Fast-light Enhanced Fiber Gyroscope, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Current state-of-the-art navigation systems incorporate optical gyroscopes and optical accelerometers as inertial sensors. These devices contain no moving parts and can sense rotations and accelerations with high bandwidth. However, there is a fundamental tradeoff between the size of an optical gyroscope and its sensitivity. Highly sensitive gyroscopes are needed to meet navigation goals, but Size, Weight and Power (SWaP) are extremely precious resources in spacecraft or UAVs. Enhancing the sensitivity of existing devices, reducing their size, or both can allow the use of inertial navigation in smaller airframes, or free up room to include larger mission payloads for scientific or military purposes. Using fast-light effects generated in fiber with Stimulated Brillouin Scattering, we will enhance rotation sensitivity of conventional Ring Laser Gyroscope, to develop IMUs that will deliver higher performance and/or lower SWaP than a traditional navigation system. Previous results have shown sufficient fast-light effects with COTS components to demonstrate the technology, while numerical analysis indicates that a gyro could provide rotation sensitivities as low as 10-8 rotations/second. In the proposed Phase I work, we will demonstrate fast-light enhancement of an RLG in the lab for the first time and analyze factors affecting the performance and stability of the system in order to verify specs and design a prototype for construction in Phase II.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The improvement of inertial sensor components is essential to support navigation and attitude control systems for future NASA satellite missions. The proposed technology will have significantly reduced size and weight with ruggedized components designed to meet stringent dynamic, mechanical, thermal and radiation specifications for operation in space. A robust, high

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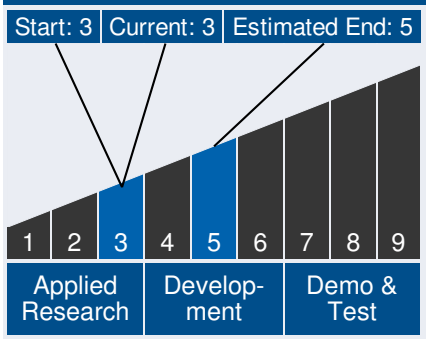
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

performance, and cost effective gyroscope suitable for space based operations will also have significant impact on demanding NASA applications that require stabilized platforms for long term space applications in smaller and smaller satellites. In particular, the technology can allow: Tracking and control of launch vehicles for placing payloads into orbital or sub-orbital trajectories. Precision inertial feedback during orbital maneuvers or stationkeeping operations on manned or unmanned spacecraft. Actively stabilize instrument platforms during sensitive astronomical observations or scientific measurements.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Self-guided ordinance and unmanned aerial vehicles, where traditional high sensitivity optical INS systems are too large to use. Stabilizing weapons platforms or communications devices mounted on ground and naval vehicles of all sizes. Commercial aircraft and marine vessels commonly use optical inertial measurement devices for navigation, stabilization, and tracking. Accurate navigation and gyrocompasses in a small form factor in the oil and gas industry for well-drilling.

Management Team *(cont.)*

Principal Investigator:

- Caleb Christensen

Technology Areas

Primary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└ Position, Navigation, and Timing (TA 5.4)
  └ Sensors and Vision Processing Systems (TA 5.4.3)

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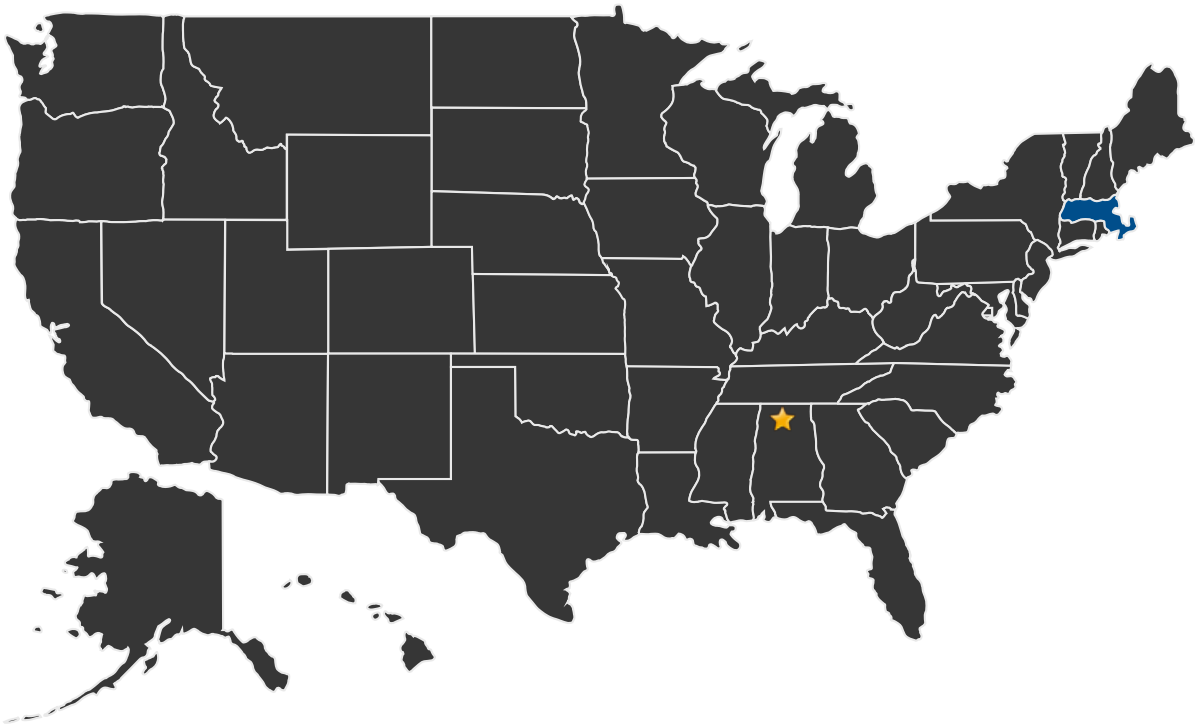
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

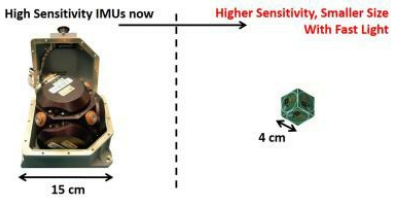
- MagiQ Technologies, Inc. (Somerville, MA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23425)

IMAGE GALLERY



Fast-light Enhanced Fiber Gyroscope, Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

Fast-light Enhanced Fiber Gyroscope, Phase I

Potential Applications

The improvement of inertial sensor components is essential to support navigation and attitude control systems for future NASA satellite missions. The proposed technology will have significantly reduced size and weight with ruggedized components designed to meet stringent dynamic, mechanical, thermal and radiation specifications for operation in space. A robust, high performance, and cost effective gyroscope suitable for space based operations will also have significant impact on demanding NASA applications that require stabilized platforms for long term space applications in smaller and smaller satellites. In particular, the technology can allow: Tracking and control of launch vehicles for placing payloads into orbital or sub-orbital trajectories. Precision inertial feedback during orbital maneuvers or stationkeeping operations on manned or unmanned spacecraft. Actively stabilize instrument platforms during sensitive astronomical observations or scientific measurements.