Special Notice 13-SN-0018
Special Program Announcement for 2013 Office of Naval Research
Research Opportunity:
"Robust Adaptive Sensor Filtering / Fusion for Shipboard Autolanding"

I. INTRODUCTION

This announcement describes a research thrust, entitled "Robust Adaptive Sensor Filtering / Fusion for Shipboard Autolanding", to be launched under the ONRBAA13-001, Long Range Broad Agency Announcement for Navy and Marine Corps Science and Technology which can be found at http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Broad-Agency-Announcements.aspx. The research opportunity described in this announcement specifically falls under numbered paragraph 1 of the "Naval Air Warfare and Weapons (Code 35)" sub-section. The submission of white papers, proposals, their evaluation and the award of contracts will be carried out as described in that Broad Agency Announcement.

The purpose of this announcement is to focus attention of the scientific community on (1) the area to be studied, (2) announce a proposers workshop day for dialogue amongst those interested in this arena, and (3) the planned timetable for the submission of white papers and proposals.

II. TOPIC DESCRIPTION

Background:

The Navy and Marine Corps need to operate highly capable unmanned air vehicles (UAVs) in the Group 4 and 5 classes (1,320 lb gross weight and up) from ships at sea. These UAV's can be fixed wing aircraft, landing aboard an aircraft carrier, or rotary wing aircraft, landing aboard a small deck surface combatant ship. These UAV's must have a reliable, high quality ship-aircraft relative navigation system to conduct launch and recovery operations from these ships. Analysis indicates that no single sensor can support reliable UAV operations under demanding at-sea conditions, which include adverse weather, deck motion, extreme variations in light, electromagnetic interference, and operation under emission control (EMCON). Therefore, it is important to understand the capabilities and limitations of each sensor type, and how the inputs from two or more sensors can be utilized in a navigation process to provide the necessary accuracy, integrity, continuity, and availability across all anticipated conditions.

Objective:

The Office of Naval Research (ONR) is interested in a research project to develop architectures, abstraction methods, and navigation filtering and fusion algorithms to combine inputs from multiple sensors to achieve a high quality precision ship-relative navigation (PS-RN) solution in demanding naval environments. The resulting PS-RN solution must be capable of being directly plugged into an air vehicle's command guidance system such that the air vehicle's flight control

system can fly the vehicle along the desired approach path to landing. The performance objectives for the PS-RN system are the following:

• Capable of providing final approach guidance for fixed wing aircraft carrier (CVN) based aircraft out to 3 nmi (nautical miles), or rotary wing aircraft out to 1.5 nmi. CVN aircraft approach the ship from the stern; rotary wing aircraft can approach the ship from any direction. The choice of sensors for these two different applications may not be the same, but the architectures, abstraction methods, and algorithms should be compatible.
• Navigation system error at touchdown of 10 cm spherical error probable (SEP)
• Compliance with electromagnetic emissions control so that risk of ship detection is not increased during aircraft recovery operations.
• Fully operable with high degree of deck motion, and capable of detecting this motion.
• Fully operable with deck marking degradations experienced during the course of an extended deployment (snow, ice, spilled liquids, wear and tear).
• Fully operable in complete darkness (night, no moon, heavy overcast sky).
• Compatible with shipboard eye-safety requirements.
• Fully capable, at reduced range, in heavy rain, snow, sleet, smoke, haze and fog.
• Not dependent on GPS
• High reliability: likelihood of aircraft position error at touchdown exceeding 1m is 10E-6.
• High integrity, continuity, and accuracy to account for aircraft performance limitations and safety margins.
• Low impact to aircraft and ship in terms of size, weight, power and cost, even factoring in redundancy needed to meet reliability.
• Capable of integrating data from sensors detecting obstructions to safe landing (i.e. self-determination of landing safety)
• Potential for use in shore-based automated landings
• Potential for landing on unsurveyed ships with no special equipment

System Description and Attributes

This effort is not for the purpose of sensor development but to demonstrate technology to bring sensor inputs together to produce a high quality navigation solution in a very specific environment. Sensors of interest include the following:

• Electro-optic (visible wavelength) and Infrared (short, medium, long wavelengths) imagers
• Scanning LIDAR
• Flash LIDAR
• Very compact radar
• Range / Pseudo-range Finder
• Aircraft inertial measurement units

<u>Architecture:</u>
Sensors can be suitable for install on either aircraft or ship, and applicable to fixed wing or rotary wing application, or both.
Sensor data can originate from either the ship or the aircraft or a combination of both
Sensor processing algorithms should be capable of referencing a stored template database.

