

A study on discomfort reduction based on ANC and auditory masking for factory noise

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1. Introduction

In recent years, the factory noise has been focused as one of the social problems. Several methods such as ANC [1], auditory masking [2] and so on have been proposed as general noise reduction methods. However, their methods are designed for the noise which consists of lower-frequency or higher-frequency bands. In this paper, we propose a new discomfort-reduction method based on ANC and auditory masking for factory noise (especially, grinding-work noise).

2. The proposed method

We proposed a new discomfort-reduction method based on ANC and auditory masking. Figure 1 indicates the overview of the proposed method. It employs the open-air type ANC headphone with reference microphones. The noise in lower-frequency band is reduced with ANC. In the ANC, the control signal is designed with same amplitude and inverse phase for the target noise from the observed signal. On the other hand, the noise with spectral peak in higher-frequency band is also reduced with auditory masking. In the auditory masking, the masker signal is designed with the band-limited noise with critical band (CB) to the spectral peak of the target noise. The spectral peak should be detected from the observed noise. From the detected spectral peak, CB for band-limited noise is calculated as follows:

$$CB = 25 + 75 \left(1 + 1.4 \left(\frac{f_c}{1000} \right)^2 \right)^{0.69}, \quad (1)$$

where f_c indicates center frequency of the masker signal. The band limited-noise is designed with the critical band and white noise. In the proposed method as the hybrid of ANC and auditory masking, the control and masker signals should be emitted from a headphone. Therefore, the proposed method can reduce the factory noise which consists of lower-frequency and higher-frequency components with the spectral peaks.

3. Subjective evaluation

We conducted a subjective evaluation to indicate the effectiveness. We evaluated the original noise, the ANC, the auditory masking, and the proposed method. Subjects were 7 listeners for the evaluation. In the proposed method

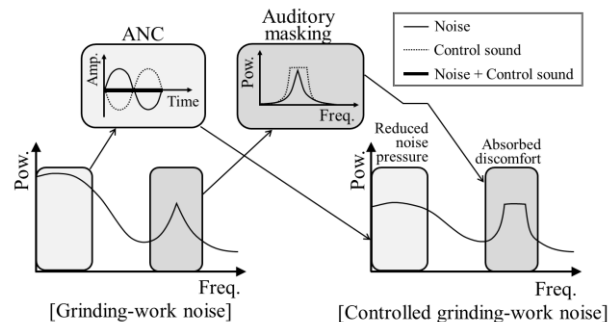


Fig. 1: Overview of the proposed method

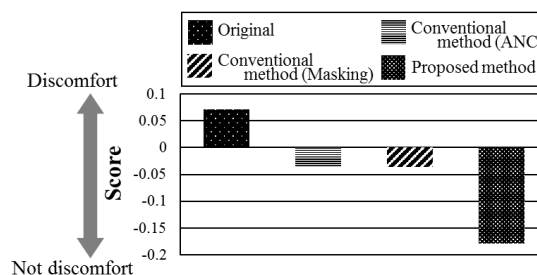


Fig. 2: Discomfort of the grinding-work noise with each method

od the control and the masker signals for the factory noise were emitted from a headphone. We employed the Scheffe's paired comparison [3] for scaling of the evaluation. Figure 2 indicates the results of the evaluation. As a result, we confirmed the proposed method can reduce discomfort compared with the conventional methods.

4. Conclusion

In this paper, we proposed a new discomfort-reduction method based on ANC and auditory masking for the grinding-work noise. As a result, we confirmed the effectiveness of the proposed method. In the future work, we intend to evaluate the effectiveness of the proposed method in various factory noises.

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References

- [1] S. J. Elliott, et al. IEEE SP Magazine, 10, pp. 12-35, 1993.
- [2] D. Ikefujii, et al. IEICE A, J-96-A(8), pp. 511-519, 2013.
- [3] H. Scheffe, et al. JASA, 47(259), pp. 381-400, 1952.