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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

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Monterey, California: Naval Postgraduate School

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

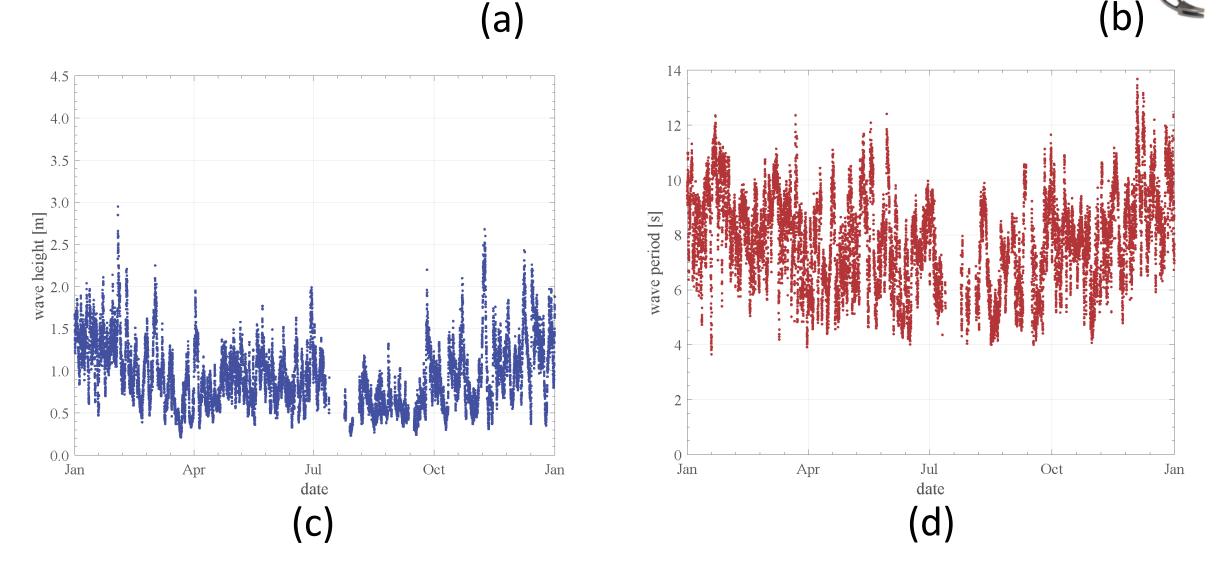
MOTIVATION

- 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.

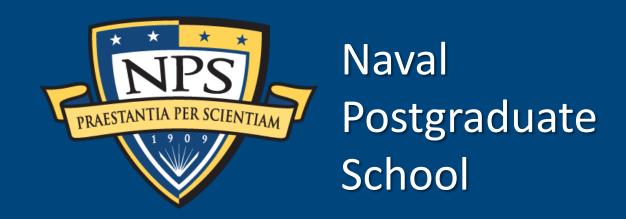
OBJECTIVE

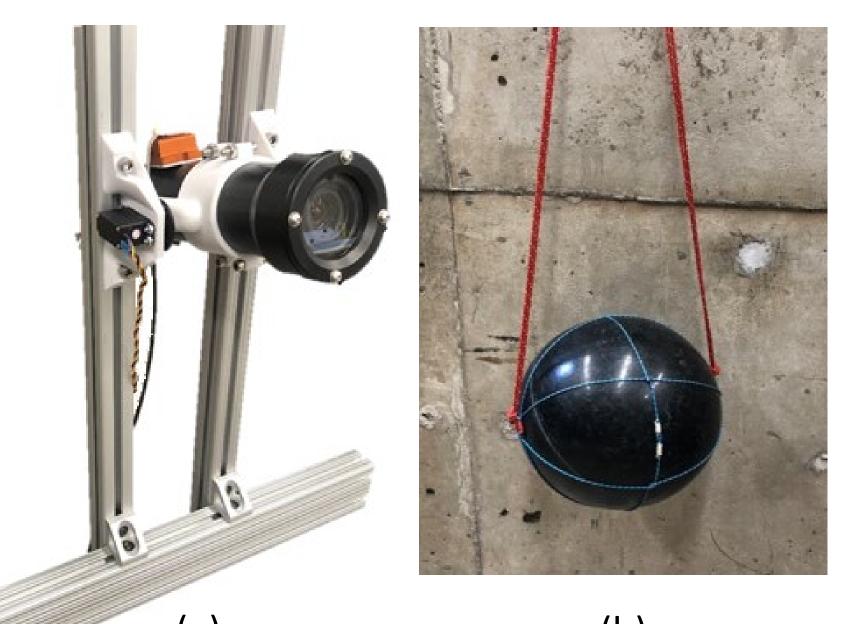
 Determine the effect that sensor motion has on the performance of object detection software used to detect mines.





