Low frequency detection experiment by microphone array for infrasound measurement

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1.Abstract: Human audible frequency is between 20 Hz and 20 kHz. Low frequency sound waves of 20 Hz or less are called infrasound, which are caused by large-scale natural phenomena such as volcanic eruption, tsunami, meteorite entry into the atmosphere, and artificial explosions such as rocket launches. In a region of low frequency,there is low attenuation due to the small viscosity of air and has characteristics of long-distance propagation, so it is focused as remote sensing technology.
At Kochi University of Technology Yamamoto Laboratory, low-cost infra sound sensors using piezo and PSD devices have been developed. However, since these sensors have a container with a membrane having a certain volume and the expansion and shrinkage of the membrane surface due to small atmospheric pressure fluctuation is detected, there is a problem of performance changing due to deterioration of the film surface. Therefore, we propose to detect the infrasonic waves by a combination of condenser microphones without using film surface, and here, we are conducting experiments.

2.Experiment: Although it is difficult to detect low frequencies such as infrasound with only one condenser microphone, low frequency sensitivity is improved by arranging multiple microphones in an array. In the present experiment, a few types microphone arrays using 16 condenser microphones each was prepared and evaluation experiments used them were carried out. Each microphone element can be placed on a 2 mm thick styrene board and the arrangement can be freely changed by using the round pin socket as a connector to each microphone. Arduino UNO was used as an A/D converter (sampling frequency: 40 Hz).
We conducted an experiment of low frequency detection using a vacuum chamber and a syringe pump in our laboratory. The vacuum chamber was used only as a rigid volume container and infrasound was generated in a pseudo manner by slightly varying the pressure inside the chamber only with the push and pull of small volume air by the connected syringe pump. The syringe pump can input a fixed volume to be injected in 1 minute, so that the frequency to be generated can be determined. In this experiment, the experiment was conducted by changing the frequency at 0.1 Hz, 0.05 Hz, and 0.01 Hz.
We also conducted experiments to confirm the sound receiving performance of audible sound of the microphone array produced. We fixed the distance from the speaker to the microphone in a quiet room as 1, 2, 3, and 5 m, and confirmed the attenuation of sound waves. Experiments were conducted without anti-aliasing filter while sequentially changing the frequency at 200, 150, 100, 75, 50, 40, 30, 20, and 10 Hz at each distance.

3.Results: The shape of the microphone array used in this experiment was a circle with a diameter of about 9 cm placed on a 10 cm square styrene board and a circle with a diameter of about 19 cm arranged in a 20 cm square styrene board, and another curved shape arranged in a 20 cm square that 3 microphone rows are extended while curving at 120° intervals from the center. In the chamber experiment of infrasound, low frequency detection of 0.01 Hz was succeeded only in the microphone array of the curved shape.
In the room experiment of audible sound measurement, the attenuation of the sound wave by the distance was seen, and the attenuation due to the array shape was also observed. Everything from 1 to 3 m attenuated in the same way, with a difference in attenuation at 5 m. The attenuation was large in the

order of a circle with a diameter of 9 cm, a circle with a diameter of 19 cm, and a curve shape in that order. Moreover, since it was largely attenuated from 200 Hz to 20 Hz, it seems to be the effect of cutting the high frequency by the shape of the array arrangement. Especially, the effect in the curve shape was large.

4.Conclusions: Infrasound can be detected by arraying multiple condenser microphones through several experiments and it was confirmed that the performance could be determined by devising the shape of the array arrangement. In the future experiments, we plan to verify the effects on sonic waves from the obligue direction with respect to the microphone array, resolve the noise aflection, and improve the circuits.

Keywords: Infrasound, Microphone array

