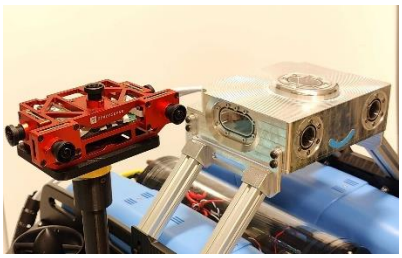
Adaptive Underwater Camera Model for integration in Visual SLAM



Abstract: Underwater Computer Vision has the potential to enhance the scalability and versatility of autonomous underwater robots due to its low sensor costs and rich perception. However, to deploy underwater robots while maintaining resilience, it is important to address challenges in using cameras for tasks of underwater localization, navigation, and spatial understanding. A major challenge is the varying camera parameters due to changes in physical properties of water. We aim to bridge the gap between camera calibration in air and the underwater counterpart using optic concepts to obtain a camera model that minimizes the need for re-calibration. The formulation will be then parameterized as a function of refractive index and depth to obtain a novel optimizable framework that will be integrated into a variable camera model Visual SLAM method. This will allow to reduce the preparation time for the deployment of underwater robots and enable long-term resilient operations.

Tasks:

- Study the basics of cameras, distortion models and visual SLAM.
- Derive the camera model using optics (e.g., Snell's law) for a flat interface (glass plate).
- Extend the above task to a general spherical interface.
- Experimental verification of the formulation using conventional camera calibration.
- Integrate the derived formulation with depth and refractive index parametrization into OpenVINS[3] (or similar method with optimizable camera Intrinsics).

Literature (indicative):

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[4] Ferrera, M., Creuze, V., Moras, J., & Trouvé-Peloux, P. (2019). AQUALOC: An underwater dataset for visual–inertial–pressure localization. The International Journal of Robotics Research, 38(14), 1549-1559.

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Relevant Project Information

- **RESIFARM Project - Funding Agency:** Research Council of Norway

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