

Are There Pirates in the Great Belt?

Detecting Hidden Ships Using DAS Data and Deep Learning

Gustav Hylsberg Jacobsen	S214374
Bjarni Olsen	S223885
Sofie Groth Dige	S211917
Sebastian Zimmer Leffmann	S185373

The Automatic Identification System (AIS) is the standard method for tracking marine traffic. However, AIS signals can be deliberately turned off, allowing vessels to move “in the dark.” These so-called *black ships* could represent anything from fishing vessels operating illegally to foreign naval units or even modern-day pirates. The motivation of this project is to explore whether Distributed Acoustic Sensing (DAS) data from an undersea cable in the Great Belt can reveal such hidden maritime activity.

DAS systems continuously record acoustic vibrations along fiber-optic cables, effectively turning the cable into a massive, real-time sensor. This technology can detect subtle patterns in underwater activity, including ship movement, without relying on active emissions or cooperation from vessels. Previous work within this area can be seen in *A Feasibility Study of Automated Detection and Classification of Signals in Distributed Acoustic Sensing*¹ [Hasse B. Pedersen] which lays the fundamental theory behind the project.

Step-by-step plan.

1. Collect DAS recordings from a fiber-optic cable under the Great Belt and corresponding AIS data for the same time intervals.
2. Develop models like CNN or transformer-based architectures to identify clusters in DAS data without predefined labels.
3. Match the discovered clusters to AIS ship data to assign vessel identities and generate labelled datasets.
4. Retrain the model using the labelled data to recognize ships directly from DAS input, without requiring AIS information.
5. Evaluation: Test the model’s ability to detect ships (including potentially unregistered or “black” vessels) and analyze its generalization performance across unseen data.

Milestones

- ✓ Establish data pipeline and perform initial unsupervised clustering on DAS recordings.
- ✓ Match discovered clusters with AIS data to assign vessel identities and refine the model using self-supervised learning.
- ✓ Evaluate model performance on new data and analyze its ability to detect vessels without AIS signals.

If successful, the project will demonstrate that DAS data can reveal vessel movements even when AIS is disabled. This has significant implications for maritime security, infrastructure protection, and environmental monitoring. From a geopolitical standpoint, such systems could become critical assets or potential targets in information warfare and surveillance.

¹ <https://orbit.dtu.dk/en/publications/a-feasibility-study-of-automated-detection-and-classification-of/>