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Object Identification Based on Analysis of Broadband Acoustic Signals Using Multiple Frequency Air Ultrasonic Transducers

マルチ空中超音波トランスデューサを用いた広帯域音響特性解析に基づく物体識別

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1. Introduction

In recent years, many types of air ultrasonic transducers have become readily available, and the engineering applications of ultrasonic waves are being actively studied[1-5]. The author's group has been developing acoustic sensing and object identification using acoustic characteristics including inaudible sound[6-7].

Previously, we have performed the robust classification system using high resolution acoustic measurement and machine learning. That study shows that high affinity between broadband acoustic measurement and machine learning.

In this study, we created a transmitting and receiving system using multi-frequency ultrasonic transducers and conducted experiments to obtain basic data using broadband acoustic signals for analysis in machine learning.

2. Measurement Method

Fig. 1 shows the prototype of transmitting and receiving system using the multiple frequency air ultrasonic transducers used in this experiment.

This prototype system utilizes four transducers, two each of UR1612MPR and 250SR160. Table.1 shows the devices of system.

The chirp signal from 10 kHz to 70 kHz was used as a sound source. Fig. 2 shows the frequency-amplitude characteristics when driven by the chirp signal. The red, blue, and black lines are the results of driving the 250SR160, UR1612MPR, and all the transducers, respectively. The combination of the two types of transducers made it possible to obtain a broadband incident signal.

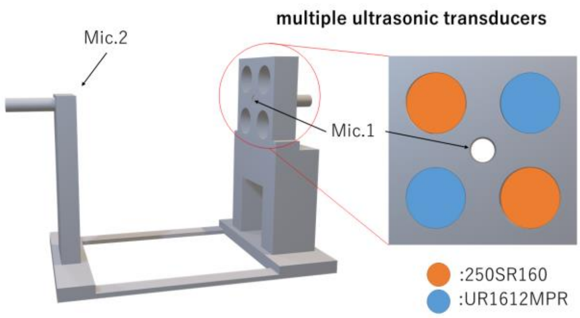

Fig. 1 prototype of transmitting and receiving system using the multiple frequency air ultrasonic transducers

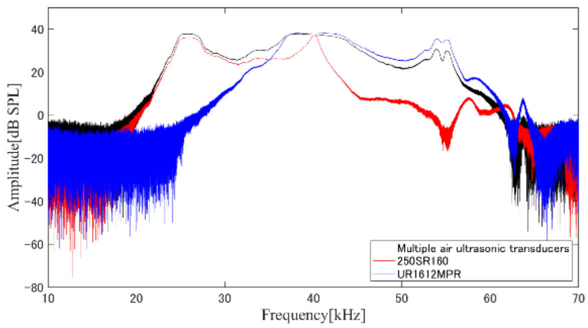

Fig. 2 frequency-amplitude characteristics for transducers

3. Experimental results

A target is inserted between the microphone and the transducer in the system shown in Fig. 1. The signal is transmitted while the target is inserted. Fig. 3 shows the frequency-amplitude characteristics when a Teflon sheet is installed. In this figure, the result with no target object is also depicted.

	DEVICES	SPEC
MICROPHONE	**1/4" free-field microphone Type4939 (Brüel & Kjær)**	**Freq. range 4Hz~100kHz**
MICROPHONE CONDITIONER	**Type2690 NEXUS (Brüel & Kjær)**	**Freq. range 0.1Hz~100kHz**
ULTRASONIC TRANSDUCER	**UR1612MPR (SPL)** **250SR160 (Prowave)**	**Oscillation freq. 40kHz±1kHz** **Oscillation freq. 25kHz±1kHz**
A/D CONVERTER	**Measurement System：ADI-2 Pro (RME)** **Generating System：Babyface Pro (RME)**	**PCM 768kHz/32bit** **PCM 192kHz/24bit**

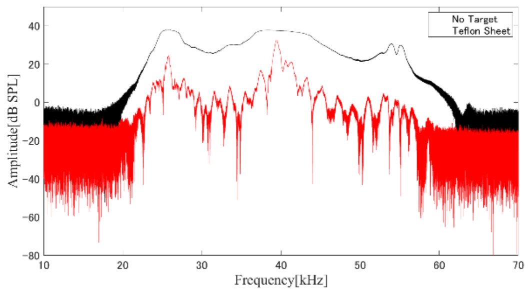

Fig. 3 Frequency-amplitude Characteristic of a Teflon sheet.

