

## WASP Project Course 2023

# Multi-Vessel Control for Unmanned Surface Vessels

## Background

This project will explore and implement multi-vessel planning and control for unmanned surface vessels, USVs. Having multiple vessels act as one single virtual agent at the higher layers of a mission control, would improve operator efficiency in complex missions such as in a search-and-rescue scenario. In the research arena WARA-PS, the planning and visualization of missions is performed via the Arena Map [1]. Project scenarios and assignments include:

- Relocation task. When relocating a group of vessels, the group of vessels should then self-organize the transition and stop once the relocation is completed. The relocation is to be performed efficiently and collision free and could be done in a lead-follow manner.
- Formation control. Having two vessels work in a pair, they could pull a rescue device between them. This requires the vessels to keep a side-by-side formation with a predefined distance in between, and subsequently autonomously perform a rescue operation when reaching the target.

**Constraints:** Initial field experiments at WARA-PS in Gränsö, Västervik in September. Additional experiments and final field demonstration as part of delivery, with location to be decided among group members.

## Participants

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## Challenges to investigate

- Starting off with control for one single vessel, the problem will step-wise increase in complexity with the ultimate objective to perform a field demonstration of formation control for USVs.
- Path control based on the onboard course and speed controller, using absolute position measurements from the onboard GPS.
- Formation control. Implement robust control for keeping the formation despite disturbances from the environment and the surrounding vessels. For an introduction theoretical background on multi-agent formation control, please see [3] and [4].
- Optionally: Explore relative control by utilizing LIDAR sensor information available from the Piraya vessel.

## Resources

Vessels in use will be the WARA-PS Mini-USVs [2], equipped with sensor information from GPS and controlled through provided set-points for course and speed. Optionally, for relative measurements, the Piraya vessel with LIDAR may also be used. The WARA-PS Software-In-The-Loop (SITL) Simulator, built on ArduPilot Simulator [5], is available as a development tool.

## Deliverables

- Simulation and visualization in WARA-PS SITL simulator
- Field demonstration with WARA-PS Mini-USVs
- Deliverables according to course requirements

## References

- [1] <https://portal.waraps.org/page/applications-and-tools>
- [2] <https://portal.waraps.org/page/mini-usv>
- [3] Oh, K. K., Park, M. C., & Ahn, H. S. (2015). "A survey of multi-agent formation control". *Automatica*, 53, 424-440.
- [4] Parker, L.E., Rus, D., Sukhatme, G.S. (2016). Multiple Mobile Robot Systems. In: Siciliano, B., Khatib, O. (eds) Springer Handbook of Robotics. Springer Handbooks. Springer, Cham. [https://doi.org/10.1007/978-3-319-32552-1\\_53](https://doi.org/10.1007/978-3-319-32552-1_53)
- [5] ArduPilot Simulator <https://ardupilot.org/dev/docs/sitl-simulator-software-in-the-loop.html>

## Keywords

USVs, formation control, multi-vessel, field experiments