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Noise Reduction System Using Passive Bandpass Noise Filter on Podcast Microphone

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Abstract—The general properties of waves are refraction, reflection, bending (diffraction), interference and polarization. Sound is a form of wave and is in accordance with the law of wave refraction where waves coming from a less dense medium to a denser medium will be refracted closer to the normal line or vice versa. Sound waves easily experience diffraction because sound waves in air have wavelengths of around several centimeters to several meters. Then basically every room, whether you feel it or not, will always have sound. This is inversely proportional to light which has a wavelength of around 500 mm. Therefore, an interference reduction system using a passive bandpass interference filter on the podcast microphone is necessary to reduce interference. Test results carried out by filters used to reduce noise using Passive Band Pass. the waveform is still the original spectrum at 0 Hz – 120 Hz, the original sound conditions and does not cause interference, but interference occurs and filtering Category (Noise %) 10 – 40 low - 98 – 99 high.
Keywords: Sound, Spectrum, Passive Bandpass Noise Filter, Podcast Microphone

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1. Introduction

The rapid development of technology has made world civilization increasingly progress and also made it easier to do work. One of the important technological things in doing work is using a communication system. The human voice is the most important communication medium in communicating which will best occur if our voice or tone is heard very clearly, if our voice is not heard clearly and well, it is certain that two-way communication will not be good [1]. for example, if two people communicate in a room, there will be mutual information and if with more than three people there will be an unclear sound if there is noise, the cause of the noise reduction will be interference [2], [3]. In assessing the quality of the resulting speech signal, it is a means of two-way information that must be clear. If the quality is not clear, the sound signal will not be conveyed properly. In good speech, the conversation that will be recorded using a microphone will be clearly audible using a closed room [4], [5]. Technological advances now record sound using smartphones and other types and will cause high noise, for example two people talking if they make a sound other than the speaker will be recorded [6]. Noice is defined as a vibrating sound that causes noise, in general the noise propagates in the air non-periodically which can cause unwanted sounds and have a negative influence on the desired sound. Noise in voices with unwanted sounds that are based on the type of wind and rain or come from the background where the source of our conversation is in the form of vehicle sounds and white noise [7].

Podcasts can be defined as broadcasts that can be recorded in the form of the host's voice or in

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other words someone who speaks or talks and with certain topics that will be listened to by all listeners, starting from radio broadcasts and now developing with smartphone technology or other things, Podcast is an abbreviation of the words iPod and broadcast, and there are also those who define podcast as play on demand or personal on demand [8], [9]. These terms can generally be interpreted as sound broadcast podcasts in the form of audio that can be listened to at anytime and anywhere by the listener. This is different from radio broadcasts which are arranged by an announcer to be heard at certain times [10], [11]. Control and filtering techniques during podcasts for noise must use filters and reduce noise in microphone performance and the signal noise value or signal to noise ratio (NSR) in spectral is to use filters that can reduce and filter noise in the sound output during podcasts to produce best sound, this technique can use a passive bandpass noise filter.

2. Method

There are several methods used to change sound, and this uses techniques or methods that are very difficult, because you have to obtain the characteristics of a combination of sound or sounds, such as light wave phenomena and sound is a wave phenomenon involving air molecules. pressed on an audio device, the system vibrates back and forth to produce a longitudinal pressure value that is received as sound. And to make the sound harmonics better, a method is used with a noise reduction system using a passive bandpass noise filter on the podcast microphone.

2.1 Analog Signal Proses

Process the audio signal is the output of the recording, good enhancement and good storage will determine the quality of the audio content, because audio signals are in analog and digital form because the limit of our ears is 20 to 20,000 Hz, analog signals appear in electrical signals, to reduce noise in these signals must be converted from analog to digital as shown in Figure 1.

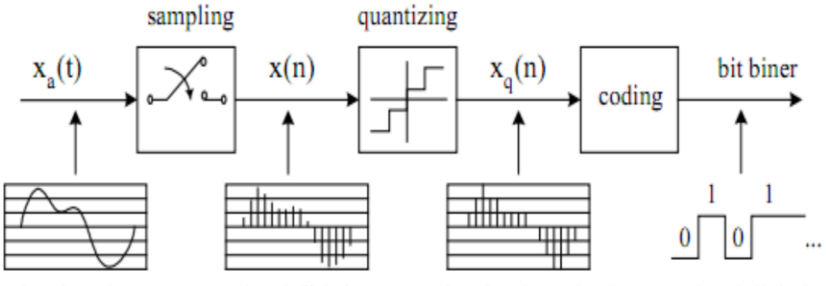


Figure 1. Analog to digital signal conversion [12]

Sound has a continuous number of values and digitally generated sound has a limited range of values. In the digital sound wave version, it will require digital representation of audio information. A microphone or mic is a part of an electronic device and component that can change the form of acoustic energy (sound waves) into the form of electrical energy (audio signals) as shown in Figure 2.

