

# Li-Fi Based Autonomous Underwater Vehicle with Integrated Optical Communication and Obstacle Detection

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## **Abstract:**

Underwater communication remains a significant challenge due to the severe attenuation of radio frequency signals in water. This paper presents the design and implementation of a compact underwater obstacle detection and real-time image transmission system using laser-based Light Fidelity (Li-Fi) technology. The proposed system employs a Raspberry Pi Pico microcontroller to coordinate obstacle detection, optical modulation, and signal processing. A laser-based reflection mechanism is utilized to detect obstacles within short range underwater environments. Upon detection, an image of the obstacle is captured and enhanced using contrast improvement and edge enhancement techniques to improve visibility under low-light and scattering conditions. The processed image is resized and converted into binary format for efficient transmission. The binary data modulates a laser diode, where ON-OFF keying represents digital '1' and '0' states, enabling optical wireless communication through the water medium. At the base station, a photodiode coupled with an amplification circuit detects the modulated laser pulses and reconstructs the transmitted image. The received image is displayed on an embedded LCD and a PC interface for monitoring purposes. Experimental evaluation in controlled water conditions demonstrates reliable short-range data transmission with improved image clarity through enhancement techniques. The proposed system offers a low-cost, energy-efficient, and scalable solution for underwater robotics, vessel monitoring, marine inspection, and surveillance applications, providing an alternative to conventional acoustic or wired underwater communication systems.

## **Keywords:**

Optical communication, laser Li-Fi, obstacle detection, image transmission, embedded systems.