Rover II: An Autonomous Bottom-Transecting Instrument Platform for Long-Term Measurements in Deep Benthic Environments OS15F-15

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Abstract

Rover II is a bottom-crawling, autonomous vehicle capable of making long (greater than six months) time-series measurements at abyssal depths up to 6000 m. Rover II is being designed as a collaborative effort between the Monterey Bay Aquarium Research Institute and the Scripps Institution of Oceanography, building on the earlier work of Smith and associates, 1997. Core instruments include two respirometers for measuring sediment community oxygen consumption, and two scanners for making fluorometric maps of the sediment surface as well as ultrasound images to a sediment depth of 10 cm. Three cameras provide close-up images of the scanned sediment surface and a wide-angle view of the Rover's immediate surroundings. A number of additional guest instruments can also be accommodated.

This unique vehicle presents several design challenges. Unlike the current generation of Remotely Operated Vehicles (ROVs) and free swimming Autonomous Underwater Vehicles (AUVs), all of which are recovered and serviced after each dive, Rover II must continue to operate for greater than six months with no maintenance. A number of design features address these rigorous requirements. The vehicle's frame will be constructed of only titanium and plastic to prevent corrosion. Key instrument packages, such as the respirometers and scanners, will be deployed in pairs to provide 100% redundancy. A power monitoring and ground-fault scanning system will detect defective instruments and remove them from service, allowing the mission to continue with the remaining instruments.

Current Meter

An acoustic current meter (not shown, 2D-ACM, Falmouth Inc.) measures water current direction and magnitude, as well as compass heading and vehicle tilt.

Transit Camera

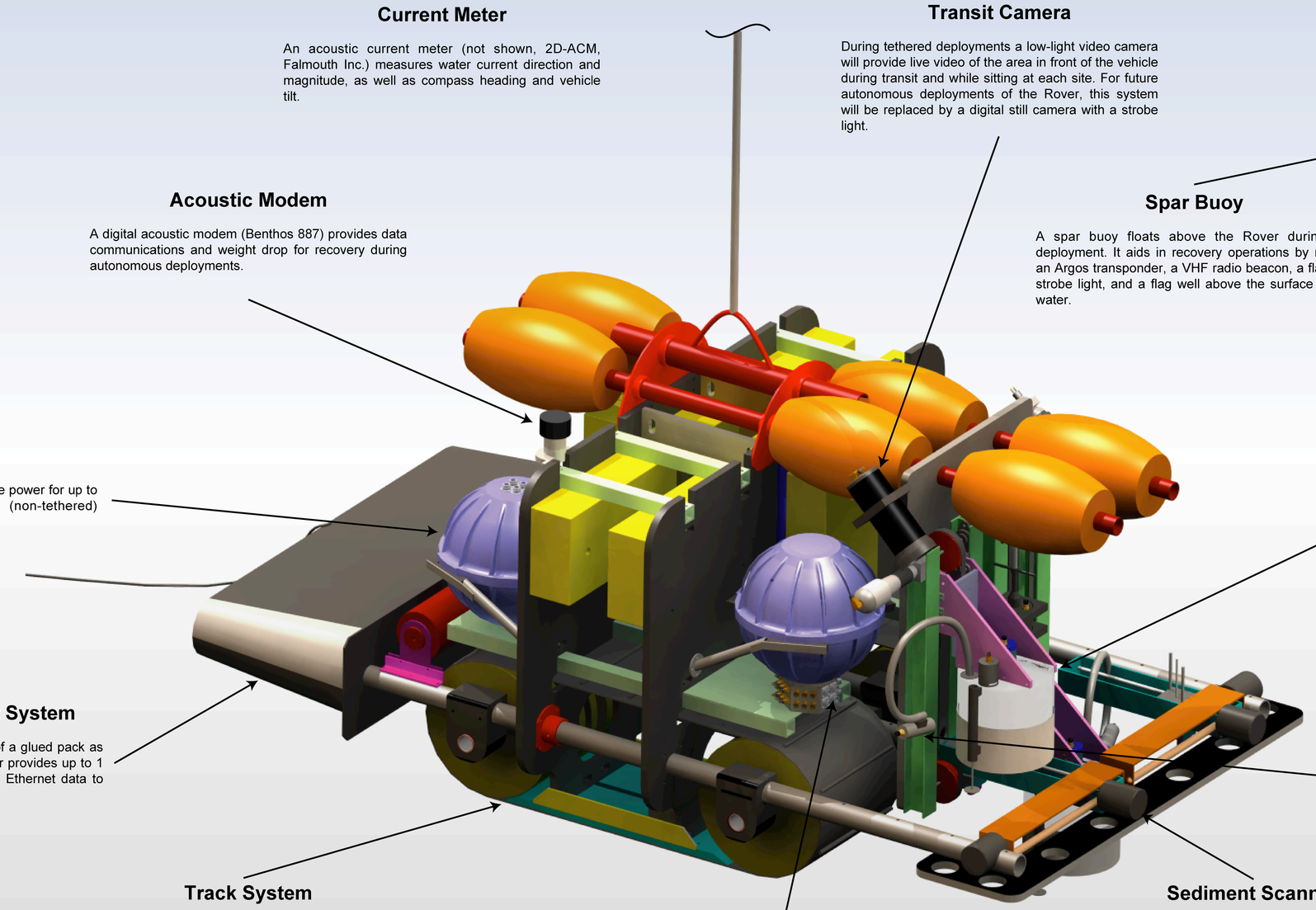
During tethered deployments a low-light video camera will provide live video of the area in front of the vehicle during transit and while sitting at each site. For future autonomous deployments of the Rover, this system will be replaced by a digital still camera with a strobe light.