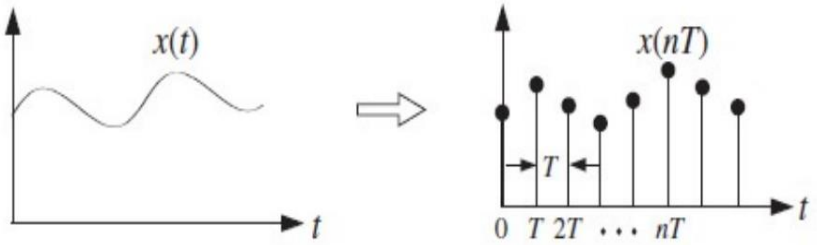


Figure 2. Signal analog to digital [13].

2.2 Spectrum Noise

In principle, sound waves are the propagation of energy originating from a source sound that propagates in all directions, where the wave front is spherical (spherical). Sound intensity is the energy of sound waves that penetrate a surface area per unit area per second. Figure 3, if we describe a sound source as having power is P watts, then the value of the sound intensity at a distance r from a sound source can be stated.

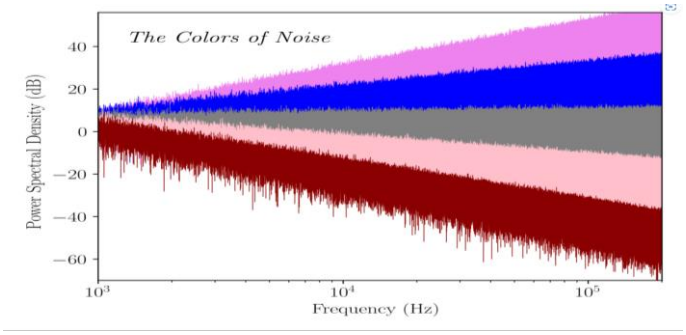


Figure 3. Color of noise [14]

$$V + \sqrt{\frac{\gamma RT}{M}} \tag{1}$$

The speed of sound in solids is determined by Young's modulus and mass the type of substance. The equation can be written as follows.

$$V + \sqrt{\frac{E}{\rho}} \tag{2}$$

Interference caused by two sound waves can cause sound propagation events, namely the strengthening and weakening of sound. This occurs due to the superposition of two waves that have frequencies slightly different and propagate in the same direction. If the two sound waves propagate at the same time, they will produce the strongest sound when both phases are the same. If both vibrations opposite phase, the weakest sound will be produced. If both waves These sounds travel together, producing the strongest sound when both phases are the same. If the two vibrations are in opposite phase, a weakest sound mathematically [15]. Sound Wave Interference occurs if the path difference is an integer multiple of half the wavelength of the sound.

$$f_p = | f_1 - f_2 | \tag{3}$$

$$\Delta s = \frac{(n + 1)\lambda}{2} \tag{4}$$

3. Result and Discussion

Podcasts can be defined as the process of distributing audio files via the internet using RSS subscriptions, other definitions of Podcasts also come from Playable on demand and Broadcast. where the podcast can be about the delivery method and content. The audio results in the form of files are uploaded on the internet, which can later be downloaded by anyone who wants to listen to them. Apart from that, you can also subscribe so you always know the latest developments from audio file makers. Time window 50 ms, D50 definition is the listener's ability to distinguish the sound of each instrument in a piece of music. Performance in transient conditions, basic tones and harmonics begin to form, allowing spectrum variations to occur. Definition is also a criterion for determining sound clarity in a

room by using the concept of comparing the energy used with the total sound energy in the room. D50 is the ratio between the energy received in the first 50 ms and the total energy received. A duration of 50 ms is also called the limit of acceptable speech intelligibility. The greater the D50 value, the better the level of speech clarity, because more sound energy is utilized in 50ms. Good intelligence or clarity is obtained at the D50 price >0%. Meanwhile, the speech clarity assessment categories based on D50 are shown in Table 1.

