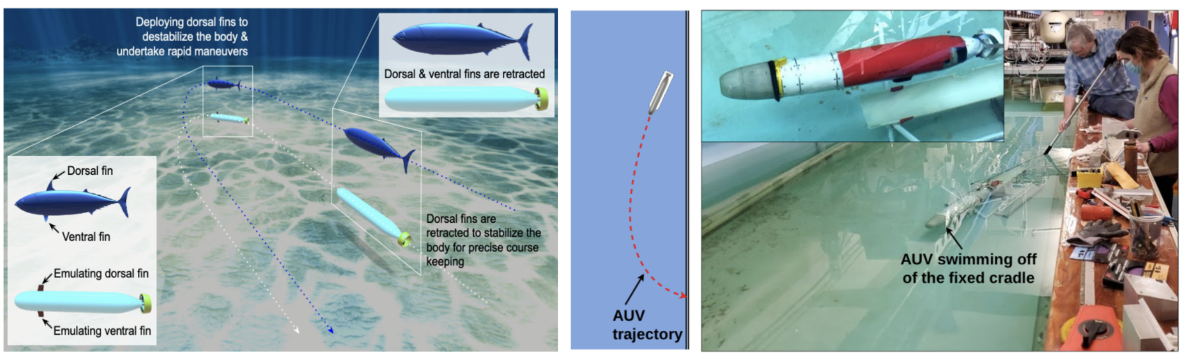
Morpheus - A Highly Maneuverable AUV with Bioinspired Dorsal Fins

By adopting bioinspired morphing dorsal and ventral fins, this project demonstrates how to achieve good directional stability, exceptional maneuverability, and minimal adverse response to turbulent flow, properties that are highly desirable for rigid hull AUVs, but are presently difficult to achieve because they impose contradictory requirements. This project develops the theory and design for switching between operating with sufficient stability that ensures a steady course in the presence of disturbances, with low corrective control action; reverting to high maneuverability to execute very rapid course and depth changes, improving turning rate by 25% up to 50%; and ensuring at all times that angular responses to external turbulence is minimized. Developments are demonstrated through tests on a 1-meter long autonomous underwater vehicle (AUV), named *Morpheus*. The vehicle is capable of dynamically changing its stability-maneuverability qualities by using tuna-inspired morphing dorsal fins, which can be deployed, deflected and retracted, as needed. A series of free-swimming experiments and maneuvering simulations, combined with mathematical analysis, led to the design of optimal retractable dorsal fins.



`Status:`	Ongoing since August 2019
`Sponsors:`	Lockheed Martin
`People:`	Supun Randeni, Michael Sacarny, Michael Triantafyllou (PI), Michael Benjamin (PI), Emily Mellin, Skyler Cheung
`Software:`	MOOS-IvP public codebase, Hydroman
`Robots:`	`https://oceanai.mit.edu/pavlab/robots/morpheus`

Recent Publications

2022 (1 item)

1. Supun Randeni, Emily M Mellin, Michael Sacarny, Skyler Cheung, Michael Benjamin, and Michael Triantafyllou. Bioinspired morphing fins to provide optimal maneuverability, stability, and response to turbulence in rigid hull auvs. *Bioinspiration & Biomimetics*, 17(3), April 2022.

2021 (1 item)

2. Supun Randeni, Emily Mellin, Michael Sacarny, Skyler Cheung, Michael Benjamin, and Michael Triantafyllou. Bioinspired dorsal fins to provide optimal maneuverability, stability, and response to turbulence in rigid hull auvs. Submitted and Under Review, 2021.

2020 (2 items)

3. 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.
4. 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.

References

[1] 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.

[2] Supun Randeni, Emily Mellin, Michael Sacarny, Skyler Cheung, Michael Benjamin, and Michael Triantafyllou. Bioinspired dorsal fins to provide optimal maneuverability, stability, and response to turbulence in rigid hull auvs. Submitted and Under Review, 2021.

[3] Supun Randeni, Emily M Mellin, Michael Sacarny, Skyler Cheung, Michael Benjamin, and Michael Triantafyllou. Bioinspired morphing fins to provide optimal maneuverability, stability, and response to turbulence in rigid hull auvs. *Bioinspiration & Biomimetics*, 17(3), April 2022.

[4] 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.