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Performance Impacts on Unmanned Vehicle and Sensor Capabilities for Standoff Mine Detection in the Very Shallow Water, Surf Zone, and Beach Zone

Klamo, Joseph; Kragelund, Sean P.; Gozzi, Benjamin; Loberg, Ronan

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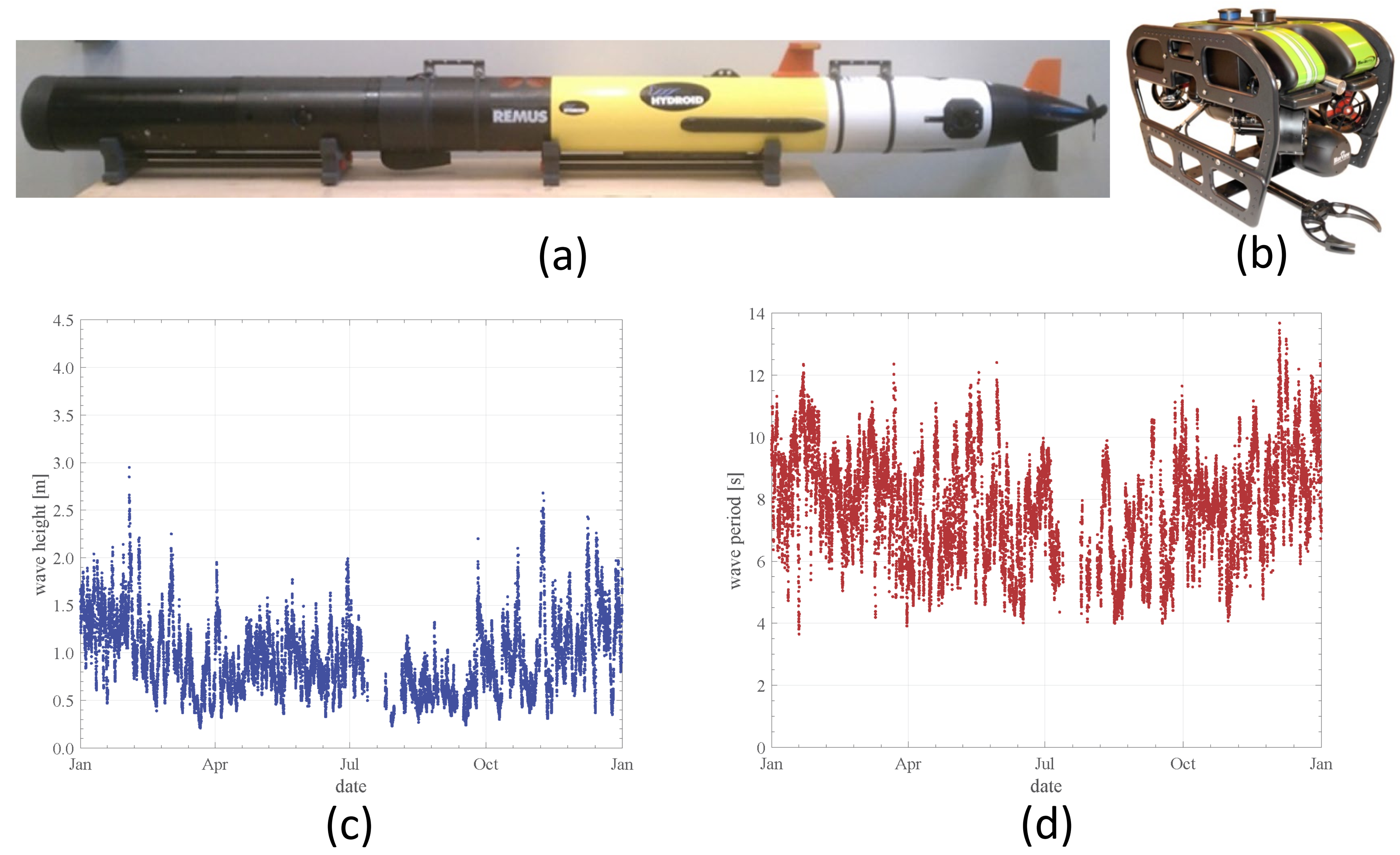
Performance Impacts on Unmanned Vehicle and Sensor Capabilities for Mine Detection in Very Shallow Water, Surf, and Beach Zones

