National Aeronautics and Space Administration

Industrial Technology

A Non-Contact, Remote, Micron Accuracy, Laser Fresnel Distance Ranging System

A highly accurate state-of-the-art technology for distance measurements at ranges up to 20 meters from measurement device to target

NASA's Marshall Space Flight Center is offering a state-of-the-art distance measurement system, with micron accuracy, at ranges of up to 20 meters from the target. Such measurement accuracy is accomplished by employing changes in laser Fresnel patterns, which are extraordinarily sensitive to changes in distance. Differences in patterns are compared with known pattern/distance relationships, allowing the range to be uniquely determined. The technology could be especially useful in a variety of aerospace, industrial, and consumer systems where verification of a target's dimensional consistency can only be performed through remote, non-contact methods.

Benefits

- **Micron accuracy:** Distances measured with high precision, potentially to sub-micron accuracy
- **Real-time scanning:** Results available immediately after measurements are made
- **Range:** Measurements can be made from 20 meters away
- **Easy to use:** Complex hardware unnecessary
- **Simple computing requirements:** Distance data ports easily to a laptop or PC
- **Lightweight and compact:** Small component of a larger system

technologyopportunity

The Technology

How it works

This laser technology measures distance to micron accuracy at ranges up to 20 meters from the measuring device to the target object. Micron accuracy at this range is made possible by leveraging Fresnel patterns, which are highly sensitive to changes in distance. This novel approach compares the resulting Fresnel pattern's unique distance 'signature' to the device's database, resulting in a precise distance measurement. More specifically, a laser beam is aimed at the target object through a pinhole in an opaque screen. A portion of the beam passing through the aperture generates a region of diffraction, which varies as a function of distance from the aperture. A digital imaging system built into the measuring device focuses on a target plane in the region of diffraction with the generated image being compared to known diffraction patterns. Each known diffraction pattern has a unique value associated with it that is indicative of a specific distance from the aperture. With software embedded in the device, this pattern lookup and matching process occurs within approximately 1 millisecond, then it is ported to a laptop or other computing device via a standard cable (universal serial bus (USB) or Ethernet). Industry- or application-specific software on the computer takes the raw distance measurements and displays them in whatever format is needed by the operator performing the distance measurement.

Potential Applications

- Quality control operations (profiling to detect errors)
- Mold manufacturing (aerospace, automotive, shipbuilding, consumer products, and wind turbines)
- Steel work manufacturing
- Defense applications for careful machining of missile and other weapon system parts
- Milling machine calibration
- Computer hardware manufacturing (measuring thickness of hard drives to ensure balance)
- Dental/orthodontic appliance manufacturing

Why it is better

Beyond a range of 10-15 meters, current technologies cannot measure distances with micron accuracy. In heat- or robotic-intensive settings, measuring devices cannot be placed within 10 meters of the object. In addition, some targets must be measured within a larger object – such as components inside an airplane airframe. NASA's measuring device overcomes these challenges. The Nonintrusive, Remote, Micron Accuracy, Laser Fresnel Ranging System has several additional benefits, including the ability to measure non-reflective materials such as ceramics and curved surfaces without information on the curve being inputted ahead of time. This measuring system can also map non-uniform surfaces and measure target surfaces that are off perpendicular from the laser beam by 15 to 20 degrees or even more if the object is not completely reflective. It is accurate in field conditions and in manufacturing environments; normal air currents and routine amounts of dust or particles in the air do not hamper measurements. Capable of recording a measurement in 1 to 10 milliseconds, this innovative measuring system does not require complex processing to transmit data. Only a USB or Ethernet cable is required to transfer the data from the measuring unit to a laptop, PC, or other handheld computing device. The technology is not bulky, and is capable of being miniaturized to a unit about the size of a laser pointer.

Patents

This technology is covered under the issued U.S. patent 7,446,860.

Licensing & Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about licensing the Non-contact, Remote, Micron Accuracy, Laser Fresnel Ranging System (MFS-31649-1) for further development and commercial applications.

Fuentek is a contractor to NASA's Innovative Partnerships Program, providing support for the access and transfer of technology.

For More Information

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