Noise reduction through active noise control using stereophonic sound for increasing quite zone

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ABSTRACT

The low frequency impact noise generated during machine operation is difficult to control by conventional active noise control. The Active Noise Control (ANC) is a destructive interference technic of noise source and control sound by generating anti-phase control sound. Its efficiency is limited to small space near the error microphones. At different locations, the noise level may increase due to control sounds. In this study, the ANC method using stereophonic sound was investigated to reduce interior low frequency noise and increase the quite zone. The Distance Based Amplitude Panning (DBAP) algorithm based on the distance between the virtual sound source and the speaker was used to create a virtual sound source by adjusting the volume proportions of multi speakers respectively. The 3-Dimensional sound ANC system was able to change the position of virtual control source using DBAP algorithm. The quiet zone was formed using fixed multi speaker system for various locations of noise sources.

Keywords: Active noise control, stereophonic sound
I-INCE Classification of Subjects Number(s): 38.2

1. INTRODUCTION

The noise reduction is a main issue according to improvement of living condition. There are passive and active control methods for noise reduction. The passive noise control uses sound absorption material which has efficiency about high frequency. The Active Noise Control (ANC) which is the method for generating anti phase control sound is able to reduce low frequency. In this study, the stereophonic sound was applied to ANC for increasing the quite zone. The virtual control sound was generated using fixed speakers, and the stereophonic sound ANC experiment has verified the efficiency.

2. Active noise control using a stereophonic sound

2.1 DBAP algorithm

The Distance Based Amplitude Panning (DBAP) algorithm is based on a distance between a virtual sound source and a speaker. The virtual sound source is generated at the desired position through calculated amplitude of each speakers. Figure.1 shows the method of the virtual sound source generation. The distance from the virtual source to the speakers D_n is calculated as

$$D_n = \sqrt{(X_{Sn} - X_B)^2 + (Y_{Sn} - Y_B)^2} \quad (1)$$

where X_{Sn}, Y_{Sn} are the positions of the each speakers and X_B, Y_B are the positions of the virtual sound source.

The ratio of the distance to the minimum distance g_n is calculated as

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$$g_n = \frac{H}{D_n} \quad (2)$$

where H is the minimum value of the D_n.

The amplitude of each speaker is calculated according to Eq.(3).

$$\sqrt{\sum_{n=1}^{N} g_n^{\ 2}} = 1 \quad (3)$$

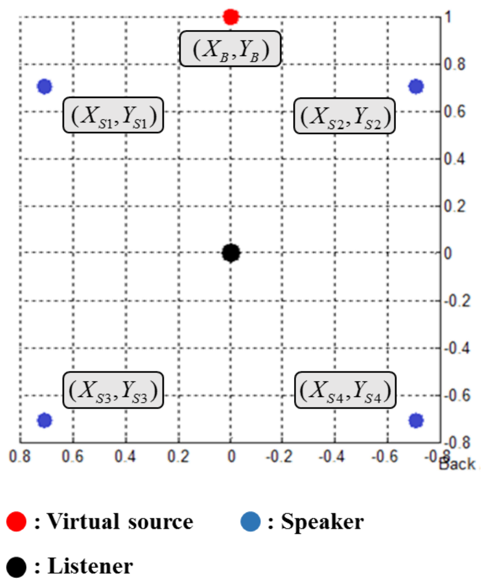

Figure 1 – The position of a virtual source, fixed speakers and listener

2.2 FxLMS algorithm

The FxLMS algorithm for ANC was used to generating anti phase control sound. The algorithm has the advantage of simplicity in the adaptation of the filter coefficients. The noise was reduced by the control sound which minimize the power of the error signal.

