MULTI-BAND NOISE GATE PRODUCT PROPOSAL

Alexander C. Nugroho 450039470

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Graduate Program in Audio and Acoustics
Faculty of Architecture, Design and Planning, University of Sydney

ABSTRACT

This final written review will focus on the Multi-Band Noise Gate that is developed as a plug-in for a Digital Audio Workstation (DAW). This report will describe the noise problems that many sound engineers face, the technical specification of this product, the implementation of the developed algorithm and the performance evaluation of the product.

1. INTRODUCTION

Noise gate is a type of Dynamic Range Controller (DRC) that is used to modify the dynamic range of a signal, the same as compressors, limiters, and expanders. Basically, a noise gate is an expander with a very high ratio, attenuating the signal to be as close to silence as possible if the signal drops below a specified threshold.

Noise gates can come in many forms, such as electronic devices to audio software. Most guitarists use noise gate pedals to reduce the amount of hiss that their guitar produces while performing live, while most recording engineers use noise gate plugins to remove unwanted disturbances on their tracks.

Sometimes noise is only present in select frequencies only, and applying a generic noise gate will significantly alter the tone and the quality of the original signal. To accommodate this problem, a Multi-Band Noise Gate software is proposed to allow the user complete control of a noise gate without altering the quality of the signal.

2. PROBLEM DESCRIPTION

Noise in microphones is usually produced by electrical circuits which depend on the sensitivity of the transducers inside them (Ballou, 2008, p. 514). The higher the sensitivity of the transducer, the more sound that it would pick up, which would include unwanted levels of noise as well. This is most evident on drums, where each individual drum microphones will usually pick up sound from other elements of the kit resulting in a "dirty" mix. In electric guitars, noise is generated by the magnetic fields in guitar pickups (another type of transducer) which will be amplified even more the louder it gets. Noise can also be introduced as an effect from other audio processors such as compressors which reduce the dynamic range of a signal, usually amplifying noise from an already weak signal.

The ubiquitous nature of noise means that it can be found nearly anywhere whether in live performances or even studio recordings, in which a noise gate is essential to alleviate this problem. In most live performances, the number of open microphones on stage will introduce severe unwanted noise in the overall mix. Although this problem can be avoided by a more experienced sound engineer, the use of noise gate will automatically eliminate the background noise if set up correctly. A noise gate applied to a drum kit would also ensure each individual drum's microphone only picks up the signal from that drum only.

In recording applications, noise gates are usually used to filter out unwanted background noise. For example, the noise gate can be applied to a recording of a guitar to eliminate the amplifier hiss or bleeding from other instruments. For speech / vocal applications, noise gates can be used to remove breathing sounds, air conditioning hums, or other background noise such as traffic noise which is useful for recording engineers or even video editors having to deal with unwanted noise. Besides eliminating noise, the noise gate can also be

used to alter the sound envelope of the input signal to create a wholly new sound. For example, by changing the attack or release time of the noise gate we can change the timbre of the sound envelope, such as the drums on the song *Intruder* by Peter Gabriel or *In the Air Tonight* by Phil Collins.

Sometimes, noise is only present in several frequencies only, such as the low-frequency hum of guitar amplifiers. Applying noise gate into the whole audio would frequently affect the tonal characteristics of the whole frequency spectrum, affecting the quality of the whole audio. With this product we could address the noise that is present on specific bands of frequency, allowing total control of the tonal quality of the audio. This noise gate also has a bypass capability to allow unmodified signals to pass through without degrading their quality.

