Robotics and Embedded Systems

Human Brain Project

Master/Bachelor Thesis

Exploring Underwater Salient Object Detection for Improved Underwater Robotic Vision

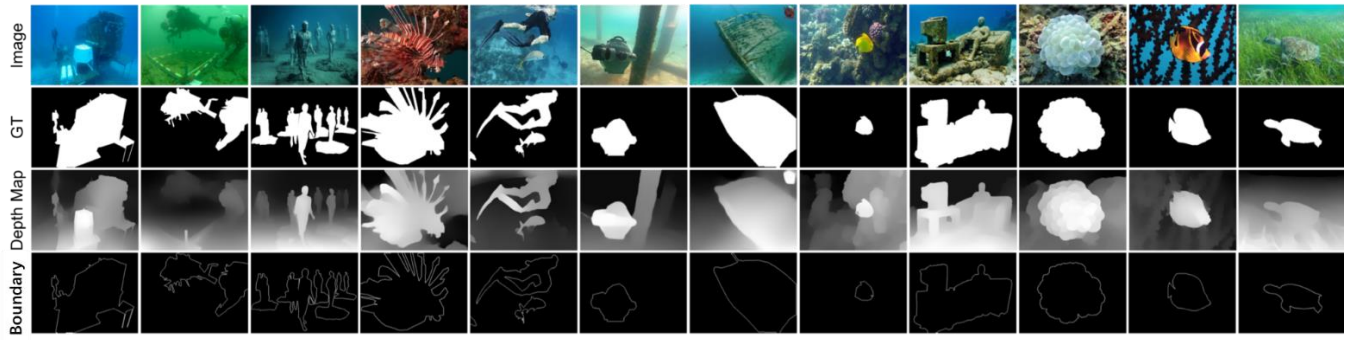
Background

Underwater robotic vision is crucial for a wide range of applications, including marine exploration, biodiversity conservation, infrastructure inspection. A key challenge in underwater vision is the ability to detect and segment objects of interest within complex and dynamic underwater environments. Salient object detection (SOD), which focuses on identifying visually prominent and semantically significant regions in an image, has become a foundational component for enabling effective underwater robotic vision. Underwater Salient Object Detection (USOD) serves as a specialized extension of SOD, designed to address the distinct challenges presented by underwater environments. USOD prioritizes the detection of salient regions in underwater scenes, forming the basis for downstream tasks such as object recognition, tracking, and instance segmentation. By enhancing the ability of robotic systems to interpret underwater imagery, USOD significantly improves their visual perception and decision-making capabilities. Despite its importance, the underwater environment introduces unique obstacles that make salient object detection significantly more challenging than in terrestrial contexts. Factors such as light absorption, scattering, and turbidity degrade image quality, leading to issues such as low contrast, color distortion, and blurring. Additionally, dynamic lighting conditions caused by varying water depths, turbidity, and surface reflections further complicate the detection process. These challenges highlight the need for robust USOD methods capable of overcoming image degradation, handling complex scene compositions, and adapting to fluctuating environmental conditions.

Your Tasks

In this thesis, your primary objective is to develop a deep-learning-based USOD model, specifically,

1. You will get knowledge about salient object detection, underwater optical imaging, and deep neural networks;
2. You will work on the basis of our current algorithm about USOD and USOD10K dataset;
3. You will develop a novel USOD model by integrating advanced deep learning techniques, such as attention mechanisms, multi-scale feature extraction, and feature fusion strategies.



USOD and USOD10K dataset

Requirements

1. High self-motivation and passion for research;
2. Six months working time;
3. Existing knowledge about deep learning, PyTroch and TensorFlow framework.

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[2] Islam, Md Jahidul, Ruobing Wang, and Junaed Sattar. "SVAM: Saliency-guided visual attention modeling by autonomous underwater robots." arXiv preprint arXiv:2011.06252 (2020).

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