Table 1. Category Speech Clarity

Category	(%)	Results
0- 20	0-60	Very poor
20-30	60-80	Bad
30-45	80-90	Fair/moderate
45-70	90-97.5	Good
70-80	97.5-100	Very good

Then, the condition of the sound wave form when there is no noise is as presented in Figure 4, where the resulting wave form is still in the original spectrum at 0 Hz – 1200 Hz, the condition of the original sound form and does not cause noise.

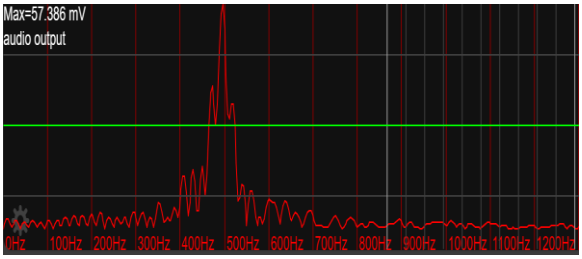


Figure 4. Sound Normal

Intelligibility is measured by comparing the energy of the sound used (which appears around the first 0.05 – 0.08 seconds after the direct sound) with the subsequent reflected sound, with reference to the assumption that the sound perceived by the listener in conversation is between 50-80 ms and the sound that comes after is considered a destructive sound. The higher the C50 value, the shorter the reverberation time, and vice versa. The speech intelligibility level will be good if the C50 is less than or equal to -2dB. C80 is the ratio in dB between the energy received in the first 80 ms of a received signal and the energy received thereafter. This limit is intended for clarity in music. The C80 value is a parameter value that is measured excessively from 80ms, the higher the C80 value, the worse the sound will be. TS is the middle time between incoming sound (direct) and reflected sound (start to end), the higher the TS value, the worse the sound clarity. TS is a point where the energy received before that point is balanced with the energy received after that point. TS is a measure of the extent to which the clarity of a sound is received by the listener, where the lower the TS value, the clearer the sound received. Below in Table 2 are the results of speech clarity.

Table 2. Speech Intelligibility

Category	(Noise %)	Results
10	10 – 40	low
20	40 – 50	low
30	50 – 60	low
40	64 – 62	medium
50	66 – 60	medium
60	90 - 92	high
70	95 - 96	high
80	97 – 97,5	high
90	98 – 99	high

Then the resulting data from speech clarity is presented in graphic form, which can be seen in Figure 5 and Figure 6 which can illustrate the noise categories and values.

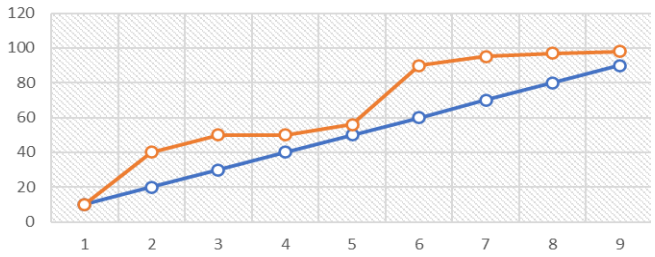


Figure 5. Line graph of noise values

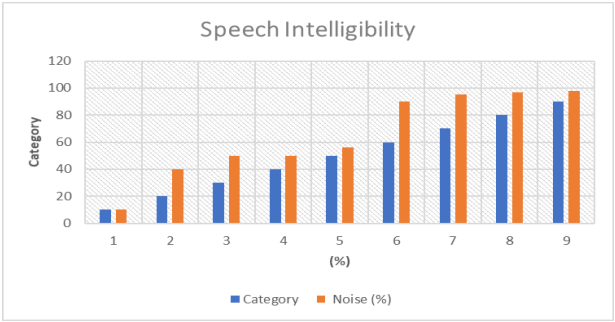


Figure 6. Graph speech Intelligibility on noise values

Furthermore, sound noise can be observed and predicted by knowing the noise in the sound spectrum, this can be seen in Figure 7 and Figure 8, sound noise forms a spectrum by following the pure sound pattern that is sent, the spectrum becomes an influence that can interfere with forming a sound. can be heard well, this will also be a problem in the sound spectrum which has good clarity and also in the characteristics of an appropriate spectrum.

