Automated Semantic Labeling of Sea Ice Images Using Custom Sensor Systems

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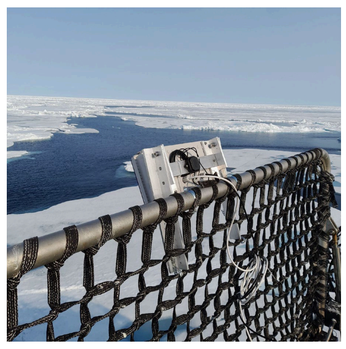
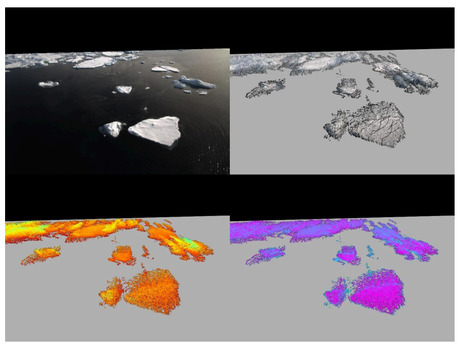
Overview

- The proposed work is designed to support the progression of the DigitalSealce project, aimed at advancing the automated analysis of sea ice.
- The focus is on developing a methodology to create extensive datasets of semantically labeled sea ice images without manual annotation, leveraging a custom sensor system mounted on an icebreaker.

Motivation

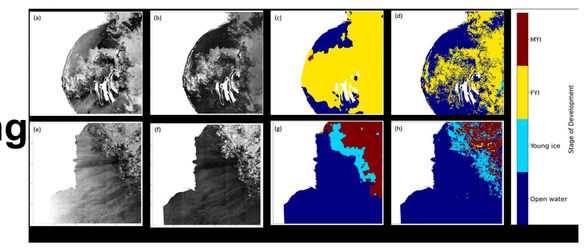
- Limited Public Data: Despite significant research in sea ice image analysis, publicly available labeled datasets are scarce.
- Automation Needs: Manual labeling of images is labor-intensive and impractical for large datasets.
- Technological Advancements: Combining optical images with LiDAR point clouds to automate and enhance the accuracy of sea ice segmentation.





Background

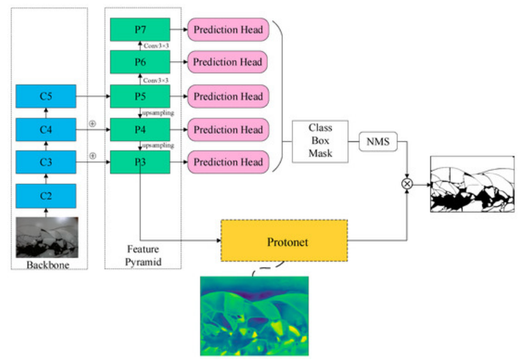
- There is a limited amount of high-quality, labeled sea ice imagery available for training machine learning models.
- Existing datasets often rely on manual annotation, which is time-consuming and prone to errors
- In [1], a weakly supervised learning method is used from lower-resolution regional labels.
- It achieves exceptional pixel-level classification by applying regional loss during training.

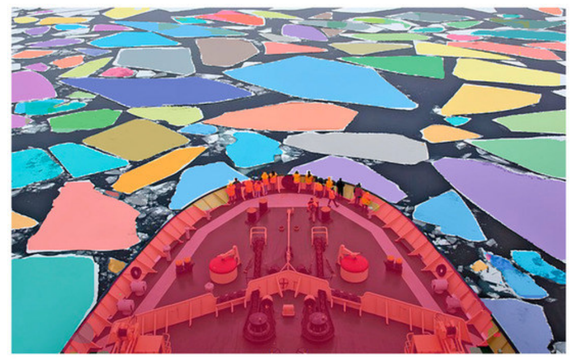


- In [2], based on digital images captured by onboard cameras, a novel network called Ice-Deeplab for pixel-wise ice image segmentation is proposed.