3. SPECIFICATION

This product's primary function is a MATLAB based three-way multi-band noise band that accepts audio signal as its input. The input signal is then checked with an `if` function to see whether the audio signal is mono or stereo. If the signal is mono, it would directly split the signal into three frequency bands: low-pass, band-pass, and high-pass, apply the noise gate function to each band, and then summing it up together to create a mono noise gated output. If the signal is stereo, it would differentiate the signal into the left channel and right channel first and then apply the same band-splitting process of the noise gate to create a stereo noise gated output. Figure 1 illustrates the flowchart diagram of the product.
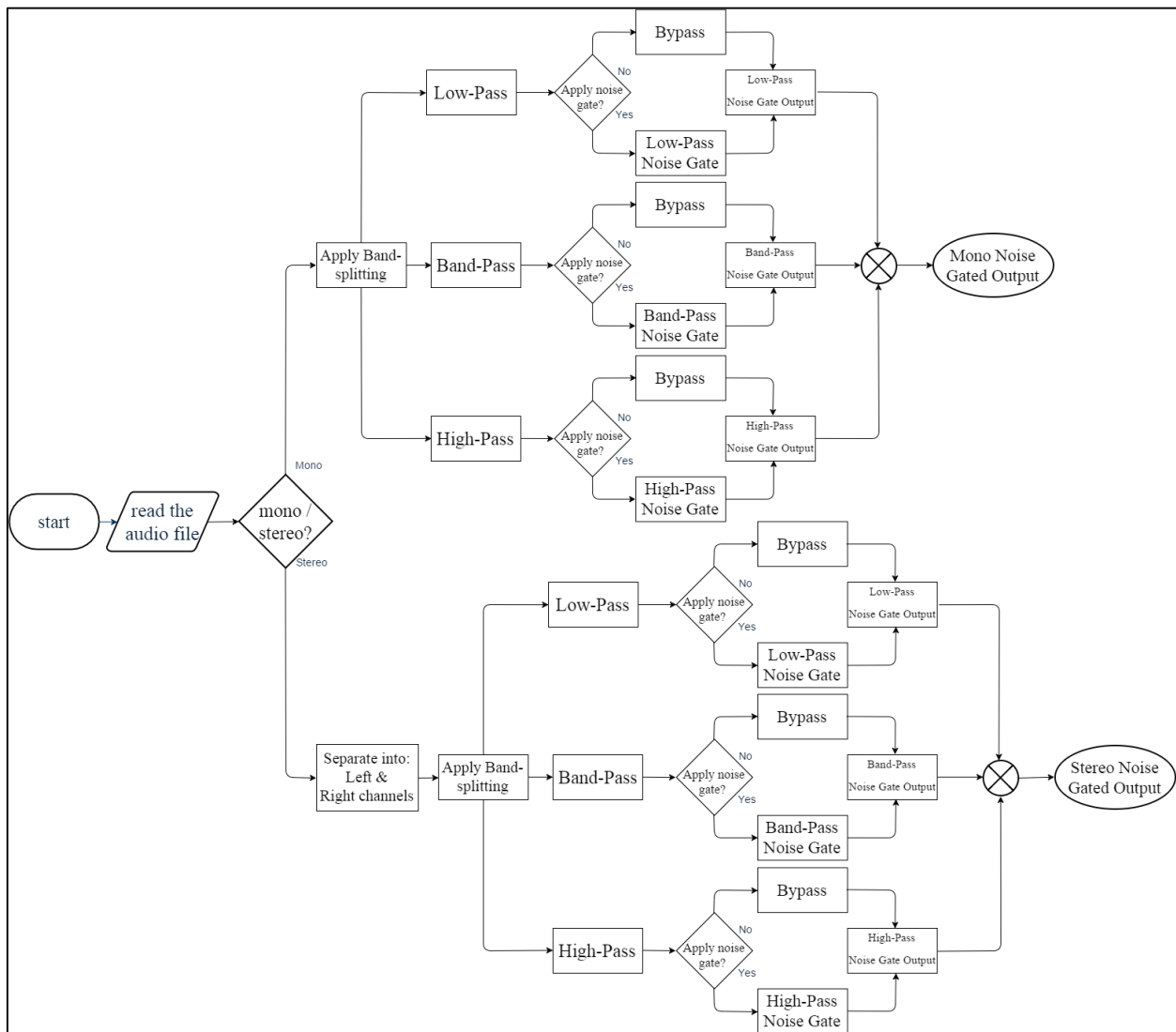

Figure 1. Flowchart Diagram of the Multi-Band Noise Gate

This product is based on several scripts implemented in MATLAB. The first script "mynoisegt.m" is the basis for this product, which contains the actual noise gating process that is used based in the DAFX text (Zolzer, 2011, pp. 113-114) The main script that presided over this product is the "mymultinoisegt.m" script which includes the input parameters of the noise gate as well as generating the final output. Both of these functions are then combined into a script called "Multi-Band Noise Gate.m" which allows simple definition of all variables that are needed for the product.

This product is simple and intuitive to use with a GUI that allows the user to experiment with the different values of the noise gate. It is also proposed to make this product a standalone VST plug-in allowing seamless integration to be used by most DAWs.

4. IMPLEMENTATION

A proposed GUI of the product is illustrated in Figure 2. The GUI will be split into 3 bands, Low-pass, Band-pass, and High-pass, with each band has its own corresponding parameters for the noise gate process. Each band will have its own on/off switch, located right below the name of the frequency band in the GUI. It has an indicator light which will glow green if the noise gate function in that particular band is turned on, and red if it is turned off.