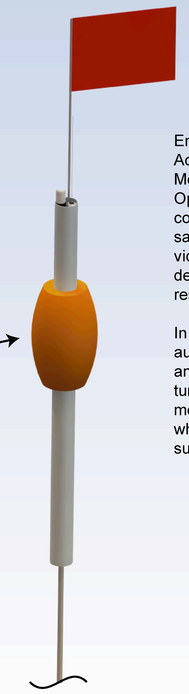
Acoustic Modem

A digital acoustic modem (Benthos 887) provides data communications and weight drop for recovery during autonomous deployments.

Spar Buoy

A spar buoy floats above the Rover during the deployment. It aids in recovery operations by raising an Argos transponder, a VHF radio beacon, a flashing strobe light, and a flag well above the surface of the water.





Development Schedule

Engineering tests will be performed in late 2006 with Rover II connected to the Monterey Accelerated Research System (MARS) seafloor network cable at 1000 m depth in Monterey Bay, California. The Rover will be plugged in to the MARS cable by a Remotely Operated Vehicle (ROV). The cable will provide power and high-bandwidth communications to the Rover, which will permit researchers to interactively develop new sampling schemes, troubleshoot problems as they occur, and obtain real-time data and video of the benthic environment. The information obtained from these tethered deployments will greatly speed the development of sampling protocols and methods for responding to vehicle faults during autonomous deployments.

In 2007, Rover II development will continue with the addition of batteries to the vehicle for autonomous, untethered operation. Software will be developed to store all science data and images on local flash memory, and to more closely manage the vehicle's power by turning off the main vehicle computer and all instruments when they're not actively taking measurements. An acoustic modem will provide state-of-health reports to ships above when requested, and will receive the command to release the drop weight and float to the surface when the deployment ends.

Batteries

Two 9.6 kW-h lithium batteries provide power for up to 7 months during autonomous (non-tethered) deployments.

Respirometer Chambers

Two 30-centimeter diameter chambers measure Sediment Community Oxygen Consumption (SCOC). A purge valve opens during chamber insertion to prevent the bow wave from disturbing the sediment. A stirring motor slowly mixes the water in the chamber during incubation.

Tether Management System

Up to 500 meters of cable peel off of a glued pack as the Rover moves forward. The tether provides up to 1 kilowatt of power and multi-megabit Ethernet data to the vehicle.

Chamber Cameras

Two miniature color CCD cameras (Nova, Insite Pacific Inc.) will be used to view the respirometer chambers. Each camera has built in LED lights which provide illumination. Video will be collected from these cameras while the respirometers are inserted and removed from the sediment.

Track System

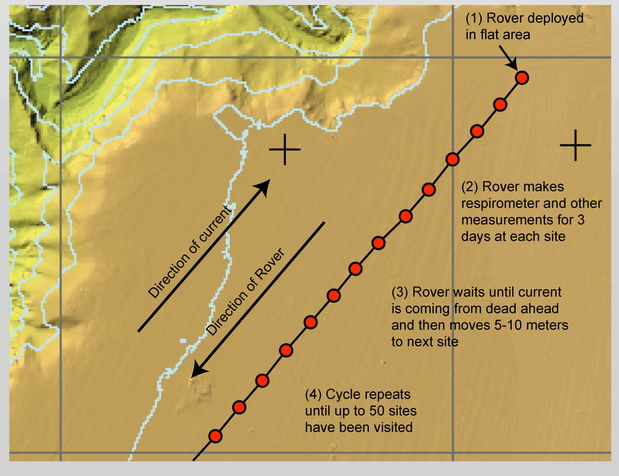
Two fiber-reinforced rubber tracks with cleats are driven by independent brushless DC gear motors through synchronous belt drives. A large footprint yields a low sediment loading of less than 66 kg/m^2

Sediment Scanners

Each sediment scanner consists of a three-axis gantry. Two instruments will be mounted on each scanner: a two-channel fluorometer to measure quantities of Phycoerythrin and Chlorophyll on the sediment surface, and an ultrasound transducer to profile the top 10 cm of the sediment. Each scanner covers a 81 cm x 81 cm area.

Guest Instrument Ports

The Rover will be equipped with four general-use ports for additional instruments. Each port will provide power (12 V, 1 A) and communications (RS232 or Ethernet) back to the main vehicle controller. This flexibility will enable the Rover to conduct new experiments with each deployment.

The Rover II chassis under construction at Scripps Institution of Oceanography

Typical deployment operations