technology ■ opportunity

National Aeronautics and Space Administration
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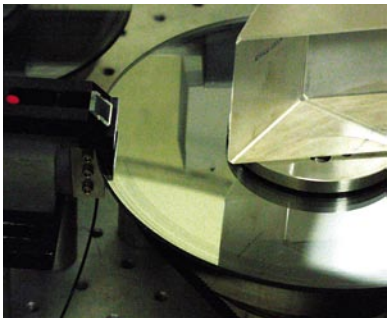
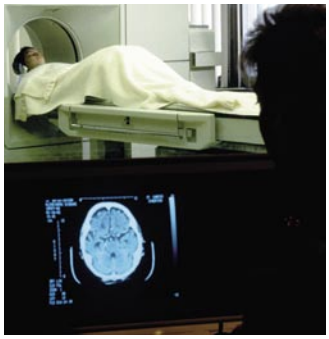
subassemblies and components

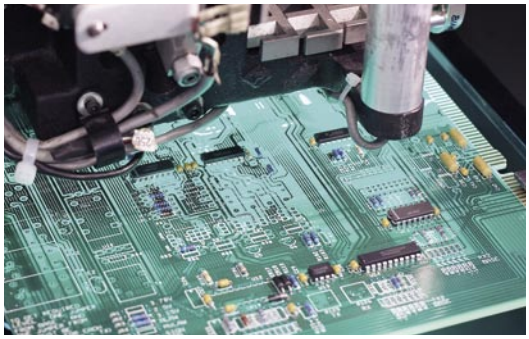
Linear and Rotary Absolute Optical Encoders with Ultra-high Resolution

Highly efficient, temperature-resistant encoders with high sensitivity



NASA Goddard's rotary encoder (pictured above) has an angular resolution below 0.01 arcseconds





NASA Goddard Space Flight Center invites companies to license its new linear and rotary encoders. These technologies use an area array image sensor to measure the relative and absolute position of an object by imaging a micro-lithographic scale on the object. Optical encoders perform precision measurements of angular and linear position and speed for a variety of applications. This invention won the NASA Government Invention of the Year Award for 1999 and has since undergone several important design improvements, including temperature-resistant engineering, high-efficiency vertical binning technology, and encoding speed improvements.

Benefits

- **Highly sensitive**: Features ultra-precise linear or angular resolution
- **Fast**: Employs vertical binning to help reduce exposure, image readout, and image processing times
- **Cryogenic tolerant**: Can operate in vacuum and at technologically important temperatures, ranging from as low as absolute zero to well over 100 °C
- **Lower cost**: Is inexpensive to manufacture
- **Damage tolerant**: Features designs that are far less susceptible to scale damage or contamination than conventional absolute encoders
- **Simple**: Is very compact and simple to assemble, install, and align
- **Versatile**: Is suitable for a wide variety of travel and resolution requirements

Applications

- Aerospace and aviation
- Computer-aided machining
- Semiconductor manufacturing
- Inspection equipment
- Linear positioning mechanisms
- Machine tools and robotics
- Medical imaging
- Profilometers and other instruments
- Surveying and telescopes

The Technology

Optical encoders measure the linear or angular position of an object by optically detecting marks on a scale affixed to the object. Goddard's linear encoder uses a microlithographically patterned scale and an image sensor. A light source projects the scale's pattern onto the image sensor, and the image information is digitized and analyzed by an image processor. In some implementations, encoding speed is dramatically enhanced using a technique known as vertical binning of image features. Pattern recognition algorithms are then used to determine the relative and absolute position of the object at very high resolution.

Why it is better

Goddard's optical encoders offer many advantages over other absolute encoders. Notably, the encoders offer conversion rates exceeding 20 kHz, making them ideal for many commercial applications. Through the technology's vertical binning capability, exposure time, image readout time, and image processing time are reduced—shortening the overall conversion time.

Goddard's encoders also provide superior resolution. The absolute linear encoder has a resolution of 1 nm using a modest scale magnification of 10X and is capable of encoding motion over 400 mm. The rotary encoder's resolution is 0.02 arc second for a 125-mm diameter code disk.

The manufacturing costs for Goddard's encoders are also significantly lower than for conventional encoders, and the encoders are smaller in size than others with comparable resolution. Unlike conventional encoders, they have also proven to be operable in cryogenic environments. In addition, because of the novel encoding method, the microlithographic scale pattern is far less susceptible to damage and contamination than are conventional encoder scale patterns.

Patents

NASA Goddard holds patents for its ultra-high-sensitivity, incremental and absolute optical encoding (U.S. Patent No. 5965879) and for its two-dimensional, absolute optical encoding (U.S. Patent No. 6765195) and is pursuing patent protection for its vertical binning technology.

Licensing and Partnering Opportunities

These technologies are 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 consider licensing the incremental and absolute optical encoding technologies (GSC-13703-1, GSC-14633-1, GSC-14766-1) for commercial applications.

For More Information

If you are interested in more information or want to pursue transfer of these technologies (GSC-13703-1, GSC-14633-1, GSC-14766-1), please contact:

Office of Technology Transfer
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More information about working with NASA Goddard's Office of Technology Transfer is available online:
http://techtransfer.gsfc.nasa.gov

GSC-13703-1
GSC-14633-1
GSC-14766-1
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