



EchoRanger

Large-Diameter Unmanned Underwater Vehicle Test Bed

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Current Environment

New sensor and system payloads are rapidly being introduced for Unmanned Underwater Vehicles (UUVs). The increase in payload availability and development has outpaced UUVs ability to support the numerous applications in the current environment. Viable test platforms that meet payload application requirements and varied mission sets are needed to support the demonstration and refinement of capabilities in open ocean environments under realistic operational conditions.

The Boeing Solution

Testing these proposed systems requires a vehicle with ample payload capacity and energy. The Echo Ranger Large-Diameter UUV (LDUUV) is uniquely suited to this task given its proven autonomy and its generous external payload volume and available energy capacity. Echo Ranger has been used in the Gulf of Mexico as a survey asset to capture high fidelity sonar images of the seafloor for various petroleum interests.

Navigation System

Echo Ranger has demonstrated remarkable navigational accuracy. The primary navigation system features a Kalman filtered inertial navigation unit (INU) aided by a Doppler velocity log (DVL), depth sensors, and position fixes provided by either the host ship ultra-short baseline (USBL) or seafloor long baseline (LBL) transponders. The vehicle also features a backup navigation system that includes a magnetometer and roll/pitch pendulums. Key navigation performance characteristics:

- **Altitude Stability:** 0.81 ft ‡ (0.25 m)
- **Depth Stability:** 1.00 ft ‡ (0.3 m)
- **LBL aided position accuracy:** 7.7 ft ‡ (2.3 m)
- **USBL aided positioning accuracy:** 0.2% water depth
- **Unaided position accuracy:** 0.15% distance traveled
‡ - RMS values

Acoustic Communications

Underway communications, including command, control and status messages, are transmitted using the Linkquest 3010 acoustic modem. The system also supports near real-time acoustic transmission of collected payload data using the Linkquest 4010 acoustic modem.

Remote Capability

Echo Ranger allows shore-based personnel to access the system network via an encrypted Internet connection. All diagnostics, status, mission planning and data transfer performed on deck can be remotely controlled via wireless networks or by satellite link for extended long-range deployments. These links can be enabled to provide the land-based user with operational control equivalent to that afforded by shipboard personnel.

Ballast and Trim

The vehicle features an active seawater ballast and trim system with the following features:

- Autonomous ballast capability
- Forward and aft ballast tanks, up to 130 lb water each
- Operating capability to depth of 10,000 feet
- Provides capability to moor on seafloor

Launch and Recovery

Short-term, near-shore operations are conducted out of Dana Point Harbor in Southern California. Located less than an hour from Huntington Beach, the harbor provides support for towing the vehicle to sea and affords access to deep water a few miles offshore. Vehicle command, control and tracking equipment are sized to fit aboard small vessels.



Echo Ranger Vehicle

Echo Ranger is a fully autonomous untethered vehicle featuring:

- **Weight in Air:** 10,500 lb (4,545 kg)
- **Envelope:** 18.5 ft x 4.2 ft x 4.2 ft (5.6 m x 1.3 m x 1.3 m)
- **Maximum Depth:** 10,000 ft (3,000 m)
- **Maximum Speed:** 6 knots (14.5 km/hr)
- **Minimum Speed:** 1.5 knots (2.8 km/hr)
- **Optimal Speed:** 2.5 - 3 knots (4.6 - 5.6 km/hr)
- **Continuous Run:** 28 - 150 hours - dependent on battery
- **Battery Types:** Nickel hydride, silver zinc, lithium ion, lithium thionyl chloride

Modular Payload Capacity

Echo Ranger has been used extensively in the Gulf of Mexico with a fully functioning area survey payload. Echo Ranger's payload support capability includes:

- **Size:** 60 in x 50 in x 20 in (1.5 m x 1.25 m x 0.5 m)
- **Volume:** Approx. 21 ft³ (0.6 m³)
- **Capacity:** Approx. 500 lb dr (225 Kg)
- **Power:** Bus voltage 0 - 250V, current as needed. Power modules easily swapped to meet payload needs.
- **Communication:** Ethernet, RS-422/232/485

The vehicle can also accommodate a medium-sized payload in the tail section. This smaller volume is 1.4 ft³ and displaces approximately 90 lb. The vehicle can also accommodate payloads that extend outside of the nominal envelope.