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.





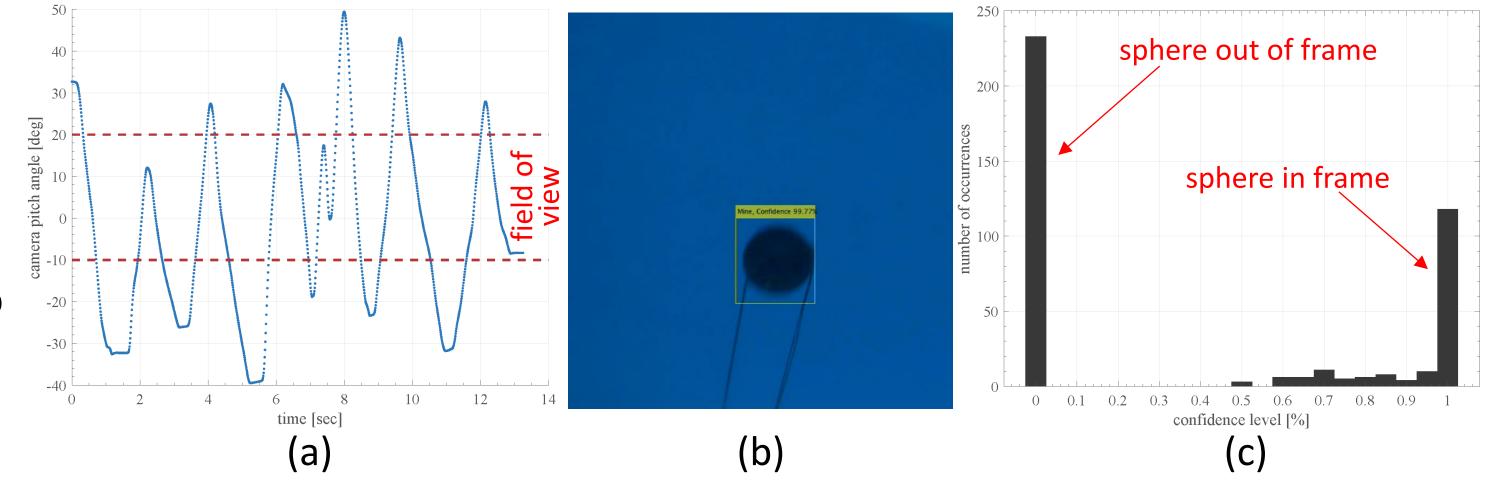
(a) (b)
Experimental set-up: (a) 1-DoF rotating camera,
(b) sphere used to represent underwater mine.

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

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.

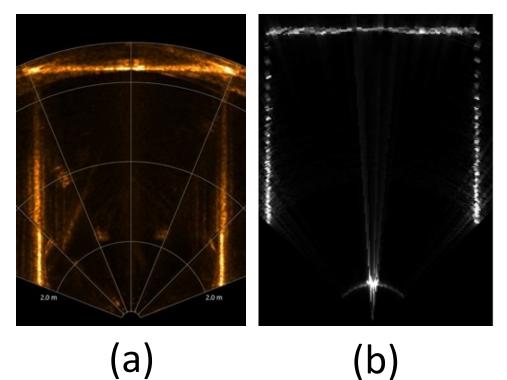


effect on the detection confidence.

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.



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