
# MEASUREMENT OF NOISE IN ULTRASONIC FREQUENCY RANGE IN TRAFFICS AND ENVIRONMENTS

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## Abstract

Various environmental noises have been generated a lot in daily life. Recently, results of many studies on noise have been reported. Research subjects are restricted mainly in audible frequency range noises because of their effect or harm to human being. For this, since noises in ultrasonic range are inaudible, and their existence and the effects are not evident, reports on ultrasonic noise are few. However, it is considered that noises exist in not only audible frequency range but also ultrasonic frequency range.

Many kinds of measurement systems for measurement of noise are marketed. However, measurement systems which can measure noises up to ultrasonic frequency range are few and expensive. Moreover, they are not suitable for the outdoor measurements. In this study, we made and used a measuring system, microphone and peripherals, to measure noises in ultrasonic range. The measuring system we made can be operated with battery and is easy to carry because it is small and simple.

We measured at such places as urban road and expressway with a lot of cars where ultrasound might exist. It was found from the result that noise in ultrasonic frequency range exists in our environment.

Eds.: J. Eberhardsteiner, H.A. Mang, H. Waubke

## INTRODUCTION

Various environmental noises have been generated a lot in daily life. There are many research subjects in audible frequency range noises because of their effect or harm to human being and environmental disruption. [1][2] It also rose to the surface that infrasound and vibration caused from train have a bad influence upon health. For this, since the noise in the ultrasonic range is not audible, attention has not been paid and researches on ultrasonic noise are few. Effects of the noises in ultrasonic range to man cannot be denied, while various useful information is included in the noise [3]. Recently, research that ultrasonic wave gives relaxation effects to man's brain was reported [4]. In this paper, noises in ultrasonic range included in traffics and environment mainly on road noises were measured.

## MEASUREMENT SYSTEM

We constructed our measurement systems which can measure noises in wide frequency range by regarding which frequency the traffic noise exists was uncertain.

Figure 1 shows block diagram of the measurement system. Microphone detects signals generated from noise sources and converts it into electric signals. It is necessary to amplify the signals with amplifiers because they are very small. The amplified signals are converted into the digital signals of 8bit with the data acquisition unit (PC card type high speed data acquisition system NR-350 made by Keyence Co.). By handheld PC, waveform is observed and stored. The analyzing power of this system is not necessarily high because the resolving power is only 8bit. However, measurable frequency range is wide and 10MHz. Signal analysis such as FFT is executed by using Mega View (Keyence Co.) etc..

The microphone is important in this system. Various microphones of audible frequency range including standard microphones are marketed. Unfortunately, ultrasonic range microphones on the market are very few. Another condition necessary to the microphone in this study is that use in outdoor is easy.

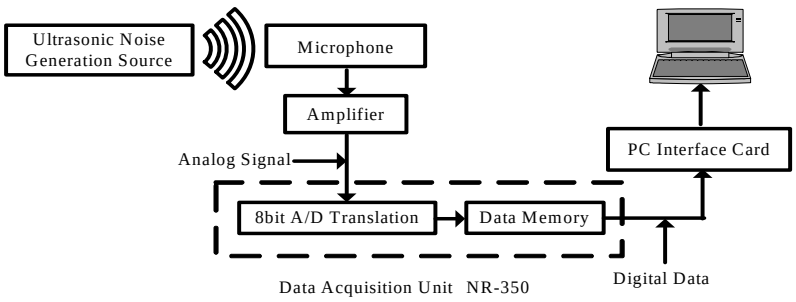


*Figure 1 – Schematic diagram of measurement system*

It is desired that carrying and supplying power are easy for measuring apparatus in outdoor. Microphones marketed that can measure in ultrasonic range are limited to such standard microphones as made by Brüel & Kjær. Moreover, these microphones are inappropriate for such measurements in harsh condition in this study. Then, we designed and made a microphone as shown in Fig.2.

It is important that microphone is wide-band because measurements are in ultrasonic range. We thought that to obtain overall data is important than to obtain precise data in this study. Therefore, PVDF (Polyvinylidene Fluoride) film was used as a receiving element because its frequency characteristic is smooth and wide-band.

Since PVDF film was used as receiving element, the microphone has wide frequency range though low sensitivity. Consequently, this low sensitivity was compensated with high gain amplifier. Sensitivity and frequency characteristics were calibrated with a microphone manufactured by Brüel & Kjær [5]. As a result, the system which is measurable up to about 200kHz was constructed.

