



Acoustic measurement of Marimba, Xylophone and Xylorimba

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Abstract

A set of wooden-keyboard percussion instruments, namely xylophone, marimba and xylorimba are acoustically compared. Since the size of xylophone and marimba has not had a standard size, their size and tone have a variety among them. More concretely, an American company Deagan produced the xylorimba between 1920-1930, which was played by a xylophone player Yoichi Hiraoka, and then conveyed to Japan. The timber of xylophone is felt as to have the features of both marimba and xylophone. The acoustic feature is, however, not measured until now. A professional marimba player cooperated in our experiment. She is asked to play a single note C4 with a consistent hard mallet. The power spectrum of recorded acoustic signal is evaluated in terms of salient peaks on the recorded sound. Although the salient peaks on marimba and xylophone are almost well-known shape, the one on the xylorimba has a distinct feature, which has 1) consonant peaks to F0, such as 2oct and 3oct+perfect 5th and 2) dissonant peaks to F0, such as 3oct major 2 degree (detuned to +1 and +22 cents). Therefore, the xylorimba is acoustically confirmed as to have both xylophone and marimba's features.

1 INTRODUCTION

Acoustical measurement of musical instruments is the key target of the field of musical acoustics. This study was motivated by a discussion with a professional Marimba player "Ms. Mutsumi TSUZAKI", who is reading Marimba player in Japan. Her musical instruments "Xylorimba" is originally played by the Marimba player Yoichi Hiraoka, who plays in USA during the 1930-1942. Since his performances were famous not only in US and Japan through radio broadcasting. After Ms. Tsuzaki started to play the Marimba, she felt that the sound or timbre has specific feature, namely it has the timbre both Xylophone and Marimba. The objective measurement of the Xylorimba, has not yet been conducted until now, so that at this time we tried to clarify the difference of the feature of timbre on the Xylorimba.

2 AIMS

At this report we aimed at clarification of the difference of timber among conventional Marimba, Modern-Xylophone, a vintage Xylophone, and Xylorimba. In particular, we measured the frequency component on the played sound to differentiate the four instruments. At this measurement, we focused on the acoustical similarity of the played sound of Xylorimba to either Marimba or Xylophone.

3 ACOUSTIC ANALYSIS

3.1 Measurement conditions

Followings are the list of the details of the measurement.

Instruments to be measured: Marimba, Modern-Xylophone, Vintage-Xylophone, Xylorimba

Task: Single stroke

Note height: C4

Used mallet: Normal mallet with normal hardness

of trial: Three

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3.2 Analysis

Firstly, the Marimba player Mustumi Tsuzaki was asked to play an instruments under the conditions denoted in 3.1. The recorded sound's beginning time, at here we use 250 msec from the onset of the waveform, is employed to be analyzed. The FFT (Fast Fourier Transform) was conducted for the beginning 250msec waveform, then its power spectrum is obtained. By observing the peaks in the power spectrum, the peak of the sound is picked up and the frequency is measured. Among the three trials, we observe the frequency on each peak number, then averaged the frequency on each peak, in order to get rid of the differences of frequencies due to trials. The fundamental frequency is obtained as the 1st peak of the analysis. Then, each tone interval between the fundamental frequency (F0) and each peak.

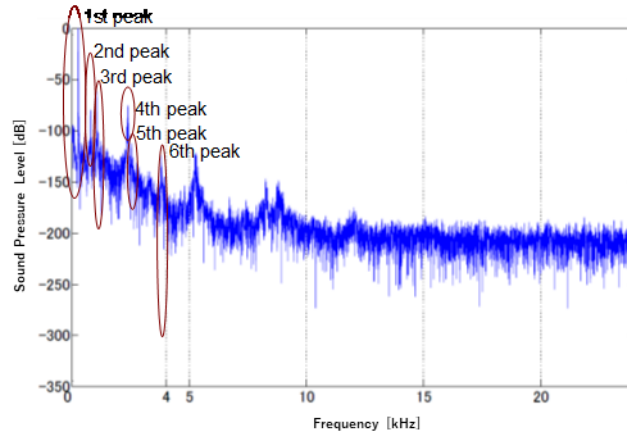
4 RESULTS

Table 1 shows the tone interval from fundamental frequency and peaks on the recoded sound, where the "oct." means 1 octave, and the cents are measured from each interval of the current. If we label as "major 3rd", it is not a precise measurement but somewhat rounded. If the interval's label is apart from 30 cents, the underlines are denoted.

