NJORD

Njord - Preliminary Task Description

Contents

All of us in Njord are proud to present the 2021 Autonomous Ship Challenge. To allow for participants from anywhere in the world, the first challenge will be entirely digital.

This year, teams are tasked with designing a guidance system for a vessel in our simulation platform. The vessel will be outfitted with all necessary sensors, including GPS, IMU, 4 optical cameras and a lidar. Using this data, teams are expected to establish situational awareness, and complete tasks in various scenarios whilst respecting COLREGs.
Teams will control the vessel pictured below, an 11 meter long retrofitted lifeboat inspired by our main sponsor Kongsberg's Ocean Space Drones. Outfitted with two azimuth thrusters, it is capable of dynamic positioning.

The scenarios teams will be challenged with are split into 3 categories, including docking, maneuvering through trafficked waters and navigating difficult waterways. Within each category, teams will face multiple scenarios with slowly increasing difficulty. All scenarios will have a success condition, for example a GPS coordinate the vessel must reach.

For example, the **first** docking scenario will lack any significant obstacles, whereas in the later scenarios, there may be significant crosswinds in addition to other vessels in the vicinity of the dock.
The **second** category will require teams to navigate their vessel through trafficked waters in a predictable and safe manner.
Lastly, the **third** category includes scenarios where the vessel must navigate through shallow and slim waterways, relying on physical markers and buoys to reach its destination.

The performance of each team's guidance system will be assessed by a panel of judges on the competition day itself in August 2021. The judges will have a range of relevant backgrounds, including representatives from naval and technical universities, relevant businesses and other organisations. They will assess teams based on both qualitative and quantitative data, awarding points for efficiency in pathfinding, maneuvering in accordance to COLREGs and discovering potential obstacles at an early stage (among other aspects), and penalizing for undesirable behaviors, such as collisions. Lastly, the judges will also assess each team's technical report, explained in further detail in the participant requirements section.

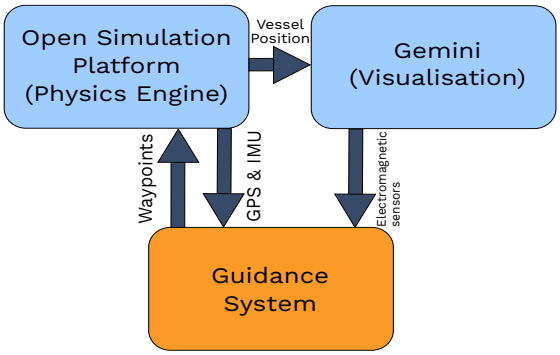
The 2021 Autonomous Ship Challenge will be run using the Open Simulation Platform in combination with Gemini. The Njord technical team works closely with the developers of both platforms to add functionality tailored for the challenge, and offer participants high quality technical support.

The Open Simulation Platform (OSP) is a powerful co-simulation platform based on the Functional Mockup Unit (FMU) standard, posed to become an industry standard. OSP will be responsible for the physics simulation in the challenge, as well as controlling the surrounding environment.

OPEN SIMULATION PLATFORM

Gemini is a Unity-based visual simulator developed at NTNU. In addition to visualising simulations in real time, it boasts virtual lidar and cameras which can be used with image recognition software.

To interface with the simulation platform, teams will communicate with OSP and Gemini using well documented APIs. Teams will not be required to implement any modules in OSP or Gemini, only communicate with them. Feeds from the optical cameras and lidar will be accessible directly from Gemini. Traditional navigation sensors such as GPS and IMU will be accessible from OSP. To control their vessels, teams will continuously relay waypoints to the physics engine. This high-level control is deliberately chosen to increase the focus on situational awareness and collision awareness, rather than thruster allocation and dynamic positioning.



This year's challenge is limited to the guidance system block in the figure above. This module may include systems for sensor processing, state estimation, situational awareness, guidance algorithms and collision avoidance. Teams are not expected to implement control algorithms, as these are outside of the scope of the challenge, and already installed in the simulation platform. Further details of this implementation will be made available when the platform is released.

Teams are welcome to incorporate existing software platforms and middleware into their guidance systems. For example, a bridge to ROS will be included in the simulator package. Existing image recognition software may also be implemented.

Finances

As the 2021 challenge will be entirely digital, the estimated required budget is not large. Registering to participate in the competition is completely **free**. However, teams are still encouraged to seek partnerships and sponsorships with their universities and local businesses to fund their efforts. In addition to financial support, many relevant businesses may be able to aid with technical equipment or experience.

A significant expense teams may have is a computer to run simulations. The simulation platform runs best with a dedicated graphics card, which is recommended for participation. Tests have been carried out on mid-ranged laptops as well, where simulations are successful, albeit a bit slow.

Furthermore, if applicable travel restrictions allow, teams will be invited to Trondheim in August 2021 for the competition. Teams will have to cover board and travel expenses themselves, with more information coming closer to the event.

Check-ins

We understand the scale of the challenge teams will be undertaking, and as organizers we aspire to facilitate effective communication and progress. In the months leading up to the competition, teams will have brief, periodic meetings with members of the organizing team to have questions answered and help ensure they are on-track for the competition.