Each band has similar parameters that can be adjusted which are attributed to their specific bands. The only exception is in the Band-Pass frequency, which has a "Lowpass Limit" and a "Highpass Limit." The user can select a frequency limit at which the input's low and high-frequency content will be processed by their corresponding band parameters. This is more commonly known as the cutoff frequency, and it is specified in Hertz. The range for the low pass limit is from 20 Hz – 2 kHz, and 2 kHz – 20kHz for the high pass limit. The user can experiment to adjust the limits of the band to create unique and distinct sound themselves.
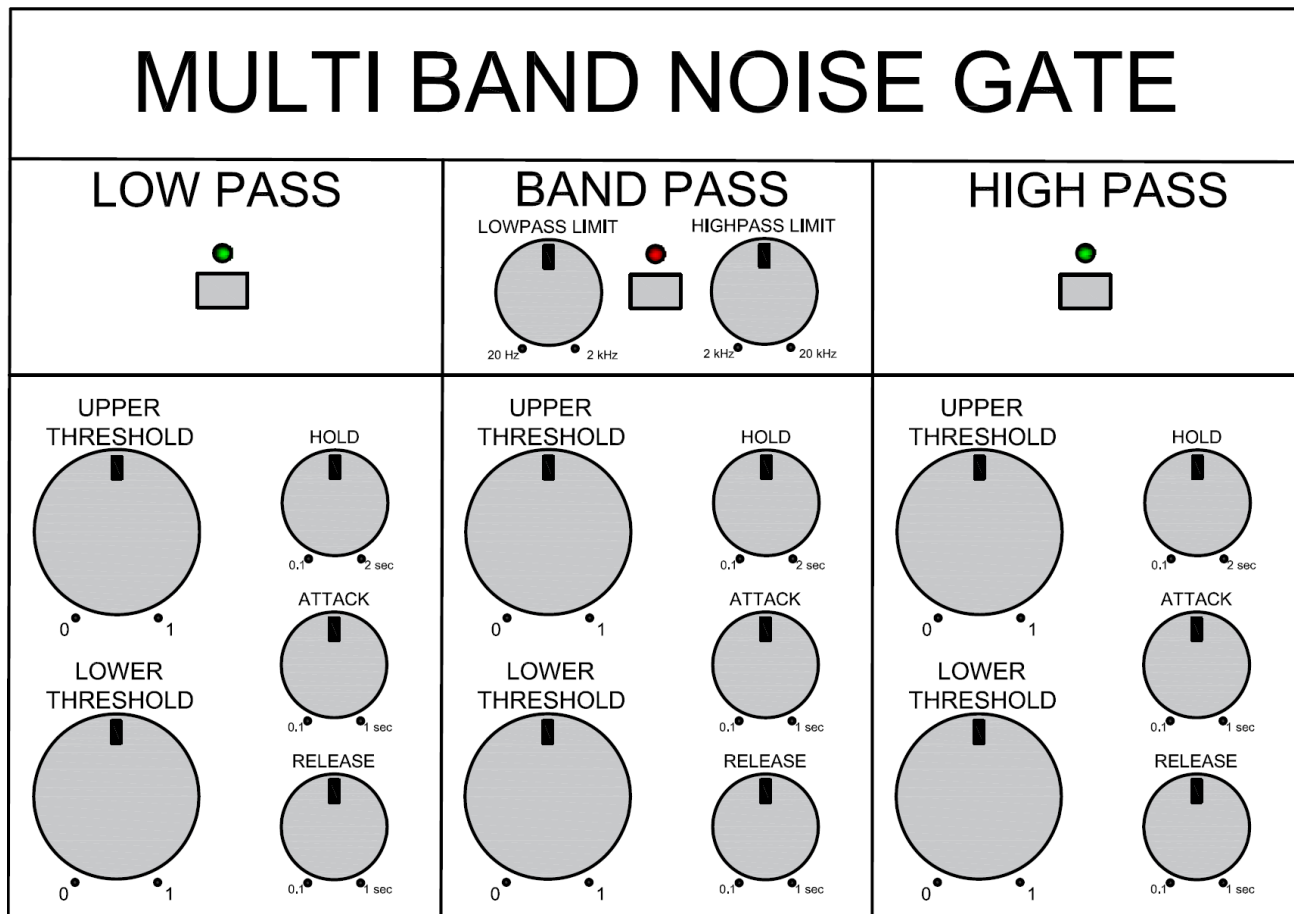

Figure 2. The prototype Graphic User Interface for the Multi-Band Noise Gate

As for the noise gate function in each band, the explanation for each parameter is as follows:

- Upper & Lower Threshold
  The Upper Threshold in each band corresponds to the limit which the sound is passed through, while the Lower Threshold will reject any input signal below this level. These thresholds are applied in this product to avoid the closing and opening of the gate rapidly in succession, which we know as a phenomenon called "chattering". Lower Threshold cannot exceed the Upper Threshold

- Hold Time
  Sets the minimal time that the gate is kept open. This parameter is also used to prevent chattering from the fluctuation of the input signal level.