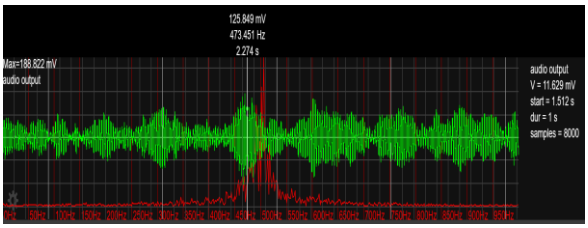


Figure 7. Spectrum Noise follows the pure sound pattern that is transmitted

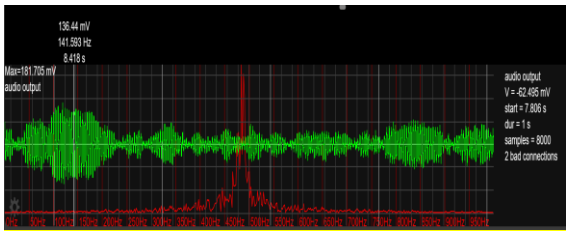


Figure 8. Spectrum Noise follows the pattern of pure sound transmitted at low values

Then the band pass filter is obtained by cascading the low pass and high pass filters. Second order filter because it contains two reactive elements. The order of the filters depends on the number of cascading circuits used in the circuit. The output signal gain is always smaller than the input signal. In the middle frequency the output signal is in one phase, but the output is below the middle frequency the signal is in phase with a phase shift of +90° and above the middle frequency the output signal will

be out of phase with a phase shift of -90°. This was implemented on the noise spectrum after filtering, resulting in results like Figure 9.

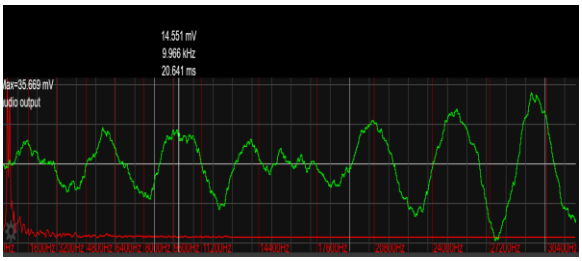


Figure 9. Spectrum noise after filter

Then, in closed rooms such as auditoriums, noise is generated by mechanical or electrical equipment such as air conditioners, fans, etc. The reduction in noise can be seen in Table 3.

Table 3. The reduction in noise

Category	(Noise %)	Results
10	10 – 40	low
20	40 – 42	low
30	40 – 44	low
40	42 – 45	medium
50	40 – 45	medium
60	40 - 45	high
70	45 - 48	high
80	47 – 48	high
90	48 – 50	high

Soundproof materials are generally used to prevent sound interference from one room to another. In the illustration in Figure 9, the sound source comes towards the insulating material, then is isolated with insulating material, and some of it is reflected, causing the sound to leak or move from inside the room or vice versa to be minimized. After filtering the spectrum noise after the filter, the sound condition is original and does not cause noise as in Figure 10 and the resulting waveform is shown in Figure 11.

