ICE-SHIP INTERACTION QUANTIFICATION & PREDICTION

LOGAN PALMER RESEARCH INTERESTS

December 1st 2023

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AGENDA

1. **Support role with Shamima's final paper**
    1. MRCNN computer vision & force prediction
        1. My contributions
2. **Future Interest Topics**
3. **Outline of proposed research**
    1. Formal document WIP; delivery before Christmas
4. **Questions & RFI**

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SUPPORT ROLE WITH SHAMIMA'S FINAL PAPER

- **Implementing MRCNN semantic segmentation**
    - Floe/Ship only; does not consider brash/slush ice.
    - Thickness provided
- **Extracting force predictions**
    - Local-region based ice distribution extraction from predicted masks (ice area, mean floe size, std dev)
    - Each video frame to train RNN (vessel speed*, ice thickness incl.)
- **Query RNN against validation image set**

SUPPORT ROLE WITH SHAMIMA'S FINAL PAPER

- Radii $= [0.5, 1, 2.5]$
- Angles $= \pm[0, 20, 60, 135, 180]$

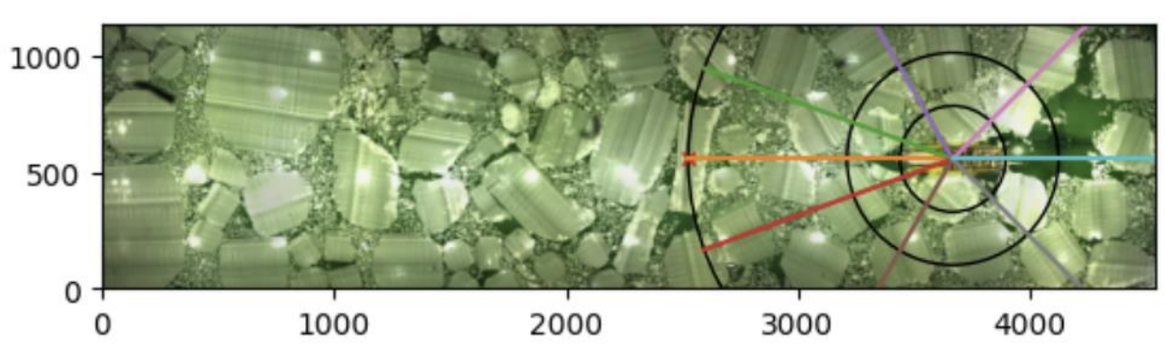
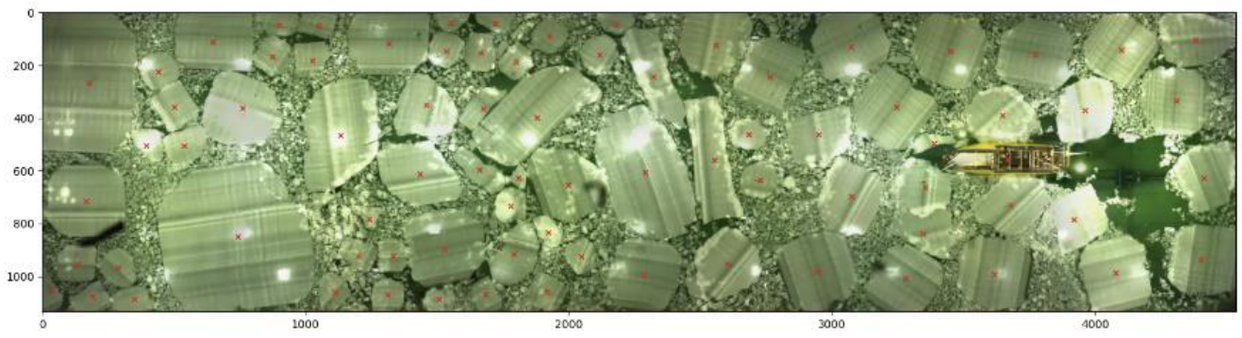
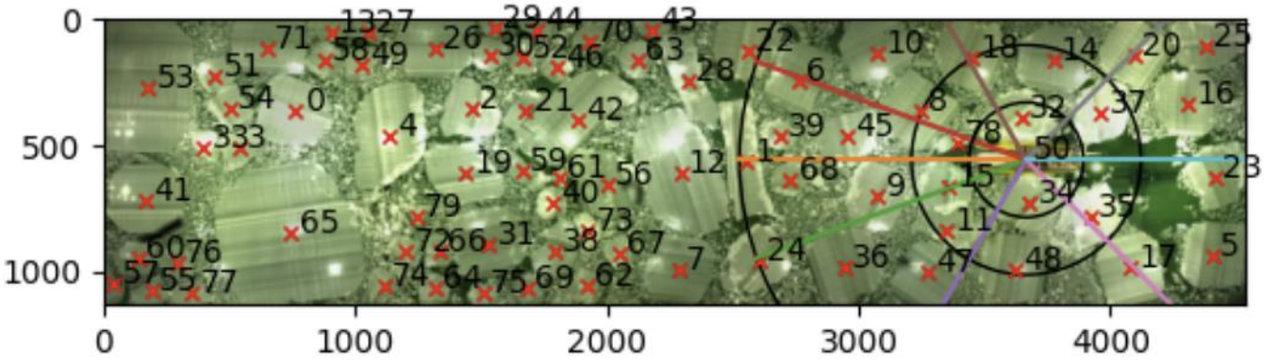


