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Robots to the rescue for the ailing Hubble?

Space: A team at the University of Maryland, College Park has developed a robot called Ranger that could help extend the life of the imperiled orbiting telescope.

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SUN STAFF

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COLLEGE PARK - With top NASA officials unwilling to risk astronauts' lives to service the Hubble Space Telescope, and with the clock ticking toward the moment when fading batteries or failed gyroscopes are likely to cripple it, perhaps only a miracle can save the revered observatory.

Or a robot.

Enter David L. Akin, a robotics engineer and director of the Space Systems Laboratory at the University of Maryland.





Almost unnoticed, Akin and his team at College Park have spent 14 years - and \$14 million of NASA's money - developing a robot called Ranger to repair and upgrade orbiting satellites, particularly Hubble.

Ranger is one of several systems that the National Aeronautics and Space Administration is studying before proposing a possible robotic rescue for Hubble. NASA administrator Sean O'Keefe is expected to make a final decision by September.

"We're positioning ourselves to be able to do it," said Mike Moore, Hubble program executive at NASA headquarters. "We're all very hopeful and excited we can actually do this."


Ranger has never flown in space. But early last month, Akin described a hypothetical Ranger rescue mission to NASA officials at the Goddard Space Flight Center in Greenbelt. A space-certified Ranger is 70 percent built, he told them. It's in storage and ready for final tests and assembly.

"We basically said we'll not only fly all the hardware, but we'll put it all in the same places the astronauts were going to put it," he said. "We think we can make it work."

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 **Brian Roberts**
(Sun photo by Kim Hairston)
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Twenty-six other government, industrial and academic organizations have also described their robotic technologies to NASA.

With O'Keefe on the record as opposing a manned service mission to Hubble - and scientists predicting that the telescope will fail as early as 2007 without repairs - the agency is scrambling to develop alternatives for extending Hubble's scientific usefulness.

Astronauts on the canceled servicing mission, referred to as SM4, were scheduled to replace batteries and gyros to keep the telescope alive until at least 2010. They were also supposed to install scientific instruments to expand Hubble's view of the cosmos.

Strict safety standards

O'Keefe said his decision was unavoidable, given the strict flight-safety standards set since the shuttle Columbia accident last year and the demands on the shuttle program for completing the International Space Station.

Astronomers, politicians and ordinary citizens - who had been mesmerized for years by Hubble's spectacular images of the universe - rose in protest. In response, NASA asked the National Academy of Sciences to review options for saving the telescope.

The Hubble assessment committee named by the academy could recommend that the manned SM4 mission to Hubble be revived, Moore said. But "from my point of view," he said, "unless we have a new administrator, that isn't going to happen."

The panel members were asked to consider other solutions, including engineering adjustments by ground controllers that could squeeze more work out of the telescope or servicing by a remote-controlled robot.

Scientists at the Space Telescope Science Institute in Baltimore are working to devise new ways to keep Hubble operating for as long as possible if no rescue attempt is made.

But the astronomers there love the idea of a robot.

"If they service it with aliens, it doesn't matter to me. I just want to see Hubble continue," said the institute's director, Steven V.W. Beckwith.

Beyond the obvious gains for space science, a successful robotic repair and upgrade would offer enormous promise for the future, he said.

"If they can make this thing work, we could service Hubble over long periods, and we wouldn't be limited anymore by the short shuttle flights," Beckwith said. "The whole history of human evolution has been to invent tools to do what was risky for people to do. This is a natural evolution. ... I think it's very exciting."

Proven space robotics would also be useful in the lunar and Mars exploration missions proposed by President Bush.

NASA engineers have always known that they would have to send some sort of unmanned vehicle back to Hubble, Moore said. The telescope has no propulsion, and without something to nudge it into a safe re-entry over an empty ocean, the bus-sized telescope could make a risky, uncontrolled fall to Earth as early as 2013.

In February, Moore said, O'Keefe challenged his program managers to find a way to tackle the re-entry problem. He also wanted them to find a way to accomplish some of the tasks planned for SM4, Moore said, "but in a way that wouldn't involve risking human life."

NASA's initial in-house discussions were promising. "We've convinced ourselves the idea is worth pursuing," Moore said. But they needed to reach out and review the state of the art in robotics, including the University of Maryland's Ranger system.

Since 1980, a decade before he moved his lab to Maryland from the Massachusetts Institute of Technology, Akin and his colleagues have worked with NASA to develop robotic systems that could maintain satellites in orbit.

'A wonderful example'

Recent research at College Park suggests that more than \$1 billion worth of commercial, military and scientific satellite "assets" are lost each year to premature breakdowns. "That is the market," Akin said. "Hubble is a wonderful example."

Because Hubble was designed to be repaired in orbit by astronauts, Akin used the telescope, and the experience of those who have worked on it, as the "gold standard" for his robot.

"If humans and robots could do the same tasks, you had a more robust system," he said. So Ranger evolved as a pair of highly dextrous arms with a varied set of interchangeable tools for "hands." And it's all sized to go where astronauts' hands and arms go.

The arms are atop a single flexible "leg" with a "head" equipped with a stereo camera.

In Akin's most optimistic assessment, Ranger would be mated to an upper-stage rocket platform called the Interim Control Module (ICM), developed by the Naval Research Laboratory in Washington.

A version of the ICM has reportedly proved itself in classified "black" missions for the military, Akin said.

A 6-ton Ranger-ICM package carrying batteries, gyros and new instruments for Hubble would be launched into orbit atop an Atlas or Delta rocket. The ICM would fly Ranger to Hubble and dock to its base, using the same mating hardware flown on the shuttle.

Guided by astronauts and engineers on the ground, Ranger would unfold itself, methodically open Hubble's access doors, then disconnect and replace the old hardware and instruments.

"It opens the doors and does it pretty much the way the astronaut does it," Akin said. It could also rotate the telescope, and reach every serviceable part.

Ranger could not remain attached to Hubble without interfering with the telescope's scientific work. So, after boosting the telescope to a higher orbit, it would fly some distance away, ready to return with additional spare parts if needed. When the time came, it could guide Hubble to a safe re-entry.

Akin conceded that Ranger, as a university project, lacks the redundant, "fail-safe"

systems that aerospace companies are expected to provide. "But we have more than 1,000 hours on the robot, and it hasn't failed," he said. "It's really good hardware."

Akin calculates that NASA could fly the entire Ranger mission for \$300 million or less. That's far less than the \$500 million-plus cost of a shuttle servicing mission.

He said he knows of two other systems that are competitive with Ranger. One is a "humanoid" NASA robot with five-fingered hands. The other is the Special Purpose Dexterous Manipulator (SPDM), developed by a contractor for the Canadian Space Agency for use aboard the International Space Station.

SPDM is as close to being ready as Ranger is, Akin said. But he argues that the Canadian robot's "hands" might be too large for work on Hubble and that it lacks the flexibility of Ranger's interchangeable tools. "Sort of like doing repairs with wastebaskets for hands," he said.

At NASA headquarters, Moore said the agency is likely to issue a formal request for proposals next month, detailing its vision for a robotic Hubble rescue and soliciting competitive responses from the robot builders.

With preliminary findings from the Hubble assessment committee expected by late summer, he said, O'Keefe could be ready to make a go or no-go decision by the end of September.

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▶ **Brian Roberts, a research engineer at the University of Maryland, changes a tool on the arm of the Ranger robot.**

(Sun photo by Kim Hairston)

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