JPPIPA 8(6) (2022)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppScience.unram.ac.id/index.php/jppipa/index

Analyzing and Comparing Frequency of the Birds Sound Spectrum using Audacity Software in Practicum Activity

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Received: May 30, 2022
Revised: November 21, 2022
Accepted: December 17, 2022
Published: December 31, 2022

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DOI: 10.29303/jppipa.v8i6.1697

Abstract: In the science learning process especially sound waves concept, experiments are needed that can help someone in gaining a meaningful learning and using technology. In this study, the aim is to analyze and compare the bird sound frequency assisted by Audacity software. The subjects used are three different bird sound (*Murai Batu's* sound as the main subject while the *Love Bird* and *Kenari's* sound as the compared subject). The implementation of this study uses several tools such as a microphone, Audacity software on a laptop and bird sounds. This experiment was carried out by bringing the microphone closer to the bird with 15 cm, so that the sound was captured by the microphone, then transferred to the laptop and read by the Audacity software. Furthermore, the data recorded in Audacity were analyzed. From the results of the study, it can be concluded that combination of bird sounds and audacity tools can be used in practicum, can read and capture bird sound waves effectively in analyzing and comparing the bird sound frequency and spectrum in the software. Thus, it tends to be utilized as one of the learning media in practicum on sound wave material at secondary school.

Keywords: Audacity Software; Bird Sound; Frequency; Sound waves; Spectrum.

Introduction

Science learning includes processes as well as products. In this case, the process becomes an important thing that provides a meaningful experience to students in building knowledge, abilities, skills, and other competencies. The existence of experiments in science learning can train students to work and think (Ariantara et al., 2019). Experiment devices in schools, especially in the learning process, are needed as a learning medium that has an important role to achieve learning success, especially independent learning. Previous findings have applied the Inquiry learning model to improve the ability to do experiments in mastering concepts. Nurinsani et al. (2018) and Danika et al. (2018) have identified the development of secondary school students to conduct experiments in learning and increase mastery of the static fluid and energy concepts. The results of other studies describe science learning carried out by a laboratory based on inquiry learning that can optimize the mastery of science concepts and process skills of students (Wardani et al., 2016).

One of the fascinating points regards to secondary school science material in the growing experience learning is about sound. Sound is a mechanical wave with a type of longitudinal that propagates and there is a source of sound in the form of vibrating objects (Xia et al., 2016). Sounds are waves due to the compression and rarefaction on the gas medium. Each sound source will have a different characteristics sound. It characteristic differences are seen based on the frequency and intensity values of the sound source. One of the science learning concepts taught in schools is sound waves that requires one of the experiments where students can describe the characteristics of sound, especially frequency, amplitude, period of wave.

The frequency analysis of sound by designing a tool to determine the speed of sound travels in the air using

How to Cite:
Hujatulatif, A., Jumadi, J., Kuswanto, H., & Ilma, A.Z. (2022). Analyzing and Comparing Frequency of the Birds Sound Spectrum using Audacity Software in Practicum Activity. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 2586–2592. https://doi.org/10.29303/jppipa.v8i6.1697

an impedance tube with a sound source namely Audio Frequency Generator (AFG) with a frequency from 300 – 1000 Hz. Experimental tools in determining sound usually use open or closed organa pipes where the tool is less effective if carried everywhere and takes a long time to analyze it in the learning (Agustina & Astuti, 2016).

The existence of experiment will make students understand the concept of physics in this sound wave material by utilizing existing media. Wave and sound are materials that are difficult for students to understand them. Therefore, interactive learning media are needed so that students can understand the concepts easily (Yanto et al., 2019). The existence of learning media in open organa pipe material by combining cultural elements, the art of utilization of existing technological developments is expected that students will be more interested in learning. Therefore, it takes a simpler tool, easy to assemble, and operate by students. In order to carry out an experiment, that is suitable for sound recording equipment such as microphone or hydrophones where the use of the recording device is called passive sounding (Pranoto, 2018). The process of sound recording or processing of sound signals is also needed equipment in the form of software. One type of software that can be used is Audacity.

In this study will use a simple experimental tool and analyze sound quickly and precisely. Audacity is a free licensed sound file processing software. One of the functions of Audacity is the ability to record sound signals that are inside the computer, as well as from outside the computer (Farida et al., 2020). Nursulistiyo (2015) used pentatonic bamboo flutes as a medium of physics learning and categorized both as them in open organa pipe material. Widayanti & Pramudya (2014) also identified the frequency of Bonang Barung where data obtained by recording sound with Audacity software and analyzed with tools in the program. So, in this study, researchers formulated ideas to analyze the use of Audacity software for the implementation of sound wave experiments in life. The data obtained from this experiment is expected to be used as a reference material in science and can know the frequency testing spectrum with the help of existing software that is Audacity software. This article can be used in generating a practicum by using software in everyday life.