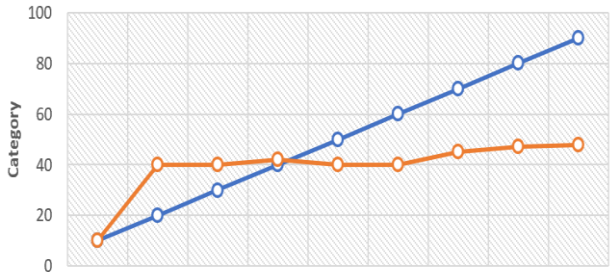


Figure 10. Line spectrum noise after filter

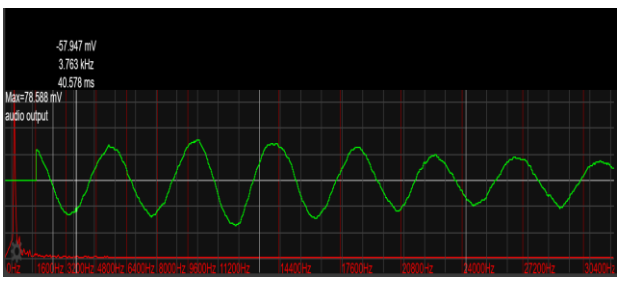


Figure 11. Spectrum noise after filter

4. Conclusion

In the formation of sound produced by the object sound waves will be distorted by the surrounding sound, this must be reduced to obtain sound without distortion. In this study, the result to reduce noise was by reducing noise produced by filters reduced by 60 percent. The filter is used to reduce sound noise using a Passive Band Pass. The waveform is still the original spectrum at 0 Hz – 120 Hz, original sound conditions and does not cause noise, but noise occurs and is filtered Category (Noise %) 10 – 40 low - 98 – 99 high. ambient noise can be reduced with the Passive Band Pass filter and the noise is reduced by 60 percent and the sound output is clearly 99 percent clearly audible.

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References

[1] B. Crockett, L. R. Cortes, and J. Azana, "Passive Amplification and Noise Mitigation of Optical Signals Through Talbot Processing," *J. Light. Technol.*, vol. 41, no. 3, 2023.

[2] C. H. Quan, Z. J. Wang, J. C. Lee, E. S. Kim, and N. Y. Kim, "A highly selective and compact bandpass filter with a circular spiral inductor and an embedded capacitor structure using an integrated passive device technology on a GaAs substrate," *Electron.*, vol. 8, no. 1, 2019.

[3] Y. Nie, Y. Zhang, and P. B. Nelson, "Auditory stream segregation using bandpass noises: Evidence from event-related potentials," *Front. Neurosci.*, vol. 8, no. SEP, 2014.

[4] H. Shao, P. I. Mak, G. Qi, and R. P. Martins, "A 266-μW Bluetooth Low-Energy (BLE) Receiver Featuring an N-Path Passive Balun-LNA and a Pipeline Down-Mixing BB-Extraction Scheme Achieving 77-dB SFDR and -3-dBm OOB-B-1 dB," *IEEE J. Solid-State Circuits*, vol. 57, no. 12, 2022.

[5] Z. Agorastou, A. Michailidis, A. Lemonou, R. Themeli, T. Noulis, and S. Siskos, "Integrated Filter Design for Analog Field Mill Sensor Interface," *Sensors*, vol. 23, no. 7, 2023.

[6] P. Song and H. Hashemi, "Mm-Wave Mixer-First Receiver with Selective Passive Wideband Low-Pass Filtering," *IEEE J. Solid-State Circuits*, vol. 56, no. 5, 2021.

[7] L. K. Yeung, X. Zou, and Y. Wang, "Parametrically enhanced bandpass filters," *IET Microwaves, Antennas Propag.*, vol. 15, no. 2, 2021.

[8] J. Kim, Y. Oh, and H. Chae, "An intermediate frequency reconfigurable bandpass noise-shaping SAR ADC for IoT and mobile application," *Electron. Lett.*, vol. 59, no. 18, 2023.

[9] S. W. Park and E. Sánchez-Sinencio, "RF oscillator based on a passive RC bandpass filter," *IEEE J. Solid-State Circuits*, vol. 44, no. 11, 2009.

[10] G. F. Zhao, J. Ying, L. Wu, and Z. H. Feng, "Eddy current displacement sensor with ultrahigh resolution obtained through the noise suppression of excitation voltage," *Sensors Actuators, A Phys.*, vol. 299, 2019.

[11] T. Tapen, Z. Boynton, H. Yuksel, A. Apsel, and A. Molnar, "The Impact of LO Phase Noise in N-Path Filters," *IEEE Trans. Circuits Syst. I Regul. Pap.*, vol. 65, no. 5, 2018.

[12] S. G. Chang, B. Yu, and M. Vetterli, "Adaptive wavelet thresholding for image denoising and compression," *IEEE Trans. Image Process.*, vol. 9, no. 9, 2000.

[13] S. Mitrović, "A note concerning a theorem of Cramér," *Proc. Am. Math. Soc.*, 121(2), 1994.

[14] R. F. Dwyer, "Detection Of Non-Gaussian Signals By Frequency Domain Kurtosis Estimation.," in *ICASSP, IEEE International Conference on Acoustics, Speech and Signal Processing - Proceedings*, 1983, vol. 2.

[15] H. Liu, Z. Zhang, S. Liu, T. Liu, and Y. Chang, "Destriping algorithm with L0 sparsity prior for remote sensing images," in *Proceedings - International Conference on Image Processing, ICIP*, 2015, vol. 2015-December.