its construction

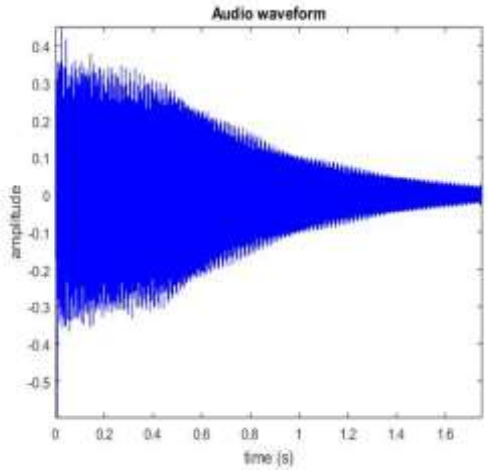
While playing maddalam, the loaded head is played with left hand. Deeper and resonant sounds are produced by maddalam due to its larger size and huge amount of black paste loaded on the drum head (Rajagopalan et al., 2010). Shudha maddalam and Veera maddalam are the two variants of the instrument. Suddha maddalm is used in ensembles like panchavadhyam and temple rituals and veera maddalam is only used in krishnanattam, a dance form about Lord Krishna played at Guruvayoor temple, Kerala. The pitch is kept fixed in maddalam and not varied during the performance (Aruna Thampy, 2016).

Strokes of Maddalam

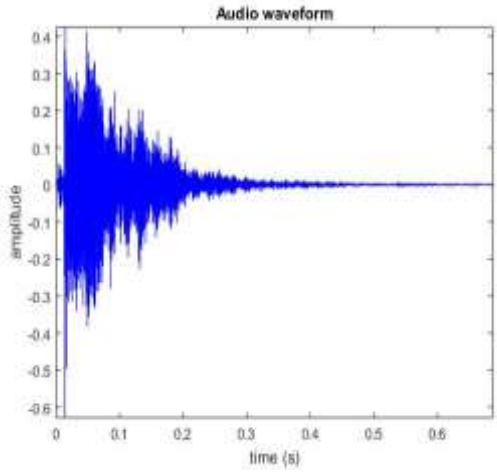
There are mainly five single strokes played on maddalam out of which, four are played on the loaded head and one stroke is played on the other head. The main strokes played on right head are *Dheem, Naam, Thaam* and *Thi*. The stroke *Thi* is sometimes termed as *Te*. The only stroke in left head is *Tha,* which is sometimes called as *Na* or *Ri*.

Materials and Methods

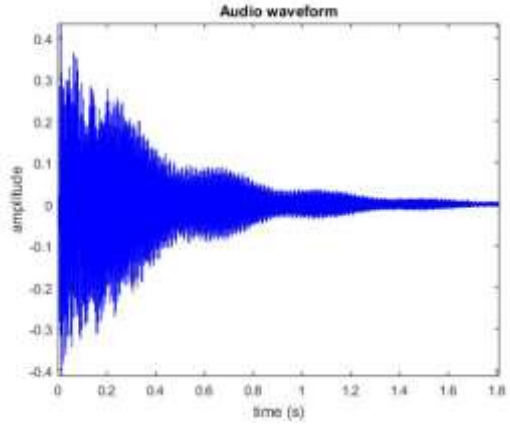
The sound samples of different single strokes of maddalam are collected and converted into audio format for analysis using MIR toolbox. The frequency spectrum represents distribution of energy over different frequencies. So it is convenient to find the prominent frequencies present in different strokes from their frequency spectrum. Using the toolbox, the frequency ratios for each stroke was found and tabulated. The basic wave form of each strokes are also plotted. The harmonic nature of strokes was found from the analysis of attack and decay parameters like time, slope and leap (Lartillot & Toiviainen, 2007). The overall energy of each stroke was found from the RMS energy of the samples.



