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Workshop Proceedings

APPLICATIONS OF MINI-ROV SYSTEMS FOR COASTAL AND ESTUARINE MONITORING

Ann Arbor, Michigan
July 11-13, 2004

Funded by NOAA's Coastal Services Center through the Alliance for Coastal Technologies (ACT)

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An ACT 2004 Workshop Report

A Workshop of Developers, Deliverers, and Users of Technologies for Monitoring Coastal Environments:

Applications of Mini-ROV Systems for Coastal and Estuarine Monitoring

Ann Arbor, Michigan
July 11-13, 2004

Sponsored by the Alliance for Coastal Technologies (ACT) and NOAA's Center for Coastal Ocean Research in the National Ocean Service.

Hosted by ACT Partner organization the University of Michigan.

ACT is committed to develop an active partnership of technology developers, deliverers, and users within regional, state, and federal environmental management communities to establish a testbed for demonstrating, evaluating, and verifying innovative technologies in monitoring sensors, platforms, and software for use in coastal habitats.

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ACT Workshop: Applications of Mini-ROV Systems for Coastal and Estuarine Monitoring

Executive Summary

The Alliance for Coastal Technologies (ACT) convened a Workshop on the Applications of Mini-ROV Systems for Coastal and Estuarine Monitoring in Ann Arbor, Michigan on July11 to 13, 2004.

The objectives of the workshop were as follows: (1) educate potential users (managers and scientists) about the current capabilities of mini-ROV systems, (2) provide an opportunity for users (managers and scientists) to directly operate and experience the capabilities of various mini-ROV systems, (3) engage manufacturers with scientists and managers in discussions on system capabilities and requirements needed to promote further application of their Mini-ROV systems, (4) promote a dialogue about realistic advantages and limitations of current Mini-ROV samplings, and (5) develop a set of key recommendations for advancing both the capabilities and uses of Mini-ROV systems.

To achieve these goals, representatives from research, academia, industry and resource management were invited to participate in this workshop. Participants obtained hands on experience as they test piloted various models of Mini-ROVs in the physical model basin of the University of Michigan's Marine Hydrodynamics Laboratories. Working groups then convened for discussions on current commercial usages and environmental monitoring approaches including; user requirements for Mini-ROVs, current status of Mini-ROV systems and enabling technologies, and the challenges and strategies for bringing new Mini-ROVs "on-line."

The following recommendations were made:

- Establish a Mini-ROV user group or expand NOAA's AUV user group.
- Develop a reliable, less expensive positioning system for the Mini-ROV, as well as improving the Mini-ROV plug and play capability for enhanced data collection.
- Explore inter-agency collaboration to support development and use of ROVs as well as partnerships between industry and academia/research, the service sector and government agencies. Pursue dialogue with other agencies pertaining to their efforts using robots.
- Build a mini-ROV customer base by promoting uses in research, education (K-12 as well as university level), public outreach and service. Education of the public on the capabilities and uses of mini-ROVs will also help build the customer base. This could be accomplished through workshops and symposiums, displaying Mini-ROVs at national level scientific and educational conferences, connection with programs like the Marine

Advanced Technology Education (MATE) program as well as usage in the public arena. Development of a list of demonstration projects and applications could also be an important tool in public awareness.

- Develop protocols for standardizing hardware and software for universal connectivity.
- Define user requirements on basis of power, sensors and connectivity.

Additional recommendations were directed to ACT with its resources of both organizational and technological resources:

- Populate ACT database with currently available Mini-ROV information.
- Begin a dialogue with manufacturers about the possibilities of a demonstration with ACT.
- Facilitate communication with regional Integrated Ocean Observing System (IOOS) programs and identify contacts within those programs.
- Develop an ACT workshop focused on training for users of Mini-ROVs.