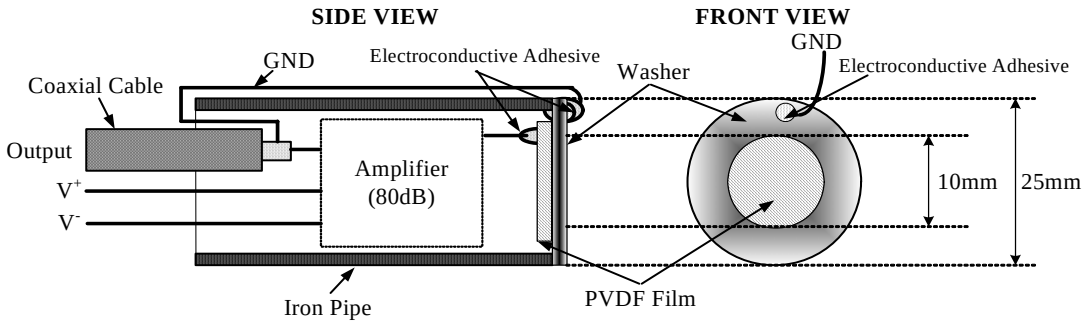


*Figure 2 – Structure of PVDF microphone*

## MEASURED RESULTS

By using the measurement system, noises in ultrasonic range such as urban road noise, expressway and Shinkansen railway were measured. As a result, it was found that noises in ultrasonic range were generated in roads in heavy traffics and expressways. In these measurements, microphone of Brüel & Kjær was properly used together with our microphone for the data reliability. Examples of obtained data are shown in Fig.3 to Fig5. Figure 3 is a data when vehicles are few. This figure is a result of FFT analysis. Figure 4 is a data when lots of vehicles are passed in the same place. These data were obtained at about 1m from roadway. As shown, noises in Fig.4 are increased compared with those in Fig.3. Further, humps in around 45kHz and 55kHz are the noises from a motorcycle just passed. Since these noises from motorcycles were seen in general, we measured the noise from motorcycles themselves. Figure 5 shows an example. As shown, characteristic noises are also seen in this figure. This data was measured at 20cm from the muffler.

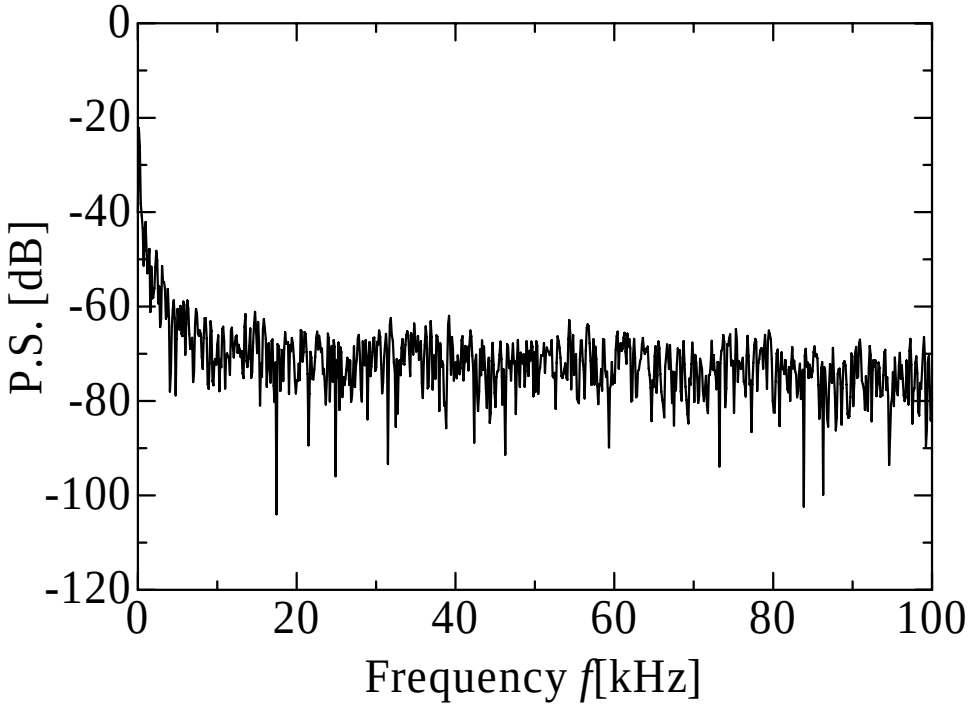


*Figure 3 – Road noise* (*vehicles are few*)