Method

This type of study is experiment that aims to provide some data by read and capture bird sound waves in analyzing and comparing the bird sound frequency and spectrum in the software. This study conducted at Ngrombo 2, Balong, Girisubo, Gunungkidul, Yogyakarta, Indonesia. The subject is three kind of birds which is easy to find. The implementation of this physics experiment tool is a test in seeing sound waves, especially frequency-assisted Audacity software. The tools and materials used are laptops with Audacity software program and three kind of sound bird that have been described. The experimental procedure can be observed in Figure 1.

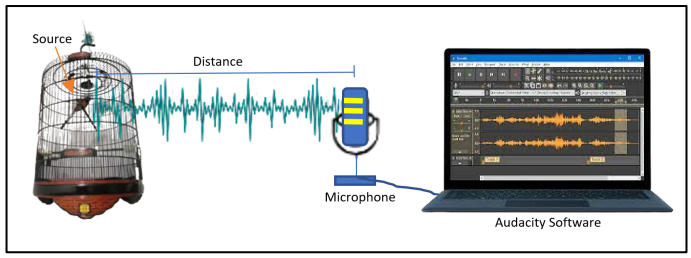

Figure 1. Implementation Process

The procedures of this experiment are turning on the computer, installing the Audacity Software, and then connecting a microphone with the computer. When the bird plays the sound, the microphone picks up the sound and connects it to software that records and measures frequencies and waveforms. The signal intensity and time were measured using Audacity software. Then, perform an analysis of the dominant frequency of each number instrument using the Fast Fourier Transform (FFT). The measurements were repeated to determine the mean and standard deviation of the frequencies.

Result and Discussion

From the results of experiments obtained data spectrum shape and frequency of sounds in birds. In this study was conducted on three bird sounds under different species. The explanation of the condition of the bird analyzed can be seen from Table 1.

Table 1. Bird Description Analyzed

Local Name	Gender	Binomial name
Murai Batu	Male	*Copsychus malabaricus*
Love Bird	Male	*Agapornis swindernianus*
Kenari	Male	*Serinus canaria*

In Table 1, researchers examined three birds analyzed under different species were taken and also analyzed with Audacity. In the Audacity software window will be able to view visible signals or sound waves. The reason of the *Murai Batu* as the main subject is because it can imitate the sound of other birds. There were analyzed here the data analysis of each bird's sound, the data of the bird's sound compared to other birds and in particular the comparison between the original sound of the bird and the sound imitated by the *Murai Batu* (Forum Agri, 2012).

Figure 2. Murai Batu (Jalaksuren.net, 2021)

The chirping of a beautiful *Murai Batu* can hypnotize its lovers. In addition, when singing the *Murai Batu* is also able to show its very attractive fighting stylish by moving its tail, straightening or bending its chest, and moving its head. These various abilities cause this bird to be liked by many people. They hunted the desired *Murai Batu* to remote areas, whatever the price of the bird is not a problem. This fact is an opportunity for bird sellers. Bird sellers often get *Murai Batu* from the wild. Massive poaching, forest conversion and forest degradation have caused the population of this bird continue to decrease.

Bird species is one of the animals that besides being physically beautiful, it is also popular with its sound, even to the point of a chirping bird contest (Iskandar & Iskandar, 2015). The beauty of the sound of birds chirping has its own charm, not only for fans but also for scientists. It turns out that the song (chirping) of birds has attracted the interest of Charles Darwin, the scientist who founded the theory of evolution, developed a theory of sexual selection in a book entitled "The Descent of Man and Selection in Relation to Sex" in 1871.

Some of bird sounds that can imitated by *Murai Batu* are *Kenari* and *Love Bird* sound. *Kenari* is one birds that have the ability to learn sounds which continues until adulthood or after going through the stages of the period sensitive. They are very favored by people in Indonesia. It has a wide variety of colors and unique color combinations. The sound of the *Kenari* is very varied with ups and downs of notes that have a good rhythm (Auzaini & Fadli, 2013).

Figure 3. Kenari and Lovebird (merdeka.com, 2020)

Love Birds are still in the same family as old parrots. Of the nine species, eight of them come from mainland Africa. Only one *Agapornis canus* comes from Madagascar, an island close to the African continent (Tim Karya Tani Mandiri, 2018). This bird is also in great demand as a pet in Indonesia.

