ANALOG ACTIVE NOISE CONTROL SYSTEM

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Tajuk Projek : **Analogue Active Noise Control System**

Sesi Pengajian :

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ABSTRAK

Analog Active Noise Control System, merupakan projek untuk mengawal bunyi dengan menggunakan teknik pembatalan isyarat. projek ini memerlukan kajian berdasarkan isyarat bunyi yang terhasil daripada persekitaran dan lain-lain sumber. Nilai "Cutt-Off frequencies" yang sesuai perlu ditentukan bagi memastikan sistem ini dapat pembatalan frekuensi yang tidak dikehendaki. Sebagai tambahan litar-litar sampingan seperti litar mini microphone, litar Op-Amplifier, litar pencampur dan litar power amplifier diperlukan bagi mengeluarkan signal frequensi yang terhasil daripada penyerapan bunyi disekeliling. Untuk projek ini, model juga dihasilkan bagi tujuan pengujian sistem ini.

ABSTRACT

Analog Active Noise Control System, this is a project to control the sound by using a signal cancelling technique. This project will require research about the sound signal that produce via environmental and other sources. The suitable value of "Cut-Off frequencies" should be determined to ensure that systems able to filter out unwanted frequencies. In additional ancillary circuits, such as mini-microphone circuit, the circuit op-amplifier circuit, mixer and power amplifier circuits is needed to produce the frequency signal resulting from the absorption of sound around the environment. For this project, the model was also produced for the purpose of testing this system.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Nowadays various technologies have been created to facilitate the conduct of human life. Modern technology now covers a variety of system facilities are very useful to mankind. In the rapid progress now, people will sometimes feel threatened by the sound of noise annoying us.

Most people are preferred with comfortable and peaceful surrounding without any noise. The noise will make it difficult to do the work. Especially those students who wish to studying, the baby wants to sleep and etc.

For this purpose, this system was design to solve the noise problem that was faced for most people. To design this system, various factors need to focus. Especially the type of frequencies must be to known. Upon identifying types of frequencies, the circuit will be constructed. The sensor that should used in this system is sound detector to detect noise investigate into a room. Filter circuit was constructed to filter out the unwanted frequencies that called noise.

1.2 Objective

Before start to build this project, there are some things that need to be considering to achieving the target. The objective of this project is:

a) Identifying the range of frequencies and amplitude level for normal human
b) Identifying the range frequencies and amplitude level for normal environment
c) Build the mini microphone driver circuit as a sensor to detect the sound
d) Build the amplifier circuit to amplified the signal from mini microphone circuit
e) Build the mixer circuit to combine the signal from mini microphone
f) Build the adjustable power amplifier to increase the level signal from mixer circuit
g) Build the low-pass filter to filter the unwanted frequencies signal
h) Decides the position of speaker
i) Decides the position of mini microphone

1.3 Problem Statement

Noise annoyance is a one of common disorder that was faced by all people. It can occur from any environment factors such as vehicle, work on construction site and many more. It may also be disturbing certain people to doing some job. Some work may be problem if the noise level reaches a serious stage.

1.3.1 Sound Recording

Usually those who use jamming studio wanted a good sound quality. Therefore, interference from outside noise will give the bad quality of sound. Most jamming studios still use the old method to absorb the outside noise. Majority the jamming studio still use the egg container for ensure that the outside noise enable to through into the jamming studio.

Figure 1.3.1: Jamming Studio

1.3.2 Shooting Film

In addition, the quality shooting the film must be focused on the many options. It also includes an environment that wants to do the shooting. For situation in noisy environment will affect the quality of a film. Thus, a variety of modern techniques used to achieve the objectives of yielding a film of quality. Noise control system is likely to help the film company to increase quality of films.

Figure 1.3.2: Shooting Film

1.3.3 Driving Problem

This system can also be applied into a vehicle for consumers who want to enjoy a quiet and relaxing ride. Now days is very busy with traffic will make drivers impatient and tired. The noise generated by other vehicles will make us feel uncomfortable. Accordingly, this system was designed to reduce pressure on road users. Users can enjoy the comfort driving while not having the luxury vehicle. By this, road traffic accidents may be reduced.

