

On an improvement of the stability of a spatial mist screen employed a fan without blades in the display of a projected holographic image

Kunihiko Takano¹ Yudai Totsuka¹ Yoki Takano² Kazuma Hara³ Mito Kotoyori³
Koki Sato⁴ Kikuo Asai⁵

Abstract— Electro-holography equipped with a spatial light modulator (SLM) is considered to be an important basic technique for 3D-TV. However, the resolving power of ordinary SLM seems to be very low, and so it looks very difficult to satisfy the space-bandwidth product (SBP) condition. It is unfavorable since the values of the size and the viewing angle of the reproduced images are known to be restricted. We tried to manage this problem by introducing several processes using a spatial screen of a mist flow or a micro-bubble^{1,2}, and discharged air plasma³. In these processes, since we have jetted out the scatterer into the space directly, fluctuation reducing process of the screen has come to be an important problem. In this paper, we shall report that, to improve the stability of the mist screen, a spatial screen employed a bladeless fan (without blades)⁴ is introduced, and a challenge is made for holographic projected images to be presented in an extended display area of the screen. As this result, we confirmed that an effective display area is exactly enlarged, and a performance of highly bright projected images is carried out by this new system.

SYSTEM AND RESULTS

Fig.1 shows total scheme of holographic image projecting system used in the experiment. In this system, we prepared a spatial screen employed a bladeless fan. It plays an important role to produce a multiphase air flow with high directivity, and to improve the stability of the mist screen. Using this system, we studied the improvement of the stability of the mist screen by investigating the quality level of the projected images recovered on the screen carefully. The results obtained in the new system and in the previous one adopted two fans¹ are compared. We noted the following remarks. Our system utilizes the property such that the reproducing wave produces the projected image through the scattering effect of the mist flow of the moving water particles. If the fluctuating level of the screen tends to be large, spatial variation and the flickering of the projected image may be remarkable, and the brightness of the image may be extremely violated. For this, we introduced Particle Image Velocimetry analyzing method, and studied the particle image average vector V_a of water particles. We made a statistical approach with respect to the frequency of occurrence of $V_a=0$ detected in each interval of 30sec in successive time (see Fig.2). The results are applied for the evaluation of the stability of the screen using a relation between the stability and the temporal change in the brightness of the images. In addition, taking the photo of the projected picture of a square in the display area and the ones projected in all of the other region close

to the display area (not display area), we found the average brightness and the rate of the recovered pictures with high brightness (see, table-1, Fig.3). The results are used to confirm an extended situation of the effective display area. Like this way, with the help of statistical approach, we confirmed that the stability of spatial mist screen is improved, and the effective display area is extended. In addition, we examined here to find the average distances between the reproduced figures and applied the similarity decision making program by AKAZE. This result also shows the effectiveness of the new system. We would like to take it as a future work. This research was partially supported by the Grant-in-Aid for Scientific Research (No. 20K12113 and 23K11352) in Japan.

REFERENCES

- [1] K.Takano, et.al., Proc. of SPIE, Vol. 12592, IWAIT2023; 125920T
- [2] K.Takano, et.al., Proc. of IWAIT2018 #91
- [3] Y.Ochiai, et.al., Proc. of ACM SIGGRAPH 2015, 9-13(2015).
- [4] Dyson Technology Limited. US-Patent, No.US8308445B2, 2012.

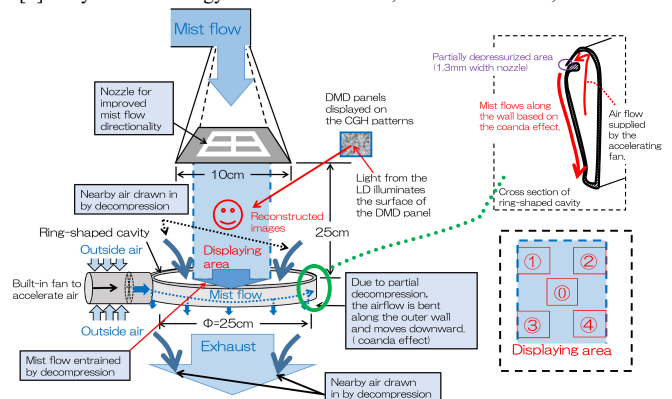


Fig.1 Total scheme of holographic image projecting system

Table-1 Comparison of image quality analysis results

	Center position labeled 0	Mean value of results outside 0 labeled 1 to 4
Average of pixel values (Average luminance value)	82.6 → 98.1	23.4 → 77.3
Percentage of brightness value more than half %	80.7 → 95.0	25.4 → 79.9
※※※※※※※※	Privious system → New system)	

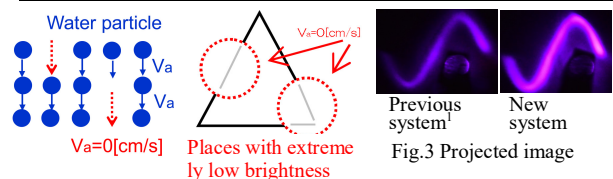


Fig.2 Diagram showing how $V_a=0$ affects the reconstructed images

Fig.3 Projected image

¹Tokyo Metropolitan College of Industrial Technology, Japan (ktakano@metro-cit.ac.jp), ²Tokyo University of Agriculture and Technology, Japan, ³Nagaoka University of Technology, Japan, ⁴Shonan Institute of Technology, Japan, ⁵The Open University of Japan, Japan.