Frequency Measurement of Bonang Barung and Peking in Javanese Gamelan using Audacity

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Abstract. Javanese Gamelan has been used as acoustical research to investigate the tune in terms of frequency and intensity. In this research, the bonang barung and peking frequencies were measured using Audacity. It is low cost software to record and analyze the sound. It can process the sounds to generate the FFT of them. The bonang barung and peking are part of Gamelan Gending Bahana Yogyakarta ensemble. The sounds were measured in the hall where the gamelan is located. The lowest and the highest frequencies of the first row of Laras Pelog of Bonang Barung are 609.6 ± 0.1265 Hz and 1050 ± 0.09487 Hz, respectively. For the second row, the lowest and the highest frequencies are 300.1 Hz and 512.8 Hz, respectively. The lowest and the highest frequencies of Laras Pelog of Peking are 1176.1±1.1 Hz and 2101.0±0.0 Hz, respectively. The lowest and the highest frequencies of Laras Slendro of Peking frequencies are 928.1±2.2 Hz and 2118.1±1.1 Hz, respectively. Hence, by using low cost software and non-acoustical room, the gamelan frequency measurement has been performed with high accuracy and precision.

1. Introduction

Javanese Gamelan has unique set of instruments that has their own characteristic in term of the way of playing and their pitch. Hence, the intensity and frequency of the instruments are different between each other’s. There are two types of tone set in Gamelan. There are Laras Pelog and Laras Slendro. The instruments also have different shapes and material. The shape of Bonang Barung kettle is similar to inverted bowl. The Saron wilah shape is a bar with rounded on the top side. However, the Bonang Barung and Saron have the same material [1]. The frequency has been measured using oscilloscope on Gamelan Swastigitha and Gamelan Kyai Kaduk Manis [2]. The other measurement using sonogram to measure frequency of Gong [3].

The freeware software is important to introduce the sound produced by musical instrument to the students and the player. The Audacity is the example of freeware software. The software is useful tools to introduce the student to understand the signal of voice and noise [4]. The Audacity software has been used to measure frequency of copper flute instrument [5]. Even, the software is useful to be
employed to assist the students to understand the gravitational wave [6]. Hence, the gamelan frequency especially the Laras Pelog of Bonang Barung is possible to be measured using Audacity [7]. In this paper, we investigate the comparison the frequency measurement between the Bonang Barung and Peking using Audacity.

2. Methodology

We measured frequency of Bonang Barung and Peking at the Hall of Universitas Ahmad Dahlan. It is a regular meeting room. Hence, we need to wait until night to reduce the noise. The Bonang Barung and Peking are part of gamelan ensemble in Universitas Ahmad Dahlan. The name of the gamelan is the Gamelan Gending Bahana. The scheme of Bonang Barung of Laras Pelog is shown in figure 1. There are two rows in Bonang Barung. The top row has higher pitch than the lower one. The player need to play the kettles in the first row and the second row, simultaneously. The kettels or small gong is hit by padded stick or tabuh.

![Figure 1](image1.png)

**Figure 1.** The Laras Pelog of Bonang Barung have two rows of kettle or small gong with different pitch.

The Peking has similar arrangement of note as shown in figure 2. There are two types of peking that we used for frequency measurement. There are Laras Pelog and Laras Slendro. They have different wilah or bar arrangement. The peking is also known as Saron Panerus.

![Figure 2](image2.png)

**Figure 2.** The Laras Pelog and Laras Slendro of Peking have different wilah or bar arrangement.

The Audacity software was employed to measure the the Intensity and Time of the signal. The Fast Fourier Transform (FFT) is utilized to analyze the dominant frequency for each tone. The measurement was repeated to obtain the average and standard of deviation of frequencies. The Laras Pelog of Bonang Barung frequency measurement can be shown in figure 3(a). Similar arrangement of microphone and laptop for frequency measurement of Peking can be shown in figure 3(b). The microphone is placed right under the wilah or bar.
3. Result and discussion

3.1. Result

The result of frequency measurement of Bonang Barung and Peking can be discussed in this section. The sound spectrum of Laras Pelog of Bonang Barung and Peking can be shown in figure 4. Each kettle of laras Pelog of Bonang Barung was hit 10 times for statistical purpose. The number of repetition for hitting each wilah or bar was 7 times.

![Figure 3](image1.jpg)

Figure 3. The frequency measurement scheme of (a) Bonang Barung using Audacity and Laptop and (b) Peking using Audacity and Laptop.

![Figure 4](image2.jpg)

Figure 4. (a) The sound spectrum of Laras Pelog of Bonang Barung in Audacity. (b) The sound spectrum of Laras Pelog of Peking in Audacity.

After the data sound was captured and recorded by using Audacity, the FFT menu of the software was employed to get dominant frequency for each tone as shown in figure 5.
Figure 5. (a) The FFT analysis of Laras Pelog of Bonang Barung in Audacity. (b) The FFT analysis of Laras Pelog of Peking in Audacity.

From the FFT analysis, we can obtain the dominant frequency of Laras Pelog of Bonang Barung and Peking. The frequency is chosen that has the highest intensity. The cursor on the software is the right tool to pick up the dominant frequency. The frequency of Laras Pelog of Bonang Barung for the higher pitch and lower pitch can be shown in table 1 and table 2, respectively. The table also shows the comparison to the other frequency measurement on different gamelan ensembles and different methods.