Architecture should specify (in addition to the data filtering / fusion processing functions) the control functions, interfaces, and associated databases

Fusion Optimization

System must be capable of determining when data received from a sensor is no longer valid (corrupted) and subsequently remove it from determining the relative navigation solution.
Architecture should provide optimized fusion of sensor data such that the resulting navigation solution is better than would be possible when these sources were used individually.
System should adapt in real time to the optimal set of available navigation inputs.

Scalability and Transportability

Solutions should follow sound system and software engineering and open architecture practices.
Architecture, abstraction methods, and algorithms support scalability and transportability across Navy and Marine Corps ships and aircraft with minimal modification, verification and validation.

Plug and Play capability

System must be capable of fusing inputs from at least four separate and distinct sensors with scalability to accommodate new and different sensors that may be added.
System must allow alternate sensor integration with minimal modification.
Architecture should support the plug-and-play introduction of new sensor hardware and new state-of-the-art data fusion algorithms.

Joint Precision Approach and Landing System (JPALS) compatibility

PS-RN system will provide quality navigation for landing in demanding conditions when GPS inputs are not available or unreliable.
Architecture, algorithms, and abstraction methods should accommodate integration with JPALS.

Program Structure and Tasks

Development should occur in two phases: Simulation and Flight Demonstration.

Simulation phase tasks should include the following:

1. Use of the highest fidelity sensor models available. These models should represent sensor use for shipboard approach and landing in varying weather and lighting conditions. ONR is preparing to fund a parallel effort under solicitation 12-SN-0020 to test actual sensors in conditions representing shipboard landing in degraded conditions. The models developed in this effort will be provided when available.
2. Incorporation of inertial measurement unit (IMU) and at least two other sensors. Demonstrate plug-and-play interchangeability of these sensors with others of the same type.

3. Characterization of fused PS-RN sensor performance in demanding conditions representative of the Naval operating environment. Develop data that shows how fused sensor performance varies with the magnitude of the obscuring and deck motion condition, and with range from zero out to 1.5 nmi for helicopter systems and 3 nmi for fixed wing systems.
4. Conduct and analyze tests in a simulation environment to determine the impact of degraded conditions on the sensor fusion algorithm and precision ship-relative navigation (PS-RN) solution. Degraded conditions include fog, rain, snow, smoke, haze, varied lighting conditions, electromagnetic interference from other ship/aircraft systems, jamming, and thunderstorms.
5. Determine system accuracy, integrity, and continuity under different combinations of sensors and operating conditions.
6. Demonstrate plug and play capability of the multi-sensor precision ship-relative navigation (PS-RN) solution output with simulated air vehicle (rotary wing and fixed wing) flight control systems.
7. Deliver models, software code, and documentation so that results can be validated using government simulation facilities at Naval Air Warfare Center Aircraft Division, Patuxent River, MD. The documentation should include ICDs (Interface Control Documents) that describe relationships between the sensor filtering / fusion block and the rest of the system blocks such as flight control, aircraft (movement), ship (movement), (degraded) environments of sea, atmosphere and space. All the models, software code and documentation should be based on the open architecture practices mentioned above.
8. Provide recommendations, supported by the simulation tasks and analysis, as to what GPS-denied precision ship-relative navigation system would be best suited for FW-CVN and RW-small deck ship use, assuming ship-aircraft cooperation.
9. Fusion with JPALS. The government will provide the JPALS model.

Flight Demonstration phase tasks should include:

1. Validate the simulation results in flight, to the maximum extent possible. Demonstrate the above capabilities in real time, in a suitable airborne platform, using a simulated ship landing area, in the most demanding of available weather conditions.
2. Update the models, software code, documentation, system recommendations provided in the simulation phase to reflect the results of flight demonstration

III. Proposer Workshop Day

ONR will hold a web-based workshop for those interested in proposing projects under this Special Notice. The web-based workshop will occur on 21 May 2013 from 1300 – 1530 Eastern Standard Time. This will be a web-based workshop. ADVANCED REGISTRATION IS REQUIRED.

Register at https://secure.onr.navy.mil/events/regdetail.asp?cid=943. Registered participants will be provided with connection instructions a few days before the workshop. Participation in the Proposer Workshop is not mandatory for either White Paper or Proposal submission. There is no registration fee for participation.

IV. WHITE PAPER SUBMISSION

White papers are desired and strongly encouraged for all offerors seeking funding. Each white paper will be evaluated by the Government to determine whether the technology advancement proposed appears to be of particular value to the Department of the Navy. Initial Government evaluations and feedback will be issued via e-mail notification from the Technical Point of Contact. Only authors of white papers that appear to be of particular value to the Department of the Navy will be invited to submit full proposals.