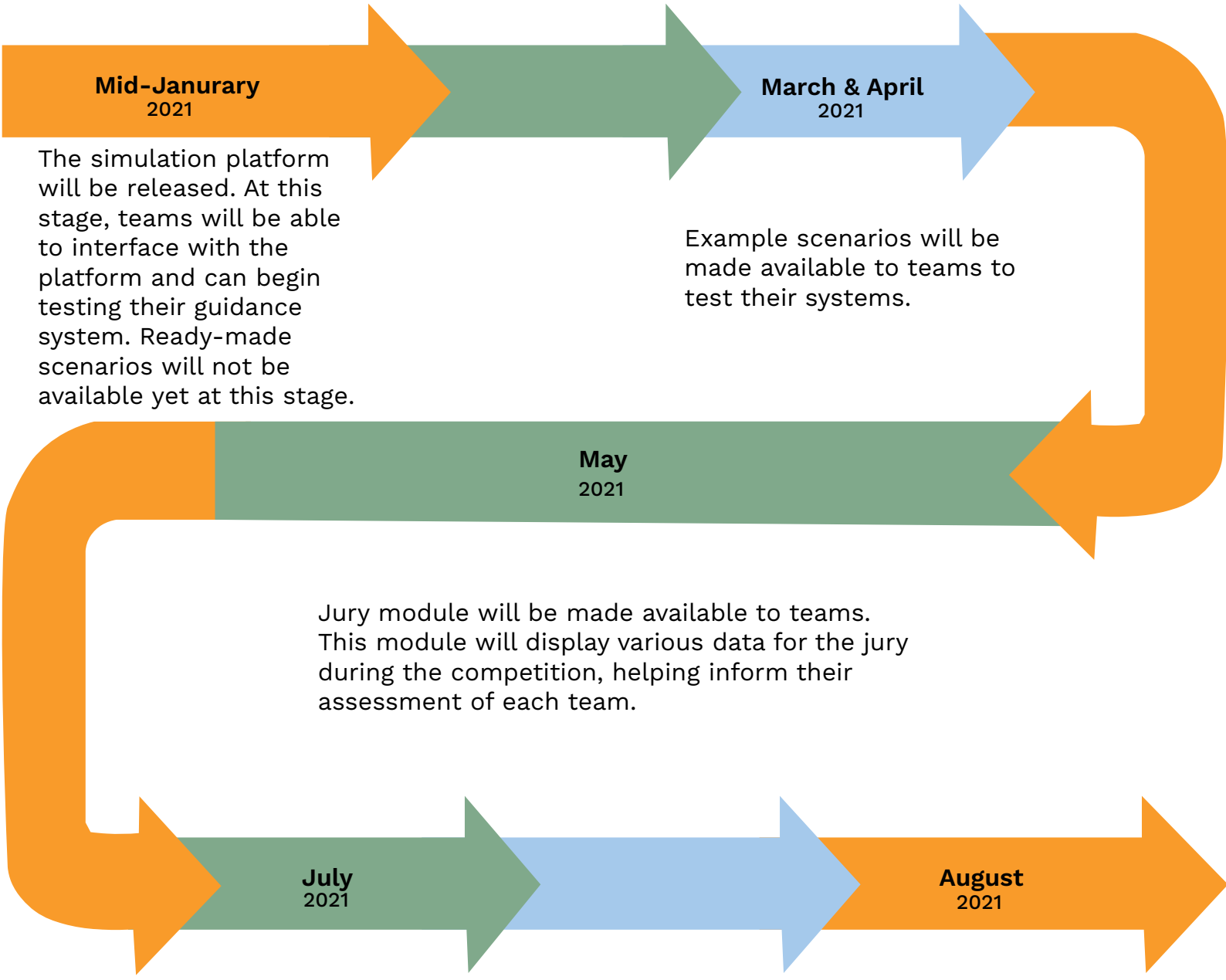
In addition, an official forum will be launched where teams can communicate with each other and ask questions related to the competition.

Technical Report

The Technical Report is a written report outlining design choices and considerations made by teams during the creation of their autonomous guidance system. It is an opportunity for teams to highlight their attention to detail and reason for their design choices. The report is expected to include an overview of the system architecture, as well as an increased focus on any innovative aspects. The reports will be made available to the jury and count towards a team's overall competition score. Detailed requirements to the report will be made available at a later date.

Timeline until the Competition

As the simulation platform is still not quite ready for distribution, we kindly ask for your patience on this aspect. Despite this, we encourage interested students to begin recruiting team members, as significant progress in terms of research of existing software and system architecture can be made. Additionally, we encourage teams to ask us to elaborate upon anything in this document prior to the simulator release.



How to join the Challenge

To join the competition, you and your team must be in an undergraduate or graduate program. You will also need to send in a form to Njord, where you can document team members (at least two), and a contact person from your university.

There is no upper limit for the number of members in a team, but we estimate that you will need at least 4 students. The challenge is intentionally multi-disciplinary, and we encourage teams to include members with varied backgrounds. Students studying cybernetics, computer science, electrical- or marine engineering are all relevant to the team, amongst others.

To formally join the challenge, go to
https://www.njordchallenge.com/the-competition/join
and follow the given instructions.