It is found that the amplitude received is reduced by the Teflon sheet. It can be said that the Teflon sheet has a high sound insulation property in this frequency range. The Teflon sheet would have better sound insulation performance in this frequency range.

Next, we investigate the effect of moisture content for frequency-amplitude characteristics. Fig. 4 shows the frequency-amplitude response, in which a fine-meshed cotton cloth moistened is used as a target. In this figure, the result for dry object is also depicted. Fig. 4 shows that the amplitude decreases slightly in the higher frequency range due to the effect of moistened.

Fig. 5 shows the frequency-amplitude response, in which a fine-meshed polyethylene cloth moistened is used as a target. In this figure, the result for dry object is also depicted. Fig. 5 shows that large decrease is caused in amplitude in the higher frequency range due to the effect of moistened.

Fig. 6 shows the frequency-amplitude response, in which a coarse-meshed polyethylene cloth moistened is used as a target. In this case, the moistened effect is smaller.

6. Conclusion

In this study, we fabricated a transmitting and receiving system using multi-frequency ultrasonic transducers and conducted experiments to obtain basic data.

In addition, the acoustic characteristics of Teflon material and cotton and polyethylene were measured and analyzed using multi-frequency ultrasonic transducers system. Moreover, it was found that the cloth material had characteristic sound transmission characteristics by controlling the water content.

This system was clarified to be promising for broadband active measurement for machine learning analysis.

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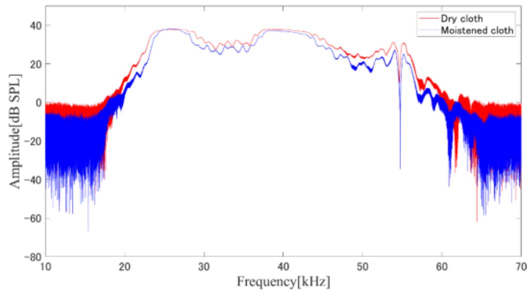

Fig. 4 Frequency-amplitude Characteristic of a fine-meshed cotton cloth.

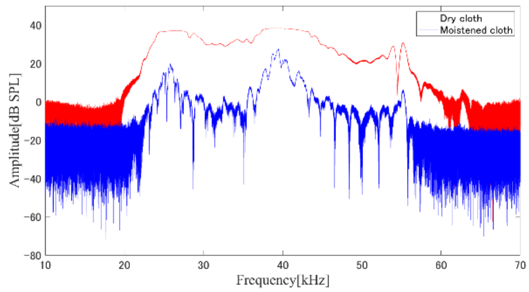

Fig. 5 Frequency-amplitude Characteristic of a fine-meshed polyethylene cloth.

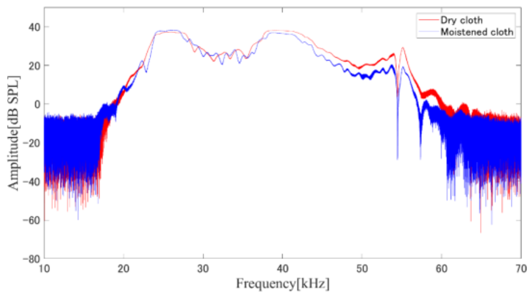

Fig. 6 Frequency-amplitude Characteristic of a coarse-meshed polyethylene cloth.

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