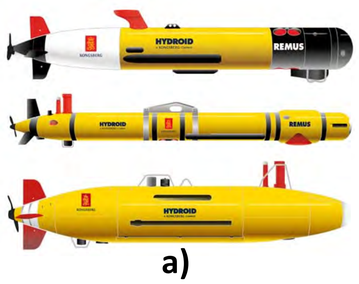
Investigation of unsteady hydrodynamic loads on a UUV during near surface operations

Naval Postgraduate School



a)

b)

Left: A Navy unmanned underwater vehicle approaches the USS Ponce (BreakingDefense.com)
Right: a) Hydroid's family of UUVs; b) Boeing's Echo Voyager

BACKGROUND

- Growing US Navy interest to increase the use of unmanned underwater vehicles in a wider range of operational missions, including
  - **SECNAV's DoN Unmanned Systems Goal: to deploy a Large Diameter Unmanned Undersea Vehicle (LD UUV) from an operational squadron.**
- Many of these missions will require the UUV to operate in a precise manner near the surface in a seaway.
- Potentially large unsteady hydrodynamic loads can develop on a UUV from waves passing overhead that tend to pull the vehicle up toward the surface.
- These unsteady loads reduce the UUV's maneuverability and controllability, since most control algorithms do not account for the loads, reducing their mission effectiveness and in a worst case scenario causing an unwanted broach of the surface exposing the UUV to the enemy and resulting in a loss of the vehicle.

APROACH

- **Multidisciplinary approach** involving the SE and MAE departments and incorporating both experimental model tests and numerical modeling
  - Experimental model tests explore the vast parameter space of wave height and length and vehicle geometry and depth.
  - Numerical studies are conducted to supplement the experimental data.
  - Establishment of **Navy relevant research program** by NPS faculty and potential involvement of **2-3 resident students** Master's Thesis work (both are part of **NPS Mission statement**)
- Outcomes:
  - Experimentally generated database of unsteady loads
  - Numeric model to predict and explore loading in limiting parameter spaces
- Follow-on work collaboration and **partnership with naval lab** at NSWC Carderock

IMPORTANCE

- Understanding the dominant parameters controlling the generation of unsteady loads on a UUV near the surface are needed for increased operational effectiveness of UUVs
- Improved maneuverability and controllability of UUVs by incorporating hydrodynamic load predictions into control algorithms is necessary across all the various vehicle geometries and operational objectives:
  - needed for mission planning to determine objectives that are feasible.
  - needed for performing **fleet-spoofing military deception (MILDEC)**
  - needed for realizing the benefits from **accurate and robust positioning, navigation, and timing** for the navigation and stationing keeping of UUVs.
  - needed for effectively deploying and operating a **Large Diameter Unmanned Undersea Vehicle from an operational squadron.**

CRUSER
Consortium for Robotics and Unmanned Systems Education and Research

FY17 Call for Proposals

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