

LICENSING OPPORTUNITY: COMPACT ATOMIC MAGNETOMETER AND GYROSCOPE BASED ON A DIVERGING LASER BEAM

DESCRIPTION

Invention

The NIST Compact Atomic Magnetometer is based on a diverging (or converging) beam of light that passes through an alkali atom vapor cell and that contains a distribution of beam propagation vectors. The existence of more than one propagation direction permits longitudinal optical pumping of the atomic system and simultaneous detection of the transverse atomic polarization. This design can be implemented with a micro-machined alkali vapor cell and light from a single semiconductor laser. A small modification to the cell contents and excitation geometry allows for use as a gyroscope. Atomic magnetometers are scalar sensors - they sense the magnitude of the magnetic field, rather than the projection along one spatial direction. This is particularly important for applications on moving platforms since platform motion adds considerable noise to a vector sensor as the angle between the field and the sensor axis changes.

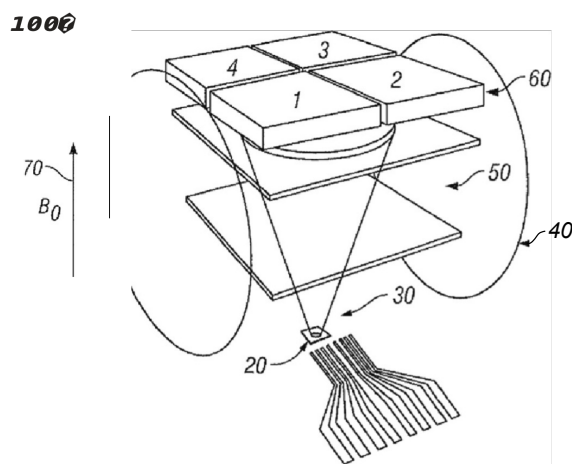
BENEFITS

Potential Commercial Applications

Multiple addressable markets exist based on the combined performance of the magnetometer and gyroscope in inertial navigation systems (INS), as well as multiple

end-use applications, including manned aircraft, automotive, and autonomous vehicles. NIST is seeking partnerships via CRADAs and patent license agreements.

Gyroscope applications include inertial navigation and platform stabilization (anti-roll systems in cars, for example). Other applications include those requiring ultra precise navigation with extreme size, weight, and power limits, such as on spacecraft or submarines.



An atomic magnetometer 100. Light is emitted from a semiconductor laser 20. It passes through some optics 30 that makes the laser polarization circular, attenuates the light beam and changes its spatial mode. A set of radio-frequency coils 40, positioned about the cell creates an oscillating magnetic field in the cell. The light then enters an alkali vapor cell 50 with some divergence. The magnetic field, B_0 , 70 is oriented along the direction of the average propagation direction of the light field. Alkali atoms in the cell are thereby polarized along this direction by the circularly polarized light field. The transmitted light power is detected by photodetectors 60.

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Competitive Advantage

Gyroscopes sense rotation. In combination with magnetometers, gyroscopes are used in inertial navigation and platform stabilization applications. The NIST Compact Atomic Magnetometer and Gyroscope is the first to demonstrate simultaneous measurement of rotation, rotation angle, and acceleration with a single source of atoms.

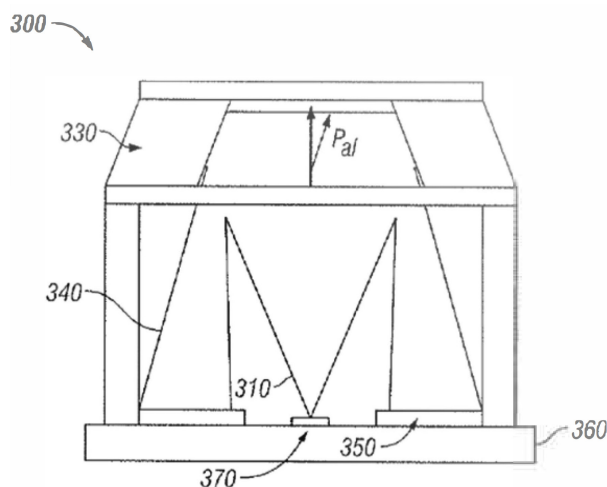
This technology simultaneously achieves high sensitivity, simple fabrication, and small size. For example, the NIST gyroscope's sensitivities for the magnitude and direction of the rotation measurements are 0.033 degrees per second and 0.27 degrees with a one-second averaging time, respectively. A variety of magnetometer/gyroscope combinations exist, but they are expensive.

The NIST compact atomic gyroscope enables multitasking measurement capabilities. It simultaneously measures rotation, rotation angle and acceleration with a single source of atoms. Signal strength and data acquisition speed increased to increase sensitivity measurements. In addition, it features a smaller design for compact systems that can be used in the field.

- Gyroscope capability
- High sensitivity
- Simple fabrication
- Small size
- Multitasking measurement capabilities
- Measures rotation, rotation angle, and acceleration with a single source of atoms

Partnerships

Cooperative Research and Development Agreements (CRADAs), Patent License Agreements (PLAs) Abound.



A schematic of an implementation of the diverging beam magnetometer or gyroscope 300. The diverging components of the laser beam 310 are reflected by angled walls inside the alkali vapor cell 330 to form counter-propagation probe beams 340. These beams are reflected a second time of the opposite wall and the power is detected by photodiodes 350 placed on the base plate 360 with the laser 370.

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