

Aperture size dependence in Crossed Mirror Array for converging ultrasonic wave

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In recent years, many sorts of 3D displays have been proposed. Tangible 3D displays have been reported¹ because tangible 3D is very useful for sensational 3D image. However, for tangible 3D display, tactile sensation in free space is important, which has been reported by using ultrasonic wave². For converging ultrasonic wave, we propose to use Crossed Mirror Array (CMA), because light and ultrasonic can be converged at same position. This indicates that CMA is easy to display tangible 3D images.

In previous research³, ultrasonic wave can be converged by using large aperture-size CMA. However, appropriate aperture size for converging ultrasonic has not been reported.

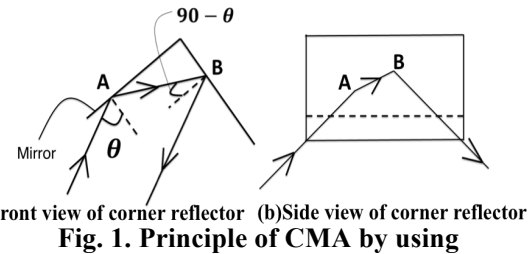
In this paper, we have examined frequency dependence of converged ultrasonic wave intensity in order to obtain appropriate aperture size of CMA for ultrasonic-wave.

Fig. 1 shows principle of imaging by the corner reflector. When light enters into corner reflector, the light returns to the same direction as incident light direction by twice reflection as shown in Fig. 1(a). From the side view as shown in Fig. (b), the light goes to plane symmetry direction of CMA as incident light. This results in that, as CMA is composed of the corner reflectors in a grid pattern, incident light can be converged at plane symmetry position of CMA as incident light source.

Fig. 2 shows experimental apparatus to examine frequency dependence of ultrasonic intensity by using CMA. Ultrasonic source was put at 150 cm from CMA. Microphone was at converging point. CMA's aperture size was 15 cm and overall size was 45cm.

Fig. 3 shows frequency dependence of ultrasonic-wave intensity in CMA. When the frequency is between 32000 and 43000 Hz, ultrasonic-intensity envelope has the broad peak, although there are several small peaks in it. CMA aperture size of 15 cm is equivalent to ultrasonic frequency of about 2200 Hz. This indicates that appropriate CMA aperture size is between 15 times and 20 times larger than ultrasonic wavelength.

Thus, for converging ultrasonic wave by CMA, CMA aperture needs to have the size of between 15 and 20 times larger than ultrasonic wavelength.



(a)Front view of corner reflector (b)Side view of corner reflector
Fig. 1. Principle of CMA by using

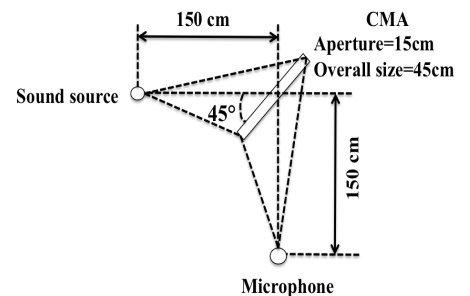


Fig. 2. Experimental apparatus to examine frequency dependence of ultrasonic

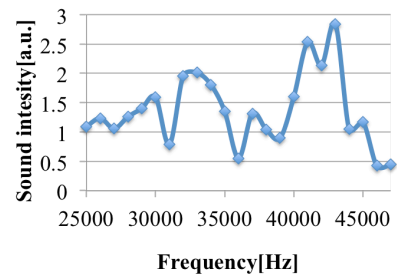


Fig. 3. Frequency dependence of ultrasonic intensity in CMA

Acknowledgment

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References

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