National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Communications

Space Optical Communications Using Laser Beams

New method for optical data transmissions from satellites using laser arrays for laser beam pointing

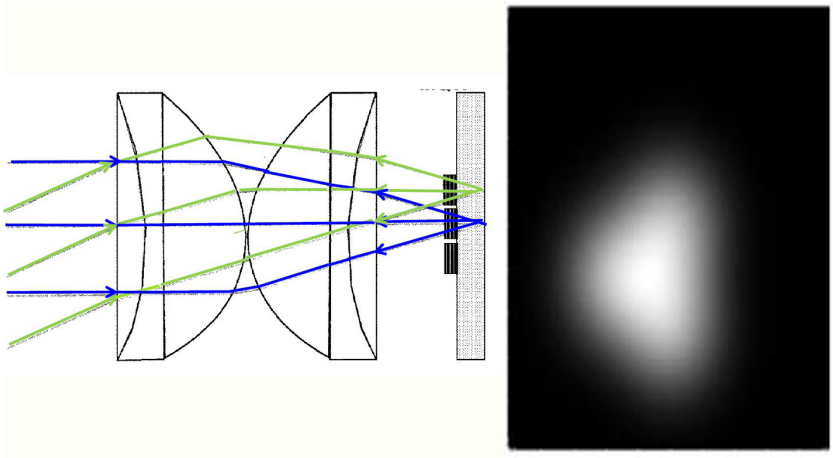
NASA has developed a new laser beam pointing technology for use in space optical communications. With further development, possible applications include communications from the Earth to spacecraft in Earth orbit and in deep space, such as at the moon and Mars. A possible application is to the Artemis Program for CubeSats in low-Lunar Orbit (LLO). Current architectures use dynamical systems, (i.e., moving parts, e.g., fast-steering mirrors (FSM), and/or gimbals,) to turn the laser to point to the ground terminal and possibly use vibration isolation platforms (VIP). This patented technology from NASA Ames uses a combined lens system and a vertical-cavity surface-emitting laser (VCSEL)/Photodetector Array. This static system has the potential to replace the current dynamic systems and VIP, dependent on studies for the particular application. Laser beam pointing is very challenging for low-Earth Orbit (LEO), including science missions. Computer simulations using this design have been made for an application to a CubeSat in LEO.

BENEFITS

- Minimal maintenance required
- Components are simple, static, and reliable
- Increase in communications performance
- Compact, with no moving parts
- Does not need a vibration isolation platform

THE TECHNOLOGY

This invention provides a new method for optical data transmissions from satellites using laser arrays for laser beam pointing. The system is simple, static, compact, and provides accurate pointing, acquisition, and tracking (PAT). It combines a lens system and a vertical-cavity surface-emitting laser VCSEL)/Photodetector Array, both mature technologies, in a novel way for PAT. It can improve the PAT system's size, weight, and power (SWaP) in comparison to current systems. Preliminary analysis indicates that this system is applicable to transmissions between satellites in low-Earth orbit (LEO) and ground terminals. Computer simulations using this design have been made for the application of this innovation to a CubeSat in LEO. The computer simulations included modeling the laser source and diffraction effects due to wave optics. The pointing used a diffraction limited lens system and a VCSEL array. These capabilities make it possible to model laser beam propagation over long space communication distances. Laser beam pointing is very challenging for LEO, including science missions. Current architectures use dynamical systems, (i.e., moving parts, e.g., fast-steering mirrors (FSM), and/or gimbals) to turn the laser to point to the ground terminal, and some use vibration isolation platforms as well. This static system has the potential to replace the current dynamic systems and vibration isolation platforms, dependent on studies for the particular application. For these electro-optical systems, reaction times to pointing changes and vibrations are on the nanosecond time scale, much faster than those for mechanical systems. For LEO terminals, slew rates are not a concern with this new system.



Left: Space Optical Communications using a Lens System with a Vertical Cavity Surface Emitting Laser (VCSEL)/ Photodetector Array

Right: Irradiance of three overlapping laser beams after 500 Km of propagation from LEO. Computational results

APPLICATIONS

The technology has several potential applications:

- CubeSat communications
  - Artemis Program, CubeSats in LLO
- Spacecraft industry
- Space communication:
  - Deep space optical communications (DSOC)
  - Optical multiple access (OMA)
- Communication between a constellation of close satellites

PUBLICATIONS

Patent No: 9,774,395; 9,954,613

Peter M. Goorjian, "A new laser beam pointing method using la arrays", Paper 10910-51, Conference 10910, Free-Space Lase Communications XXXI, SPIE Photonics West 2019, San Francis California, February 2-7, 2019

https://www.spiedigitallibrary.org/conference-proceedings-of-spie/10910/109101F/A-new-laser-beam-pointing-method-usin arrays/10.1117/12.2506303.full

Goorjian, P. M., "A New Laser Beam Pointing Method Using La Arrays" NASA/TM-2018-58815, November 2018

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technology.nasa.gov

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More Information

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Ames Research Center

MS 202A-3
Moffett Field, CA 94035
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

www.nasa.gov

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