Department of the Navy SBIR/STTR Transition Program

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NAVSEA ##2023-0784

Topic # N211-067
Atomic Inertial Sensor as an Alternate Position Source
AOSense, Inc.

WHO

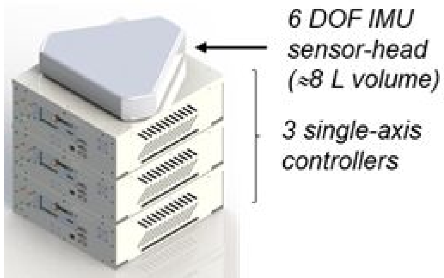
SYSCOM: NAVSEA

Sponsoring Program: PEO IWS

Transition Target: Surface Ships Combat Systems (CS)

TPOC: thanh.n.tran.civ@us.navy.mil

Other Transition Opportunities: Underground, underwater, shipboard, airborne, and space platforms requiring accurate position, velocity, and/or attitude information with limited access to external aiding such as satellite navigation signals



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Notes: An inertial measurement unit (IMU) measures 3-axis rotations and 3-axis accelerations. Conventional IMUs use gyroscopes with drift rates that limit navigation accuracy between Global Positioning System (GPS) updates. Inertial sensors employing atom interferometry can achieve superior stability and reduced sensor drift. The image shows a computer-aided design (CAD) model for an AOSense quantum-atomic IMU (QuIMU) comprising a 6 degree-of-freedom (6 DOF) sensor head operated by 3 single-axis controllers. Future QuIMUs will merge single-axis subsystems into a low-size, weight, power, and cost (SWaP-C) integrated instrument.

WHAT

Operational Need and Improvement: The primary positioning source for maritime surface platforms is GPS, which is susceptible to interference and may not be continuously available. Many military platforms supplement GPS by also deploying IMUs, which provide continuous, all-weather rotation and acceleration information. Conventional IMUs use gyroscopes with drift rates that limit navigation accuracy between GPS updates. Higher-performance IMUs with lower drifts would extend the time duration that marine platforms can maintain accurate navigation when GPS is unavailable.

Specifications Required: When GPS is unavailable, surface ships could navigate more accurately using a higher-performance IMU featuring shipboard-compatible SWaP-C and sufficient dynamic range and measurement bandwidth to support deployment on a dynamic marine platform.

Technology Developed: In laboratory environments, quantum-atomic inertial sensors have measured rotations and accelerations with superior stability and noise relative to conventional sensors. AOSense QuIMUs employ novel techniques to attain higher accuracy than conventional IMUs with higher dynamic range than other atomic inertial sensors. The Phase II effort will support prototype QuIMU testing in a Government facility. Ultimately, the integration of low-SWaP-C QuIMUs into a wide variety of platforms will extend the time duration that they can maintain accurate navigation in a GPS-denied environment.

Warfighter Value: AOSense QuIMUs will facilitate the success of U.S. Navy missions by providing personnel and platforms with access to accurate and reliable position, velocity, and attitude information to support safe shipboard operations and weapons employment.

WHEN

Contract Number: N68335-23-C-0078 **Ending on:** Nov 15, 2024

Milestone	Risk Level	Measure of Success	Ending TRL	Date
QuIMU design and performance simulations	N/A	Simulations support specified navigation performance	4	2nd QTR FY22
Single-axis sensor assembled	Low	Sensor subsystems integrated	4	1st QTR FY24
Single-axis sensor validated	Low	Sensor performance validated for simulated environment	5	1st QTR FY25
If Option exercised, QuIMU testing	Medium	QuIMU performance validated	6	1st QTR FY26

HOW

Projected Business Model: In 2022, we sold prototype single-axis quantum-atomic inertial sensors to large defense contractors, with whom we are actively collaborating to facilitate the integration of QuIMUs into future military platforms. This is a major step toward commercialization of QuIMUs. The prototype QuIMU that this SBIR project is developing will be suitable for U.S. Navy surface ships. The relatively benign dynamics of marine platforms relative to terrestrial and flight platforms make surface ship navigation a particularly attractive initial QuIMU application. Upon a successful Phase II prototype demonstration, we will seek Phase III funding to develop a lower-SWaP-C manufacturing prototype that eliminates unnecessary redundancies by merging single-axis subsystems into integrated QuIMU subsystems that streamline the manufacturing process. In parallel, we will seek funding from other sources to develop QuIMUs that operate under higher dynamic conditions, as well as continuing to miniaturize sensor, laser, and electronic subsystems to address a broader range of navigation applications.

Company Objectives: AOSense's mission is to transition quantum-atomic technologies from research laboratories to fielded systems. With global quantum initiatives driving accelerating investments in quantum science, we target rapid revenue growth from both R&D services and commercial product sales. The growth of product sales to 35% of total revenue in 2022 demonstrates the success of our commercialization efforts. For navigation applications, our primary objective is to supply QuIMUs and quantum-atomic inertial navigation systems. However, we will also supply single-axis sensors to customers who want to integrate them into their own navigation systems.

Potential Commercial Applications: As we successfully reduce the SWaP-C of QuIMUs, they will become attractive for applications that require precise position and/or attitude information in the absence of global navigation satellite system (GNSS) signals. Since GNSS signals attenuate rapidly underground and underwater, borehole navigation and geophysical exploration using unmanned underwater vehicles (UUVs) are particularly promising commercial applications.

Contact: Brenton Young, President
byoung@aosense.com (408) 470-9612