Digital Twin of Åboat

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Introduction

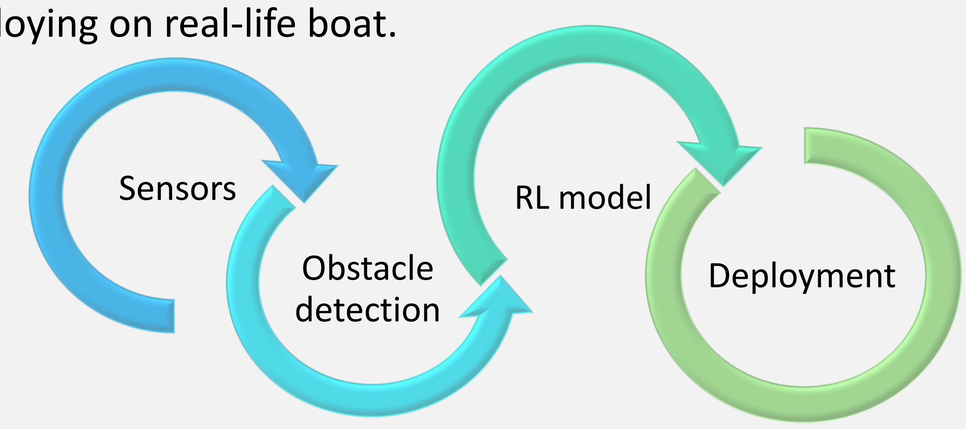
Since human error is the most likely cause of accidents at the sea, interest and research in autonomous maritime operations is increasing. While the idea of autonomous maritime vessels is compelling, the design and testing of such vessels requires hefty financial sources. Our “Digital Twin” provides a safe, agile and efficient solution to the development and deployment of autonomous ships. By rigorously testing our machine learning and computer vision algorithms in a 3D environment, we can iteratively incorporate intelligence into the Åboat.

The strength of our project lies in:

- Incorporation of situational awareness in Åboat
- Use of state-of-the-art machine vision algorithms
- Intelligent and fully autonomous path planning
- Ease of iterating

Methodology

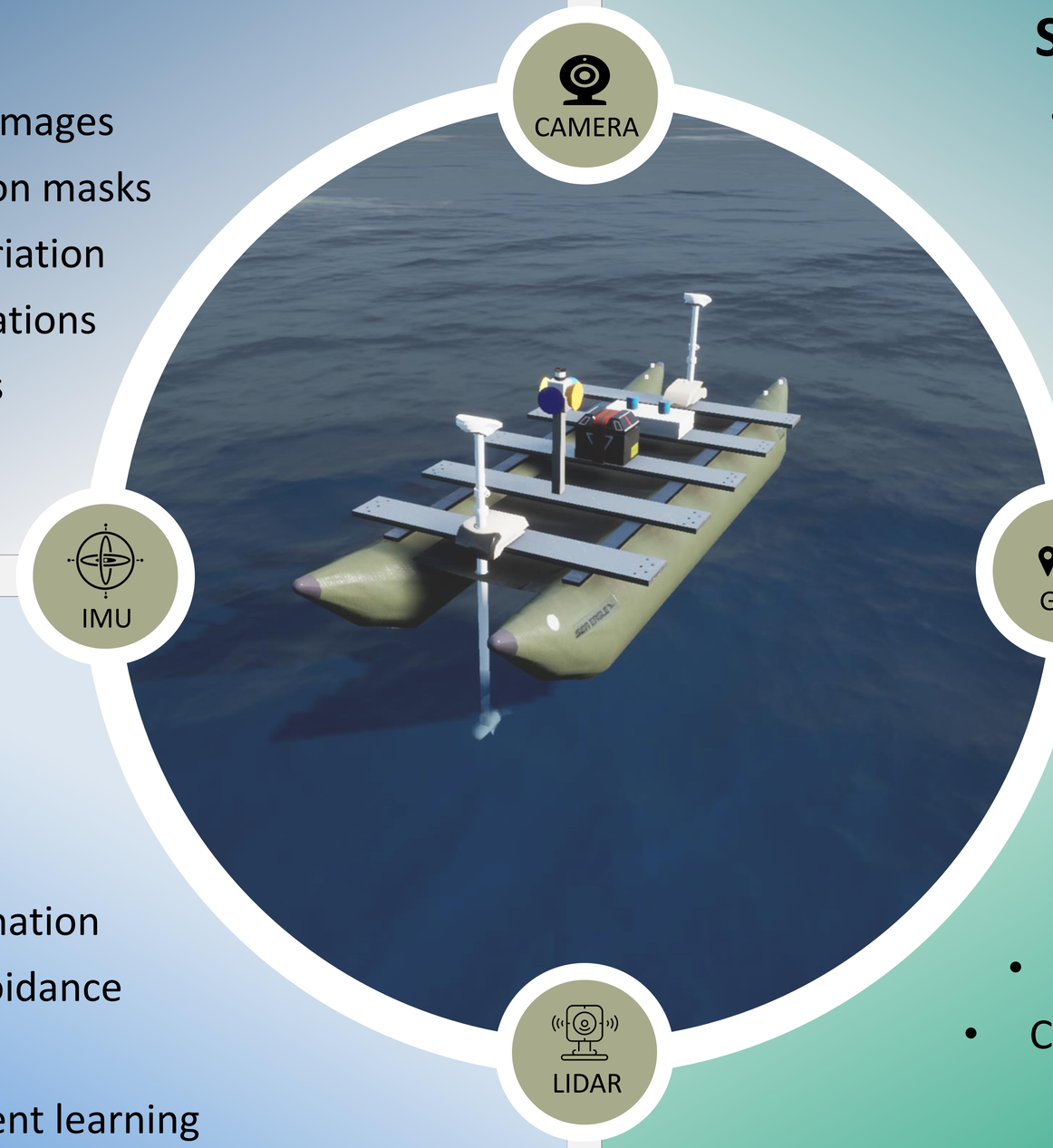
We created an identical sensor configuration in simulation for Åboat. We use camera and LIDAR to localize the obstacles (boats, rocks and buoys). IMU and GPS provide information about the position and speed of the boat. We leverage the power of artificial intelligence for our reinforcement learning model. Once the model performs well in simulation, we test it by deploying on real-life boat.