Naval Postgraduate School

MOTIVATION

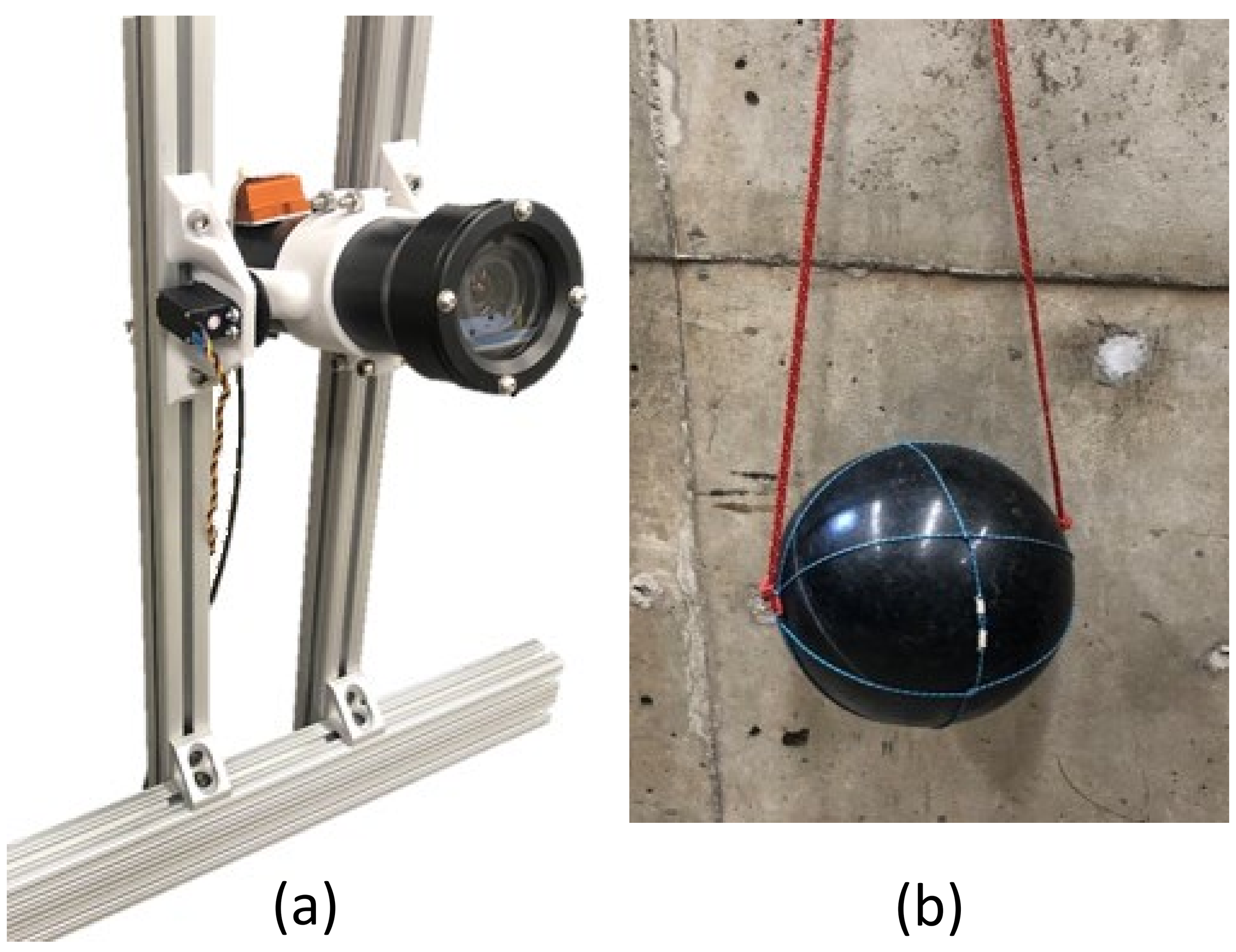
- Near-shore mine detection occurs in an environment that contains marine vegetation, strong water currents, and wave-induced loads.
- Wave-induced loads can cause an underwater vehicle to oscillate and degrade the quality of the collected sensor data.
- Degraded sensor data can make mine detection difficult for object detection algorithms trained using only high-quality images of mines.



Types of vehicles used for MCM: (a) REMUS-100 AUV, (b) NPS vLBV300 ROV ; Monterey Bay wave environment during 2020: (c) wave height, (d) wave period.

OBJECTIVE

- Determine the effect that sensor motion has on the performance of object detection software used to detect mines.



