The Heron



The Heron is a small unmanned surface vehicle (USV) made by Clearpath Robotics in Waterloo Canada. MIT has six Herons with plans for addition vehicles in the Spring of 2021. They are the primary teaching platform for MIT 2.680 taught each Spring Term since 2012.

Size:	53.2 x 38.6 x 12.6 in
Weight:	28 kg (62 lbs)
Sensors:	GPS, IMU
Top Speed:	1.9 meters / sec
Battery Life:	1-2 hours depending on misssion/speed
Software:	Front Seat (ROS/Clearpath), Back Seat RasPi MOOS-IvP
Further Info:	https://oceanai.mit.edu/herons
Heron USV Photos:	https://oceanai.mit.edu/media/HeronUSV/album
Current Projects:	https://oceanai.mit.edu/pavlab/proj/seatrain
	https://oceanai.mit.edu/pavlab/proj/iitchs
	https://oceanai.mit.edu/pavlab/proj/swarmbox
Recent Events:	https://oceanai.mit.edu/media/Aug3121-SeaTrain/album
	https://oceanai.mit.edu/media/Oct1821-SeaTrainTests/album

Recent Publications

2024 (1 item)

1. Tyler Paine and Michael Benjamin. A model for multi-agent autonomy that uses opinion dynamics and multi-objective behavior optimization. In *International Conference on Robotics and Automation (ICRA)*, May 2024.

2023 (3 items)

2. Tyler Paine and Michael Benjamin. An ensemble of online estimation methods for one degree-of-freedom models of unmanned surface vehicles; applied theory and preliminary field results

with eight vehicles. In *International Conference on Intelligent Robots and Systems (IROS)*, October 2023.

3. Nikolai Gershfeld, Tyler Paine, and Michael Benjamin. Adaptive and collaborative bathymetric channel-finding approach for multiple autonomous marine vehicles. *The IEEE Robotics and Automation Letters*, 8(7):4028–4035, 2023.
4. Nicholas Rober, Karan Mahesh, Tyler M. Paine, Max L. Greene, Steven Lee, Sildomar T. Monteiro, Michael R. Benjamin, and Jonathan P. How. Online data-driven safety certification for systems subject to unknown disturbances, 2023.

2021 (2 items)

5. Michael Benjamin, Tyler Paine, and Supun Randeni. Autonomy algorithms for stable dynamic linear convoying of autonomous marine vehicles. In *OCEANS 2021 MTS/IEEE*, October 2021.
6. Blake Cole and Michael Benjamin. Ais-based collision avoidance in moos-ivp using a geodetic unscented kalman filter. In *OCEANS 2021: San Diego - Porto*, October 2021.

2019 (1 item)

7. Michael Novitzky, Caileigh Fitzgerald, Paul Robinette, Michael R. Benjamin, and Henrik Schmidt. Updated: Virtual reality for immersive simulated experiments of human-robot interactions in the marine environment. In *Proceedings of the Workshop Virtual, Augmented, and Mixed Reality for Human-Robot Interaction ACM/IEEE International Conference on Human-Robot Interaction*, Daegu, South Korea, March 2019. ACM/IEEE.

2018 (2 items)

8. Michael Novitzky, Paul Robinette, Michael R. Benjamin, Danielle K. Gleason, Caileigh Fitzgerald, and Henrik Schmidt. Preliminary interactions of human-robot trust, cognitive load, and robot intelligence levels in a competitive game. In *Companion of the 2018 ACM/IEEE International Conference on Human-Robot Interaction*, pages 203–204. ACM, 2018.
9. Paul Robinette, Michael Novitzky, and Michael R. Benjamin. Longitudinal interactions between human and robot teammates in a marine environment. In *In Workshop on Longitudinal Human-Robot Teaming at HRI 2018*, Chicago, IL, March 2018.

