SFI · AUTOSHIP
Autonomous ships

Kunnskap for en bedre verden

Comparison of methods for using risk information in path planning for autonomous surface vessels

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Presentation outline

1. Introduction
2. Method
3. Case study and results
4. Discussion and conclusion

Introduction

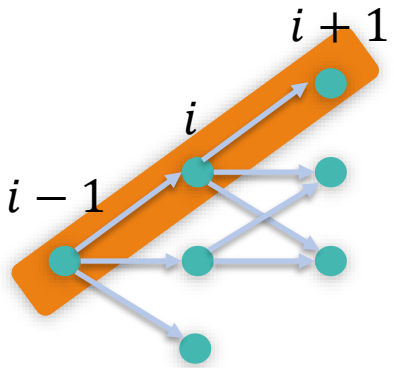
- Autonomous surface vessels (ASVs) are under development
- Autonomous operation
  - Perception of risk
- Online risk models

Introduction

- ASV operations → path planning
- Must consider risk → grounding
- Different approaches to providing risk information
  - Static safety domain
  - Online risk model

With a focus on risk of grounding, how does using an online risk model to support path planning compare to using a static safety domain?

Method – path planning



Goal: Find a set of waypoints to travel safely from start to goal.

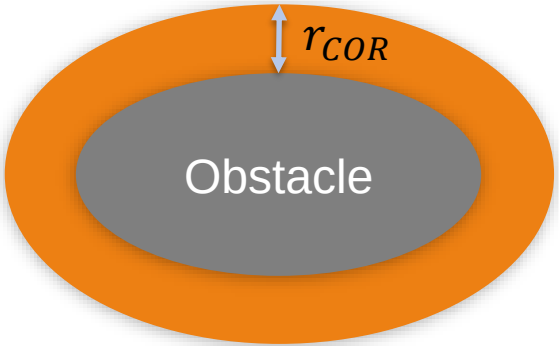
Heuristic search algorithm A* [1]

$$f(i) = g(i) + h(i)$$

Risk information can be included in the search [2].

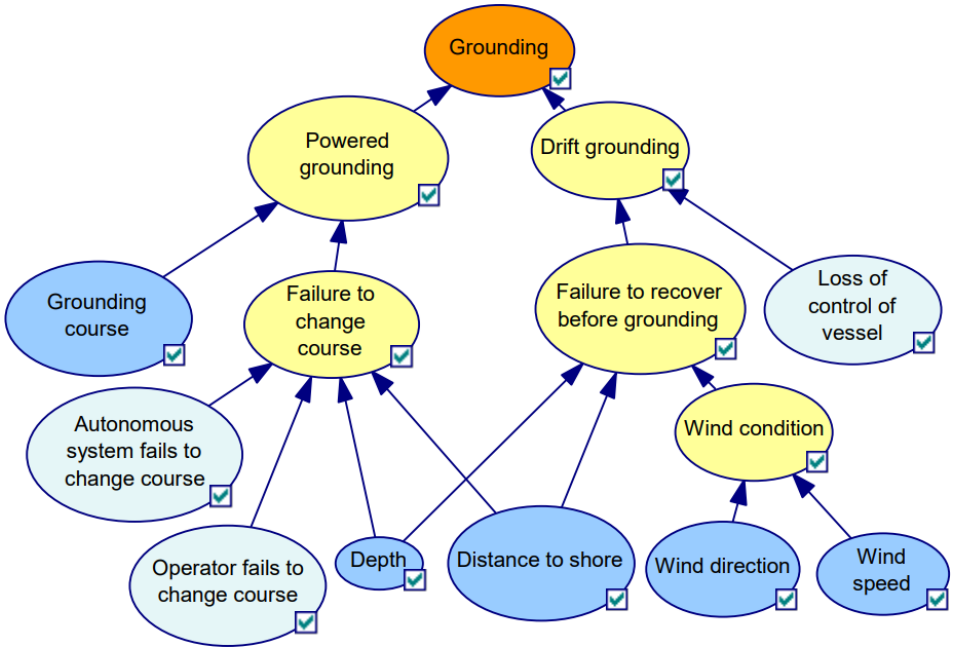
Method – static safety domain

- A circle of rejection (COR) around obstacles [3]
- Should not be entered unless strictly necessary