Alliance for Coastal Technologies

There is widespread agreement that an Integrated Ocean Observing System is required to meet a wide range of the Nation's marine product and information service needs. There also is consensus that the successful implementation of the IOOS will require parallel efforts in instrument development and validation and improvements to technology so that promising new technology will be available to make the transition from research/development to operational status when needed. Thus, the Alliance for Coastal Technologies (ACT) was established as a NOAA-funded partnership of research institutions, state and regional resource managers, and private sector companies interested in developing and applying sensor and sensor platform technologies for monitoring and studying coastal systems. ACT has been designed to serve as:

- An unbiased, third-party testbed for evaluating new and developing coastal sensor and sensor platform technologies,
- A comprehensive data and information clearinghouse on coastal technologies, and
- A forum for capacity building through a series of annual workshops and seminars on specific technologies or topics.

The ACT workshops are designed to aid resource managers, coastal scientists, and private sector companies by identifying and discussing the current status, standardization, potential advancements, and obstacles in the development and use of new sensors and sensor platforms for monitoring, studying, and predicting the state of coastal waters. The workshop goals are to both help build consensus on the steps needed to develop and adopt useful tools while also facilitating the critical communications between the various groups of technology developers, manufacturers, and users.

ACT Workshop Reports are summaries of the discussions that take place between participants during the workshops. The reports also emphasize advantages and limitations of current technologies while making recommendations for both ACT and the broader community on the steps needed for technology advancement in the particular topic area. Workshop organizers draft the individual reports with input from workshop participants.

ACT is committed to exploring the application of new technologies for monitoring coastal ecosystem and studying environmental stressors that are increasingly prevalent worldwide. For more information, please visit www.act-us.info.

ACT Headquarters is located at the UMCES Chesapeake Biological Laboratory and is staffed by a Director, Chief Scientist, and several support personnel. There are currently seven ACT Partner Institutions around the country with sensor technology expertise, and that represent a broad range of environmental conditions for testing. The ACT Stakeholder Council is comprised of resource managers and industry representatives who ensure that ACT focuses on service-oriented activities. Finally, a larger body of Alliance Members has been created to provide advice to ACT and will be kept abreast of ACT activities.

Goals for the Mini-ROV Workshop

The ACT Workshop on Mini-ROVs was convened on July 11-13, 2004 in Ann Arbor, Michigan to summarize the state of Mini-ROV technology and to make strategic recommendations for the future development and application of Mini-ROVs for commercial use and coastal environmental research and monitoring.

The workshop addressed the following goals:

- education of potential users (managers and scientists) about the current capabilities of mini-ROV systems,

- to provide an opportunity for users (managers and scientists) to directly operate and experience the capabilities of various mini-ROV systems,

- to engage manufacturers with scientists and managers in discussions on system capabilities and requirements needed to promote further application of their Mini-ROV systems,

- to promote a dialogue about realistic advantages and limitations of current Mini-ROV samplings, and

- to develop a set of key recommendations for advancing both the capabilities and uses of Mini-ROV systems.

ORGANIZATION OF THE MINI-ROV WORKSHOP

The workshop was sponsored by NOAA's Alliance for Coastal Technologies and hosted by the University of Michigan's Marine Hydrodynamic Laboratories. The workshop was organized by Dr. Tom Johengen, Dr. Guy Meadows and Mr. Hans Van Sumeren. Mr. Jeffery Gray of Thunder Bay National Marine Sanctuary served as a facilitator. Participants arrived on Sunday afternoon, July 11, and gathered that evening for a reception and dinner. Participants were welcomed to the workshop by Dr. Guy Meadows, and a presentation was given to introduce them to the ACT program by Dr. Tom Johengen, followed by a presentation on The Thunder Bay National Marine Sanctuary and Underwater Preserve given by Mr. Jeffery Gray. Monday morning participants gathered to hear presentations describing the overall design, capabilities and operation of each Mini-ROV system brought by the manufacturers participating in the workshop. Manufacturers represented were SeaBotics, Video Ray, NOVA Ray, Deep Ocean Engineering and Outland Technology. Following the presentations, participants gathered at the Marine Hydrodynamics Laboratories' physical model basin. They were allowed approximately two hours to work with all the Mini-ROV systems being demonstrated. Each user was given individual instructions and allowed to "fly" the Mini-ROVs throughout the tank. During the afternoon sessions, participants gathered for presentations by Dr. Tom Johengen and Dr. Guy Meadows describing the workshop organization and recent advances in Mini-ROV technology respectively. Participants then divided into groups of individual sectors, academia/research, industry and resource managers.

