Air Force SBIR/STTR

Innovation

Air Force SBIR/STTR Innovation Story

SBIR Topic Number:
AF06-197

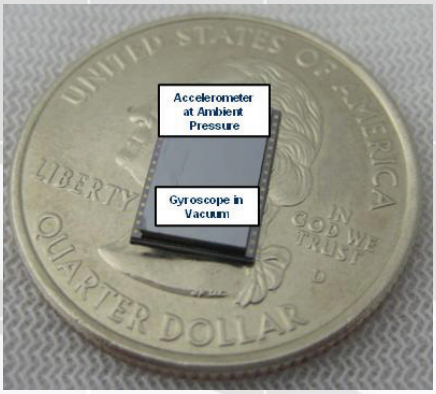
SBIR Title:
Navigation-Grade Microelectromechanical Systems (MEMS) Inertial Measurement Unit (IMU)

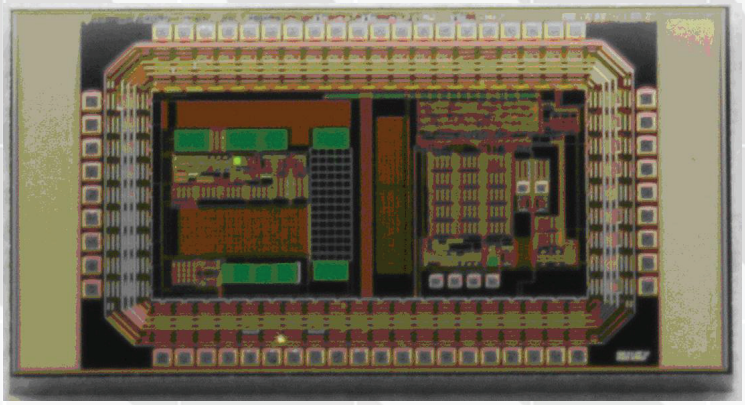
Contract Number:
FA8650-07-C-1184

SBIR Company Name:
Evigia Systems, Inc., Ann Arbor, MI

Technical Project Office:
AFRL Sensors Directorate, Wright-Patterson AFB, OH

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.





Left: Wafer-level packaged single-axis IMU chip. Right: Single-axis IMU front-end electronic interface chip.

Navigation-Grade Microelectromechanical Systems Inertial Measurement Unit

- The objective was to develop a navigation-grade Microelectromechanical Systems (MEMS)-based Inertial Measurement Unit (IMU) which would significantly reduce size, weight, power, and cost and improve reliability compared to existing navigation-grade IMUs
- Evigia Systems, Inc., designed and fabricated innovative prototype single-axis MEMS capacitive accelerometer and vibratory gyroscope pairs, which were fabricated together on a single-silicon chip
- A robust high-yield manufacturing process was developed for fabrication of MEMS accelerometers and gyroscopes atop of integrated circuits (ICs), leading to improved accuracy and inertial navigation capability as well as smaller size, weight, power, and cost; also, wafer-level micro-packaging technology for the MEMS sensors was developed and tested
- This technology would provide improved guidance and navigation for missiles, munitions, manned and unmanned air and space vehicles of all sizes, dismounted soldiers, and micro-robots

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Air Force Requirement

Gyroscopes and accelerometers are the critical components in an Inertial Measurement Unit (IMU). A promising approach to gyroscopes and accelerometers is Microelectromechanical Systems (MEMS) technology. A navigation-grade MEMS IMU would provide improved guidance and navigation for missiles, munitions, manned and unmanned air and space vehicles of all sizes, dismounted soldiers, and micro-robots as well as position, velocity, and attitude referencing for helmet-mounted cueing systems and antennas and targeting sensors on various ground, air, and space platforms.

The objective was to develop a navigation-grade MEMS-based IMU which would significantly reduce size, weight, power, and cost and improve reliability compared to existing navigation-grade IMUs.

SBIR Technology

During this SBIR project, Evigia Systems, Inc., designed and fabricated innovative prototype single-axis MEMS capacitive accelerometer and vibratory gyroscope pairs, which were fabricated together on a single-silicon chip.

A robust high-yield manufacturing process was developed for fabrication of MEMS accelerometers and gyroscopes atop of integrated circuits (ICs), leading to improved accuracy and inertial navigation capability as well as smaller size, weight, power, and cost. Also, wafer-level micro-packaging technology for the MEMS sensors was developed and tested.

IMU architecture and micro-controller designs were developed. Three orthogonal MEMS accelerometer-gyroscope pairs comprise the core of the IMU design. A system-level approach for reducing MEMS gyro bias was developed, leading to increased IMU accuracy. These collective research efforts resulted in one patent and another patent which is being granted.

Potential Application

A navigation-grade MEMS IMU has the potential to positively impact military and civilian applications. Such an IMU would provide a highly reliable, small size and weight, low power, and low cost solution to current and new navigational and reference requirements for a myriad of platforms. This technology would provide improved guidance and navigation for missiles, munitions, manned and unmanned air and space vehicles of all sizes, dismounted soldiers, and micro-robots. Further, it would provide position, velocity, and attitude referencing for helmet-mounted cueing systems, antennas, and targeting sensors on various ground, air, and space platforms

Company Impact

"The technologies developed in this SBIR Phase II project and integration with IC electronics were leveraged by Evigia Systems in two additional SBIR Phase II projects, with options from the Navy on development of single chip multi-sensor systems for equipment health monitoring and prognostics," states Dr. Navid Yazdi, founder and chief executive officer. "In particular, the sensor fabrication improvements are employed to form silicon strain, vibration, and mechanical shock sensors atop of an IC wafer. The wafer-level micro-packaging technologies, which were developed in this SBIR contract, will also be employed in the multi-sensor system SBIR project for the Navy."

"In addition, a Phase II Army SBIR and enhancement was awarded to leverage some of the wafer integration technologies Evigia Systems developed in an embedded wireless sensing system for parachutes. Potential transition of the navigation-grade MEMS IMU technology into government programs is enabled through additional government contracts for follow-on work in the ongoing technology and collaborations with aerospace companies."

U.S. AIR FORCE

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