Safe coast proposals

Decision Support for GNSS Failure in Congested Channels
Autonomous ships operating in narrow and congested waterways may experience intermittent or degraded GNSS signals due to jamming, spoofing, or environmental constraints. Without accurate positioning, the vessel must decide between fallback strategies such as anchoring, switching to dynamic positioning, or proceeding based on dead reckoning. Each fallback option involves trade-offs related to safety, environmental constraints, and operational context.

This thesis focuses on evaluating and comparing fallback strategies under GNSS degradation and developing a decision support tool that can assess the risks and feasibility of each fallback option. The tool should include a mechanism for collaboration with remote operators and be tested using a maritime simulator in realistic congested channel scenarios.

The main research question of this work is: *How can fallback strategies be evaluated and recommended in GNSS-degraded environments to ensure safe navigation in congested waterways?*

Tasks related to this proposal could include:
1. Literature review on GNSS vulnerabilities, fallback strategies, and remote operator integration.
2. Modeling and simulation of fallback options in a realistic test environment.
3. Design of a decision support tool that evaluates the feasibility and safety of fallback options.
4. Integration of remote operator interaction and oversight.
5. Evaluation of robustness across different traffic, weather, and signal degradation scenarios.

Supervisors are Børge Rokseth and Tor Arne Johansen

Decision Support for Propulsion Mode Switching in Hybrid Maritime Systems
Hybrid propulsion systems enable ships to operate using either the main engine (mechanical mode) or electric propulsion (PTO/PTI). In case of a faults or degraded operation in the main engine, an autonomous ship must choose between continuing to operate the engine (risking further damage) or switching to reduced-power fallback modes that may limit maneuverability. These decisions involve trade-offs between safety, efficiency, and long-term equipment health, particularly when remote operator support is unavailable.

This thesis explores how a Bayesian Decision Network can be used to support autonomous fallback decisions under uncertainty. The network will model various propulsion modes, environmental factors, and the consequences of engine fault progression. As part of the project, the student will conduct a literature review on fault modes and damage accumulation in diesel engines to better quantify the risks of continued engine use under degraded conditions.

The decision model will be tested in a simulation environment, comparing its performance across different operational scenarios.

The main research question in this project is: *How can a probabilistic decision model support autonomous fallback decisions in hybrid propulsion systems, considering both environmental conditions and damage risks?*

Tasks related to this proposal could include:

1. Literature review on hybrid propulsion systems and fallback strategies.
2. Survey of fault types, degradation patterns, and damage risks in diesel engines operating under fault conditions.
3. Design of a Bayesian Decision Network to model fallback trade-offs.
4. Implementation and simulation of fallback scenarios (mechanical, PTO, PTI).
5. Evaluation of the model's performance in terms of safety, robustness, and long-term engine impact.

Børge Rokseth with be the supervisor on this project

Robust Decision-Making under Situational Awareness Degradation in Autonomous Maritime Systems

Autonomous ships rely on multiple sensors for situational awareness, including GNSS, radar, AIS, cameras, and inertial navigation systems. Under adverse conditions, such as fog, rain, spoofing, jamming, or partial system failure, these inputs may degrade resulting in uncertainty about the vessel's position, environment, and traffic situation. In such cases, the system must decide whether to continue operation, reduce speed, stop, reroute, or escalate to remote operator intervention.

This thesis explores how a Bayesian Decision Network (BDN) can support robust fallback decisions when situational awareness is degraded. The BDN will integrate observable indicators such as visibility, traffic density, and evidence of sensor degradation (e.g., inconsistent sensor readings, confidence levels, or environmental conditions), along with expert knowledge (e.g., rules from COLREG or operator best practices) and potentially learned models from data (e.g., sensor failure likelihoods, or success rates of fallback strategies). The model will infer the safest and most appropriate action given the current level of uncertainty.

The framework will be tested in simulation to evaluate its effectiveness across a range of sensor degradation and environmental conditions, with an emphasis on robustness, explainability, and adaptability.

The main research question of this project will be: *How can a Bayesian Decision Network combining observations, expert knowledge, and learned models support robust fallback decisions under degraded situational awareness in autonomous ships?*

Tasks related to this proposal could include:

1. Literature review on situational awareness, sensor degradation, and decision-making in autonomous maritime systems.
2. Identification of key observations (e.g., visibility, sensor reliability, traffic density) and expert decision rules.
3. Design and implementation of a Bayesian Decision Network combining observable data, domain knowledge, and (optionally) learned components.
4. Modeling fallback strategies such as speed reduction, station keeping, rerouting, or escalation to remote operators.
5. Simulation-based evaluation of decision robustness across varied scenarios.
6. Optional: Integration of remote operator input as a variable in the decision model.

Supervisors are Børge Rokseth and Tor Arne Johansen