The microphone receives the sound from each bird. Sound waves from a bird are still analog signals that can measured a device like a microphone. Microphone converts the acoustic vibrations to electrical signals (Mei & Cheng, 2020). *Analog-to-digital converter* (ADC) converts analog signals into digital representations that are displayed on a computer. A digital signal of sound is shown in Figure 4. There is changing the analog signal into digital representation can be used in a computer.

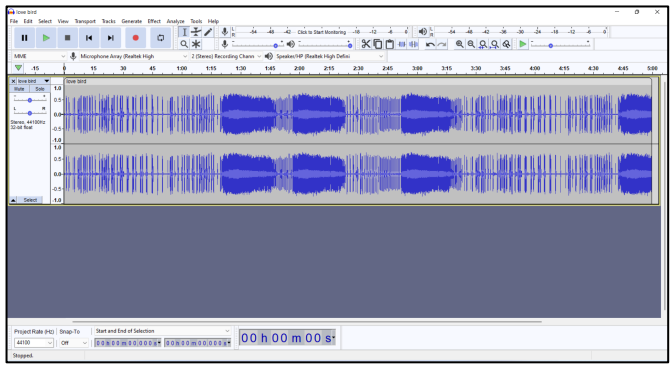

Figure 4. Input Signal

There is the link of the bird sounds,

Figure 5. QR Code for The Link of Bird Sounds

A digital signal consists of discrete values sampled at fixed time intervals. The representation is in the time domain (Salamon et al., 2014). It can convert a digital signal to the frequency domain to display the spectrum or spectrum analysis. One approach in spectrum analysis is based on Fourier analysis. This theory was finally implemented with an algorithm known as the Fourier Transform (FT). Implements FT which performs the conversion of music or sound signals over time to frequency can also show the sound or musical tone's harmonics. From the received input signal, the segment can be extracted as shown in Figure 6. After that, the result of window segment will be obtained.

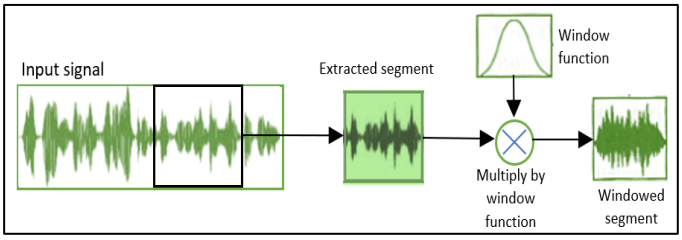

Figure 6. Process Input Signal into Windowed Segment

One type of FT is the Fast Fourier Transform (FFT). The FFT is more efficient and often used to implement the FT on digitized signals (Kosasih et al., 2018). The basic premise of the FFT algorithm is that the signal is periodic and indefinite. However, if the signal in a particular analysis window does not have the exact period, the frame discontinues (Lin & Ye, 2019). Window functions can be applied to minimize these discontinuities. Hamming, Gauss, and Blackman are examples of window functions (Firmansyah et al., 2021). The window functions used in this study are the Hamming window functions shown in some Figure 7.

