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## DepthX

This month's column explores the current adventures of DepthX, a NASA-funded robotic vehicle designed initially to explore deep underwater alien environments here on Earth. During dives it now makes, the robot tests systems that it may someday use to explore the ice-covered oceans of Jupiter's moon Europa.

The photo on this month's cover shows DepthX exploring our planet's deepest flooded sink hole, the 1,099-foot-deep Zacatón Cenote, located near Tamaulipas, Mexico. The dives that the robot makes are all critical tests of the autonomous systems that give it the ability to operate without any human intervention. If it is to ever explore Europa, it will seek out and explore a very alien world

too far from its human handlers to ask them for advice as to where to go, what to do when it gets there, and especially what to do if it gets in trouble.

Bill Stone, a specialist in industrial automation, first envisioned the robot's structure. With NASA funding, Stone built most of DepthX at his own company, Stone Aerospace, located in Austin, TX. Final assembly contains many off-the-shelf parts, as well as a number of systems specifically designed for DepthX at other facilities. Engineers at Southwest Research Institute,

located in San Antonio, TX, developed the robot's sample arm and some of its other scientific instruments. The software for DepthX was developed under the leadership of David Wettergreen at the Field Robotics Institute at Carnegie Mellon University in Pittsburgh, PA.

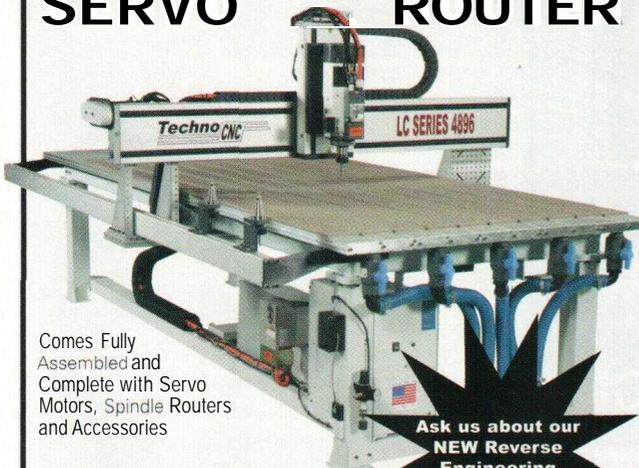
The explorer, shown in Photo 1, contains 36 computers, hundreds of sensors, 56 sonar units, and multiple video cameras and lights to help it



Photo 1

David Wettergreen, Carnegie Mellon University

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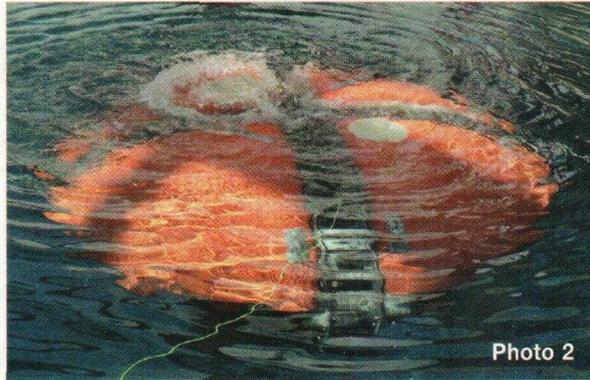
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map and explore its environment. All of DepthX's hardware relies on the Carnegie Mellon SLAM (Simultaneous Localization and Mapping) software that provides it with a detailed map it can use to navigate its surroundings.

To understand how the SLAM software guides DepthX on its underwater journeys, let's compare what it does to a more familiar land-based GPS mapping system. GPS satellites provide location data that is overlaid onto a map in the GPS receiver. As DepthX slowly descends (Photo 2), it slowly revolves to give its 56 sonar units a chance to create a 3D map of the area. It also uses the data it gathers to pinpoint its own location on a 3D map that it creates during its descent. It now uses other software to help it plan its voyage of exploration. It maps, locates itself on its map, spots interesting locations within visual or sonar range, and

then uses its map to create the safest route to explore that location. It also uses these maps to find its way home at the end of its voyage.



DepthX is designed to not only visually explore its environment but also to take samples for analysis. Onboard analysis includes visual examination under an onboard microscope. The software that controls this microscope has subroutines designed to track objects in the sample that show the physical characteristics of a living organism. Larger objects that might be no more significant than slime-covered

rock formations are also physically and visually sampled for later study after the samples and video are retrieved from DepthX.

Microbiologists from the Colorado School of Mines are also currently studying samples taken onboard. This earth-bound exploration has already led to the discovery of nine new microbes that might contain DNA that could lead to all kinds of new discoveries here on Earth.

We can only imagine what DepthX might discover if it gets a chance to swim and map the oceans of Europa!

#### Recalling the Facts

1. How do the builders of DepthX control the vehicle's location during a dive?
2. How does this vehicle create a 3D map of its environment? ©

*Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit [www.technologytoday.us](http://www.technologytoday.us) for past columns and teacher resources.*

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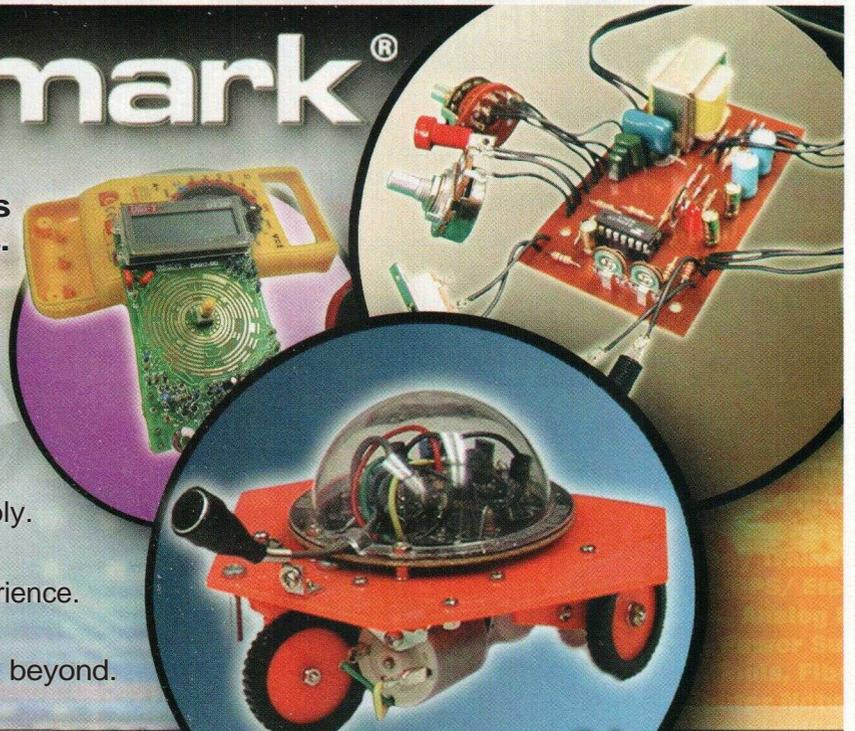
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