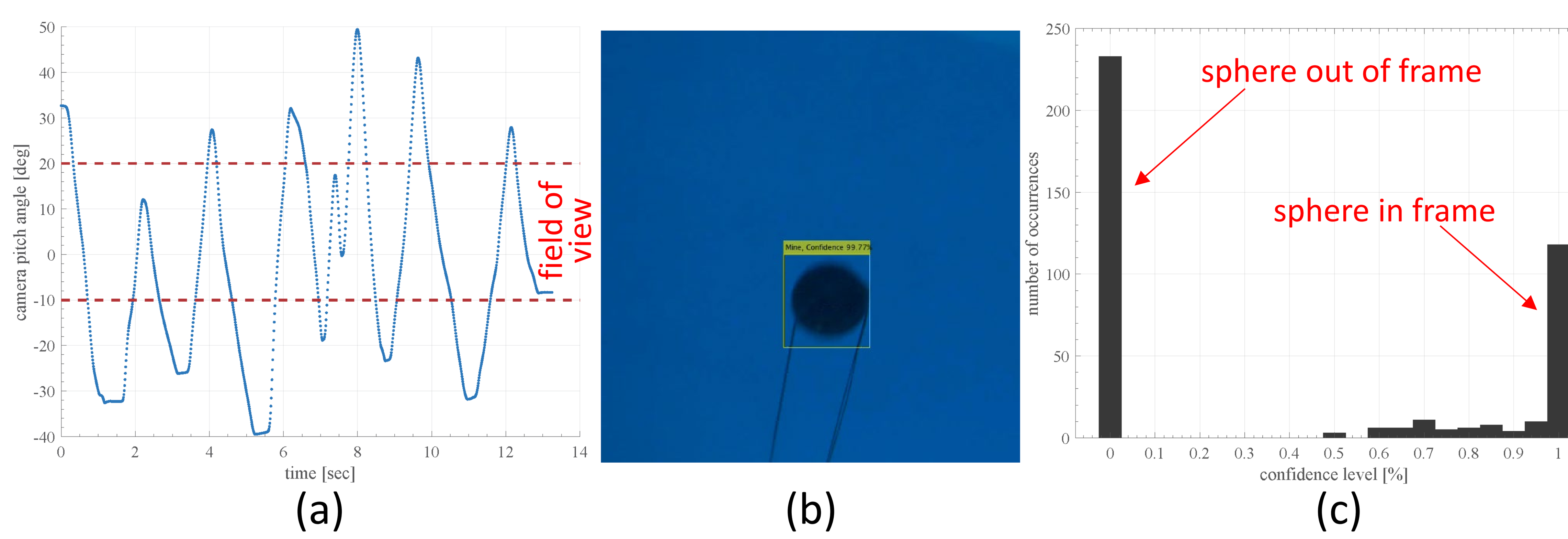
Experimental set-up: (a) 1-DoF rotating camera, (b) sphere used to represent underwater mine.

TECHNICAL APPROACH

- Performed experiments in the CAVR water tank at NPS using a Basler video camera and BlueView forward-looking sonar to capture images of a sphere submerged underwater.
- Sensors were subjected to multiple pitch angle and pitch rate profiles while recording raw images and inertial motion data.
- R-CNN deep-learning object detection software, trained using static images of a glass sphere, was used to identify this surrogate mine shape in the pitch motion test videos.
- Software returned the confidence that each detected object in an image was the sphere.

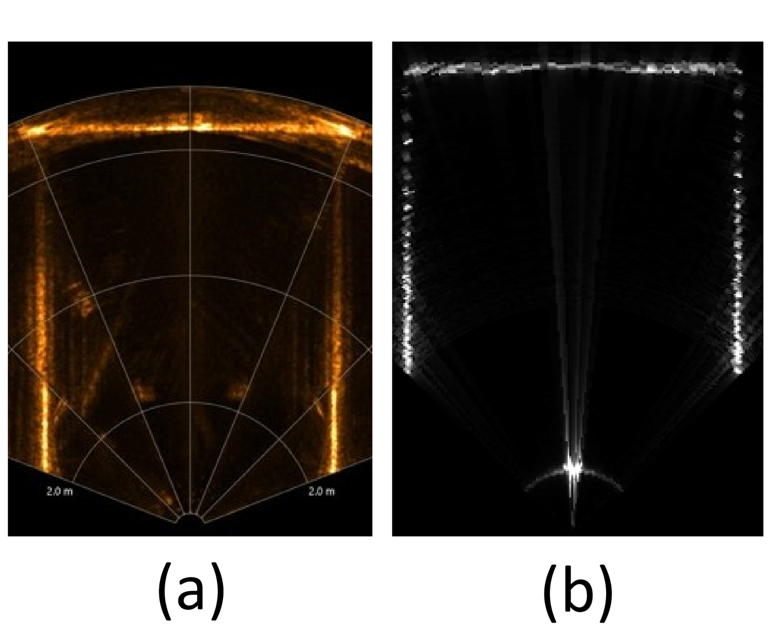
RESULTS

- Detection software identified the sphere with greater than 0.99 confidence when it was fully visible.
- The pitch angle and pitch rate had no effect on the detection confidence.
- Pitch rate faster than the camera frame rate resulted in blurry images and lower detection.



Analysis of the camera images: (a) time history plot of camera pitch angle, (b) sample image frame where R-CNN software identified the sphere, (c) confidence levels of detection.

FUTURE WORK



Sample sonar images to be processed with R-CNN object detection software: (a) experimentally collected, (b) synthetically generated.

- Perform detection analysis of the sonar images using the same R-CNN object detection software and training approach.
- Investigate the effects that marine vegetation or entrapped air, located between the sensor and the sphere, has on the confidence of object detection.

Researchers: Dr. Joseph Klamo & Dr. Sean Kragelund
Graduate School of Engineering and Applied Science

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