Autonomous Mobile Buoy

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ABSTRACT

A new type of surface vehicle/buoy is needed for marine biological studies, physical oceanography, environmental impact assessment and integrated marine environment management. This poster presents the development of an autonomous self-mooring vehicle that collects meteorological, acoustic, and physical data, while simultaneously obtains water samples for chemical analysis through mass-spectrum analysis from littoral and estuary waters. The vehicle is programmed to use and analyze the oceanographic and meteorological data in its guidance system to track and analyze a specific phenomenon. During the project several scientific surveys will be performed to test the abilities of the vehicle. For example, the assessment of the biodiversity of organisms (e.g., phytoplankton) that live at a specific region will be conducted. All operations will be completely autonomous with the exception of the high level communication between the vehicle and the operations center. The vehicle houses commercial and student designed measurement units containing instruments such as multi-chemistry analyzer, conductivity, temperature, depth gages, and a fluorimeter that detects various chemicals such as chlorophyll, rhodamine, and fluorescein.

OBJECTIVES

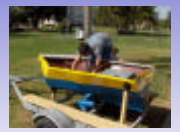
The autonomous mobile buoy is aimed to moor and unmoor itself at specified locations in river, lagoon, or near shore ocean areas to take data for a certain amount of time. The buoy will be able to remain on mission for up to one month without contact other than communication through GPS/cellular phone technology. The GPS/cellular phone technology will allow for transmittal from the buoy to land of location, and possibly sending new commands from land that could alter the course of the buoy. The buoy will travel 2-mile transects before resting at a mooring location.

MOTIVATIONS

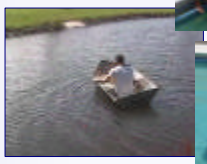
The purpose of this project is to design and construct a remotely operated buoy that has the capability to moor and unmoor itself, be able to conduct meteorological and oceanographic measurements along pre-programmed transects. The key motivations for designing and building this product from an operational point of view are in the title: autonomous and mobile. The advantages of an autonomous mobile buoy make it superior to permanently moored buoys. Just like permanently moored buoys, the initial deployment and recovery are the only physical interaction with the buoy (besides periodic cell phone connection for mission updates), but unlike permanently moored buoys the vehicle can relocate itself. This mobile buoy also allows researchers to collect data at desired locations instead of estimating from the nearest permanently moored buoy or sending a cruise out to collect the data. Additionally, an autonomous buoy is much more cost and time efficient, and requires less man-power than conventional buoys or research vessels.

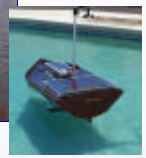
From the aid of these operational advantages, the buoy can monitor more coastal and lagoon areas, collect more data on environmental ecosystems, processes and changes in one launch than other data-collecting options. Possible uses of the system encompass a wide variety of underwater and surface monitoring.

PRO-ENGINEERING FILES



INITIAL TESTS

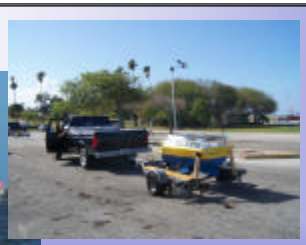


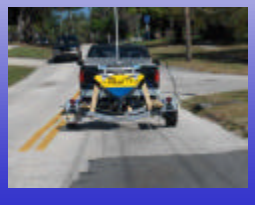


General Vehicle Design

The AMB (made of 50-52 H32 and T6 marine grade aluminum) has a fundamental concept based on the NOMAD buoy. The vehicle is designed for easy transport, assembly, disassembly, and servicing. Furthermore, there is easy access to the batteries and the vehicle control system and scientific containment housings. The vehicle's specifications are:

- Dry weight: 388-lbs (176-kg)
- Displacement : 570-lbs (258.5-kg).
- Length: 7-ft. (2.13-m)
- Beam: 3-ft. (0.91-m)
- Max. Height with weather station: 7-ft 10.5-in (2.40-m)
- Max. height without tower: 2-ft 8.5-in (0.83-m)
- Draft: 13-in (0.33-m)
- Total Wetted Surface Area: 16.5-ft2 (1.53-m2)
- Theoretical Hull Speed: 6 ft/s (1.83-m/s)
- Design Speed: 4-ft/s (1.22-m/s, 2.73-mi/hr, 4.39-km/hr, 2.37-Knots), derived from the amount of power needed for the vessel to travel efficiently on its designed two-mile transects.
- Max. Anchoring Depth: 33-ft (10-m) based on the maximum design depth for safe mooring with a 100-ft (30.5-m) anchor line.





Propulsion - The vehicle is equipped with two 12-volt longitudinal thrusters capable of producing 30 to 50 lbs of trust each with an individual maximum 30-Amp draw. The thrusters are asynchronous 3-phased with an estimated motor run time based on the manufacture's published data (i.e., 0.85 * (Battery Amp Hour Rating) ÷ (Hours of Running Time) * (Motor Amp Rating)) and running at an optimum speed between 4 to 6-ft/sec.\

Battery and Power Management - The battery system is composed of three 50 Amp-hour 12 Volt Deep Cycle Gel Marine batteries where each propulsion thruster draws 14.32-Amps for sea conditions of two-foot wave heights, four-foot wavelengths, and fifteen-knot winds heading into the bow. Consequently, a two mile transect traveling at 4-ft/sec (2.73-mi/hr, 4.39-km/hr) along with raising and lowering the anchor will use 22.5-Amp-hours from the batteries. During this time 2-Amp hours at 12-VDC will be used for instruments and computers. This leaves a total of 125.5-Amp-hours to power the thrusters, computers, and instruments in extended transects, for dynamic positioning (in cases where anchoring is not possible, e.g., in environmental sensitive areas or locations deeper than anchor depth), or as reserve during cloudy days.

The batteries were chosen for their ease of operation, longevity, and recharging cycles, which greatly extend the vehicles operating range when compared with any other type of battery. The amount of electrical energy allows approximately 7.5 hours of continuous operation in calm conditions and approximately 5 hours in 2-ft seas with 15 knot winds. Both conditions were calculated at 4-ft/sec.

The recharging of the batteries underway and when on station is accomplished by two General Electric 30-watt photovoltaic panels that recharge at an average of 3.6 Amps per hour. When the buoy is moored, the electronics draw 1-Amp at intervals for data collection. Whereby, the battery can then charge at least 3-Amps per hour. Estimating the average amount charging time per day to be 4 hours, approximately 12-Amps per day will be recharged. Consequently, with these conservative estimates only one transect every two days can be planned for indefinite operation.