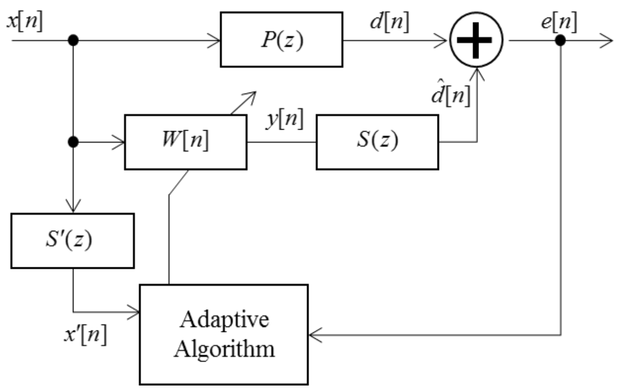

Figure 2 – The block diagram of the FxLMS algorithm

2.3 Experimental setup

Figure. 2 shows the experimental setup for ANC using stereophonic sound. The reference microphone was set in front of the noise source, and the error microphone was set at the listener position. The noise source has 1m distance, 15 and 30 degree angle from the listener. The amplitude was adjusted according to the position of the noise source.

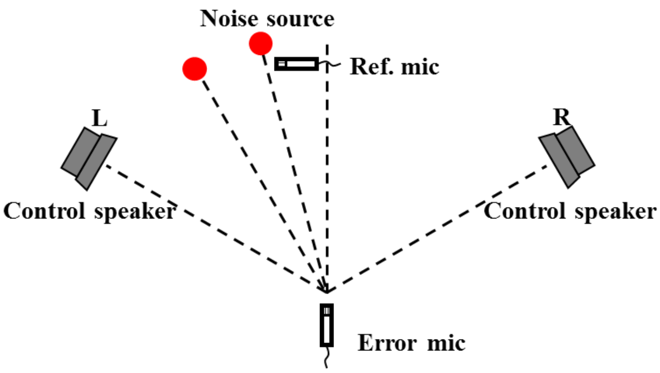

Figure 3 – Experimental setup for ANC using stereophonic sound

2.4 Results

The noise source was used 150 and 230 Hz dual sine. Figure. 3 shows the sound pressure level at the error microphone when ANC was operating. The noise was reduced more than 20dB at the main frequency using ANC with stereophonic sound.

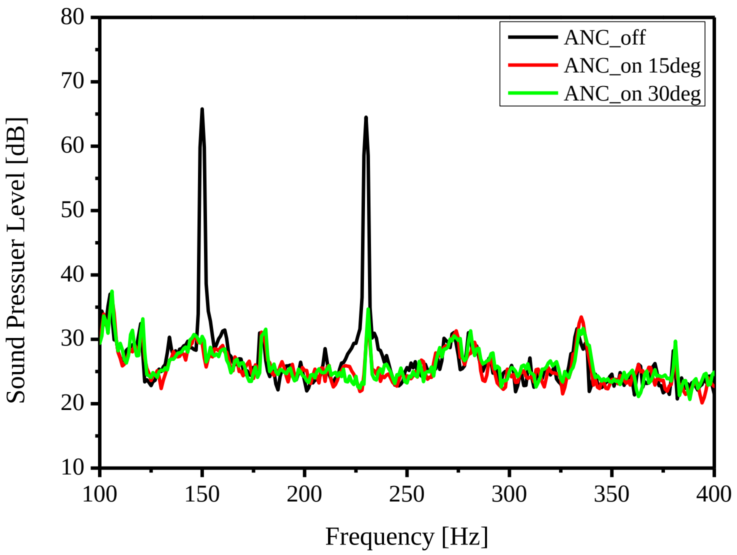

Figure 4 – Experiment results about before and after ANC

3. CONCLUSIONS

In this study, noise in different locations were reduced through generated stereophonic sound ANC using DBAP algorithm without moving the speakers. Also by comparing stereophonic sound ANC with conventional ANC methods, the efficiency was proved.

REFERENCES

1. T. Lossius, P. Baltazar, and T. d. l. Hogue, "DBAP - Distance based amplitude panning," in International Computer Music Conference (ICMC). Montreal, 2009.
2. Kostadinov, D.; Reiss, J.; Mladenov, V. Evaluation of Distance Based Amplitude Panning for Spatial Audio. *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, 2010.
3. KUO, Sen M.; MORGAN, Dennis. Active noise control systems: algorithms and DSP implementations. John Wiley & Sons, Inc., 1995.