The Future of Space Robots

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A spaceship descends with a thunderous roar and deposits a futuristic probe before taking off again. The Extraterrestrial Vegetation Evaluator (EVE) soon activates and begins flying around, scanning the barren surface for signs of life.

Scientists today can only dream of having a robotic explorer like EVE from the Disney/Pixar film "WALL•E." But some researchers are working on autonomous spacecraft, airships and rovers that can cooperate intelligently while exploring distant worlds.

"The orbiter gives you global perspective, the aerial platform a more regional perspective, and that helps determine where to deploy ground assets in a targeted fashion," said Wolfgang Fink, a physicist at Caltech in Pasadena, California.

Fink's vision of "tier-scalable reconnaissance" starts with an orbiting spacecraft to make a global survey for interesting scientific targets, before deciding on its own where to deploy an airship such as a dirigible. The airship could look even closer at a region to find the best landing site, and finally drop a rover or some other surface explorer. That surface explorer could then move quickly to the target area.

A demonstration of how such a surface explorer might deploy will take place in the Mars Science Laboratory mission, slated for a 2009 launch. NASA's Sky Crane carrier will hover above the surface of Mars on retrorockets while lowering an SUV-sized rover using a winch and tether.

Some Mars missions have already demonstrated the advantage of coordinating orbiters with surface explorers. Scientists used data from three Mars orbiters to determine the landing site for NASA's Phoenix Mars Lander, and also turned orbiter cameras on the lander as it descended to the surface. Of the three orbiters, the Mars Reconnaissance Orbiter has even helped NASA's separate Spirit and Opportunity Rovers navigate around obstacles on the Martian surface.

However, Fink and his collaborators want to take humans out of the loop and develop robots which can decide independently when and where to go. That becomes crucial for future missions to distant places such as the moons of Saturn or Jupiter, where a command signal

from Earth can take over an hour to reach robotic explorers.

The key rests with software algorithms that help robots make command decisions on their own. Fink's group has begun testing such algorithms by using three small rovers and a camera that looks down on a simulated indoor landscape. The camera identifies both targets and obstacles, which allows the rovers to deploy and drive around obstacles to reach their targets — all without human intervention.

"Integration is the biggest challenge," Fink noted. "At Caltech, we are now at the point where we're implementing a test-bed outdoors to develop the software to demonstrate this in action."

The outdoors test would involve a miniature airship taking the place of the camera. Researchers from around the world would be able to give commands to the airship via Internet and watch it move and deploy the rovers on its own.

The field tests may pave the way for using similar command software on the proposed NASA and European mission to Titan or Europa. Fink and other researchers involved with the planning have begun discussing how such a mission might shape up by the 2017 launch date.

"A Titan mission would have the orbiter deploying a balloon, and we're already thinking about having a lander," Fink explained. "There you have a three-tier mission."

The tiered approach may eventually take the form of a robot that "does its own reconnaissance, goes out and looks for anomalies, finds something interesting and makes contact with the sender," Fink said, pointing to the Imperial probe from "The Empire Strikes Back" which lands on the ice planet Hoth.

Perhaps best of all, intelligent robots could react quickly to surprises and investigate anomalies — such as a geyser on Saturn's moon Enceladus, or a landslide on Mars.

"Curiosity in itself is not present in any of our machine systems," Fink said, remarking upon WALL•E's childlike tendencies which appear to distract EVE but eventually help her mission. "That curiosity drives action."

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