Discussions focused on the following four charge questions:

(1) What are the problems with current environmental monitoring approaches?

(2) What are the requirements for Mini-ROV systems?

(3) What is the current status of Mini-ROV Systems and enabling technologies?

(4) What are the challenges and strategies for bringing new mini-ROVs "on-line"?

The groups reported out on their deliberations during the following plenary session. The final day participants divided into cross-sector groups to discuss the output from Monday's plenary sessions and refine their recommendations. Cross-sector facilitators then presented their recommendations in a final plenary session.

OVERVIEW OF THE MINI-ROVS

ROVs (Remotely Operated Vehicles) were first created for use in the military sector. In the late seventies, ROV technology moved into the commercial sector and soon became widely used in the petroleum industry. The petroleum industry became the driving force behind the majority of the research and development of ROV technology and centered on their use in support of off shore drilling rigs. ROVs were also used in environmental research and monitoring, but it became apparent that the large ROVs were too cumbersome, technically restrictive and expensive for many uses.

The first Mini-ROVs were basically video cameras with thrusters, but with the advancements in electronic technology over the years, Mini-ROVs have been developed into machines which are capable much more than just observation. The small size and lower price range have enabled a broader range of users and end user applications. Mini-ROVs are not only less expensive to own and operate, but are highly transportable, easily deployed, and technically less restrictive than the larger ROVs. Mini-ROVs are currently used in research for mapping bottom habitats, environmental monitoring of wildlife abundance and species collection. Mini-ROVs are also used in search and recovery missions, education, public outreach, and homeland security. In the commercial arena, Mini-ROVs are used for potable water tank inspections, bridge foundations, pipeline, and hull inspections.

In comparison to the larger ROVs, Mini-ROVs have a number of advantages. Mini-ROVs are compact and very transportable; they can quickly be deployed from small vessels under a variety of conditions. Larger ROVs are heavy machines; the logistics of transporting them to the field site as well as deploying them are much more difficult than the Mini systems. The deployment vessel must be much larger, carrying the equipment and a crew trained for deployment, and the seas must be fairly calm for deployment. Not only is the initial investment of the larger ROV much greater than the Mini-ROV, but the maintenance costs can also be more costly. As demonstrated by the workshop participants, the operation of the minis is much more user friendly than the larger ROVs. Advantages of the smaller vehicles include the ability to fit into and maneuver in smaller areas and less disruption of wildlife in their vicinity.

Many of the Mini-ROV limitations can be attributed to its small size. Tether drag can affect the Mini-ROV much more than the larger vehicles. Mini-ROVs have less thrust available than the larger machines, thus affecting their ability to perform in currents greater than 2 to 3 knots. They are also limited in their lifting and sampling capabilities. They are not as flexible as the larger units for attaching sensors, sonar and navigational instruments. To date, Mini-ROVs are not able to travel as deep as their larger counterparts.

This workshop created a forum in which educators, researchers, commercial users and industry could interact and discuss the capabilities and limitations of current Mini-ROVs. Participants also identified the requirements of future Mini-ROVs and the challenges and strategies of their development to fit these requirements.

There were a few advancements that all groups agreed they would like to see develop in the future. Maneuvering of the current Mini-ROV systems can be difficult at times due to the tether drag. Some of the suggestions for correcting this were the use of fiber optics or on-board batteries and data storage to reduce tether diameter, as well as eliminating the tether altogether through the use of an acoustic modem. An inexpensive and reliable navigational system needs to be developed for the Mini-ROV as well as an auto-tracking device for repeat samplings and a tether tracking capability for help in avoiding tether fouling. More sensors need to be developed for these machines that are applicable to a larger audience of users. In order to do this, the machines need to have the capability to house more than one sensor and exchange one sensor for another. The future Mini-ROVs should be available as a modular unit with the ability to attach a variety of sensors. This ability further enhances the goals of the user and the mission. This "plug and play" capability calls for the sensors and the Mini-ROVs as well as the software to be standardized. Improvement on existing video cameras was also suggested, such as improved field of view, camera tilt reference and higher resolution digital cameras.