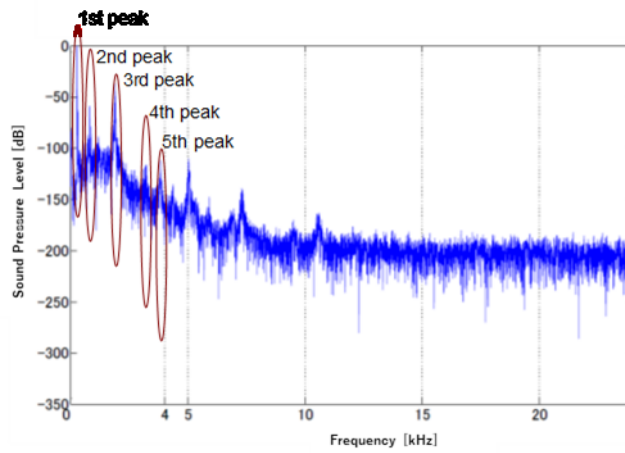
From Table 1, the result of Marimba says the second peak of the sound is 2 octaves, which consists with the literature[1]. Two Xylophones have 2nd peaks lower than the 2 octaves, but they commly have 1 octave with perfect 5th, which meets the result of literature [1]. Interestingly, Xylorimba has the same 2nd peak to Xylophone. Therefore, we can say that the Xylorimba has the Xylophone's feature on 2nd peak. Moreover, Xylorimba has the 2 octave component on the 3rd peaks which corresponds to the 2nd peak of Marimba.

Table 1 Result of measurement.

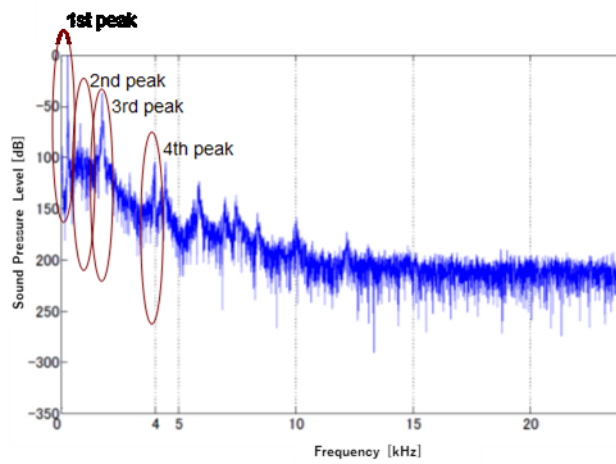
Peak Number	Insturment			
	Marimba	Modern Xylophone	Vintage Xylophone	Xylorimba
1	(F0)	(F0)	(F0)	(F0)
2	1oct.	<u>1 oct. Perfect 5th</u>	2 oct. Perfect 5th	3 oct. Perfect 5th
3	<u>3oct. Major 3rd</u>	2oct. Minor 7th	<u>2oct. Major 6th</u>	2oct.
4	-	3oct. Perfect 5th	3oct. Major 7th	3 oct. Major 2nd (+0.99cent)
5	-	3oct. Minor 7th	-	3 oct. Major 2nd (+21cent)
6	-	-	-	<u>3oct. Perfect 5th</u>



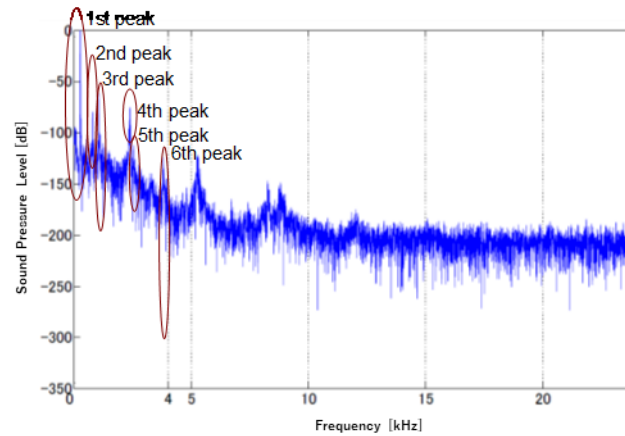
(a) Marimba



(b) Modern Xylophone



(c) Vintage Xylophone



(d) Xylorimba

Figure 1 Result of acoustic measurements on the four instruments.

5 DISCUSSION

According to the result of Table 1, Marimba has fewer number of peaks compared to the two Xylophones and Xylorimba. Therefore, Marimba is likely to produce purely timbre. On the other hand, the two Xylophones and Xylorimba have more peaks with 7th or 2nd intervals. Therefore, the three has complex sound compared to Marimba.

From here, we discuss the similarity of Xylophone and Xylorimba. In particular we focus on the 3rd or higher peaks. On the modern Xylophone the 7th intervals are observed, and on the vintage Xylophone it has 6th and 7th, which are expected to produce inharmonic sound[2]. Compared to the modern Xylophone, the vintage Xylophone has fewer peaks, which could be due to deterioration of the instrument. On the Xylorimba, it has perfect 5th components, that elicit Marimba's character, whereas it also has 2nd with out of tune component which elicits inharmonic, or percussive sound, that has different from both Marimba and Xylophone's characters.

6 CONCLUSIONS

At here we aimed at analyzing the acoustic feature of Marimba, Xylophone and Xylorimba. According to the result, the Xylorimba has component of Marimba's (major 3rd and octaves), and Xylophone's (perfect 5th), which is thought to elicit the sound character of both Marimba and Xylophone. Since the number of instruments to measure is quite limited, the obtained results may have biased. In near future we plan to measure another instruments on same category.

REFERENCES

- [1] N. Fletcher and T. Rossing, "The Physics of Musical Instruments", Springer, New York, 2008.
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