

IEEE Subsea Technologies Webinar Series

AI-Driven Single-Camera Underwater Depth Estimation and Digital Recognition in Turbid Environments

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Abstract:

Accurate underwater optical measurement and visual recognition present significant challenges due to light attenuation, scattering, and hardware resource constraints. This study presents a practical, lightweight underwater vision framework that integrates single-camera depth estimation and adaptive image processing for real-time spatial measurement and target recognition.

Utilising a single optical camera combined with a lightweight deep-learning depth-estimation model, the system estimates absolute camera-to-target distances and inter-point physical dimensions in controlled water-tank environments. To evaluate edge deployment feasibility, the algorithm was deployed and benchmarked on a Raspberry Pi embedded platform, demonstrating a compact and cost-effective hardware solution compared to conventional host PC configurations.

Furthermore, to address severe image degradation in turbid conditions, an adaptive binarisation pipeline was developed to enhance text clarity, specifically targeting digital temperature indicator strips used as benchmark phantoms.

Experimental evaluations indicate that the adaptive binarisation technique achieves high digital recognition accuracy across clear and mildly turbid conditions. Additionally, systematic comparative analyses were conducted against standard open-source baselines to evaluate the impact of target spatial placement, optical visibility, surface reflectivity, and material characteristics on measurement reliability. The proposed framework provides an efficient, low-power solution for edge-based underwater monitoring and smart aquaculture applications.

Biograph

Dr Weison Lin is an Assistant Professor in the International Master Program in Applied Artificial Intelligence at National Taiwan Ocean University, Taiwan, and Head of the Edge AI Hardware Lab.

His research focuses on energy-efficient Edge AI, hardware–software co-design, reconfigurable computing, FPGA/VLSI architectures, and low-power intelligent systems. He is particularly interested in developing reliable AI technologies for resource-constrained devices operating in mission-critical and harsh environments.

His research spans hardware acceleration for deep learning, embedded AI, intelligent wearable devices, secure IoT systems, and underwater computer vision. His recent work includes dynamically reconfigurable convolution engines for efficient AI inference, underwater image recognition under turbid conditions, and AI-based marine monitoring and early-warning systems using oceanographic and satellite data.

Through the Edge AI Hardware Lab, Dr Lin aims to bridge advanced AI algorithms with practical, energy-efficient hardware implementations, enabling intelligent systems for real-world applications, including marine and underwater environments.

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