Project Title: AUV Docking

Project # 900393

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Rev. #	Date	Changes	Approved by
Draft	04-Feb-2003	First draft	
1	11-Feb-2003	Changes after meeting on 06-Feb-2003	
1.1	10-March-2003	Changes after meeting on 26-Feb-2003	
1.2	11-April-2003		
2.1	07-June-2004	Changes to address 2005 needs	
3.1	24-Nov-2004	New version to address reformulated docking project	
3.2	8 June 2005	Objectives rewritten to reflect needs and opportunities.	
3.2.1	22 June 2005	Revised to reflect conversations from concept brainstorming.	

FUNCTIONAL REQUIREMENTS: AUV DOCKING SYSTEM 2005

OVERALL OBJECTIVES

The AUV Docking system is intended to provide an AUV survey functionality able to:

1) respond to episodic events in a timely and flexible manner[1] (O1)
2) obtain repeat surveys without requiring onsite human presence[2] (O2)
3) operate even in adverse environments (e.g. high sea state or under ice covered oceans) (O3)

In addition, the AUV Docking system should enable other capabilities such as retrieving data from and possibly even recharging benthic instrumentation. (O4)

To enhance the capability of exploration of the vast oceanic environment, there is a need for prompt deployments and prolonged operations of AUV that avoids frequent deployment and recovery. Therefore, we are looking for an AUV docking system that allows an AUV to home and transfer data and power, as required for long-term underwater operations. The AUV docking system will be a part of the MOOS/MARS systems and, in the future, the technology and experiences will be made available to the NEPTUNE community.

FUNCTIONAL REQUIREMENTS

1. The system shall provide a method allowing an AUV to conduct multiple missions over extended period (3 months or greater) without human presence. (O1, O2, O3)
2. The system shall provide a method to communicate with the vehicle to trigger missions, recover data, and download new mission scripts and commands.
3. The system shall provide a method of recharging AUV batteries so that AUV operational capability is not limited by onboard battery capacity.

GENERAL SPECIFICATIONS

1. The system shall consist of an AUV and a docking station.
    1.1. The system shall be capable of being operated as an element of both the MOOS and MARS observatories (hereafter called 'the OBSERVATORY').
    1.2. The AUV shall be capable of autonomously[3] finding the dock so that docking can be conducted.

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[1] Examples of event response include survey of the megaplume created by an underwater eruption on a mid-ocean ridge. Such eruptions might be detected acoustically, perhaps with SOSUS or and equivalent, or even seismically. Detection of an event would trigger an AUV survey. The AUV thus would allow an observatory like NEPTUNE to deploy sensors directly to a region of interest, thus using a comparatively small number of underwater nodes to obtain coverage otherwise unobtainable.

[2] Time series measurements in the ocean are typically 'point measurements.' An AUV docking system would allow one to leverage observatory infrastructure to obtain a time series of surveys. These might provide the spatial context for more intensive local measurements, or might

[3] Autonomously shall mean without human intervention, other than the configuration of AUV mission scripts.

1.3. The system shall be capable of docking autonomously.
1.4. There shall be a method of attaching the AUV to the docking station (hereafter called docking).
1.4.1. The docking attachment method shall provide a communication and power connection between the AUV and docking station.
1.4.1.1.1. There shall be a method for minimizing or eliminating AUV power consumption (putting the AUV to sleep) when the AUV is attached to the docking station.
1.4.1.1.2. There shall be a way to wake the vehicle from a sleep state.
1.4.1.1.3. The system shall extend OBSERVATORY communications to the AUV when the AUV is docked so as to allow the downloading of new mission scripts, the initiation of new AUV missions, the recovery of AUV data, and to support direct interaction with the AUV main computer and subsystems.
1.4.1.1.4. The system shall provide a means of recharging AUV batteries from the OBSERVATORY power system.
1.4.2. There shall be a method by which the AUV can detach from the dock (undock) and conduct autonomous operations (i.e. run a new mission)..
1.4.3. There shall be a method for of releasing a dead AUV for recovery to the surface, or providing a way for an ROV to recovery a dead AUV, or both.
1.5. Reliable operations is of paramount importance
1.5.1. The docking attachment shall be sufficiently robust that damage or disengagement is not a risk when the vehicle is in a sleep state.
1.5.2. The attachment method should support hundreds of dock/undock cycles
1.5.3. The dock, and the dock with docked vehicle, should be trawl resistant.
1.5.4. Failure modes should be minimized, and those that exist should be detectable by the vehicle/dock system and be recoverable.
1.5.4.1.Minimizing number of actuators is attractive
1.6. The docking solution should be scalable to support multi-AUV operations with minimal added costs or maintenance requirements.
1.7. The dock should impose minimum constraints on vehicle features such as volume for science payload, drag, and external appendages (e.g. antenna).
1.8. The docking station hall be capable of being deployed from R/V Pt. Sur, R/V Western Flyer, or smaller vessel, preferably R/V Zephyr.
1.9. Amenability to Arctic deployment desirable.

AUV SPECIFICATIONS

1. The initial AUV shall be based on the Dorado vehicle design.
   1.1. Rechargable batteries will provide 12 mission capability
2. Navigation will be provided by.
   2.1. Onboard AHRS
   2.2. Onboard ADCP/DVL
   2.3. Onboard LBL
   2.4. Onboard GPS
3. The following location devices can be assumed on the vehicle.
   3.1. USBL transponder

3.2. rf beacon
3.3. strobe
3.4. rf modem (allows communication with vehicle)

4. Vehicle costs will be minimized to enable multiple vehicle operations.

PERFORMANCE REQUIREMENTS

Initial performance objectives:
The initial application will likely be survey operations in the upper Monterey Canyon to depths of 600m. The system should be capable of supporting AUV missions in a 5x5 km area, with AUV operational ranges of 60 km per mission and 1000 km per deployment. Deployment intervals up to 3 months should be possible. The total AUV cost should be kept low to enable multiple vehicle operations – an initial target is 50K parts costs for a complete vehicle cost of 200K.

1. Shall be capable of functioning for long duration
   1.1. Design life
      1.1.1. Docking station > 2 years
      1.1.2. AUV > 2 years
   1.2. Maintenance interval
      1.2.1. Docking station >2 years
      1.2.2. AUV Initially 3 months

2. Overall size, shape, weight:
   2.1. Ease of logistics is important. Ability to freefall through water column, and be moved on seafloor by ROV highly attractive.

3. Capturing and Clamping:
   3.1. Must withstand typical currents.

4. Data Transfer:
   4.1. Mode/Method/Protocol:
      4.1.1. AUV – Dock TCP-IP
      4.1.2. Dock - OBSERVATORY ?
      4.1.3. Rate: Should be a factor of charge rate and data collection rate. Should match MOOS/MARS specifications.

5. Dock Power Supply: Needs to match MOOS/MARS host specification.

6. Environmental:
   6.1. Operating depth 250 m to 4500 m
   6.2. Operating temperature (ambient surface temp.) -4 to 60 degrees C
   6.3. Operating temperature (in water) 0 to 30 degrees C
   6.4. Operating current 0 to 1.0 knot
   6.5. Shall have minimum fouling (shall it be capable of operating in high fouling environments, or environments with large sedimentation rates?).