Wave form of converged sound by Crossed-mirror array

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We have studied aerial image for realize aerial digital signage. Because the signs are aerial and have no physical hardware at the image positions, we can walk through the signs. This indicates that our signage position is everywhere you want, for example, signs can be placed right in front of a walker's face. This aerial image of signage is formed by light and sound wave. For walking people nearby the signage, sound is perceived to be emitted from the aerial sign. This means that this type of signage have high sense of realism.

Aerial image can be realized by use of dihedral corner reflectors[1]. Dihedral corner reflectors have been designed and fabricated as a crossed-mirror array (CMA) for LED lamps in order to realize aerial image of a large LED panel[2, 3]. Sound wave can be converged by CMA for sound[4]. However, sound waveform is not known precisely.

In this paper, we clarify waveform of sound converged by CMA. Waveforms of the sound waves converged by CMA and without CMA are estimated. Waveform changes by distance change from the CMA are also investigated.

CMA can form aerial image by reflection. After double reflections, the incident rays are converging into the image position because each reflection surfaces are placed perpendicularly and act as dihedral roof mirrors. Every light emitted from a light source converges to the position of the plane symmetry of the light source about the CMA plane. This convergence can be achieved not only in light but also in any waves. Thus, CMA can converge any sort of wave that can be reflected by aperture wall of CMA.

Waveforms of the sound waves with CMA and without CMA were compared. Waveform changes were investigated by distance change from the CMA. Input sound is 10 kHz. Distance between the sound source position and the CMA was 150 cm. Incident angle was 45 degrees. CMA size was 65 cm × 65 cm and aperture size was 15 cm × 15 cm. Thicknesses of the CMA was 15 cm.

Waveforms of the sound waves with CMA and without CMA are shown in Fig. 1. Amplitude of sound waves with CMA is bigger than one without CMA. Frequency and waveform don't change.

Distance dependence of waveform converged by CMA is shown in Fig. 2. Investigating points are converging position, or at 3cm, 5cm and 30cm from converging position. Sound amplitude is largest at converging position. Although amplitude at 3 cm is small, this is derived from interference.

Thus, we clarified waveform of sound converged by CMA. When sound wave is converged by CMA, only amplitude is changed. Sound amplitude is largest at converging position. The phase and frequency don't change by CMA.

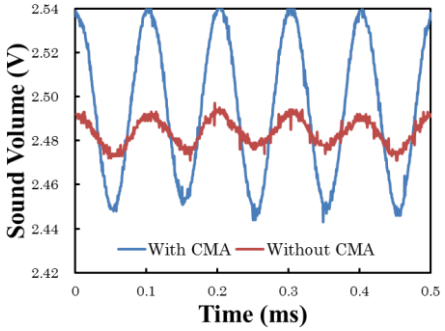

Fig. 1. Wave form with CMA and without CMA at converging position.

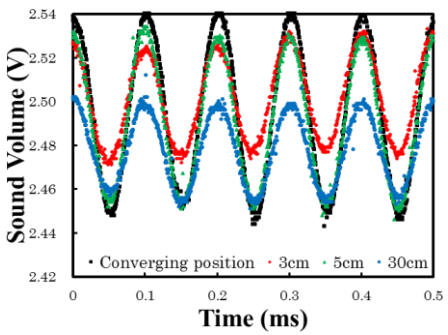

Fig. 2. Distance dependence of wave form at converging position, or 3 cm, 5cm and 30 cm from converging position.

References

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