2017 (2 items)

10. Michael Novitzky, Paul Robinette, Danielle K. Gleason, and Michael R. Benjamin. A platform for studying human-machine teaming on the water with physiological sensors. In *Workshop on Human-Centered Robotics: Interaction, Physiological Integration and Autonomy at RSS 2017*, Cambridge, MA, July 2017.
11. Paul Robinette, Michael Novitzky, and Michael R. Benjamin. Trusting a robot as a user versus as a teammate. In *Workshop on Morality and Social Trust in Autonomous Robots at RSS 2017*, Cambridge, MA, July 2017.

2016 (1 item)

12. Kyle L. Woerner. *Multi-Contact Protocol-Constrained Collision Avoidance for Autonomous Marine Vehicles*. PhD thesis, Massachusetts Institute of Technology, June 2016.

Current Projects

MIT 2.680

The Herons are the lab vehicles for MIT 2.680 Marine Autonomy, Sensing and Communications.
https://oceanai.mit.edu/2.680.

DARPA Sea Train

The Herons are test platforms for the MIT team involved in the DARPA TTO Sea Train project. Field tests are comprised of four-vehicle convoying missions with algorithms for mustering and convoying tested with Herons.
https://oceanai.mit.edu/pavlab/seatrain.

Project: IITCHS

In a collaboration with MIT Lincoln Laboratory, the Herons are used for field testing multi-vehicle mission planning software using the MIT-LL IITCHS planning software and MIT's MOOS-IvP autonomy software.
https://oceanai.mit.edu/pavlab/iitchs.

References

[1] Michael Benjamin, Tyler Paine, and Supun Randeni. Autonomy algorithms for stable dynamic linear convoying of autonomous marine vehicles. In *OCEANS 2021 MTS/IEEE*, October 2021.

[2] Blake Cole and Michael Benjamin. Ais-based collision avoidance in moos-ivp using a geodetic unscented kalman filter. In *OCEANS 2021: San Diego - Porto*, October 2021.

[3] Nikolai Gershfeld, Tyler Paine, and Michael Benjamin. Adaptive and collaborative bathymetric channel-finding approach for multiple autonomous marine vehicles. *The IEEE Robotics and Automation Letters*, 8(7):4028–4035, 2023.

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[5] Michael Novitzky, Paul Robinette, Michael R. Benjamin, Danielle K. Gleason, Caileigh Fitzgerald, and Henrik Schmidt. Preliminary interactions of human-robot trust, cognitive load, and robot intelligence levels in a competitive game. In *Companion of the 2018 ACM/IEEE International Conference on Human-Robot Interaction*, pages 203–204. ACM, 2018.

[6] Michael Novitzky, Paul Robinette, Danielle K. Gleason, and Michael R. Benjamin. A platform for studying human-machine teaming on the water with physiological sensors. In *Workshop on Human-Centered Robotics: Interaction, Physiological Integration and Autonomy at RSS 2017*, Cambridge, MA, July 2017.

[7] Tyler Paine and Michael Benjamin. An ensemble of online estimation methods for one degree-of-freedom models of unmanned surface vehicles; applied theory and preliminary field results with eight vehicles. In *International Conference on Intelligent Robots and Systems (IROS)*, October 2023.

[8] Tyler Paine and Michael Benjamin. A model for multi-agent autonomy that uses opinion dynamics and multi-objective behavior optimization. In *International Conference on Robotics and Automation (ICRA)*, May 2024.

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[10] Paul Robinette, Michael Novitzky, and Michael R. Benjamin. Trusting a robot as a user versus as a teammate. In *Workshop on Morality and Social Trust in Autonomous Robots at RSS 2017*, Cambridge, MA, July 2017.

[11] Paul Robinette, Michael Novitzky, and Michael R. Benjamin. Longitudinal interactions between human and robot teammates in a marine environment. In *In Workshop on Longitudinal Human-Robot Teaming at HRI 2018*, Chicago, IL, March 2018.

[12] Kyle L. Woerner. *Multi-Contact Protocol-Constrained Collision Avoidance for Autonomous Marine Vehicles*. PhD thesis, Massachusetts Institute of Technology, June 2016.