Sea Ice Tracking

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Introduction

In polar region operations, drift ice positioning and tracking is useful for both scientific and safety reasons. It is a multi-target multi-sensor tracking problem that poses particular challenges in

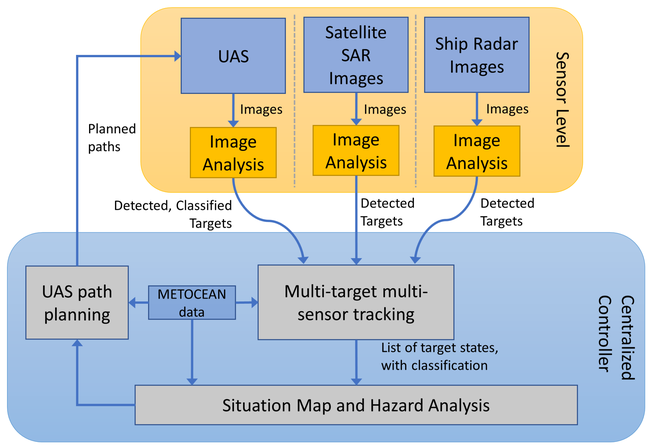
- Estimating currents and winds.
- Modeling sea ice motion.
- Deploying sensors in remote and isolated regions.
- Covering large areas with sensors.

System Design

Many types of sensors can be employed to generate detections of sea ice. Three categories of sensors considered are

- **Stationary Sensors** with known, fixed position and field-of-view, such as ground-based radar.
- **Traceable Sensors** with known but not fixed position and field-of-view, albeit not controllable, such as satellites.
- **Controllable Sensors** with known position and field-of-view that can be commanded, such as UAS's.

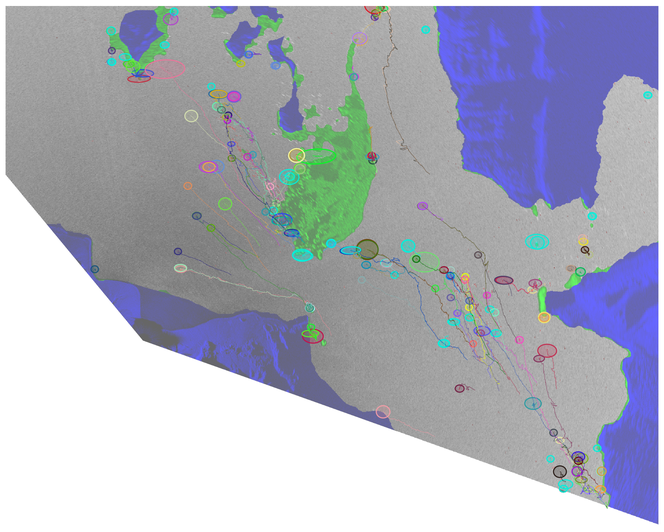
A system design for fusing and managing multiple sensors has been developed conceptually.



Tracking

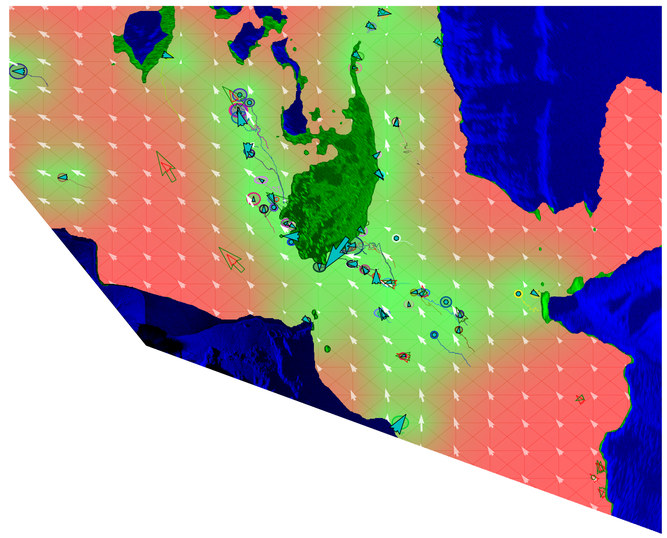
Data has been collected from a Terrestrial Radar Interferometer in Kongsfjorden, Svalbard. To track sea ice the following pipelined approach is used

- **Image Processing** to prepare the radar data.
- **Segmentation** of land, stationary ice and drift ice.
- **Clustering** of tracks using spatial indexing.
- **Tracking** using a Labelled Multi-Bernoulli (LMB) filter.
- **Estimation** using a particle filter.



Current Estimation

Given the trajectories of sea ice, the velocity components are used for estimating the currents. A Gaussian process (GP) is fitted to the data. The white arrows indicate the estimated currents, green indicates high quality of the estimate and red indicates low quality.



This is an example of a situation map that can be used by the path planning module.

Conclusions & Future Work

- Computationally demanding.
- Fusion of multiple sensors requires a modular system design.
- Possible to estimate currents from tracks.
- Improve information quality using feedback to command and plan UASs.
- Improve motion model using feedback of current estimation.

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