AUV Gulper: A Novel Large-Volume Water Sampling Payload for the AUV

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This paper presents the development of a new water sampling payload for 21" science class AUVs. Although many AUVs are currently equipped with a wide array of sensors, underway instrument readings alone are not always sufficient to investigate important science questions. Many applications require a sample of water for analysis, for example plankton and larval ecology, Harmful Algal Bloom (HAB) detection, and sediment transport / carbon flux investigations. The AUV is already capable of triggering control behaviors based on real-time sensor readings, for example oscillating vertically between temperature or density surfaces. Using AUV onboard intelligence, important phenomena can be targeted for experiments requiring water samples. The AUV Gulper, a new payload in development at the Monterey Bay Aquarium Research Institute, is designed to acquire multiple large-volume water samples aboard the AUV.

In the first phase of development, the project team and a group of multi-disciplinary science users defined a set of design requirements for the Gulper. The team decided on a 2L sample volume. The large volume requirement is necessary to adequately sample for sparse microbial populations. Furthermore, a larger sample volume enables multiple science parties to share a single sample. The payload will consist of 10 samples per mission; the number of samples is a direct result of the limited volume in the vehicle. There are additional demanding requirements on the design that stem from the desire to sample around and within small features such as thin layers of phytoplankton. To accurately sample thin layers without modifying the current AUV flight pattern the Gulper must be capable of acquiring a single sample rapidly (<4 sec/sample), and taking multiple samples in quick succession (3 samples over 10 vertical meters, <6 sec between samples).

The integrated Gulper sampling system uses a dedicated payload section that is easily inserted into a 21" diameter AUV configuration. The payload section consists of an upper and lower hull section containing a set of 10 individually controlled spring-drive piston samplers. Each 2-L sample chamber is filled with sea water through a one way valve which protrudes through an aperture in the fairing of the AUV. A titanium spring provides enough driving force to meet our timing requirements. Precise dimensions between the sampler body and seals ensure there is no sample contamination. To make certain the properties of the sample are not altered by contact with the sampler, the following materials were chosen for each component: polycarbonate (end caps, body, & piston), titanium (valve, springs, & drive shaft), and silicon (seals). A silicon diaphragm on the sampler end cap provides the necessary compliance to compensate for pressure differentials. The samplers are triggered by a light-weight, low-power NITINOL^{R} actuator. A set of distributed controllers, which communicate with the main vehicle controller via a multi-drop RS-485 bus, will trigger the actuator and measure the fill time of each sample. A time stamp can be used to precisely determine the location of each sample using the AUV navigation data. The properties of the sampled water can then be correlated with concurrent measurements from a suite of contextual sensors aboard the AUV. Software being developed will allow sampling to be driven by site, event or condition.

Individual components have been tested on MBARI's ROVs and AUVs. Testing of the integrated Gulper payload will begin in summer of 2006 during field programs in the Monterey Bay. This paper will discuss the detailed design of the system and the results from initial sea trials of this novel water sampling payload.