

Advanced Acoustic Signal Processing for Out-of-sight Vehicle Detection

Masao Ishihama¹⁾

*1) Meiji University Institute of Autonomous Driving
2-27-15 Shonan Takatori, Yokosuka 237-0066, Japan (E-mail:ishihama@alum.mit.edu)*

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1. The scope of this study

To prevent sudden collisions at road intersections, the author investigated improvement of a kind of passive SONAR system that detect vehicles outside the field of view using acoustic signals. Specifically, a new digital signal processing in the beamforming method was developed, and the following results were obtained. 1) Improved directivity toward the edge of an intersection that is the origin of diffracted sound waves and whose position relative to the own vehicle changes, 2) Suppression of background noise coming from a specific direction, 3) Suppression of background noise from rotating equipment on the own vehicle and 4) Separation of reflected waves.

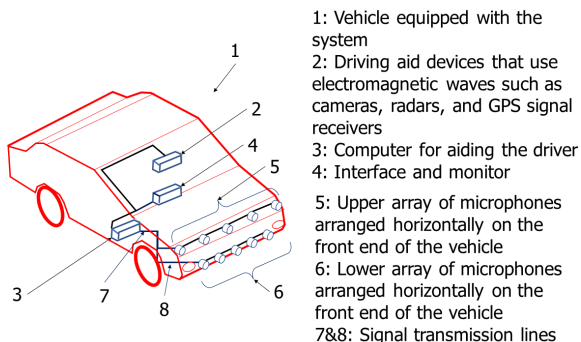


Fig.1 Diagram of the detection system hardware arrangement

2. Assumed microphone arrangement

Based on the performance requirements described above, the arrangement shown in Fig. 1 was assumed for this study. Horizontal dimension: 1.5m in total width, 0.1m between microphones, vertical dimension: 1.2m in total height, 3 rows.

3. Signal processing flow

In this research, we set the position of the sound source and its waveform virtually, and tried signal processing on a computer. Fig. 2 is a diagram showing the overall flow of signal processing. Each processing stage is explained as below in the order of the number in the figure.

- 21: Microphone array at front end of vehicle
- 22: Filter bank for limiting the frequency range
- 23: Background noise suppression processing for specific direction of arrival
- 24: Suppression of background noise caused by engine and drivetrain by feedforward adaptive control
- 25: Beamforming based on arrival time difference
- 26: Beamforming result of target sound wave
- 27: Cepstrum Analysis
- 28: Separation of diffracted sound from reflected sounds.

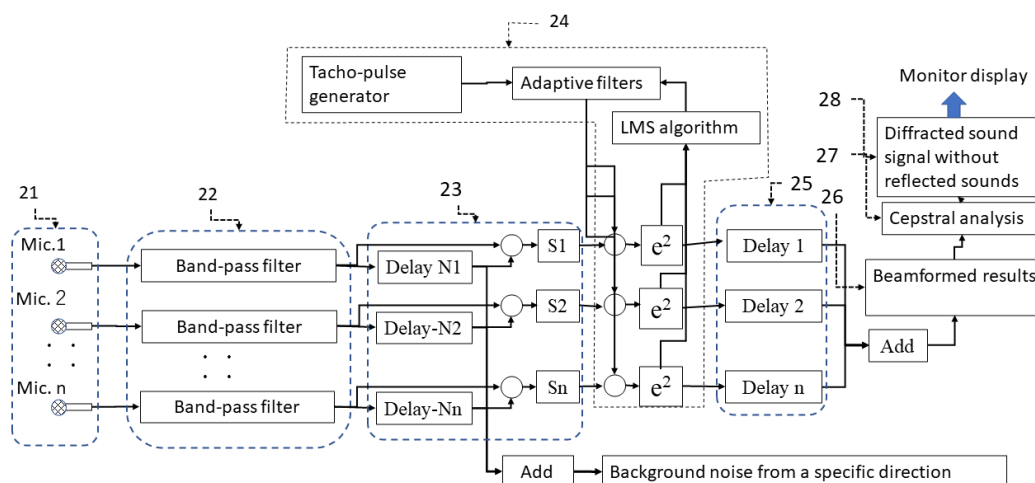


Fig.2 Overall diagram of the signal processing flow