Merging High-Resolution Underwater Depth Maps with Low-Resolution Background

About Us

JASCO Applied Sciences provides consulting and research services for assessing and mitigating underwater noise.

Since its origin in 1981, JASCO has been developing and implementing acoustic technologies ranging from advanced acoustic recorder design to complex acoustic and behavioural modelling algorithms to comprehensive field monitoring and data analysis, including acoustic detection of marine mammals and human sources.

Introduction

Sound propagation is modeled using various approximations of the acoustic wave equation. Most practical models are range-dependent, meaning environmental parameters and boundary conditions change along the propagation path. In underwater scenarios, the seabed significantly influences sound propagation, with acoustic waves traveling from water to soil and back. Good quality bathymetric data, which refers to the measurement of the depth of water bodies and the mapping of underwater features, is crucial for accurate results. This often requires in-situ campaigns to acquire high-resolution elevation data. High-resolution datasets typically cover smaller areas compared to the distances sound waves travel underwater. Therefore, it is necessary to extend these datasets with larger, often lower-resolution, publicly available datasets. The difference is stark: regional datasets may have 1 point every 200m, whereas high-resolution datasets might have 1 point every 10m or less. Low-resolution datasets are usually derived from heavy sampling, regridding, and interpolation of existing publicly available datasets. However, these methods introduce heavy biases that produce inconsistencies between datasets and introduce artefacts and discontinuities, affecting sound reflection and propagation when modelling the interaction with the seabed.

Problem Description

We aim to extend high-resolution bathymetric data to match low-resolution extensions naturally. This involves:

- Embedding high-res data into a larger low-res dataset.
- Performing accurate interpolation to avoid artefacts.

Assumptions:

1. High-res data is ground-truth and should remain unaltered.
2. Low-res data can be modified as needed.
3. Avoid resampling or regridding the high-res dataset if possible.
4. The high-res dataset is not necessarily convex.
5. The datasets' projections in the XY plane can intersect arbitrarily.
6. Datasets are random, uniformly sampled points on a 2-manifold in 3D space.

Remark: Although datasets, especially the low-resolution ones, are usually gridded, not all of them are. For those that are, the orientation, density, and type of grid can vary considerably between them

Algorithmic Complexity: Bathymetry datasets can be rather heavy especially high-resolution ones, with combined point count of tens of millions of points, so keeping down the algorithmic complexity is desirable.

Expected Results:

We would consider this workshop a success if we obtained any new insights on how to approach this problem and how to efficiently implement solutions. Additionally, developing a quantifiable metric to evaluate the quality of the matching would be a bonus. Publicly available bathymetry datasets (both high and low resolution) will be provided as example material.