Development and Implementation of a High Performance Computing Photogrammetry Pipeline for Underwater Surveying

About NIWC Pacific:

NIWC Pacific provides development, basic and applied science, test and evaluation, system engineering and integration, installation, and support of fielded Information Warfare systems from seabed to space. (Informally: NIWC provides the Navy with experts on software/cloud, sensors, signal analysis, data science, machine learning, and uncrewed vehicles).

RESEARCH LOCATION: San Diego, CA

PROJECT DESCRIPTION:

This project will improve NIWC Pacific's underwater surveying capabilities using state-of-the-art underwater photogrammetry techniques. With these techniques NIWC Pacific will be better able to assess and monitor the condition of underwater structures (i.e., coral reefs, shipwrecks, underwater pilings, ship hulls etc...). These modern methods utilize high resolution image processing, machine learning classification, and photogrammetry to quantify, map, and archive marine ecosystems. While current techniques can create workable image outputs, the use of HPC can enable higher resolution outputs and enable a more thorough quantitative analysis of the surveyed areas. Under the guidance of mentors, the intern will come away with hands-on experience working with 3-D point clouds, generating photomosaics, and using these outputs for scientific assessments of the imaged structures.

Underwater surveys play a crucial role in identifying and assessing ecological needs and shoreline infrastructure by providing detailed insights into marine habitats, species distributions, and the condition of underwater structures. Photogrammetry, the process of capturing and analyzing photos to create accurate 3D models, and point clouds, which are sets of data points representing surfaces in space, is a state-of-the-art method for surveying structures and environments (NIWC Pacific's RESTORE lab has vast experience in using photogrammetry for assessing and monitoring the condition of Naval Vessels).

Furthermore, photogrammetry can enhance underwater surveys by generating highly detailed and measurable representations of submerged environments. Underwater photogrammetry can greatly enhance underwater surveys in many ways: such as quantifying seafloor habitat (i.e., speciation, percent cover, mass/volume, growth/decline) or assessing cracks, defects, biofouling, or corrosion in underwater structures. This proposed project is to build an HPC pipeline that will be implemented to streamline future underwater surveying activity and assessments.

Over goal: Learn to use Python+HPC to create Photogrammetry products.

Week 1: Gain access to HPC resources. Goal: Use SLURM to launch a job to summarize the extent of the dataset (e.g. count files, file sizes).

Week 2: Jupyter Visualization. Goal: Visualize individual images from dataset in 'Raw' format.

Week 3: Structure from Motion. Goal: Understand how SfM images are created. Parse some collected images (likely with python libraries from www.opensfm.org/).

Week 4: Content Labeling. Goal: Learn how to apply labels to collected data (e.g. differentiate coral types, coral vs. sand).

Week 5: Image Mosaics, data alignment. Goal: Create single data product from multiple source images (e.g. likely pointcloud, possibly texture mesh).

Week 6: Image Mosaics cont'd. Goal: Create single continuous data product of entire data image collected, including strategies to resolve/discard overlapping data.

Week 7: Summarize Progress. Goal: Create slides for HIP Symposium.

Week 8: Derive volumetric metrics. Goal: create quantitative summaries of data (e.g. Coral volume, coverage percentage).

Week 9: Start final technical report. Goal: Draft of final report. Optional: Derive Coral-specific structural metrics, if warranted by data collected.

Week 10: Wrap-up.

NIWC usually hosts 20+ NREIP interns with events held specifically for them. For the past two years, our HIP student was allowed to participate in these activities, and we expect this to again to be available on Fridays in FY25. Example activities include field trips (e.g. onboard ship, NIWC 3d-printing facility), trainings (e.g. oral presentation, technical writing), and NIWC SME presentations (e.g. NIWC CTO's overview, Machine Learning 101).

ANTICIPATED START DATE:

June 2025 – Exact start dates will be determined at the time of selection and in coordination with the selected candidate.

QUALIFICATIONS:

The ideal candidate will have experience and a high level of skill with Python is essential. A moderate familiarity with Unix environment is required. Previous image processing experience, such as an undergraduate course, would be preferred but not required. An interest in physical science/oceanography would be preferred but not required. Previous HPC experience not required.

ACADEMIC LEVEL:

Degree received within the last 60 months or currently pursuing:

- Bachelor’s
- Master’s
- Doctoral

DISCIPLINE NEEDED:

- Computer, Information, and Data Sciences
- Earth and Geosciences
- Engineering
- Environmental and Marine Sciences
- Science & Engineering-related