Application for ENERGY summer student

Supervisor(s):

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Ivar-Kristian Waarum, senior engineer at Norwegian Geotechnical Institute and PhD student at UiO.

Preferred background of candidate(s):

Programming (python, pytorch), multi-sensor aggregation, data visualization, environmental monitoring

Number of available projects:

1

Preferred project period:

Mid June – mid September

Outline of project work:

Introduction

The summer project will be carried out as part of the SmartAUVs project, with UiO, Norwegian Geotechnical Institue, Plymouth Marine Laboratory (PML) and other partners. SmartAUVs will add to the toolbox that offshore operators and regulators have for monitoring the oceanic and benthic environments near industrial activity such as oil and gas extraction and CO_2 storage. SmartAUVs aims to improve the monitoring capabilities of AUVs, by applying artificial intelligence (AI) in concert with specialized signal processing techniques to enable AUV decision autonomy, i.e., the ability to take intelligent action in real time based on sensor input.

In SmartAUVs, it is PML's responsibility to simulate gas emission scenarios in a representative ocean environment at high spatial and temporal resolution. The simulations will provide insights into plume characteristics and development, which affect the desirable AUV behaviour. In practice, we want the simulations to function as databases of spatially correlated artificial sensor input, that can be used to simulate AUV surveys and test algorithms for leakage detection and autonomous behaviour. The oceanographic simulations will provide high-resolution output over two tidal cycles, capturing plume dynamics in the presence of tidal effects.

The simulations will be designed to capture horizontal and vertical displacement of the plume, including rate of dilution, bubble rise heights and dissolution, and localized concentration distribution of the dissolved gas solution. The spatial extent of the high-resolution simulation is approximately 250x250 m, with a resolution down to one meter for gas concentration and centimeters for bubbles. Temporal resolution is 10 minutes for gas concentration and hydrodynamics, and one second for bubbles. The simulated period will be ~12 hours, to cover two tidal cycles. Simulations will be run on the Sigma2 e-infrastructure for research and education, and the output from the simulations stored as comma-separated text files (bubble positions, sizes and velocities) and netCDF files (dissolved gas and hydrodynamics).

Deliverables

The student shall write a python utility library of functions and classes, for working with and visualizing the spatiotemporal output from the simulations. The work will entail developing the following functionality:

- Conversion of csv and netCDF files to a suitable data structure for fast access.
- Extraction and interpolation of dissolved gas concentrations or other oceanographic parameters over arbitrary horizontal, vertical and temporal scales. Output should be in the form of torch tensors with concentration and position data.
- Extraction and filtering of bubble sizes over arbitrary horizontal, vertical and temporal scales.
- Visualization of gas concentrations in water volumes in 2D, 3D and 4D.
- Visualization of bubble locations and distributions in 2D, 3D and 4D

The library will later be used in the SmartAUVs project where it will be an important part of the 'digital ocean lab', providing the interface between the oceanographic simulations and algorithms for gas leakage detection and autonomous behaviour.