Design and Implementation

Data Generation

- Vision data: 9000+ images
  - Segmentation masks
  - Weather variation
- LIDAR Data: 15 situations
- IMU and GPS points



Situational Awareness

- Information regarding the destination
- Ship speed and location
- Presence of obstacles

Path Planning

- Goals:
  - Reach destination
  - Collision avoidance
- Technique:
  - Reinforcement learning

Deployment

- **Goal:** navigate Åboat autonomously
- Transfer algorithms and test
- Collaborative effort with other Åboat teams

Results

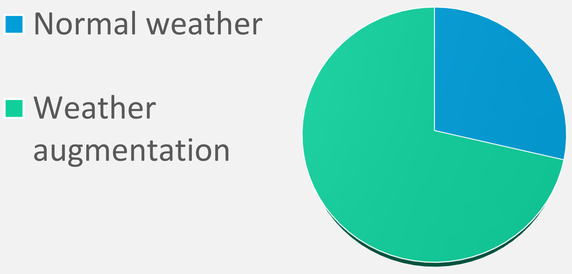


Figure 1.
Synthetic Image Data (AILiveSim)

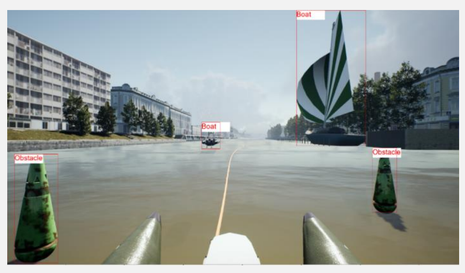


Figure 2.
Results of object detection

Results (cont.)

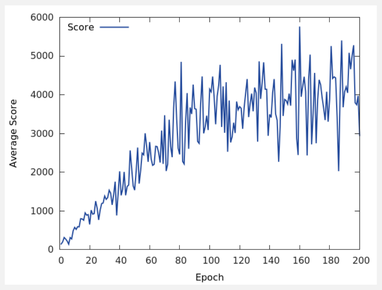


Figure 3.
Reward function across training steps of reinforcement learning model. The reward of steps progressively increases as the boat learns to avoid obstacles and reach destination

Future Work

We want to improve our reinforcement learning model by increasing the complexity of situations. Additionally, we would deploy our object detection model and reinforcement learning model on the boat and test in real-life.