Performance of an Autonomous Underwater Vehicle while Mapping Smooth Ridge in Monterey Bay

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The Monterey Bay Aquarium Research Institute (MBARI) will deploy a deep water cabled-to-shore ocean observatory in spring of 2006. This observatory, the Monterey Accelerated Research System (MARS), will be extend from the shore at Moss Landing down to 1000 m depth on Smooth Ridge in Monterey Bay. In preparation for cable laying, MBARI is currently surveying the proposed route. Although ship-based multibeam bathymetry is available, higher resolution data are required for sighting the cable through geologically and morphologically complicated portions of the route. MBARI's autonomous mapping vehicle has recently surveyed high-risk portions of the cable route from an altitude of 25 and 50 meters, and has produced high resolution bathymetry and sidescan maps.

The mapping sonar payload includes a 200 kHz .94 × .94 degree multibeam, a 110 kHz sidescan sonar, and a 2-16 chirp sub-bottom profiler. An Inertial Navigation System (INS) aided by a Doppler Velocity Log (DVL) and GPS receiver provide navigation. These three are integrated into a single package, where a Kalman Filter combines the measurements to produce an overall position estimate good to within .05% of distance traveled (CEPR) in real-time, assuming the DVL has continuous bottom lock. Correlating the multibeam bathymetry of crossing and overlapping swaths in post-processing reduces the navigation error.

The AUV has a 12 hour endurance at 3 knots and is rated to 6000 meters depth. A single circular wing at the stern controls the vehicle. During straight and level flight, the vehicle generally stays within 50 cm of its commanded depth, and 1 meter of it's commanded horizontal path. Recent work includes improved transient response and the ability to fly sloping linear trajectories with geo-referenced endpoints. This capability allows us to use existing bathymetry data to plan the depth profile of survey missions and then to safely fly the vehicle near the bottom in challenging terrain.

The mapping AUV surveyed 60 km of trackline in 11 hours from the flat shelf at 100 meters depth down the upper neck of Smooth Ridge to a depth of 500 meters. The cable route itself was surveyed from a 25 m altitude, and a surrounding area of 1 × 4.5 km was surveyed from a 50 m altitude. A 2 Hz ping rate provided complete bathymetric coverage of the seafloor. The sidescan imaged seafloor character across a 400 m swath. The multibeam soundings achieved repeatability statistics of 6 cm standard deviation across a 135 degree swath. The mapping system as a whole achieved a 30 cm vertical precision with a lateral resolution of 1 meter from a 25 m altitude. The 50 m altitude survey achieved a similar vertical precision with a lateral resolution of 2 m. The fine-scale bathymetry reveals several 1-4 m scarps that the cable route must avoid. The sidescan imagery and high-resolution bathymetry together indicate that the seafloor lithology changes along the route surveyed. In particular the seafloor from 300 to 400 meters depth exhibits a fine-scale lineated morphology that is slope-perpendicular and may reflect the outcropping of eroded sediment layers. These interpretations will be ground-truthed by ROV inspection.