- Attack Time
  Sets how fast the gate will open after it crosses the upper threshold, which acts as a fade in for the signal.

- Release Time
  Sets how fast the gate will close after it falls below the lower threshold, acting as a fade out for the signal.

5. EVALUATION

A few examples of this product are shown in Figure 3, Figure 4, and Figure 5 in the time domain. It is evident by their waveform representations that the noise has decreased significantly, resulting in a clear and solid sound. The quality of the audio and the improved performance can also be heard in the accompanying files.
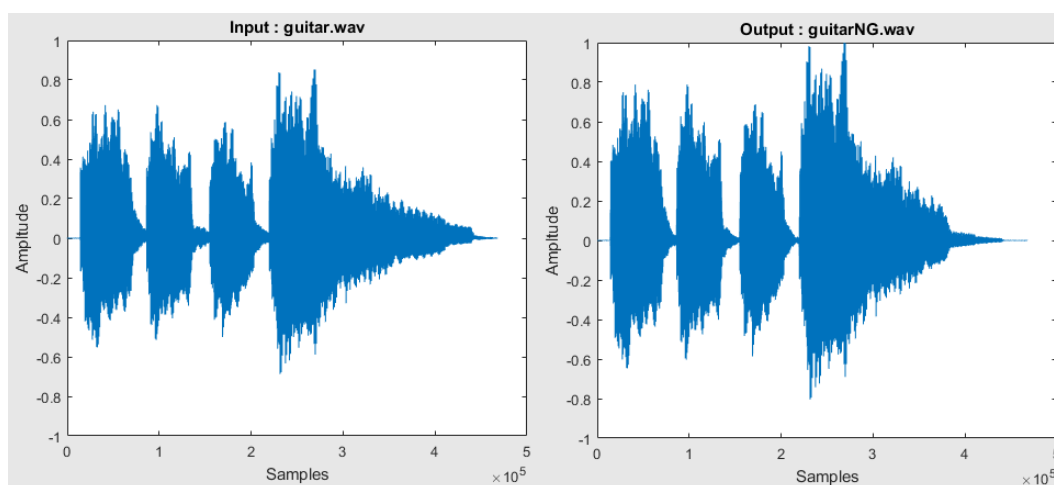

Figure 3. Example of the Multi-Band Noise Gate on 'guitar.wav'

Although a Multi-Band Noise Gate has been successfully developed, there are still rooms for improvement for the product. The underlying MATLAB code in the scripts could be streamlined to provide faster processing speed which improves performance. Also, experimentation with the type of filter that is used for the band-splitting process can also be done to search for better alternatives that don't produce audible acoustic artifacts.

The performance of this product can also be assessed by comparing the noise gating performance of this product with other existing multi-band dynamic processor plugins, such as *Precision Multiband* by Universal Audio or *MMultiBandDynamics* by Melda Productions. One way to the experiment is by performing a subjective listening test to see which plugin does the subject prefer. The test subjects will listen to a sample audio track that has been processed by each product. The subject is told to look for audible artifacts or a change in tone from the audio. The subject will then undergo a forced-choice test to choose which processed audio track that they prefer. If the Multi-Band Noise Gate is preferred more than the other products, we could conclude that this product performed better than the others and are able to compete in the market.

