

【Grant-in-Aid for Scientific Research (S)】

Broad Section J



Title of Project : Compact aerial display by use of multiple reflections and its applications for aquatic CAVE for VR Biology

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Keyword : aerial display, aquatic display, aquatic CAVE, VR biology

【Purpose and Background of the Research】

As it is said that “the fish you missed are big”, things in water look bigger than their real size. We misunderstand the underwater world as if it were an extension of the atmosphere. This is also the reason why it is often said that “I entered the river because it looked like a shallow water” in a water accident. Even if we think that we understand that refraction of light occurs at the interface, we misunderstand the underwater world based on the estimation of size and depth from the appearance, which function was acquired in the atmosphere.

In an aquarium, the transparent aquarium wall is invisible to fish. Thus, there is a problem of death due to collision. It is required to install a sign in front of the wall that does not obstruct the flow of water.

In this research, we develop the world's first “aquatic display” that does not interfere with the flow of water or the movement of fish by utilizing the “aerial display” technology that forms images in mid-air. In order to install an aquatic display in an aquarium or a water tank, it is necessary to make its optical system compact.

In this research, we develop an optical system that makes the aerial display compact. We install a thin aquatic display in the aquarium. Furthermore, we clarify the effectiveness of presenting aquatic images to fish.

【Research Methods】

Figure 1 shows the outline of the approach of this study. In the development of the optical system, (1) Polarization modulation and multiple reflection are introduced into the

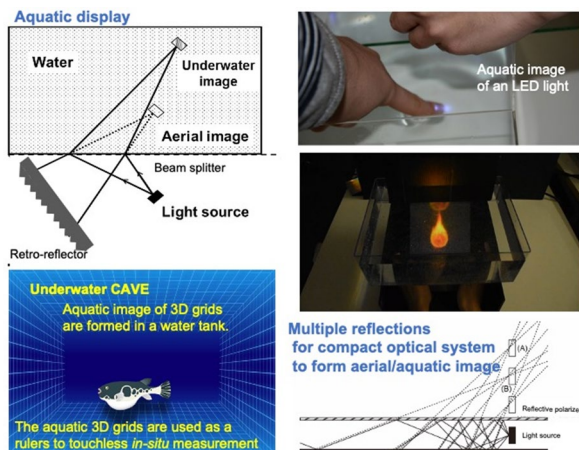


Figure 1 Our approach for aquatic CAVE.

aerial imaging by retro-reflection (AIRR) to realize thinning. (2) We develop the world's first immersive image space underwater (aquatic CAVE).

We will explore new academic fields using the developed aquatic display technology. (3) We clarify human depth perception characteristics for underwater images. (4) We conduct a behavioral biology experiment (VR biology experiment, Fig. 2) using the aquatic display system to present computer-graphics (CG) images to fish. (5) We develop a remote monitoring system for aquaculture tanks. (6) We develop a method to estimate the average length and weight of farmed fish.

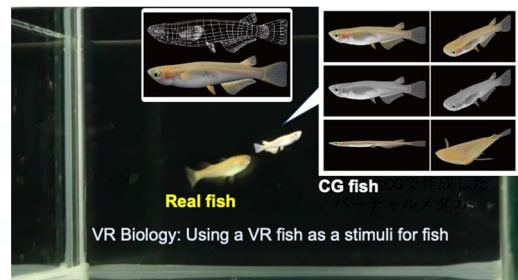


Figure 2 Virtual reality (VR) biology experiment.

【Expected Research Achievements and Scientific Significance】

By using an underwater display, we will develop a new biological experiment method using VR biology. In addition, it is possible to monitor the breeding status of fish in aquaculture without stressing the fish.

【Publications Relevant to the Project】

- Hirotsugu Yamamoto, Yuka Tomiyama, and Shiro Suyama, “Floating aerial LED signage based on aerial imaging by retro-reflection (AIRR),” *Optics Express*, Vol.22, Issue 22, pp. 26919-26924 (2014).
- Hirotsugu Yamamoto, Shiro Suyama, *et al.*, Recent Developments and Prospective Applications of Aerial Display, Hirotsugu Yamamoto (ed.), CMC Publishing Co., Ltd., ISBN978-4-7813-1335-1, 2018 [in Japanese].

【Term of Project】 FY2020-2024

【Budget Allocation】 144,900 Thousand Yen

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