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Mapping Maritime Environments: Leveraging 3D-LiDAR-based Object Mapping for High Precision Electronic Nautical Charts (ENCs)

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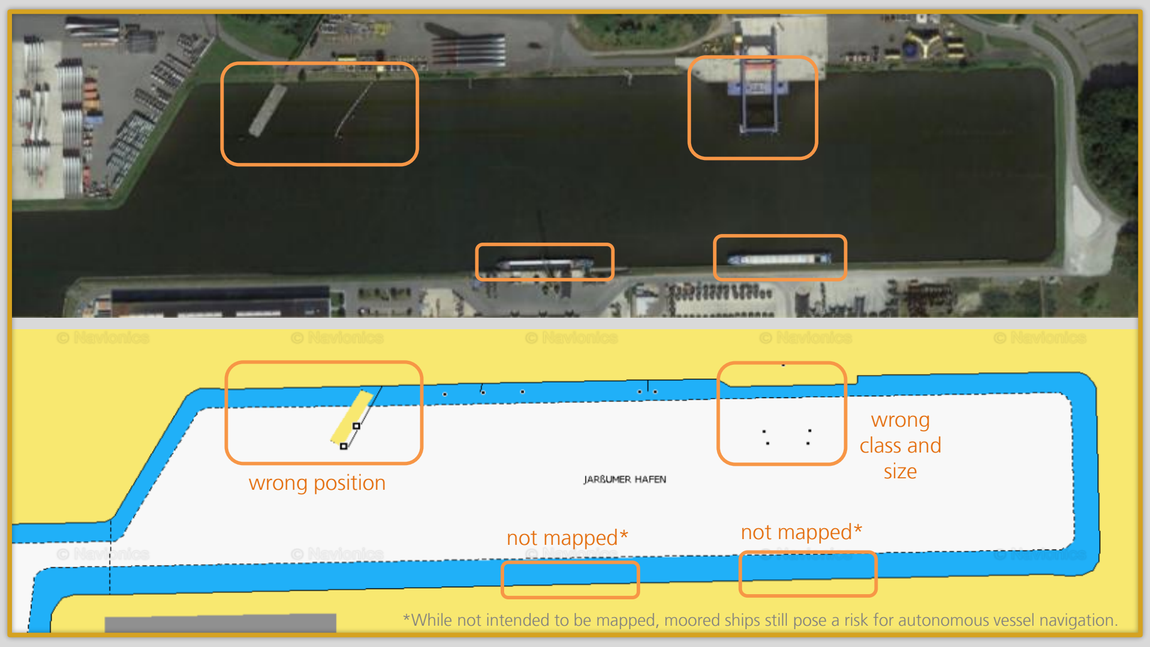
Problem Statement

Low update frequency of ENC can not capture short-term changes:

1. **Missing or displaced objects** within the charts
2. **Misclassification** of objects in the ENC data
3. **Incorrect** assessment of object **dimensions**

This leads to critical deviations between the mapped and actual positions of objects, compromising navigational safety, particularly critical for autonomous vessel.

➢ How can up-to-date sensor data be used to ensure that inaccuracies in ENC data are found and rectified?



„Digitaler Atlas 2.0“ : Development of High-Res ENCs

Approach: In-situ assessment of the harbor situation and comparison of the detected conditions against charted environment.

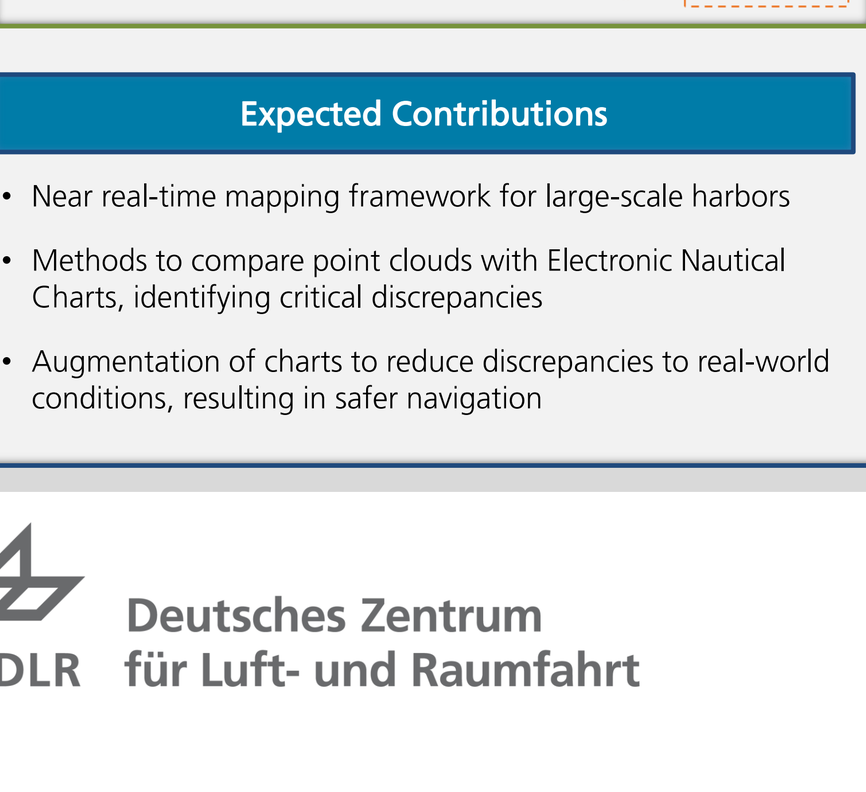
Objective: Identification and reporting of critical ENC inaccuracies in class, position or size.