Another way to compare these products is by examining their performance in rigorous laboratory testing. Each product will be compared thoroughly, testing their latency times, system distortions and other parameters as well. But this method could be more costly and time-consuming, which must be considered to choose which method of comparison is worthwhile to invest in.
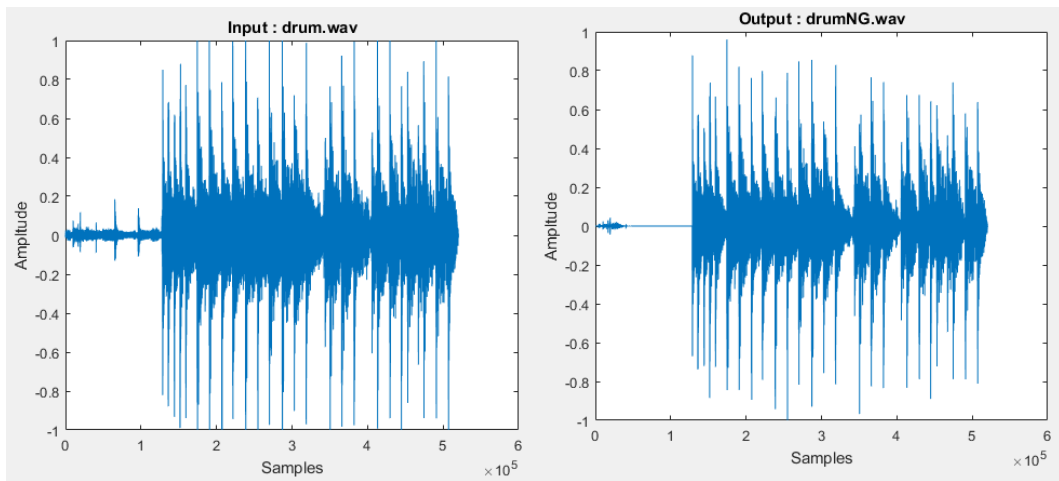

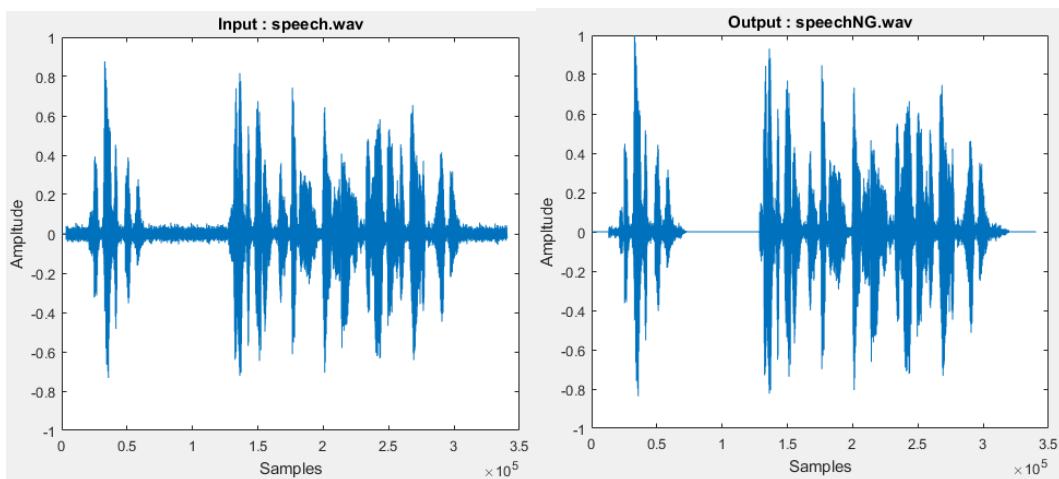Figure 4. Example of the Multi-Band Noise Gate on 'drum.wav'

Figure 5. Example of the Multi-Band Noise Gate on 'speech.wav'

6. CONCLUSION

A prototype of a Multi-Band Noise Gate has been successfully developed. This product is expected to resolve the problems that most sound engineers face regarding noise. An algorithm based on MATLAB was developed to split the audio signals into three frequency bands and process the signal with a noise gating function. A GUI is also proposed to simplify the adjustment of the parameters of the product. A way to test the performance of this product is also defined for further improvement and validation.

Overall, the Multi-Band Noise Gate is a product that is worthy of further development and investing. With some optimization and fine adjustments, the ability for total noise gating ability in select frequencies is a huge selling point and will be useful to sound engineers everywhere in the world.

7. REFERENCES

Ballou, G. M. (2008). *Handbook for Sound Engineers, Fourth Edition.* Burlington, USA: Focal Press.

Zolzer, U. (2011). *DAFX: Digital Audio Effects, Second Edition.* Chichester, UK: John Wiley & Sons.

8. SOUND SOURCES

'guitar.wav' by Julius Smith, Center for Computer Research in Music and Acoustics (CCRMA), Stanford University, California.
Samples provided by : https://ccrma.stanford.edu/~jos/wav/gtr-jaz-2.wav
Accessed on 20th May 2016

'drum.wav' by John Bonham, Led Zeppelin.
Samples provided by : http://www.saladrecords.com/bonhamfiles.htm
Accessed on 23rd May 2016

'speech.wav' by Brad Rakerd, Institute of Library & Museum Services, Washington DC.
Samples provided by : http://ohda.matrix.msu.edu/wp-content/uploads/2012/06/SpeechMild.mp3
Accessed on 29th May 2016.