National Aeronautics and
Space Administration

technology solution

Optics

Non-Scanning 3D Imager

High-resolution, real-time three-dimensional imaging using an innovative single lens system

The present innovation is a method and instrument to simultaneously generate a topographic profile of an object, surface or landscape.

Scanning LiDAR systems are most often used to simultaneously (i.e. in as short a time as possible) to achieve high spatial resolution and height (or depth) resolution over the maximum possible optical field of view. The disadvantage of the scanning system is the time it takes to scan, which prevents simultaneous image acquisition. This can be a problem for systems involving moving observers or objects, or both. Diffraction grating systems are also commonly used for three-dimensional imaging. These systems are limited by the grating throughput efficiency, and create difficulty generating a large number of spots and spots with equal energy. Flash LiDAR systems with uniform light distribution are also used, but these systems suffer from adjacent pixel crosstalk, reduced system measurement efficiency and difficulty in giving equal intensity weighting to each pixel. The present innovation overcomes the shortfalls of previously used three-dimensional imaging systems by employing a simple lens system.

BENEFITS

- Simple design: the invention does not require scanning or moving parts to produce high resolution images.
- Greatly improved system efficiency and reduced crosstalk: the physical separation of spots in the object plane using a a microlens to generate an array of equal intensity improves efficiency and reduces crosstalk between pixels.

THE TECHNOLOGY

NASA Goddard Space Flight Center's has developed a non-scanning, 3D imaging laser system that uses a simple lens system to simultaneously generate a one-dimensional or two-dimensional array of optical (light) spots to illuminate an object, surface or image to generate a topographic profile.

The system includes a microlens array configured in combination with a spherical lens to generate a uniform array for a two dimensional detector, an optical receiver, and a pulsed laser as the transmitter light source. The pulsed laser travels to and from the light source and the object. A fraction of the light is imaged using the optical detector, and a threshold detector is used to determine the time of day when the pulse arrived at the detector (using picosecond to nanosecond precision). Distance information can be determined for each pixel in the array, which can then be displayed to form a three-dimensional image.

Real-time three-dimensional images are produced with the system at television frame rates (30 frames per second) or higher.

Alternate embodiments of this innovation include the use of a light emitting diode in place of a pulsed laser, and/or a macrolens array in place of a microlens.

APPLICATIONS

The technology has several potential applications:

- Remote sensing (i.e. LiDAR mapping)
- Machine vision
- Robotic vision

PUBLICATIONS

Patent No: 8547531

More Information

National Aeronautics and Space Administration

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