OBJECTIVE: Develop a passive device or system that allows an unmanned vehicles/vessels to develop and maintain awareness of its location on the earth’s surface without using the Global Positioning System (GPS).

DESCRIPTION: This topic stands at the intersection of three needs: unmanned navigation, passive sensing, and mitigation of GPS vulnerability. First, unmanned surface vehicles/vessels (USVs) are being developed both by global navies and by commercial shipbuilders. While underway, a USV must determine its position on the earth’s surface to get to its destination while avoiding shoal waters, charted obstacles, and prohibited areas. Second, military vessels need to have the capability to operate without revealing their locations to potential adversaries. Radio frequency (RF) transmissions, including use of a surface search or navigation radar, can disclose a vessel’s location, Commercial vessels may also find that staying silent can aid in avoiding being targeted by warships during hostilities or by pirates. Third, the GPS has become the primary means for navigation for most ocean-going vessels. However, this system is susceptible to interruption or spoofing, especially during times of hostilities between nation-states. Therefore, the U.S. Navy seeks a device that allows an unmanned vessel to develop and maintain awareness of its location on the earth’s surface without using GPS or revealing the vessel’s location while meeting the accuracy requirements for restricted piloting as well as coastal and open water navigation (As described in CNSP/CNSLINST 3530.4F).

Passive navigation techniques such as celestial navigation with a sextant have been used for centuries, but the navigational fix accuracy is not sufficient for operation of modern Navy systems. Older electronic navigation systems such as Omega and Loran-C have also been retired. Other satellite-based systems such as Russia’s GLONASS and the European Union’s Galileo have the same disadvantages as GPS. Additionally, there are legislative and policy limitations on use of the Global Navigation Satellite Systems (GNSS) of other nations by the US Navy (Public Law 114-328 and DoD instruction 4650.08). Use of satellite constellations as part of the proposed solution is not prohibited, but cannot be the only means of navigation fixing. This topic seeks a novel system, an improvement over existing methods, and/or a combination of methods to achieve the stated accuracy goals. Solutions only relying on GNSS or using active RF transmission will not be accepted. Use of a fathometer and AIS is discouraged but not prohibited. The final product is a fully integrated system that interfaces with the USV’s autonomy by passing a stream of latitude, longitude, time, and confidence fields. The final product should be able to take an input from an onboard inertial navigation system that provides a "dead reckoning" solution to previous fixes and that gives a ship’s heading information.

This system will meet critical Navy needs by allowing Medium Unmanned Surface Vehicle (MUSV) and Large Unmanned Surface Vehicle (LUSV) to safely navigate without revealing their location to adversary forces. The product meeting stated goals without operator input or assistance (unmanned or autonomous) will be validated and tested ashore for compliance with the Navy-provided Initial Capabilities Document (ICD). Additionally, the product will be evaluated for ease of integration with the unmanned vehicles/vessels with respect to Hardware (Size, Weight, Power, and Cooling) and Software Integration. Once validated ashore by the Navy, it will be qualified and certified for Navy use through sea trials in at least three different geographical locations (e.g., Atlantic Ocean, Gulf of Mexico, and Pacific Ocean) and in a variety of conditions. These conditions will include near-shore and open ocean conditions, daytime
and nighttime, clear visibility and fog. Depending on the technology used, tests will be selected that provide a diversity of conditions having an impact on the solution.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been be implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Provide a concept to solve the Navy's problem as detailed in the Description. Demonstrate feasibility with modeling and or simulation. Provide any preliminary analysis and/or testing supporting the viability of the approach at the end of Phase I. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop two prototype systems for testing and evaluation. Support Government evaluation of the prototype systems at sea in both near-shore and open-ocean conditions to verify navigation accuracy on existing MUSV and LUSV prototypes. Integrate the prototypes into Navy-provided autonomy systems ashore using a Navy-specified Interface Control Document (ICD) that will be provided by the Government after award. After integration, test the prototypes ashore in a laboratory environment to verify that they meet the ICD standards and that they can send navigation messages to the autonomy systems. Develop a Phase III plan. It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL-USE APPLICATIONS: Support the Navy in transitioning the passive navigation technology for Navy use by supplying hardware, software, and technical documentation for installation and repair. Provide assistance, if required, for the first several installations, required on the MUSV and the LUSV.

This technology could be used on manned and unmanned commercial vessels of many different types. In particular, it could be used as a complement to and backup for unmanned navigation systems that rely on GPS, GLONASS, and/or Galileo.

REFERENCES:


KEYWORDS: Unmanned Navigation; Non-GPS Navigation; Passive Sensing; Celestial Navigation; Visual Navigation; Magnetic Navigation