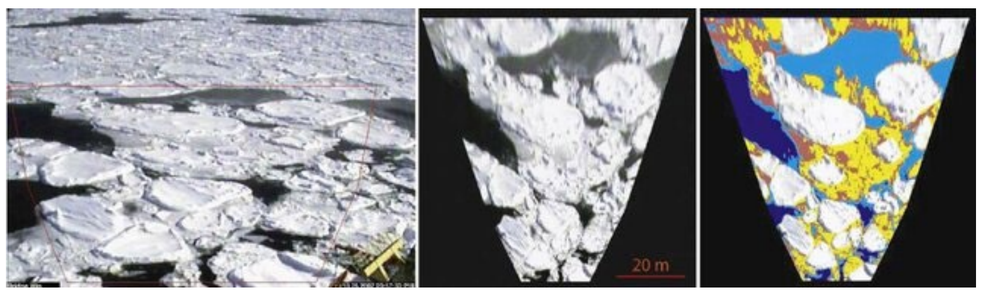
State-of-the-Art

- Different proposals have been made for image labeling in the arctics.
- In [3], they propose using the YOLACT network to address the sea ice concentration and floe size distribution.
- Cameras to train a model to identify all the targets in the image.



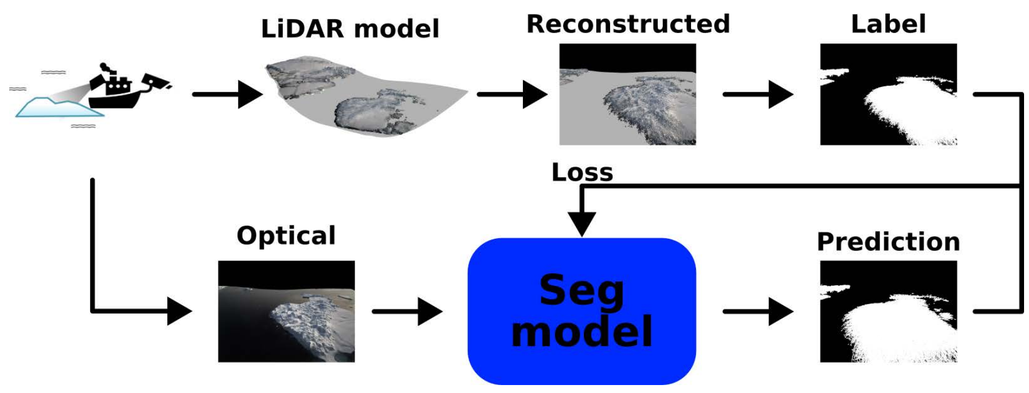


- In [4], the author presents a ship-based system for acquiring, processing, and analyzing ice condition imagery using digital images.



Expected Contribution

- Creating an autonomous pipeline to obtain semantically labeled images of sea ice.
- Developing a Deep Neural Network to perform sea ice segmentation from optical images.
- Additional sensor fusion with hyperspectral camera and thermal imaging for comprehensive sea ice analysis.
- Methodology:



Reference

1. Region-level labels in ice charts can produce pixel-level segmentation for Sea Ice types M Patel, X Chen, L Xu, Y Chen, KA Scott, DA Clausi - arXiv preprint arXiv:2405.10456, 2024
2. B. Dowden, O. De Silva and W. Huang, "Sea Ice Image Semantic Segmentation Using Deep Neural Networks," Global Oceans 2020: Singapore – U.S. Gulf Coast, Biloxi, MS, USA, 2020, pp. 1-5, doi: 10.1109/IEEECONF38699.2020.9389229
3. Zhou, Li, Jinyan Cai, and Shifeng Ding. 2023. "The Identification of Ice Floes and Calculation of Sea Ice Concentration Based on a Deep Learning Method" Remote Sensing 15, no. 10: 2663. https://doi.org/10.3390/rs15102663
4. Weissling, Blake, Stephen F. Ackley, Penelope Mae Wagner and Hongjie Xie. "EISCAM - Digital image acquisition and processing for sea ice parameters from ships." Cold Regions Science and Technology 57 (2009): 49-60.

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