Laser-sharp communication puts tiny satellites into play

TECHNOLOGY DERIVED FROM BLU-RAY DISC PLAYERS is helping engineers at Sony and JAXA link fleets of small satellites to the information highway.

Remote sensing of Earth's oceans and landmasses with satellites is essential for long-term environmental monitoring and rapid tracking of hazards such as hurricanes. Now, microsatellites equipped with extremely accurate lasers are poised to enhance space communication systems so they can handle data from remote sensing and other applications in real time, with sufficient quality to produce high-definition video streams.

Recent advances in producing small satellites that launch into space at a much lower cost have spurred ventures for improving global communication. For example, 'constellations' of small satellites strategically positioned in low Earth orbits could offer reliable internet access to billions of people currently lacking coverage. One problem with these concepts, however, is achieving sufficiently high data-transfer rates using conventional radio-frequency equipment.

USING LIGHT FOR SATELLITE COMMUNICATION

"When satellites talk to each other or the ground using radio frequencies, they consume a lot of energy and the equipment takes up a lot of space" explains Kyohei Iwamoto, a research project lead at Sony Computer Science Laboratories in Tokyo, Japan. "Because microsatellites have such small form factors, their power generation and payload capacities are limited — we can't just tack on large solar panels and big antennas."

Optical communication devices are attractive alternatives to the bulky equipment needed for radio waves. Because lasers emit at high frequencies, their beams can travel enormous distances without losing encoded signals. Iwamoto and colleagues are designing a system that can enable five microsatellites flying 4,500 kilometres apart to handle real-time data from anywhere on the globe using antennas no bigger than coffee cups. Achieving this, however, will demand improved mechanisms for laser pointing and tracking.

APPLYING BLU-RAY TECHNOLOGY IN SPACE

Currently, few laser communication terminals are used to establish satellite optical links. These modules, which combine photonic devices that generate, encode and receive light with mechanical actuators and gyroscope-like gimbals for free-space movements, are often quite heavy and bulky. The Sony team aimed to miniaturize the terminals using techniques found in consumer devices such as Blu-ray disc players.

"Video and compact disc players have really accurate controls for pointing lasers at data bits as small as a few hundred nanometres, even when a disc wobbles as it rotates, due to the presence of dirt" says Iwamoto. "Our challenge is taking the actuators and optics from these devices and ensuring they work with a gimbal to point at specific targets."

Initial experiments with JAXA Space Exploration Innovation Hub Center led by Hitoshi Kuninaka revealed this approach had a suitably high pointing precision and gimbal response to warrant testing data transmission on the Japanese Experimental Module of the International Space Station in 2018.

"This system is small, lightweight and ready for mass-production technologies," says Iwamoto. "We're looking forward to proving it in orbit." ■

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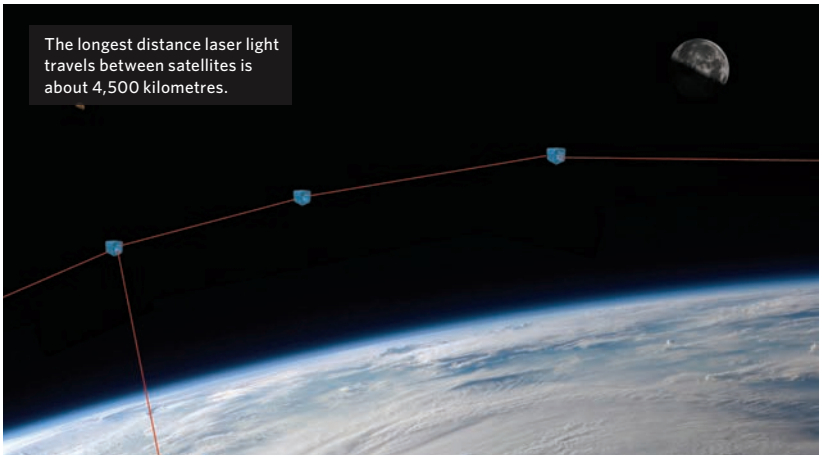
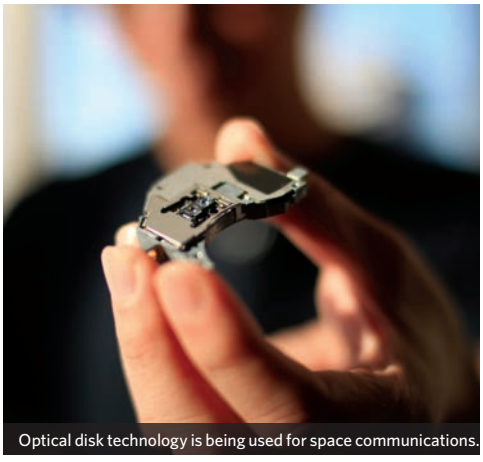


The longest distance laser light travels between satellites is about 4,500 kilometres.



Optical disk technology is being used for space communications.