Figure 1.3.3: Stress Driving

1.4 Scope of Project

The scopes are listed to ensure the project is conducted within its intended boundary. It also to ensure the project is heading in the right direction to achieve its objectives, and is listed as follows. Basically, this project is divided into two main parts:

1.4.1 Literature Review

a) Literature review about the range of frequencies that entering into small room via air or other source
b) Doing the research about the normal frequencies including human
c) Measurement of the sound reflected that propagate into a small rooms
d) Identifying the type of amplifier that suitable to amplified the signal from source signal
e) Doing the research about type of filter to filter the unwanted frequency signal and setting the range of frequency to filter operate
f) Identifying the position of mini microphone and speaker

1.4.2 Circuit Design

a) Design the mini microphone that act as sensor to detect and absorb the frequencies signal for noise, normal frequencies and human voice
b) Design the amplifier circuit to amplified the signal from the mini microphone
c) Design the mixer circuit to combine the signal from amplifier.
d) Design the power amplifier to increase the signal from mixer. The signal was drop from mixer
e) Design the low-pass filter circuit to filter the unwanted frequencies signal. Option of using low-pass filter is that it is suitable for filtering high frequency or low.

CHAPTER II

LITERATURE REVIEW

2.1 Fundamentals of Environmental Sound and Noise

Sound is mechanical energy transmitted by pressure waves through a medium such as air. Noise can be defined as unwanted sound. Sound is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation, and the pressure level or energy content (amplitude). In particular, the sound pressure level has become the most common descriptor used to characterize the loudness of an ambient sound level. Sound pressure level is measured in decibels (dB), with zero dB corresponding roughly to the threshold of human hearing, and 120 to 140 dB corresponding to the threshold of pain. [9]

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency, but rather a broad band of frequencies varying in levels of magnitude (sound power). When all the audible frequencies of a sound are measured, a sound spectrum is plotted consisting of a range of frequency spanning 20 to 20,000 Hz. The sound pressure level, therefore, constitutes the additive force exerted by a sound corresponding to the sound frequency/sound power level spectrum.[9]

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to low and extremely high frequencies instead of the mid-range frequency. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted decibels (dBA).[9]

2.2 Noise Exposure and Community Noise

An individual's noise exposure is a measure of the noise experienced by the individual over a period of time. A noise level is a measure of noise at a given instant in time. However, noise levels rarely persist consistently over a long period of time. Community noise varies continuously over time with respect to the contributing sound sources of the community noise environment. Community noise is primarily the product of many distant noise sources, which constitute a relatively stable background noise exposure, with individual contributors being unidentifiable. Background noise levels change throughout a typical day, but do so gradually, corresponding with the addition and subtraction of distant noise sources and atmospheric conditions. The addition of short duration single event noise sources (e.g., aircraft flyovers, motor vehicles, and sirens) makes community noise constantly variable throughout a day. [9]

These successive additions of sound to the community noise environment vary the community noise level from instant to instant requiring the measurement of noise exposure over a period of time to legitimately characterize a community noise environment and evaluate cumulative noise impacts. This time-varying characteristic of environmental noise is described using statistical noise descriptors. The most frequently used noise descriptors are summarized below: [9]

- **Leq:** The equivalent sound level is used to describe noise over a specified period of time, in terms of a single numerical value. The Leq is the constant sound level which would contain the same acoustic energy as the varying sound level, during the same time period (i.e., the average noise exposure level for the given time period).

- **Lmax:** The instantaneous maximum noise level measured during the measurement period of interest.

- **Ldn:** The energy average of the A-weighted sound levels occurring during a 24 hour period, and which accounts for the greater sensitivity of most people to nighttime noise by weighting noise levels at night ("penalizing" nighttime noises). Noise between 10:00 p.m. and 7:00 a.m. is weighted (penalized) by adding 10 dBA to take into account the greater annoyance of nighttime noises. It should be noted that some jurisdictions also refer to Ldn as DNL.

- **CNEL:** Similar to the Ldn, the Community Noise Equivalent Level adds a 5 dBA "penalty" for the evening hours between 7:00 p.m. and 10:00 p.m. in addition to a 10 dBA penalty between the hours of 10:00 p.m. and 7:00 a.m.