To facilitate the implementation of the above technologies, there must be better communication between users and the industry. The research/academia sector as well as the commercial market must know what is currently available in Mini-ROV technology. The manufacturers need to know what technology is developing in the research/academia fields as well as in the commercial sector. Specifically, the users' requirements must be defined on basis of power, sensors and connectivity. To accomplish this, the following is recommended:

- request sessions focusing on Mini-ROVs to be held at national conferences,
- request ACT populate their database with information on currently available Mini-ROV technology,
- begin a dialogue with manufacturers about possible demonstrations with in partnership with ACT, and,
- host a workshop on image processing and utilities for data archiving and dissemination.

To make these technological advances financially feasible, the customer base for the Mini-ROVs must be better identified and broadened. Currently, units are manufactured on a small scale. Therefore, to fund research and development of these machines there must be an increased demand. It was recommended that a Mini-ROV customer base be built through education (both K-12 and the university level), public outreach, and by promoting their use in both the research and the service sectors. This could be facilitated by educating the public through symposia or workshops and by developing a list of demonstration projects and applications. Mini-ROVs could be introduced at national level scientific and educational conferences, science museums and aquariums and by developing connections with programs such as Marine Advanced Technology Education (MATE). It was also recommended that a Mini-ROV symposium be hosted to focus on developing capabilities and the demonstration of current applications, as well as the development of an ACT workshop focused on training for users. Inter-agency collaboration to support the development and use of Mini-ROVs would further broaden the user base.

Although the Mini-ROVs are less expensive than their larger counterparts, they can still be cost prohibitive to own and operate for many users. To enable a larger user group, it was recommended that partnerships be developed between industry and universities as well as the service sectors and government agencies. The development of a flexible modular unit that could be used for a variety of purposes would make it possible for these partnerships to share the use and expenses of a Mini-ROV system. In order for this to be possible, protocols for the standardizing of hardware and software must be developed.

WORKSHOP RECOMMENDATIONS

Six general recommendations were made:

- Establish a Mini-ROV user group, or expand NOAA's AUV user groups. This would enable users to share information, aid manufacturers with a better knowledge of the requirements of their customer base, as well as promote the usage of Mini-ROVs.

- Develop a reliable, less expensive positioning system for the Mini-ROV, as well as improving the Mini-ROV plug and play capability for enhanced data collection. The ability to change the sensors on a single unit will not only allow for various usages for a single machine for a single user, but it will also aid in the development of shared Mini-ROV usage between formed partnerships. This will encourage a larger usage of Mimi-ROVs.

- Explore inter-agency collaboration to support development and use of Mini-ROVs, as well as partnerships between industry and academia/research; the service sector and government agencies, opening the possibilities of shared machine usage and technology. Pursue dialogue with other agencies pertaining to their efforts using robots in an effort to improve existing Mini-ROV technology.

- Build a Mini-ROV customer base by promoting uses in research, education (K-12 as well as university level), public outreach and service. Education of the public on the capabilities and uses of Mimi-ROVs will also help build the customer base. This could be accomplished through the Mini-ROVs' introduction at the national level through scientific and educational conferences, connection with programs like MATE as well as usage in the public arena. Development of a list of demonstration projects and applications could also be an important tool in public awareness.

- Develop protocols for standardizing hardware and software for universal connectivity. This will allow the manufacturers to create plug and play machines that have the ability to serve a user with a broad range of requirements, as well as give the users the ability to share machine usage with partner users.

