Environmental monitoring of geological carbon storage sites

Project 2: Gas leakage detection in sonar images

This project aims at processing experimental sonar data recorded by the Kongsberg M2 multibeam sonar to enhance the visual appearance of gas leakage. The data is acquired during a controlled CO2 gas release experiment run over 27 days in the Oslofjord with ocean conditions similar to a North Sea environment. The aim of the project is to develop a detector algorithm for gas leakage based on active sonar imaging.

The project is for one student, and the preferred project period is June to August 2022. The expected outcomes/deliverables are a suggestion of an algorithm, Matlab/Python code for simulation/verification, and a report.

Background

Large-scale carbon capture and storage (CCS) projects are currently realized worldwide. Several of these are geological carbon storage (GCS) projects with offshore storage locations. As part of this, huge effort is put into identifying solutions for monitoring of the reservoir and the surrounding environment. Key technologies for offshore GCSs are acoustics and chemical sensors.

The Group for Digital signal processing and Image analysis (DSB) at the Department of Informatics (Ifi) was, together with NGI, NIVA, Norce, FFI, JC-DeepSea, Kongsberg Maritime, Equinor and Total, partner in the ACT4storage project (2018 – 2020), which addressed marine environmental monitoring targeting the seabed and the water column. As part of the project, data from a broad range of acoustical and chemical sensors were collected in a controlled CO2 release experiment, run over 27 days in the Oslofjord with ocean conditions similar to a North Sea environment. Initial analysis of the data has been conducted and reported[1]. Still, a lot of knowledge and new results can be found through further data analysis. Ifi, through DSB, has access to this dataset, and this will be made available for the summer projects.

The DSB group is also partner in a new related RCN project application together with several partners of Act4Storage. In the new project, we aim at enabling more efficient monitoring of greenhouse gas seepage in the oceans through enhanced AUV autonomy. The DSB-activity within this project will include supervision of a project funded PhD. A decision for funding is expected within March 2022.

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[1] Blomberg, Ann EA, et al. *ACT4storage—Acoustic and Chemical Technologies for Environmental Monitoring of Geological Carbon Storage. D3—Nearshore Evaluation Report 2019*. Technical Report, 2020, https://hdl.handle.net/11250/2717113.

Processing of sonar data

During the Act4Storage experiment, a Kongsberg Mesotech M3 multibeam sonar was used to monitor the gas release. Gas bubbles do show up clearly on standard sonar images, as

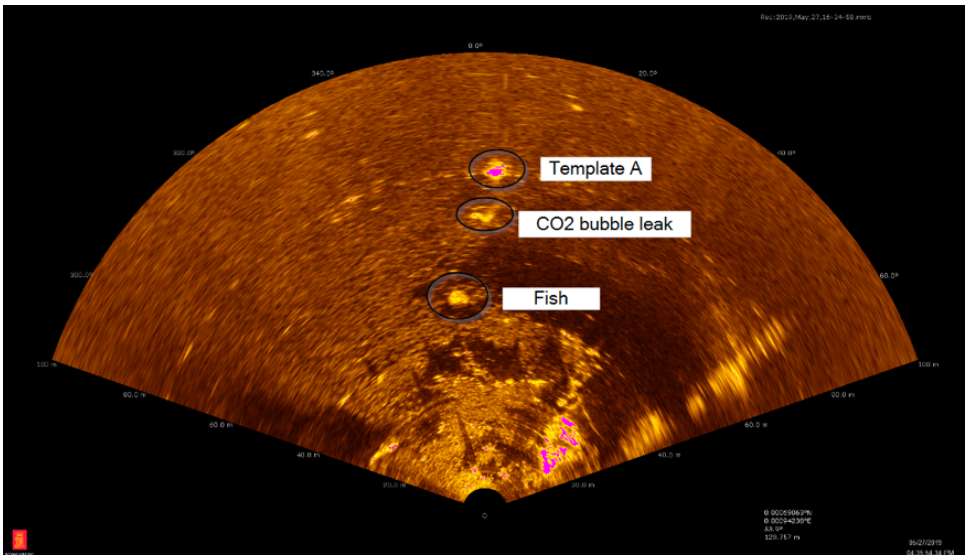

Figure 1: Sonar image A: standard processing has been used to image the seabed. The simulated CO2 bubble leak is visible at 65 m range, and another template (Template A) is visible at ~70 m range. A school of fish is also visible in this image.

seen in Figure 1, but it is difficult to distinguish gas from other events, like free swimming fish. Raw sensor data to form images like this is available for this project.
DSB/Ifi/UiO has together with NTNU, CREATIS (Univ. of Lyon, France), and Johns Hopkins University (US) developed the UltraSound ToolBox (www.USTB.no), a free, open-source toolbox for processing of acoustical signals that provides cutting-edge image reconstruction techniques. The DSB group has also, together with NTNU, led the work on defining the Ultrasound File Format (UFF), which is the first standard for sharing ultrasound data, an initiative that now involves over 12 universities worldwide.
In this project, we will convert the raw sonar data to the UFF format, and then process the data using USTB. In USTB, it is possible to process the data using advanced adaptive algorithms that can be tuned to enhance different features in the images. Our aim is to find algorithms and setups that enhance gas leakage signatures, and use this as input to a gas leakage detector algorithm.

Favourable student background

Concretely, this task involves processing sonar data using Matlab and USTB. For this task we are looking for an enthusiastic and self-driven candidate who has a passion for scientific computing, signal processing, and who would like to work with applications related to green energy.

You need to know how to write structured and clear code in Matlab/Python using version control systems (Git). Previous knowledge in signal processing and preferably array signal processing is an advantage (for instant having taken the courses IN3190/4190, and IN5450).

Contact persons

Andreas Austeng (Andreas.Austeng@ifi.uio.no) and Peter Näsholm (svenpn@ifi.uio.no).