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Monday, October 10, 2011 85.0°F 

DISCOVERERS' DAY 2011: NEW FRONTIERS, FROM SEA TO SKY

Low-cost, high-tech robotic vehicles bring underwater secrets to the surface

By Edward T. Lu

POSTED: 01:30 a.m. HST, Oct 09, 2011

What is the largest unexplored area of Earth? Hint: It covers about 70 percent of the surface area of the Earth, and is blue, wet, and filled with fish.

As Arthur C. Clarke said, "How inappropriate to call this planet Earth, when it is quite clearly Ocean." Yet, our knowledge of the status of the world's oceans is surprisingly sparse. To give you an idea of how little we know about ocean conditions, worldwide there are only 1,250 ocean buoys that report oceanographic and weather data such as temperature, salinity, pollutant concentrations, currents and winds. These reporting stations are spread out over the 361 million square kilometers of Earth's oceans. That means that we have on average only one reporting point every 288,000 square kilometers, which is more than double the area of the country of England. Imagine if we had only one weather reporting station in all of England! For comparison, the state of Hawaii covers an area of less than 17,000 square kilometers and has 244 active weather reporting stations.

In contrast, we have little idea what is really happening in great swaths of the sea. Much of our knowledge of ocean status is based upon these sparse reporting stations and a small number of oceanographic research ships (and now increasingly satellite observations).

Our oceans remain one of Earth's last unexplored frontiers. As a former NASA astronaut, during my missions to the International Space Station I used to look down at the ocean below and wonder what was going on at that moment out there in the great expanse between the scattered islands. I thought it was ironic that in some ways our knowledge of the conditions in outer space was more complete than our knowledge of the conditions in the ocean on our home planet.



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So what are we waiting for? We are becoming more and more dependent upon the ocean, for everything from transport and sources of food, to absorbing the carbon dioxide that our civilization emits into the atmosphere. So it is increasingly important that we continue to explore and discover how the ocean works. And there is much to learn.

Fortunately, our knowledge of the oceans is about to greatly improve. Why do I believe this? Because fields that are ripe for innovation often come about because of advances that make new ways of access and measurement possible or radically cheaper. Think of the effect the development of inexpensive optical sensors had on the field of photography (and even astronomy). The advent of small, cheap robotic vehicles is about to make it possible to instrument the ocean to a much larger extent and to see what is really happening out there. Already, much of the undersea work on undersea cables and drilling sites is done by remote controlled robots. These robots are also increasingly being used for exploration purposes.

Advances in computers, GPS navigation systems, miniaturized sensors and robotics have also made it possible to build and deploy autonomous robots that can roam the seas and measure everything from wave heights, currents, and temperatures, to the sound of marine mammals.

Many companies and research groups worldwide are working on such projects (full disclosure: I work for one of them, Liquid Robotics).

For instance, ocean-going robots are being used to learn about whale migration patterns, the detailed structure of ocean currents, the biology of algae blooms, and the changing temperature patterns in the ocean. Combined with satellite-based sensors, we are rapidly filling in the gaps in our data.

Our ability to explore the seas is being revolutionized in the same way that robotic spacecraft allow us to explore areas that humans cannot feasibly reach.

As we commemorate Discoverer's Day and the Polynesian voyagers who first reached Hawaii, it's time for us to reflect upon the great discoveries we have made on Earth and in space, and to prepare ourselves as we explore the next frontier: Earth's vast oceans.

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