- Define user requirements on basis of power, sensors and connectivity. The advancement of Mini-ROV technology would be aided by greater communication between the users and the manufacturers. This can be accomplished through ACT workshops as well as the ACT database.

Specific Recommendations for ACT in Developing Mini-ROV Technology

Four additional recommendations were directed to ACT with its command of both organizational and technological resources:

- Populate ACT database with currently available Mini-ROV information.
- Begin a dialogue with manufacturers about the possibilities of a demonstration with ACT.
- Facilitate communication with regional IOOS programs and identify contacts within those programs.
- Develop an ACT workshop focused on training for users of Mini-ROVs

Appendix A. Workshop Participants

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Workshop Participants (continued)

Appendix B. Participating Manufacturers

SeaBotix LBV Model

www.seabotix.com

Workshop Participants

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Product Description

The LBV is a four-part system consisting of the power unit, control unit, umbilical and the vehicle. It has 4 thrusters, 2 axial, one vertical and one lateral, giving it 4.5 kg of forward thrust with the standard thrusters. The unit weighs 10.4 kg, and can fit in two pelican cases, small enough for air travel. Standard umbilical length is 75 m and its diameter is 7.4 mm. The high-resolution camera chassis rotates a full 180 degrees allowing 270-degree field of view with light tracking the camera. The unit also carries six accessory ports and has depth ratings of 150, 300 and 1500 m. The LBV can be purchased for approximately $15,000.00

Video Ray

www.videoray.com/

Workshop Participant

gleason@mtu.edu

Product Description

The VideoRay Pro III unit is only 8 lbs. and can be easily deployed by one person. The unit has three thrusters, one amidships, one starboard and one port. It has a forward looking color camera that tilts 160 degrees and a rear-facing black and white camera. The umbilical is 76 m in length and 10 mm in diameter. Sensors include compass, depth sensor and auto depth-holding capability. The Pro III has a depth rating of 152 m (500 ft) and can be augmented with various accessories, including grippers, sonar and other sensors. The Video Ray series range in price from approximately $6000.00 for a base unit up to approximately $50,000 for a research equipped vehicle.

PARTICIPATING MANUFACTURERS (CONTINUED)

NovaRay

www.novaray.com

Workshop Participants

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Product Description

The Nova Ray has a patented bow -shaped wing design as well as dual thrusters to aid its performance in strong tides and currents up to 9 knots. The unit weighs 25 kg, can reach speeds over 4.5 knots, and is easily deployed. It carries a high -resolution camera with a 45 - degree range of view. It is available with both fo rward and side scanning sonar. Sensors include depth, heading, rate, pitch/roll and temperature. The umbilical is 91.4 m in length and 15mm in diameter.

Outland Technology

www.outlandtech.com

Workshop Particip ant

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Product Description

The Outland is an open frame ROV that weighs 39 lbs., with a 5 -lb. payload. It has four thrusters, two horizontals, one lateral and one vertical. Th e unit carries 3 cameras, a color and low light black and white forward, with tilt, and a fixed rear camera. Sensors include auto-heading, electronic compass, auto -depth with sonar and manipulators available. The umbilical is 500 ft. in length and .52 in ches in diameter. Its depth rating is 500 ft.

Participating Manufacturers (continued)

Deep Ocean Engineering

http://www.deepocean.com/

Workshop Participant

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Product Descriptions

The Trigger Fish is a sturdy machine weighing 68 lbs., unlike many Mini -ROVs this is a two-man system. It has four thrusters, with 50 lbs. of forward thrust, 12 lbs. of both lateral and vertical thrust. I ts depth rating is 500 ft. It carries a high -resolution camera with 180 - degree tilt platform, compass and autopilot as standard equipment.

The Phantom-150 is a lighter unit weighing 30 lbs. Its maximum operating depth is 150 ft. with a forward thrust of 11 lbs. The unit carries a high -resolution camera with tilt capabilities and a light that tracks the camera. The umbilical is 175 ft. in length and .4 inches in diameter.

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Copies may be obtained from:
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