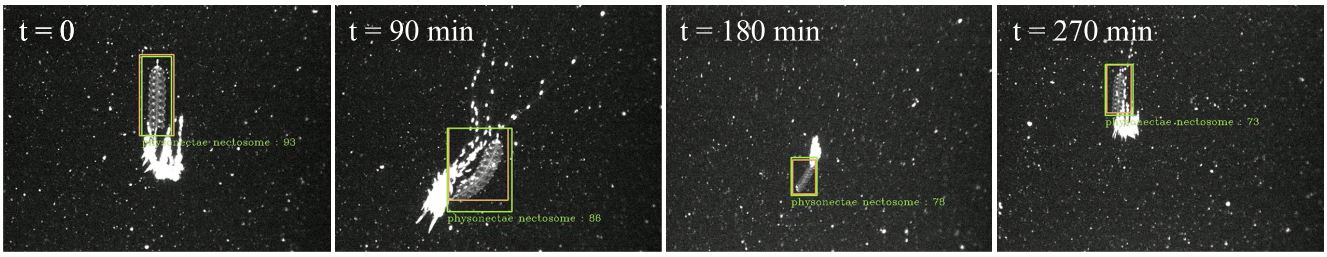
Visual tracking of deepwater animals using machine learning-controlled robotic underwater vehicles

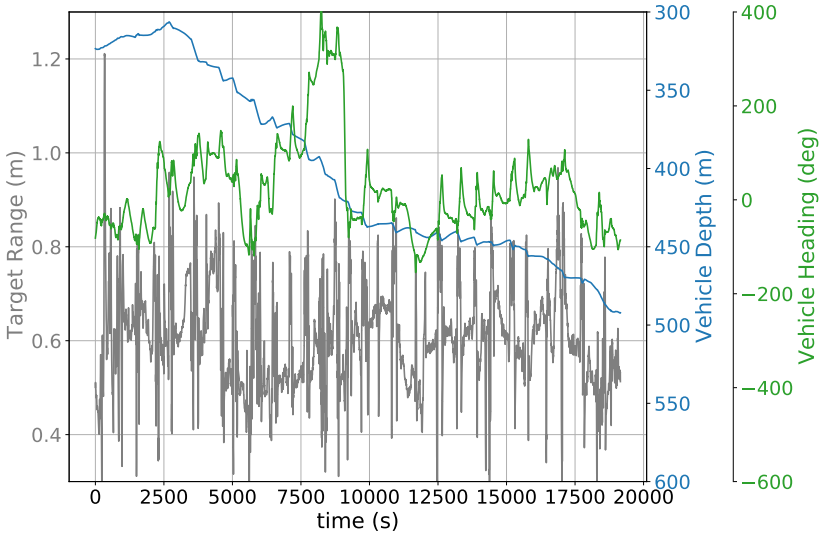
Supplementary Material

Supplementary Figures

Supplementary Figure 1. Representative color images of animal classes in the ML-Tracking detector.



Supplementary Figure 2. Framegrabs demonstrating the performance of the ML-Tracking algorithm on a 316 minute (or 5.27 hrs) observation of a siphonophore (*Lychnagalma* sp). Images shown are from the left camera, and cropped to 66% along each dimension. Green bounding boxes correspond to the detected location of the target class; orange bounding boxes correspond to the object being tracked; blue bounding boxes indicate an object that the detector has identified as a potential target; gray bounding boxes indicate objects of a non-target class. The full video sequence can be viewed at `https://youtu.be/PO784vQXA7Y`.



Supplementary Figure 3. Target range (gray), vehicle depth (blue), and vehicle heading (green) during the long duration track of a siphonophore, *Lychnagalma* sp.

Supplementary Videos

All five supplementary videos correspond to one of the use cases discussed in the main manuscript text. Full sequences are provided of both the left and right cameras of the stereo pair. ML-Tracking algorithm performance is shown, where green bounding boxes correspond to the detected location of the target class; orange bounding boxes correspond to the object being tracked; blue bounding boxes indicate an object that the detector has identified as a potential target; gray bounding boxes indicate objects of a non-target class.

Supplementary Video 1. Sequence demonstrating the ML-Tracking algorithm performance for use case 1, a steadily swimming single object (a ctenophore, *Beroe* sp.).

Supplementary Video 2. Sequence demonstrating the ML-Tracking algorithm performance for use case 2, a dynamically swimming single object (the nectosome of a siphonophore, *Prayidae*).

Supplementary Video 3. Sequence demonstrating the ML-Tracking algorithm performance for use case 3, multi-object detection with nested classes. Visible here is a giant larvacean (*Bathochordaeus*) inside its mucus house ("bathochordaeus house"), which is contained inside the larger "outer filter" structure.

Supplementary Video 4. Sequence demonstrating the ML-Tracking algorithm performance for use case 4, multi-object detection with multi-class occlusion. Here, a jellyfish (*Solmissus*) is tracked when a siphonophore (Physonectae nectosome) enters the field of view.

Supplementary Video 5. Sequence demonstrating the ML-Tracking algorithm performance for use case 5, multi-object detection with single-class occlusion. Initially, the larger *Solmissus* jellyfish is being tracked (orange rectangles), but tracking eventually transfers to the smaller individual.