Development of an Evaluation System for the Body Conduction Sound Sensor

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Abstract

A system using NAM (non-audible murmur) microphones was also reported. NAM microphone was developed to detect a very weak speech sound. We made a body conduction sound sensor based on NAM microphone. It is applicable to measure a sound of heart, breath and a variety of sounds in the body. Easy handling supports the superiority of the sensor. In this study, we made an evaluation system for the body conduction sound sensor. It is an inexpensive. We evaluated some sensors using the system. We made of body conduction sound sensor and evaluation speaker. The body conduction sound sensor are made using electret condenser microphone. We pass a signal from the PC to the speaker, and then detected by the sensor. We perform the measurement with 2 channel and A/D conversion about the signal flow in speaker and the signal detected by the sensor. We derive the frequency characteristic from the measured 2 channel signal.

Keywords: body conduction sound

1. Introduction

Solitary death of elderly people is recognized as social problem in Japan. It is difficult to substantiate a system which monitor them using camera because of lack of privacy. There is a real need for a new monitoring system that conscious of privacy.

Some researchers reported a system to find unusual sounds of the heart, and an analysis method was reported that finds an abnormal cardiac sound measured by the wireless electronic stethoscope⁽¹⁻³⁾. Body conduction sounds are used to find an abnormality in body in medicine field. A sound that produced and propagated inside of the body is measured by a body conduction sound sensor that is put on the body

surface.

A system using NAM (non-audible murmur) microphones was also reported⁽⁴⁾. NAM microphone was developed to detect a very weak speech sound. NAM microphone can be produced more cheaply than the electronic stethoscope, and has an advantage in commercialization. We made a body conduction sound sensor based on NAM microphone⁽⁵⁻⁷⁾. It is applicable to measure a sound of heart, breath and a variety of sounds in the body. Easy handling supports the superiority of the sensor.

The frequency characterization of the body conduction sound sensor have been reported by a evaluation method using a vibration exciter⁽⁸⁾. A evaluation method with the sensor attached human is poorly-reproducible. But a vibration exciter is very expensive, it has been demanded for a system that provides a low cost evaluation.

In this study, we made an evaluation system for the body conduction sound sensor. It is an inexpensive. We evaluated some sensors using the system. It is expected that a system contributes progress in a development of the body conduction sound sensor.

2. Measurement System

2.1 The Body Conduction Sound Sensor

The body conduction sound sensor is made by use of an improved small electret condenser microphone (Primo Co., EM189T). The microphone whose case is drilled a hole in and diaphragm is exposed is used. Figure 1 shows the container of the sensor that is made using polycarbonate as a material. Figure 2 is a picture of the sensor. The microphone is fixed in the center of the container, filled up with polyurethane resin. Then it can detect sounds inside of the body. Width, thickness, the thickness of the gel-filled portion is fabricated using four different types of polycarbonate case.

Table 1 shows the shape of the case.

2.2 The Evaluation Speaker

By the measurement of the body conduction sound by the real human body, it is difficult to get the same waveform every time, and plasticity is low. Therefore, we make the evaluation speaker for the evaluation of the body conduction sound sensor. Figure 3 shows the structure of the evaluation speaker. The speaker(Tokyo Cone Paper Mfg Co.,Ltd. F77G98-6) is placed in a central portion of the glass container, filled up with polyurethane resin. Figure 4 is a picture of the speaker.

Fig. 1. Structure of the container of the sensor.

Fig. 2. The body conduction sound sensor

Table. 1. The shape of the polycarbonate case

	Width / mm	Thickness / mm	Thickness of gel / mm
A	20	5	1
B	20	7	3
C	10	5	1
D	10	7	3

Fig. 3. Structure of the evaluation speaker

Fig. 4. The evaluation speaker

2.3 Evaluation System

Figure 5 shows a schematic view of the experimental. The evaluation speaker and the body conduction sound sensor are placed in soundproof room in consideration of the ambient noise. As measuring method, to output a sine wave signal from the PC and to amplify the signal by the amplifier flows in the evaluation speaker. The body conduction sensor put on the evaluation speaker, then detecting the sound reproduced from the evaluation speaker. We perform the measurement with 2 channel and A/D conversion about the signal after passing through the amplifier and the signal detected by a body conduction sound sensor.

Fig. 5. Schematic view of the experimental

3. Experiment

We derive the frequency characteristic from the measured 2 channel signal. Frequency to be output from the PC from 100Hz to 5,000Hz, sampling frequency is 20,000Hz.

Figure 6 and 7 are the results of the experiment. The amplitude characteristic was confirmed to be attenuated as frequency becomes higher. Phase characteristic was confirmed that the as the frequency becomes higher

Fig. 6. Amplitude characteristic

Fig. 7. Phase characteristic

4. Conclusions

In this paper, we made of body conduction sound sensor and evaluation speaker. We built an evaluation system to evaluate the body conduction sound sensor and measured. We pass a signal from the PC to the speaker, and then detected by the sensor. We perform the measurement with 2 channel and A/D conversion about the signal flow in speaker and the signal detected by the sensor. We derive the frequency characteristic from the measured 2 channel signal.

The results of the experiment, the amplitude characteristic was confirmed to be attenuated as frequency becomes higher. Phase characteristic was confirmed that the phase is delayed as the frequency becomes higher. We established a system that can evaluate the body conduction sound sensor

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