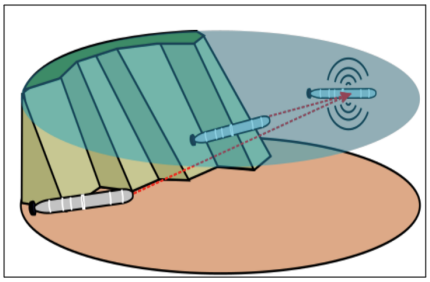
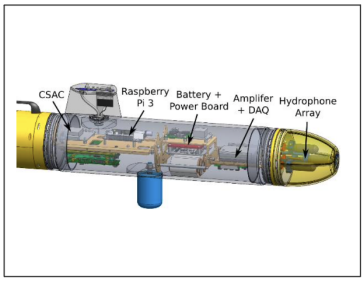
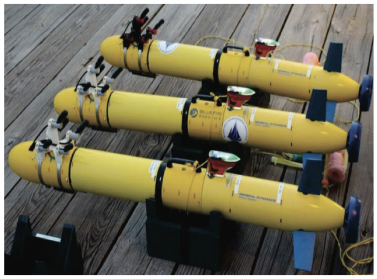
Perseus - A-Size UUV Swarming

The project addresses decentralized collaborative maritime autonomy, demonstrated through large-scale multi-vehicle distributed simulations and swarming operations using low-cost A-sized UUVs. The focus of the Perseus project is on the development of key enabling technologies required to realize Decentralized Collaborative Marine Autonomy using low-cost and expendable platforms. A key technology in this project is the one-way travel-time (OWTT) inverted ultra-short baseline (iUSBL) acoustic positioning system first demonstrated by MIT to enable multi-UUV relative navigation on a fleet of SandShark UUVs [Rypkema 2019, Fischell 2019]. The OWTT-iUSBL system consists of vehicle-mounted acoustic receiver arrays that are time-synchronized to a single acoustic beacon, allowing each UUV to calculate range and angle to the beacon and triangulate its relative position [Rypkema 2017]. This approach enables coordinated swarming behaviors such as maintaining formation [Rypkema 2019]. Although this system is significantly less expensive than a DVL-aided inertial navigation system typically used by UUVs, the prototype OWTT-iUSBL made use of a chip-scale atomic clock (CSAC) and off-the-shelf electronics resulting in increased cost; further development of the system in this project will take advantage of recently available electronics and crystal oscillator technologies to further lower system cost and size. Further refinement of system algorithms and autonomy will make it more robust for open-ocean use on A-size UUVs in Submarine Decoy missions, where multiple vehicles in formation will be used to emulate a larger target.







Status:	Ongoing since March 2021
Sponsors:	Lockheed Martin
People:	Nicholas Rypkema, Supun Randeni, Michael Triantafyllou (PI), Michael Benjamin (PI)
Software:	MOOS-IvP public codebase, Hydroman
Robots:	https://oceanai.mit.edu/pavlab/robots/morpheus

Relevant Prior Publications

2021 (1 item)

1. Toby Schneider, Supun Randeni, and Henrik Schmidt. Fast, Cheap and Good: Development of a high performance communications and navigation system for High Latitude AUV deployments using a Virtual Ocean. In *Antarctic and Southern Ocean Forum 2021*, October 2021.

2020 (2 items)

2. Toby Schneider, Henrik Schmidt, and Supun Randeni. Self-adapting under-ice integrated communications and navigation network. In *2020 Underwater Communications and Networking Conference (UComms)*. IEEE, 2020.
3. Supun Randeni, Erin Fischell, and Henrik Schmidt. An AUV dynamic model, based on the conservation of energy, for underwater navigation aiding. *IEEE Journal of Oceanic Engineering (Under Review)*, 2020.

2019 (2 items)

4. Nicholas Rahardiyan Rypkema. *Underwater and Out of Sight: Towards Ubiquity in Underwater Robotics*. PhD thesis, Massachusetts Institute of Technology, September 2019.
5. Erin Marie Fischell, Nicholas Rahardiyan Rypkema, and Henrik Schmidt. Relative autonomy and navigation for command and control of low-cost autonomous underwater vehicles. *IEEE Robotics and Automation Letters*, 4(2):1800–1806, 2019.

2017 (1 item)

6. Nicholas R. Rypkema, Erin M. Fischell, and Henrik Schmidt. One-way travel-time inverted ultra-short baseline localization for low-cost autonomous underwater vehicles. In *IEEE International Conference on Robotics and Automation (ICRA)*, Singapore, May 2017.

References

[1] Erin Marie Fischell, Nicholas Rahardiyan Rypkema, and Henrik Schmidt. Relative autonomy and navigation for command and control of low-cost autonomous underwater vehicles. *IEEE Robotics and Automation Letters*, 4(2):1800–1806, 2019.

[2] Supun Randeni, Erin Fischell, and Henrik Schmidt. An AUV dynamic model, based on the conservation of energy, for underwater navigation aiding. *IEEE Journal of Oceanic Engineering (Under Review)*, 2020.

[3] Nicholas R. Rypkema, Erin M. Fischell, and Henrik Schmidt. One-way travel-time inverted ultra-short baseline localization for low-cost autonomous underwater vehicles. In *IEEE International Conference on Robotics and Automation (ICRA)*, Singapore, May 2017.

[4] Nicholas Rahardiyan Rypkema. *Underwater and Out of Sight: Towards Ubiquity in Underwater Robotics*. PhD thesis, Massachusetts Institute of Technology, September 2019.

[5] Toby Schneider, Supun Randeni, and Henrik Schmidt. Fast, Cheap and Good: Development of a high performance communications and navigation system for High Latitude AUV deployments using a Virtual Ocean. In *Antarctic and Southern Ocean Forum 2021*, October 2021.

[6] Toby Schneider, Henrik Schmidt, and Supun Randeni. Self-adapting under-ice integrated communications and navigation network. In *2020 Underwater Communications and Networking Conference (UComms)*. IEEE, 2020.