Ship-mounted Sensor System

3D LiDAR:	Mapping of the harbor area and identificaton of harbor features to detect inaccuracies within the ENC data
6-axis IMU:	Assists with rotational movement estimation for high mapping accuracy
DGPS:	Georeferencing of the harbor map and the detected objects

Georeferencing of Objects

- Data acquisition in the local LiDAR coordinate system L.
- Adjusting for translateral and orientational displacement between LiDAR L and DGPS G with coordinate transforms.
- Georeferencing of LiDAR data LR_G with the position of the ship's DGPS receiver to localize objects globally.
- Account for error propagation from DGPS, LiDAR, and localization for total accuracy limits.

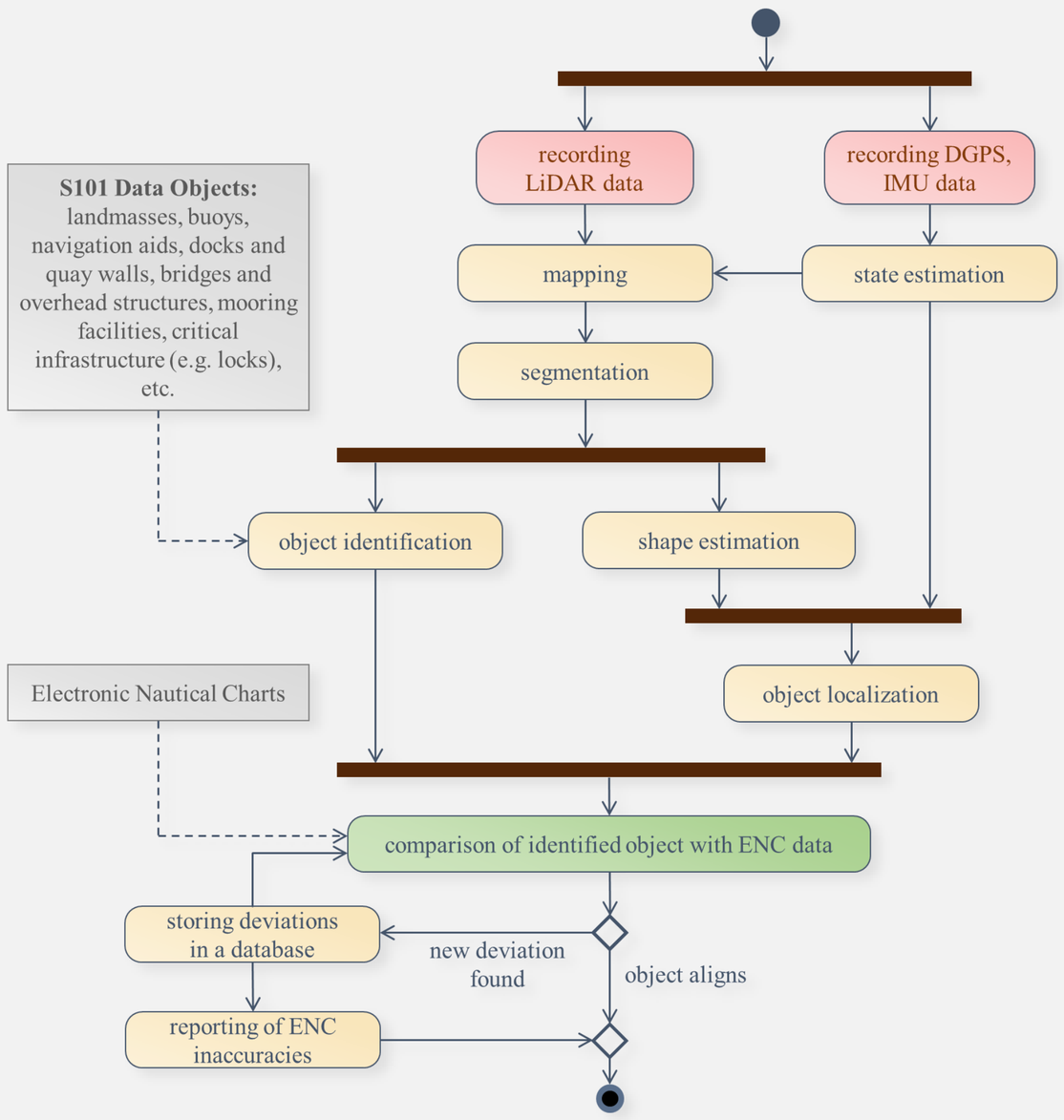


Expected Contributions

- Near real-time mapping framework for large-scale harbors
- Methods to compare point clouds with Electronic Nautical Charts, identifying critical discrepancies
- Augmentation of charts to reduce discrepancies to real-world conditions, resulting in safer navigation

Algorithmic Approach

1. **Mapping:** 3D harbor reconstruction with focus on techniques for large-scale and featureless environments
2. **Partitioning:** Point cloud segmentation, object isolation and shape estimation
3. **Classification:** Object identification according to S101-standard classes
4. **Comparison:** Matching of identified objects to the ENC data
5. **Supplementation:** Provision of navigational aids to the current ENC data to inform stakeholders of critical inaccuracies



UML-Chart of the data processing approach for identifying and reporting of descrepancies.

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