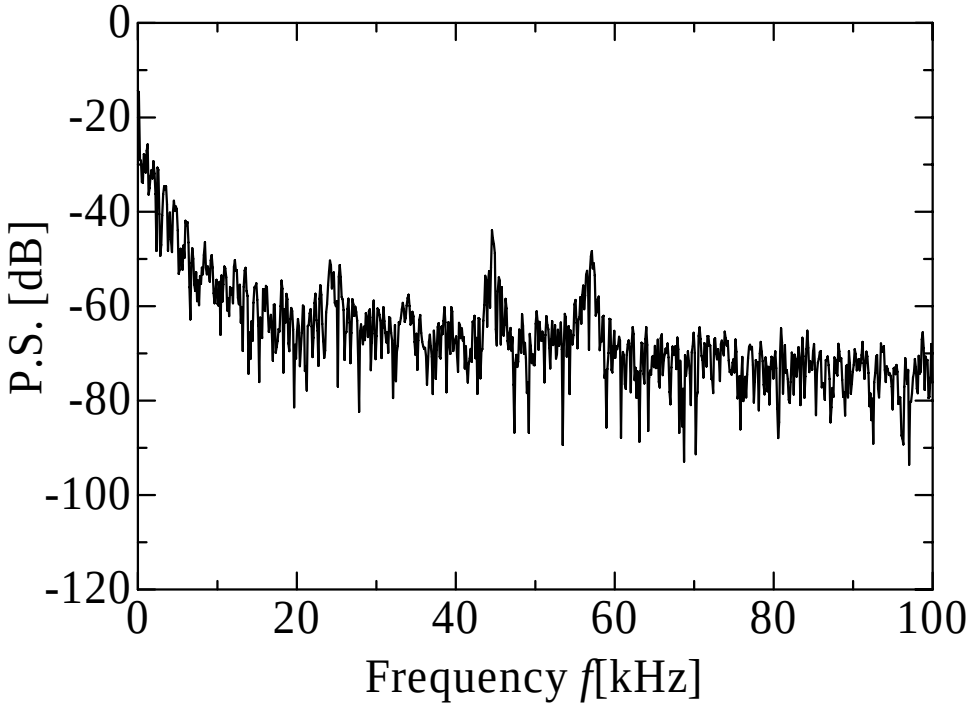


*Figure 4 – Road noise* (*lots of vehicles*)

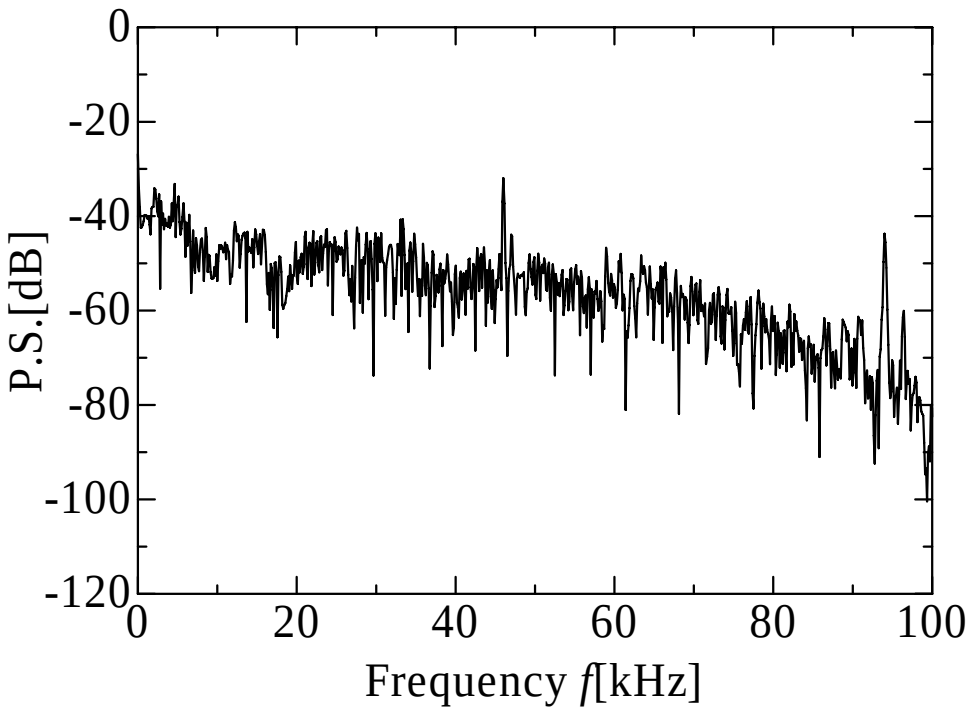


*Figure 5 – Noise from a motorcycle*

## CONCLUSIONS

We measured noises in ultrasonic range contained mainly in traffic noises which are representative environmental noises. For this purpose, we made a measurement system. As a result, ultrasonic range noises are contained in traffic noises. Especially, it was found that motorcycle generates characteristic noises in ultrasonic range. In this study, measurements were made in terms of the existence of ultrasonic noises. Hereafter, by improving the measurement system quantitative measurement and analysis will be made.

## ACKNOWLEDGEMENTS

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