Table 1. The frequencies of each kettle on the first row (higher pitch) of Laras Pelog of Bonang Barung and their comparison to the other measurements.

| Tone | Frequency (Hz)         | Gamelan Swastigita Frequency (Hz) [2] | Gamelan Kyai Kaduk Manis Frequency (Hz) [2] |
|------|------------------------|--------------------------------------|---------------------------------------------|
| 1    | 609.6 ± 0.1265         | 602                                  | 604                                         |
| 2    | 653.9 ± 0.03162        | 643                                  | 682                                         |
| 3    | 705.8 ± 0.06325        | 708                                  | 732                                         |
| 4    | 822.3 ± 0.03162        | 828                                  | 840                                         |
| 5    | 887.1 ± 0.03162        | 887                                  | 892                                         |
| 6    | 954.5 ± 0.09487        | 950                                  | 976                                         |
| 7    | 1050 ± 0.09487         | 1052                                 | 1077                                        |
The frequency of Laras Pelog and Laras Slendro of Peking can be shown in table 3. The table also show the comparison to the other frequency measurement on different gamelan ensembles and different methods.

### Table 2. The frequencies of each kettle on the second row (lower pitch) of Laras Pelog of Bonang Barung and their comparison to the other measurements.

| Tone | Frequency (Hz) | Gamelan Swastigitha Frequency (Hz) [2] | Gamelan Kyai Kaduk Manis Frequency (Hz) [2] |
|------|----------------|----------------------------------------|-------------------------------------------|
| 1    | 300.1 ± 0.03162 | 300                                    | 310                                       |
| 2    | 322.3 ± 0.06352 | 324                                    | 336                                       |
| 3    | 345.8 ± 0.09487 | 353                                    | 362                                       |
| 4    | 411.0 ± 0.06325 | 415                                    | 424                                       |
| 5    | 459.5 ± 0.06325 | 444                                    | 445                                       |
| 6    | 476.1 ± 0.03162 | 472                                    | 482                                       |
| 7    | 512.8 ± 0.1265  | 525                                    | 538                                       |

### Table 3. The frequencies of each wilah of Peking their comparison to the other measurements.

| Tone of Laras Pelog | Frequency (Hz) | Gamelan ITB Frequency using Sound Analyzer (Hz) [8] | Tone of Laras Slendro | Frequency (Hz) | Gamelan ITB Frequency using Sound Analyzer (Hz) [8] |
|---------------------|----------------|------------------------------------------------------|-----------------------|----------------|------------------------------------------------------|
| 1                   | 1176 ± 0.4158  | 1208                                                 | 6                     | 928.1 ± 0.8315 | 928                                                 |
| 2                   | 1272 ± 0.7181  | 1300                                                 | 1                     | 1075 ± 0.4158 | 1073                                                 |
| 3                   | 1409 ± 0.1890  | 1391                                                 | 2                     | 1234 ± 0.3024 | 1246                                                 |
| 4                   | 1643 ± 1.398   | 1639                                                 | 3                     | 1423 ± 0.1890 | 1418                                                 |
| 5                   | 1765 ± 0.2268  | 1757                                                 | 5                     | 1636 ± 0.4914 | 1639                                                 |
| 6                   | 1862 ± 0.2646  | 1854                                                 | 6                     | 1870 ± 1.550  | 1854                                                 |
| 7                   | 2101 ± 0       | 2050                                                 | 1                     | 2118 ± 0.4158 | 2167                                                 |

3.2. Discussion

We have done measurement of frequency of Laras Pelog of Bonang Barung and Laras Pelog and Laras Slendro of Peking using Audacity software. The results are compared to the other measurements using different gamelan ensembles and methods. The different ensembles and methods are used as references. From the results, we can see that the frequency measurements are having small differences compared to the references. These differences due to different gamelan ensembles and methods. Besides that, the rooms for taking the data are also different.

The frequency measurement of Laras Pelog and Laras Slendro of Peking are having similar deviation from the references compared to the frequency measurement of Laras Pelog of Bonang Barung. This fact is interesting since the way of playing the instrument is different. The kettle of Bonang Barung is hit gently by using the padded stick. In the other hand, usually the wilah or bar of Peking is hit loudly. It is important to investigate the influence of hitting force to wilah to the frequency of wilah. The mechanism for hitting the kettle and wilah need also to be improved in such a way the force is similar between number of hit to repeat the experiment. The shape of kettle and wilah will be interesting part to be studied. Since, they have completely different shape.
The ability of Audacity software to capture the sound and generating analysis data have potential to be used for diverse purposes. The gamelan players and gamelan maker can use this software to assist the tuning process. Since there is no fee for installment, the software is useful for the educator to introduce the concept of wave and oscillation and their application using simple and inexpensive software.

4. Conclusion
The Audacity has been employed to measure the frequency of kettle of Laras Pelog of Bonang Barung and wilah of Laras Pelog and Laras Slendro of Peking. The inexpensive and easy method was able to generate the result that has small differences from the references. The results quality need to be improved by investigating the factor of hitting force to the instruments. Hence, the method and software can be also used for measuring the other instrument in the gamelan ensemble. Moreover, the Audacity is powerful software to get fast measurement to assist the player and the gamelan maker to tune the instruments.

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