- L#: a statistical description of the sound level that is exceeded over some fraction of a given period of time. For example, the L10 noise level represents the noise level that is exceeded 10 percent of the time.

2.3 Effects of Noise on People

The effects of noise on people can be placed into three categories:

- Subjective effects of annoyance, nuisance, dissatisfaction
- Interference with activities such as speech, sleep, learning
- Physiological effects such as hearing loss or sudden start

Environmental noise typically produces effects in the first two categories. Workers at industrial plants often experience noise in the last category. There is no completely satisfactory way to measure the subjective effects of noise, or the corresponding reactions of annoyance and dissatisfaction. A wide variation exists in the individual thresholds of annoyance, and different tolerances to noise tend to develop based on an individual's past experiences with noise.[4]

Thus, an important way of predicting a human reaction to a new noise environment is the way the new noise compares to the existing noise levels to which one has adapted: called the "ambient noise" level. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged by those hearing it. With regard to increases in A weighted noise level, the following relationships occur:[4]

- Except in carefully controlled laboratory experiments, a change of 1 dBA cannot be perceived;
- Outside of the laboratory, a 3 dBA change is considered a just-perceivable difference when the change in noise is perceived but does not cause a human response;
- A change of at least 5 dBA is required before any noticeable change in human response would be expected.
- 10 dBA changes is subjectively heard as approximately a doubling in loudness, and can cause an adverse response.

These relationships occur in part because of the logarithmic nature of sound and the decibel system. A ruler is a linear scale: it has marks on it corresponding to equal quantities of distance. One way of expressing this is to say that the ratio of successive intervals is equal to one. A logarithmic scale is different in that the ratio of successive intervals is not equal to one. Each interval on a logarithmic scale is some common factor larger than the previous interval. A typical ratio is 10, so that the marks on the scale read: 1, 10, 100, 1,000, 10,000, etc., doubling the variable plotted on the x-axis. The human ear perceives sound in a non-linear fashion; hence the decibel scale was developed. Because the decibel scale is based on logarithms, two noise sources do not combine in a simple additive fashion, rather logarithmically. For example, if two identical noise sources produce noise levels of 50 dBA, the combined sound level would be 53 dBA, not 100 dBA.

2.4 Noise Figure

Noise Figure is important because it allows the comparison of devices on the basis of how much noise the device adds to the signal as it transits from input to output. All other things being equal, devices which add the least noise are preferable.[3]

2.5 Receiver Noise

The ideal limit of a receiving system's sensitivity is determined by the noise present at its input. That is, signals that are below the noise (negative signal-to-noise ratio) are masked by the noise. In practice, however, the receiving system itself generates noise, and it is this noise that limits system sensitivity. A term called Noise Factor (F) is used as a figure of merit to define how closely the ideal is approached. The noise factor for an ideal device would be one; it would add no noise. [8]

Noise Factor is defined by:

$$F = \left[\frac{S_i}{N_i}\right] / \left[\frac{S_o}{N_o}\right]$$

$S_{i/o} = Signal\ power\ in/out$

$N_{i/o} = Noise\ power\ in/out$

Noise Figure (Nf) is the Noise Factor expressed in dB:

$$Nf = 10\log F$$

Noise is a temperature related phenomenon. At absolute zero (-273*C/0K) electron activity stops as does the production of noise. It must know of attempts to reduce noise in receiving systems by cooling the receiving amplifiers. Noise is also related to bandwidth (B). The narrower the bandwidth the less noise. It must be noticed this when switching between modes on a receiver, say from AM/6 KHz B, to SSB/2.4 KHz B to CW/500 Hz B. At each decrease in B the noise drops. Noise power can be expressed as a function of temperature and bandwidth by:

$$P_n = kTB$$

$$where\ k = Boltzman'constnat\ 1.374\ x\ 10^{-23}\frac{joule}{K}$$

T = Absolute temperature, K (Room temp = 290K)

B = Bandwidth, Hz

Notice that noise is directly related to bandwidth. After converting the Pn to dB (10 log Pn) the importance of using the narrowest bandwidth can be easily seen. Reducing the bandwidth by half will gain 3 dB in signal-to-noise. Changing from 2.4 KHz to 1.8 KHz gives a 1.2 dB increase; reducing to 500 Hz produces a whopping 6.8 dB improvement.