Method – online risk model

- Factors influencing risk of grounding identified
- Uses different sources of data
- Model adapted from [4]
- Based on navigation risk theory [5]

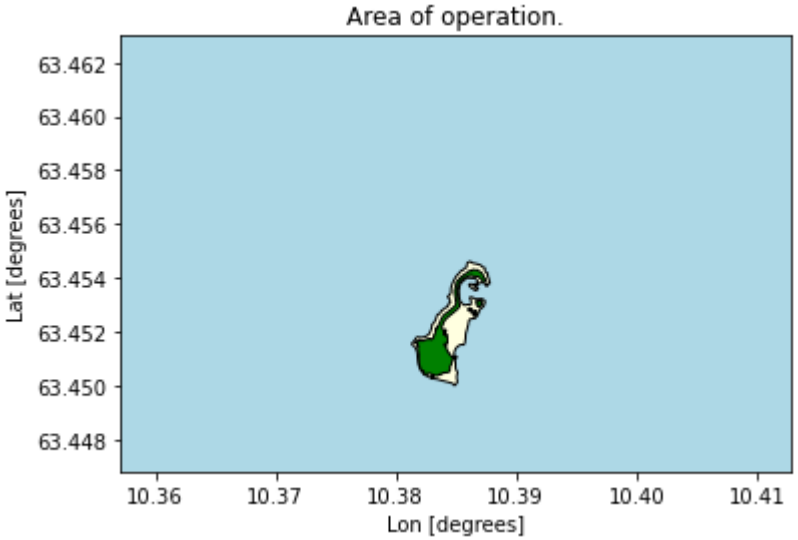


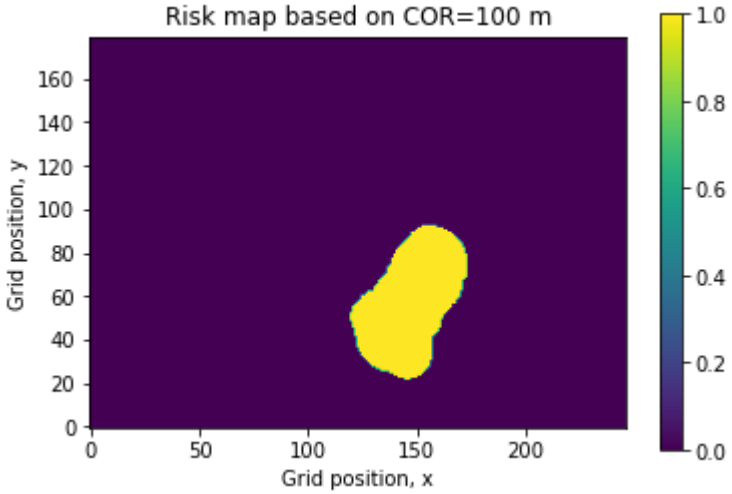
Case study

- Path planning for small ASV considering risk of grounding
- Area of operation: The Trondheimsfjord, Norway

