NASA-funded robotic sub finds bottom of world's deepest sinkhole

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Carnegie Mellon researchers use sonar to map, demystify El Zacatón

A robotic vehicle designed for underwater exploration plunged repeatedly into the depths of Mexico's mysterious El Zacatón sinkhole in late May, finding its previously undiscovered bottom 318 meters below the surface and generating a sonar map of its inner dimensions. The vehicle employed autonomous navigation and mapping systems developed by Carnegie Mellon University's Robotics Institute.

During a two-week NASA-funded exploration led by Bill Stone of Stone Aerospace, the Deep Phreatic Thermal Explorer (DEPTHX) revealed that the geothermal sinkhole, or cenote, did not have a tunnel or any other obvious underwater connections with neighboring cenotes in the Mexican state of Tamaulipas. It also obtained numerous samples of water and the gooey biofilm coating the cenote's walls.

"We're very pleased about the performance of the DEPTHX system," said David Wettergreen, an associate research professor who headed Carnegie Mellon's contingent of the research team. "We hit our technical objectives in creating a system that could explore and map autonomously."

In addition to gathering information regarding geothermal sinkholes, DEPTHX tested technologies and methods that might be useful in other underwater explorations, including the long-term possibility of exploring the oceans hidden under the icy crust of Europa, one of Jupiter's moons.

For the near term, NASA recently approved a project that will use these technologies to explore underneath the ice of West Lake Bonney in Antarctica's Taylor Valley.

The DEPTHX vehicle, 2.5 meters in diameter, included 56 sonars that the Carnegie Mellon team used to determine the location of the vehicle as it explored the cenote. It also used the sensors to create maps of the sinkhole's interior via a technique called simultaneous localization and mapping, or SLAM. Prior to the DEPTHX field experiment, SLAM had been used for navigating in buildings and mines, but had never operated in an underwater environment or with such sparse sensor input.

Robots typically navigate by recognizing features, but cenote walls, while irregular, lack distinctive features. To overcome this challenge, DEPTHX had to navigate by recognizing a more global response from all of its sensors.

Wettergreen said demonstrating that SLAM could work in such a featureless environment suggests that it will have applications in environments with similarly sparse features, like rivers or mines.

Though initially operated on a tether, DEPTHX eventually operated autonomously, without a tether or human guidance, for eight hours at a time. "The fact that we never lost it, never required a rescue mission, is an achievement itself," Wettergreen added.

Source: Carnegie Mellon University