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Space exploration's next frontier: Remote-controlled robonauts

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As Japan's second female astronaut to fly up in the Space Shuttle Discovery, Naoko Yamazaki didn't expect to spend a quarter of her time dusting, feeding mice and doing other menial jobs.

It can cost more than $430 million a year to keep an astronaut in orbit, according to 3-year-old startup called Gitai Inc. It's only possible to keep humans alive in outer space because of the money and effort poured into

ensuring their safety. One way to bring down the cost and risks is to send an avatar—a remotely controlled [robot](link).

"There's a need for robots that can help us," Yamazaki, 49, said. "Eventually, we should be able to do those tasks remotely or have them take over altogether."

As NASA opens up the International Space Station to private businesses and embarks on the Artemis mission to send astronauts back to the moon, there's a growing recognition of the need to keep spending under control, even as space-exploration projects grow increasingly complex.

That's where avatar technologies come in. Like a drone pilot, an operator equipped with wraparound screens or a virtual-reality headset will be able to move mechanical arms or an entire robot from far away. The [building blocks](link) already exist; the trick is to bring them together with software to make it all work. That's one reason why the space robotics market is projected to reach $4.4 billion by 2023.

"Avatar technologies will advance our opportunity for research in space tremendously," says Anousheh Ansari, the first Muslim woman to go into space. With the right technologies, "we can actually have the best of both worlds" of robots and human curiosity, intelligence and interactivity, she said.

Sho Nakanose, chief executive officer of Tokyo- and San Francisco-based Gitai, is betting he has the right solution. He's developing a robonaut that can be operated from Earth, handling tasks that normally would require an astronaut to go into space.

"We'll see an era in which humans will be working in space, not just going to space," Nakanose said. "We want our robots to create bases for Blue Origin and SpaceX."

A former system engineer at IBM, Nakanose left to launch a technology startup in India, and he built robots on the side for fun. Eventually, he decided that machines purpose-built to work in space had the potential to become an important business in an industry where travel costs are sky-high.

Commercial launch provider Space Exploration Technologies Corp., or SpaceX, founded by Elon Musk, built its business to bring down the cost of space travel. Rockets by the Hawthorne, California-based company cost less than $60 million per launch to low-Earth orbit, compared with more than $400 million for a typical launch. The company also is working to slash the cost of sending humans into space and eventually establishing bases on the moon and Mars.

Competing with him is Amazon.com Inc. founder Jeff Bezos, whose own Blue Origin space company is developing its own reusable rockets to send people into space, with a long-term goal of building orbiting colonies around Earth.

Theoretically, robonauts should be able to speed up the billionaires' lofty goals. That's why Nakanose is competing for the ANA Avatar XPrize, a global competition aimed at spurring development of the technology for use in disaster zones, underwater or other places considered too inhospitable or dangerous for humans. Indeed, Ansari backed one of the first XPrizes to spur development of affordable and reusable spacecraft.

By eliminating the need for air, heating, food and water that keeps humans alive, space developers can reduce the frequency of people-ferrying rocket launches and instead send up more avatars that can do spacewalks all the time—unlike humans—and assemble space stations, build bases and maintain spacecraft.

At its Tokyo office, Gitai has a mock-up of the interior of the

International Space Station, with various plugs, shelves and equipment mounted to a wall. A robot with white arms and black hands flips switches and handles experiment samples. The movements seem almost human, probably because there's an operator 10 meters (33 feet) away, wearing a headset and gloves that transmit touch. The cost? An estimated $300,000 to $500,000 for each avatar.

Gitai has raised about $4 million from Spiral Ventures and other backers to send parts of its contraptions into space next year for testing, in what will be a joint experiment with NanoRacks LLC, a Houston-based company offering launch services and access to the International Space Station.

The startup is one of 77 teams that cleared the first round of the XPrize competition, which ends in 2022. ANA Holdings Inc., Japan's largest airline, is backing the contest, and $10 million will go to the winners and finalists. "Mobility, in our definition, doesn't require bodies," said Akira Fukabori, who oversees the competition.

David Locke, a director at XPrize, points out that the use of avatars isn't just limited to space development. Remote-controlled robots could be used in places that are too dangerous for people, such as a crumbled building, burning forest or a nuclear meltdown.

Still, getting an Earth-operated robot to function in outer space is a daunting challenge. Given the distances involved, there's usually a time lag, which can make operators nauseous, a similar problem seen with virtual-reality machines. To tackle the challenge, Gitai is working to make its robots partly autonomous, which would boost their skills and make it easier for humans to operate them.

Space avatars probably won't end up looking like humans, said Masahiko Inami, professor of engineering and human augmentation at the

University of Tokyo. That would cost too much and be too bulky to transport into space. They'll also be operating in zero gravity, which means that legs aren't a necessity. "Focusing too much on making avatars look like humans might push people away from their goal."

For example, JAXA, Japan's space agency, developed an autonomous sphere called Int-Ball that was sent up to the space station three years ago to take pictures. Instead of having astronauts take photos, the device did the work, saving about 10% of their time.

Another solution is to make it easier for robonauts to do their jobs. The Lunar Gateway, the space station being developed for the Artemis program, will probably have lights and markers to guide robots, as well as charging stations for them, Yamazaki said. "They'll be building an environment that's also easier for robots to work."

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