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Underwater LiDAR utilizing Visible Light Devices

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It is expected that ICT/IoT technologies will be introduced into the underwater in order to effectively utilize the vast ocean surrounding Japan and its resources, and inspect underwater infrastructures. We have investigated underwater optical wireless technologies with broadband properties to realize visualization of underwater data in addition to acoustic waves and very low frequency magnetic-electric waves which have been used widely in underwater. This paper describes our effort to develop an underwater LiDAR, which enables acquisition of underwater ranging data and scanning images. Focusing on that optical propagation losses in visible light region is very small compared to that in infra-red region, we have developed an underwater LiDAR using visible light devices, which enables underwater ranging. We introduce underwater 3D scanning images obtained using the developed underwater LiDAR.

Firstly, we have developed an underwater LiDAR with a blue LD (GaN-LD) based on our experiences regarding air LiDAR developments. Then we measured a concrete piece in an acrylic tank filled with tap water using the blue light LiDAR located outside the tank [1]. Figure 1 shows the measured results. For comparison, a result of LiDAR using a near-infrared LD pulse light source having a wavelength of 905 nm (NIR LiDAR: Near Infra-Red LiDAR) is also shown in Fig. 1. NIR LiDAR could not measure the target in water at all, whereas the blue light LiDAR successfully achieved underwater measurements.

Accommodating the blue light LiDAR in a pressure-resistant container, we have developed an underwater LiDAR that can be mounted on ROV (Remotely Operated Vehicle) [2]. Figure 2 shows 3D scanning images measured by the underwater LiDAR in our small size experimental water tank. Using the underwater LiDAR, we performed 3D scanning on the measurement target submerged in the water tank and successfully obtained the 3D scanning image shown in Fig. 2(a) and (b). Additionally, we also performed 3D scanning of a raw fish shown in Fig. 2(c) and (d) in order to establish the way to measure fish sizes using the underwater LiDAR in aquacultures.

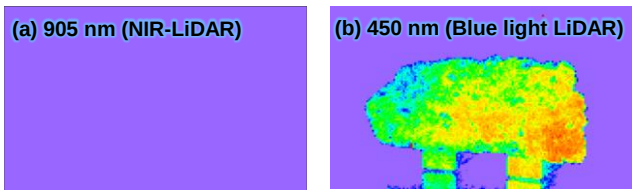

Figure.1 Scanning images of (a) NIR LiDAR and (b) blue light LiDAR

Figure.2 Measurement (a), (c) target and (b), (d) result of 3D scanning using underwater LiDAR

References

[1] S. Takahashi and N. Yamada, "3D Measurement of Underwater Object with Visible LiDAR", IEICE Communication Society Conf. '19, ABS-1-19 (2019-09)

[2] T. Shimada and K. Suzuki, "Underwater LiDAR using Blue LD", O plus E, 42 (2020)