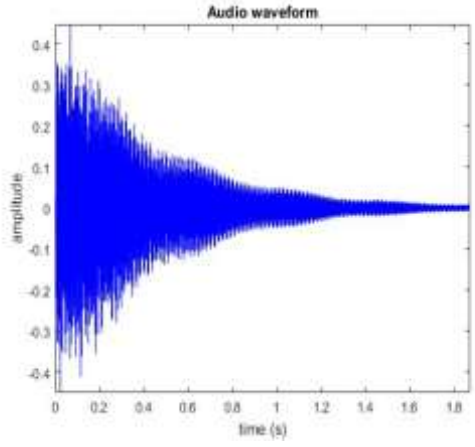
(a) *Dheem*



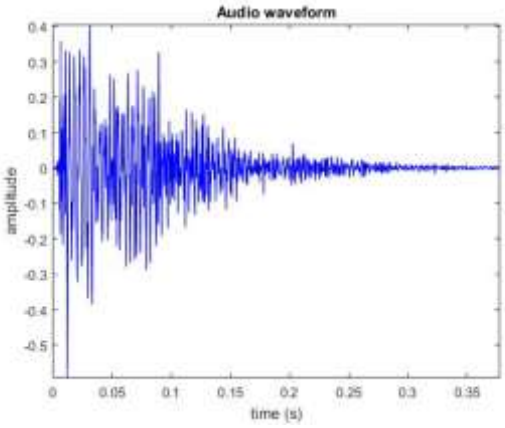
(b) *Tha*



(c) *Naam*



(d) *Thaam*

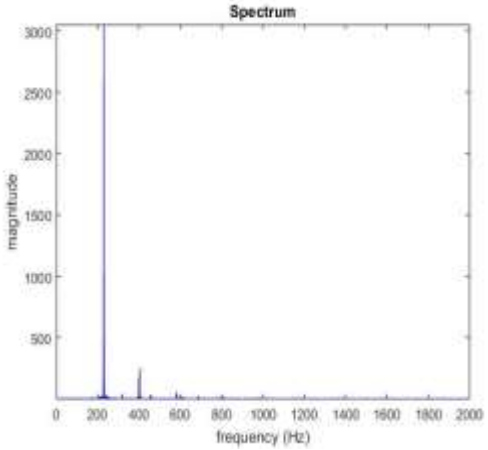


(e) *Thi*

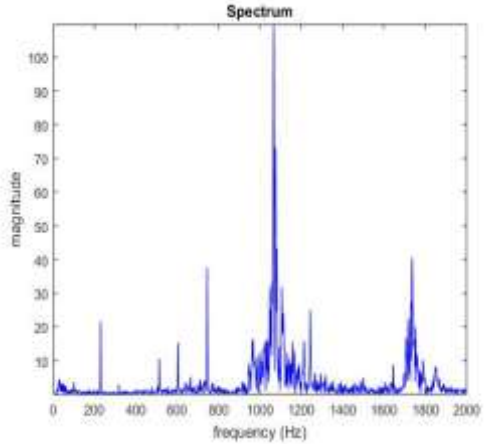
Figure 2 : The waveform of strokes of maddalam

Results and Discussion

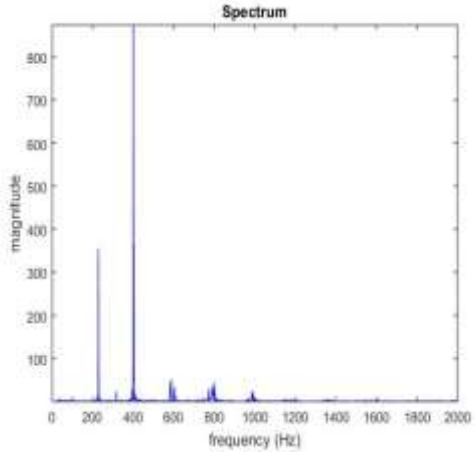
The audio waveform of the sound samples of maddalam strokes are given in Fig 2. If a stroke sustains for longer time it is heard more pleasing to the ears. The figures show that the strokes on loaded head sustains more than the stroke Tha on the unloaded head. The frequency spectra of all the five strokes of maddalam



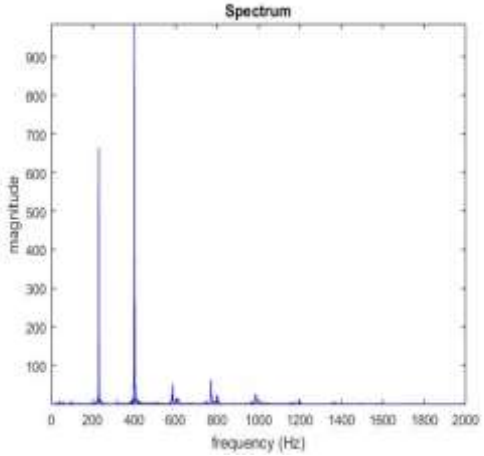
(a) *Dheem*



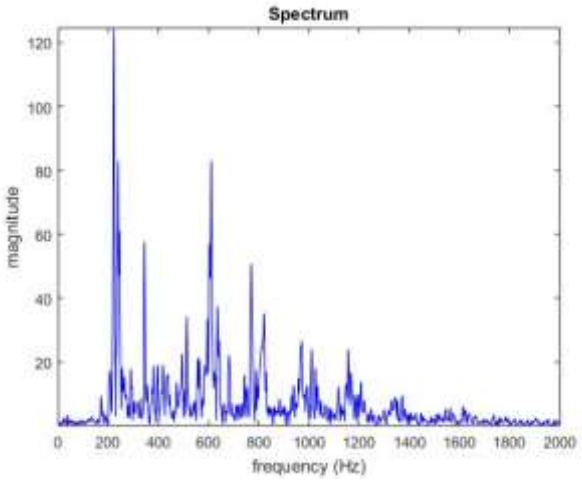
(b) *Tha*



(c) *Naam*



(d) *Thaam*



(e) *Thi*

Figure 3 : The frequency spectrum of strokes of maddalam

plotted using MIR toolbox are shown in Fig 3.