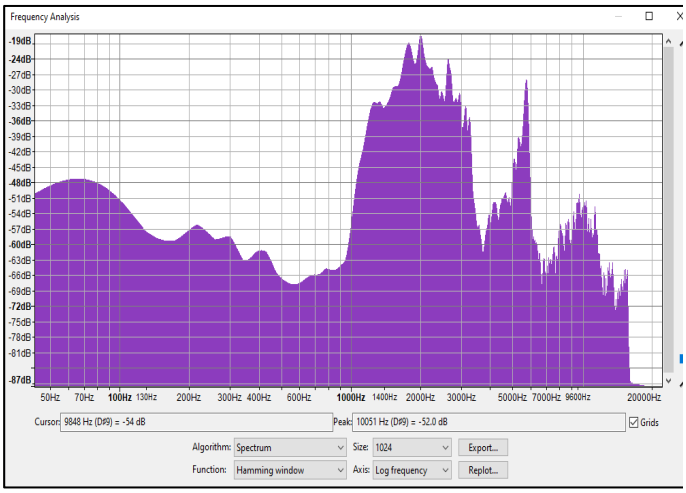

Figure 7. The Fast Fourier Transform (FFT) of *Murai Batu* Original Sound

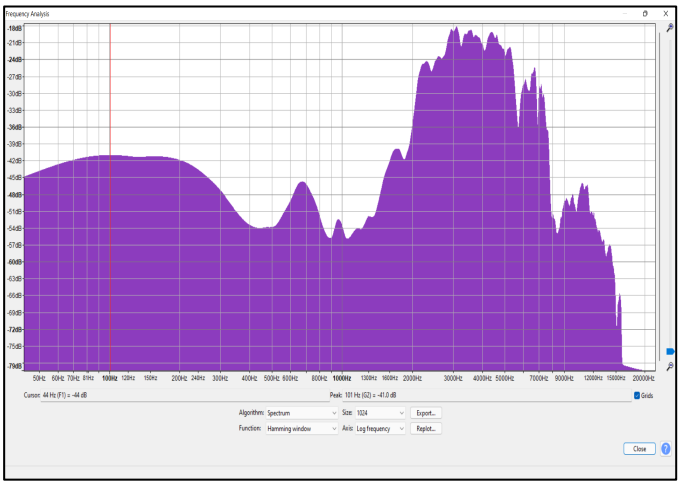

Figure 8. The Fast Fourier Transform (FFT) of *Kenari* Sound

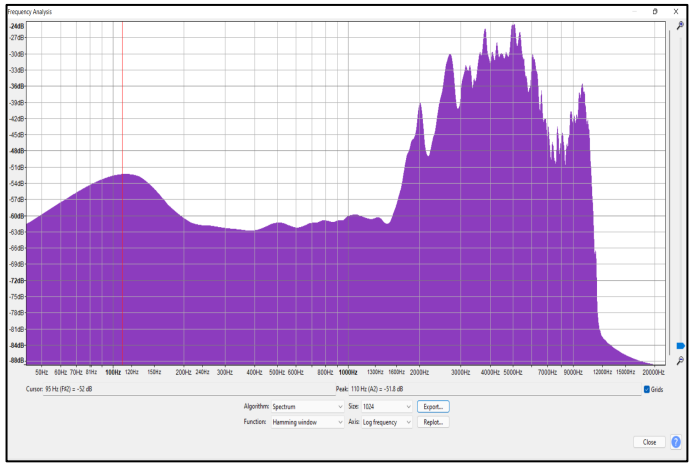

Figure 9. The Fast Fourier Transform (FFT) of *Love Bird* Sound

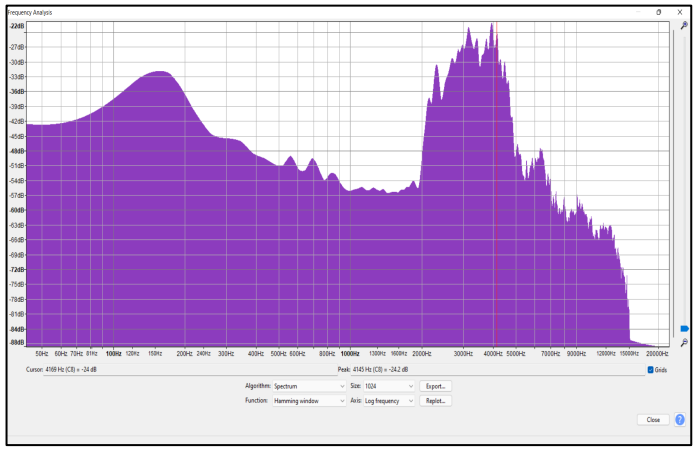

Figure 10. The Fast Fourier Transform (FFT) of *Murai Batu* Imitate *Kenari* sound

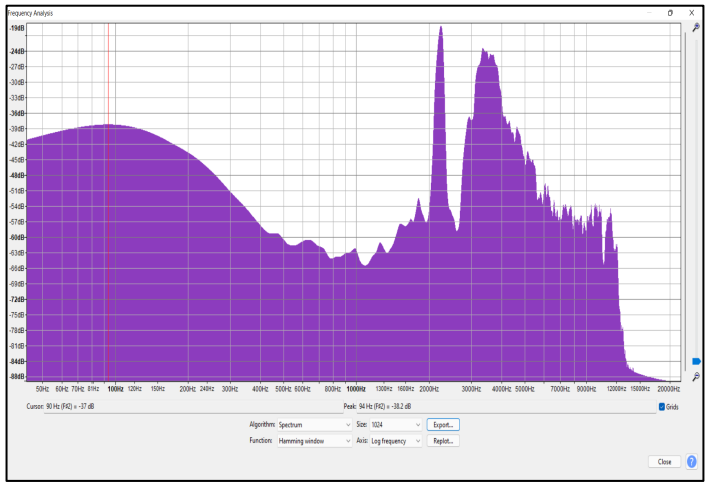

Figure 11. The Fast Fourier Transform (FFT) of *Murai Batu* Imitate *Love bird* sound

Data processing is carried out from spectrum analysis with Hamming function to facilitate analysis in this study. The result from spectrum analysis can be shown in Figure 12 and Figure 13.