Figure 17: Proposed regions to start





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FUTURE INTEREST TOPICS

- **Temporal connection between t_{n-1} ice distribution and collision at t_n**
- **Regional influence of collision events**
    - Head on vs. Oblique vs. Rubbing
- **Predicting/collecting non-trivial ice parameters**
    - Age, type, thickness
- **Generalizing model across ice situations**
- **Physics informed model (considering floe rate of motion)**
- **Consideration of non-trivial ship dynamics at collision event**
    - Pitch/Yaw/Roll rates
- **Consider application trajectory planning and DP/SK operations**
    - How can we extend prediction horizon to support these operations.

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OUTLINE OF PROPOSED RESEARCH

- **Ship mounted, non-optically reliant sensors***
    - Segment brash/slush ice as categories rather than track floe smaller than threshold.
- **Direct form of collision quantification**
    - Tactile sensor sheet , Pendulum device (strain measurement)
- **Physics informed, RL algorithm trained on samples of varying ice types, interpolation between.**
- **Final objective notes:**
    - Full automation between sensor and force prediction o/p
    - Optical consideration of non-trivial ice parameters
        - Thickness/type/age (secondary)

***Non-optical sensor consideration is out of scope**

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OUTLINE OF PROPOSED RESEARCH

B. Dowden (O. De Silva) 2020.

QUESTIONS – R.F.I.

1. Can I get access to ice-testing from NRC-OCRE testing of Magne Viking (all data; was Qualisys enabled?)
    1. From 2011 (Gash 2012), 2015 (Islam 2016), 2018 (Islam 2018) and 2022 (Akter 2022).
2. Have we thought about/ever tried:
    1. Ship mounted cameras/alternative sensors in ice?
    2. Direct form of force measurement?
3. Working with CCG live camera feeds (referenced in B. Dowden)?
4. Wayne Pearson's ship-ice model
    1. Is this possible to use?

REFERENCES

B. Dowden, O. De Silva, W. Huang, and D. Oldford, “Sea ice classification via deep neural network semantic segmentation,” IEEE Sensors Journal

R. Gash and J. Millan, “Managed ice loads on a dynamically positioned vessel,” in OTC Arctic Technology Conference, pp. OTC–23774, OTC, 2012.

M. Islam, J. Wang, J. Mills, T. Sayeed, B. Gash, M. Lau, D. Millan, and J. Millan, “Dp in ice environment-improving safety and efficiency of arctic operations,” in OTC Arctic Technology Conference, pp. OTC–27349, OTC, 2016

S. Islam, J. Wang, J. Brown, M. Lau, R. Gash, D. Millan, and J. M. Ocean, “Physical model testing for supporting ice force model development of dp vessels in managed ice,” in OTC Arctic Technology Conference, p. D023S009R005, OTC, 2018

S. Akter, “Image based real-time ice load prediction tool for ship and offshore platform in managed ice field,” 2023