ASV specifications [6,7]:
Length: 5.2 m
Width: 2.2 m
Draft: 0.3 m

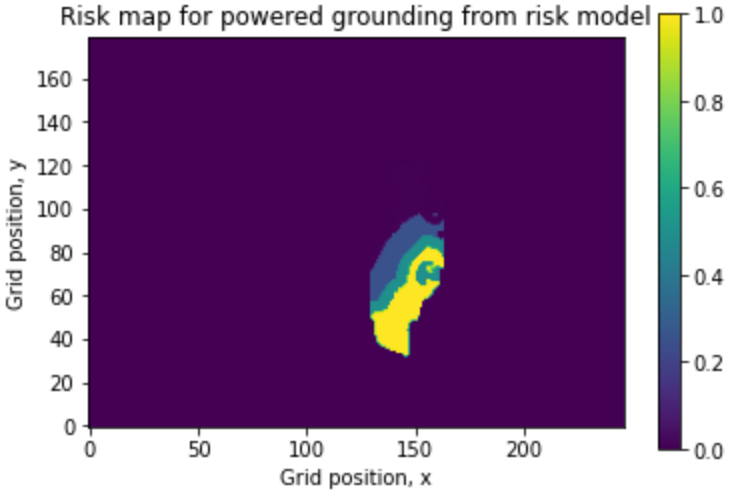
Case study results – COR

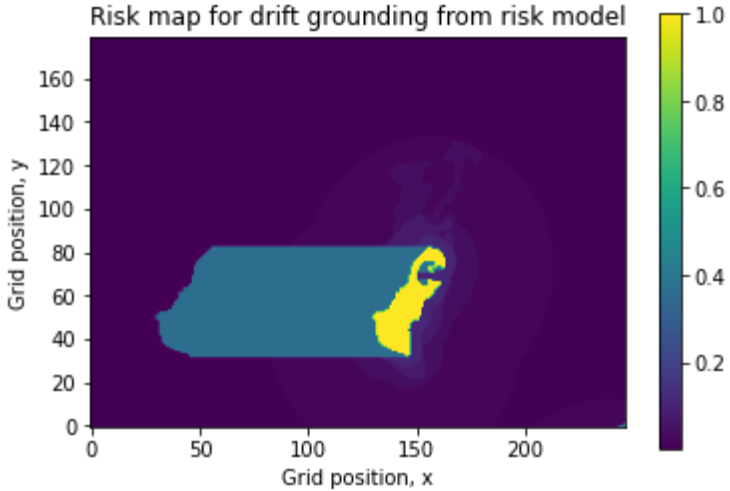




Map of area of operation. Electronic navigation charts from [8,9].

Case study results – Risk model

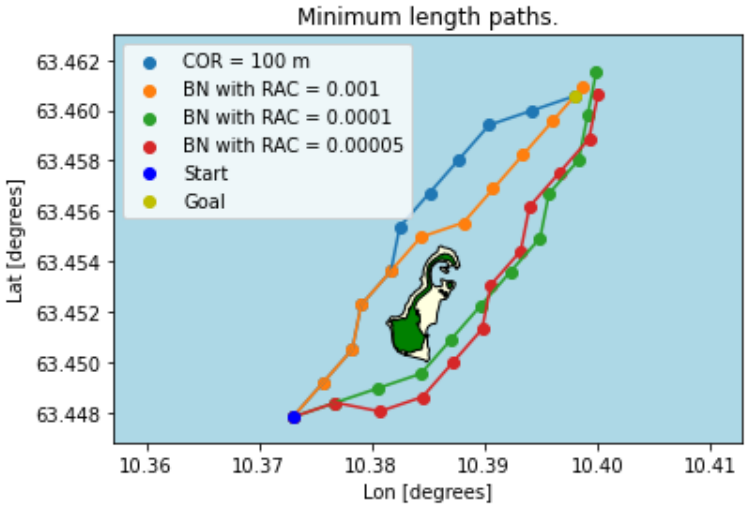


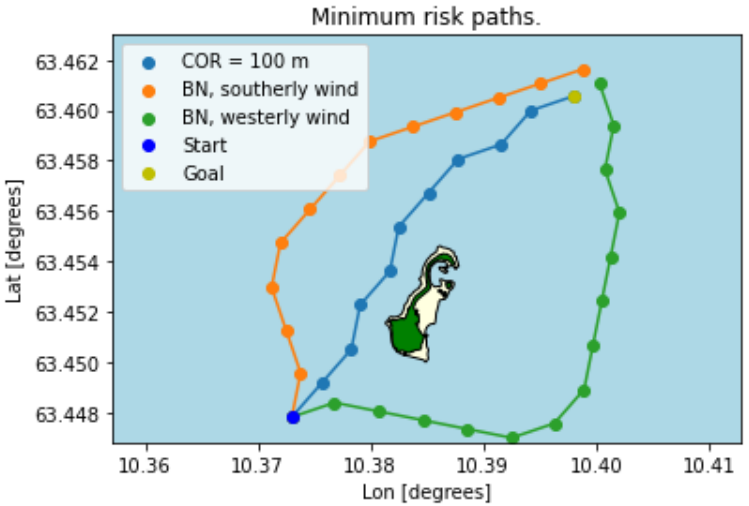


ASV heading towards south.

Westerly wind.

Case study results – Planned paths





Risk used as constraint.
Westerly wind.

Risk used in optimization function.
Varying wind direction.

Discussion and conclusion

- Factors influencing risk of grounding
  - Can be incorporated in risk model
  - Dynamic COR → large set of rules
- Risk tolerance
- Optimization

- The online risk model shows promise
- Can be a basis for a more detailed risk model

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