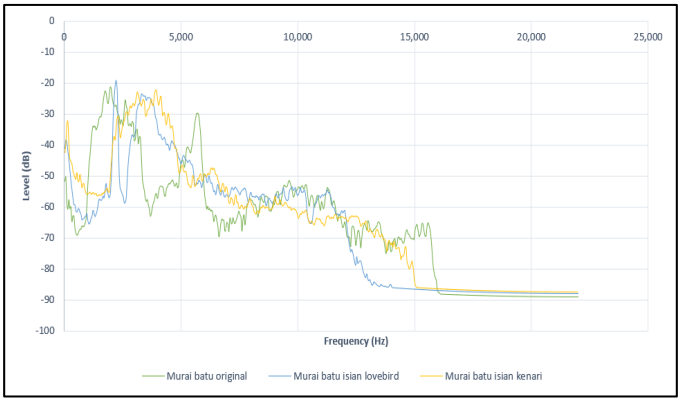

Figure 12. Spectrum Fourier Transform Sound of *Murai Batu* Original, *Murai Batu* Imitate *Love Bird* and *Murai Batu* Imitate *Kenari*

Figure 13. Spectrum Fourier Transform of All Source Bird Sound

The FFT analysis selected the dominant frequency as the highest intensity frequency. A red cursor on the window of Audacity is a good tool for displaying the dominant frequency. Sound frequency measurement is the number of sound vibrations that occur during a unit of time. The frequency of each source is different. Table 3 shows the frequency and its comparison measurements.

Table 3. Result of Fundamental Frequency

Source	Frequency (Hz)
Murai Original sound	2519
Kenari	3019
Love Bird	5056
Murai Batu imitate Kenari	2982
Murai Batu imitate Love Bird	3427

Frequency measurement using Audacity for various purposes is widely carried out. Measurement of sound frequency is the number of sound vibrations formed during one unit of time. The use of frequencies, tones and levels of sounds has also been widely developed in the fields of health, agriculture (Larry & Farmington, 2015) and even weapons.

In this study the unique sound of the *Murai Batu* and others can also be identified and analyzed by the software. Audacity also can help design experimental tool designs and also determine the value of the speed of sound propagation both the frequency and the sound amplitude (Agustina & Astuti, 2016). The use of Audacity software helps the process of analyzing frequencies well and easily so that it can get the desired and expected data. For the highest frequency at three sounds analyzed at love bird 5056 Hz and the lowest at original sound of *Murai Batu* 2519 Hz. As for it, it can also be seen that the frequency of *Murai Batu* imitate *Kenari* 2982 Hz almost matches the original *Kenari* sound at 3019 Hz.

A sound is never stagnant but constantly changes over time. This means that each sinusoid amplitude changes so that the shape of the graph that representing the spectrum also changes. This explains what we see when we pay attention to spectrum analysis with its Audacity software. This software can measure the frequency of bird sound produced, by using s Audacity will be able to measure the level of sound intensity produced by the sound source (Azalia et al., 2022). The level of sound intensity produced very significant difference. This is because the air in the environment is not constant, so it affects the magnitude of the intensity of the sound produced.

By learning sound waves using sounds in life will be more interesting and can be done anywhere. The existence of Audacity software can help teachers create interesting learning media that are suitable for learning in schools, especially with the use of technology, so as to provide opportunities for students to learn through high motivation. This is because of their interest in multimedia systems can presents a combination of various media in the form of text, images (vector or bitmap), graphics, sound, animated video interaction, and others that have been packaged into digital files used to convey messages to the public. While interactive media related to the combination of two directions or more of the communication components (Subandi et al., 2018). A combination of technology and physics can be used by teachers to invite students during the learning process. If the development of technology is used as a learning media, it will have a good impact for everyone including the students themselves. Audacity software can be applied in the study of sound waves. It has been widely used in science learning, especially physics material. Based on the rapid development of science and technology, it can help teachers implement science learning.

For the next study, there were suggestion is that the tool should to be sets easy to carry, equipped with ordinances or instructions for the use of tools, so the students can carry out experiments independently. In experiment should be considered the condition or state

of the room such as temperature and noise level. For the desired results to approach the theoretical value, it would be better to have an experiment conducted in a soundproofed room in this age of rapid development of science and technology. It is supposed to develop a technology-based learning media. Thus, Audacity is worth using in helping the process of implementing one of the experiments on sound wave material.

Conclusion

Based on the result, Audacity software can be used to read and capture sound waves effectively in analyzing sound frequency, spectrum in the software of sound learning. Audacity can be used as one of the learning media in practicum on sound wave material at secondary school.

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