***Dheem* Stroke**

The frequency spectrum of Dheem stroke show one dominant peak at 228.1 Hz and a small peak at 402.1 Hz. The peaks obtained for *Dheem* stroke are sharp.

***Tha* Stroke**

Many peaks are observed for the stroke *Tha* on the unloaded head. The peaks are found at 228.5 Hz, 512 Hz, 602.8 Hz, 744.1 Hz, 1066 Hz, 1244 Hz and 1737 Hz. The first four peaks have small magnitude but are sharp compared to the other peaks. The fifth peak was found as the most prominent peak with highest amplitude. The peaks five and six show large degree of spread. This is due to the fact that the stroke is produced by the drum head with no loading.

***Naam* Stroke**

For *Naam* stroke, the second peak was the prominent one with maximum amplitude. The first peak was found at 228.5 Hz and the second peak was at 400.6 Hz. Sharp peaks were observed for *Naam* stroke.

***Thi* Stroke**

The frequency spectrum of *Thi* stroke was less sharp compared to *Dheem* or *Naam* stroke. Different peaks show noticeable spread in frequency. The prominent frequencies in the *Thi* stroke were at 221.2 Hz, 324.8 Hz, 512.7 Hz, 610.8 Hz, 769 Hz, 971.2 Hz and 1157 Hz. From the frequency spectrum of the strokes, the ratios of the frequencies are found. The Table 1 gives the prominent frequencies found in the spectra of strokes.

Table 1 : Frequency ratio of strokes

Strokes	Frequency	Ratio
Dheem	228.1	1
	402.1	1.7628
Tha	228.5	1
	512	1.7628
	602.8	2.6427
	744.1	3.2632
	1066	4.6734
	1244	5.4537
	1737	7.6151
Naam	228.5	1
	400.6	1.7532
Thaam	228.1	1
	399.9	1.7532
Thi	221.1	1
	324.8	1.4683
	512.7	2.3178
	610.8	2.7613
	769	3.4765
	971.2	4.3906
	1157	5.2306

***Thaam* Stroke**

For *Thaam* stroke peaks were seen at 228.1 Hz, 399.9 Hz. There are sharp peaks for *Thaam* stroke like *Naam* stroke.

Parameter	Dheem	*Tha*	Thaam	Naam	Thi
Attack time (s)	0.015	0.018	0.0192	0.0185	0.0162
Attack slope	64.7292	52.8375	50.7654	52.1751	60.4767
Attack leap	0.97094	0.95107	0.97512	0.96959	0.98023
Decay time	1.0008	0.2394	1.3776	1.4016	0.156
Decay slope	0.20068	0.80286	0.14919	0.16727	1.4195
Decay leap	0.20084	0.1922	0.20552	0.23444	0.22144
Duration (s)	0.17221	0.072	0.1254	0.1884	0.092396

Table 2 : Attack and decay parameters

The frequency ratios of strokes indicate that there is a good harmonic content in the strokes of maddalam. When a stroke is given to a drum the audio waveform has attack, decay and sustain phase (Datta et al., 2017). These parameters are one of the indications of harmonic nature of the sound samples. The attack and decay parameters of the maddalam samples are tabulated in Table 2. RMS energy of the sound samples indicates the energy of the strokes. The Table 3 shows the obtained values of RMS energy of strokes of maddalam.

Table 3 : RMS energy values of different strokes

Stroke	RMS energy
Dheem	0.1287
Tha	0.061464
Naam	0.06751
Thaam	0.071837
Thi	0.078305

It is seen that the rms energy is maximum for *Dheem* stroke and this indicates that *Dheem* stroke is the most energetic stroke.

Conclusion

From the audio waveform and frequency spectrum studies it was found that *Dheem, Naam* and *Thaam* strokes of maddalam were more harmonic than strokes *Thi* and *Tha*. Sharp peaks were observed for these three strokes. More spread in peaks were observed for *Thi* stroke. In the strokes of maddalam, *Dheem* stroke had maximum energy and its peaks were all sharp. The overall study shows that the drum maddalam has strokes with good harmonic content.

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