White Papers should describe both phases: Simulation and Flight Demonstration. The estimated period of performance for the simulation phase is twelve (12) months, and the estimated period of performance for the flight demonstration phase is nine (9) months. One or two contract awards may be made.

Detailed Full Proposal will be subsequently encouraged from those offerors whose proposed technologies have been identified through the above referenced e-mail as being of "particular value" to the Government. However, any such encouragement does not assure a subsequent award.

For white papers that propose efforts that are considered of particular value to the Navy but either exceed available budgets or contain certain tasks or applications that are not desired by the Navy, ONR may suggest a full proposal with reduced effort to fit within expected available budgets or an effort that refocuses the tasks or application of the technology to maximize the benefit to the Navy.

The requirements for white paper format outlined in ONR BAA 13-001 apply. White papers should not exceed 5 single-sided pages, exclusive of cover page and resume of principal investigator.

The cover page should be labeled "Robust Adaptive Sensor Filtering / Fusion for Shipboard Autolanding" and include the following information: title of the proposed effort, technical point of contact, telephone number, fax numbers, and e-mail address.

The 5-page body of the white paper should include the following information:

(1) Principal Investigator
(2) Technical approach that will be pursued to meet the technical objectives
(3) Listing of specific sensors to be used in the fusion process and rationale for selection.
(4) Program Plan and Schedule
(5) Brief description of ongoing or prior programs that will be leveraged
(6) A funding plan showing requested funding per fiscal year

A resume of the principal investigator, not to exceed 1 page, should also be included after the 5-page body of the white paper.

White papers should be submitted electronically to the program technical points of contact, John Kinzer, via the AMRDEC SAFE Site, (https://safe.amrdec.army.mil/safe/). White papers shall be in Adobe PDF format (preferred) or in Microsoft Word format compatible with MS Office 2007.

To ensure full, timely consideration for funding, white papers should be submitted no later than 14 June 2013 1400 Eastern Standard Time. White papers received after that date will be considered as time and availability of funding permit.

The planned date for completing the review of white papers and notifying offerors of evaluation status is 3 July 2013.

V. FULL PROPOSAL SUBMISSION AND AWARD INFORMATION

In accordance with ONR BAA 13-001, Section III entitled, "Eligibility Information" research in this area is limited to “U.S. persons” as defined in the International Traffic in Arms Regulations (ITAR) -22 CFR § 120.1 et seq.

Full proposals should be submitted under ONRBAA13-001, by 9 August 2013 1400 Eastern Standard Time. Full Proposals received after that date will be considered as time and availability of funding permit.

ONR anticipates that only contracts will be issued for this effort.

Full proposals should be submitted in accordance with the instructions at Section IV, Application and Submission Information, item 2.b, Full Proposals. The Required Technical Content section shall be single spaced and not exceed 25 pages. Only resumes are excluded in the page count.

ONR plans to fund two individual awards for the Simulation Phase, each with a value of $1M for one year, using research funds. Each award will have an option for the Demonstration Phase with a value of $1M for 9 months. However, these are estimates for the base period and option, and the Government reserves the right to exercise or not exercise the options. Lower and higher cost proposals, and modified periods of performance will be considered. Full proposals should include a full cost proposal for the simulation phase, and a priced option for the flight demonstration.

Although ONR expects the above described program plan to be executed, ONR reserves the right to make changes.

VI. SIGNIFICANT DATES AND TIMES

Event	Date	Time
Proposer Workshop	21 May 2013	1300-1530 EST
White Paper Submission Due Date	14 Jun 2013	1400 EST
Notification of White Paper Evaluation*	10 Jul 2013	
Full Proposal Submission Due Date*	16 Aug 2013	1400 EST
Notification of Selection: Full Proposals *	13 Sep 2013	
Awards *	Feb 2014	

Note: * These are approximate dates**.**
EST: Eastern Standard Time

VII. POINTS OF CONTACT

In addition to the points of contact listed in ONRBAA13-001, the specific points of contact for this announcement are:

Technical Point of Contact:
John Kinzer, Program Officer, John.Kinzer@Navy.mil

Business Point of Contact:
Peter Donaghue, Contract Specialist, Desmond.Donaghue@Navy.mil

VIII. ADDRESS FOR THE SUBMISSION OF WHITE PAPERS AND FULL PROPOSALS FOR CONTRACTS

White Papers and Full Proposals must be sent via the AMRDEC SAFE Site (https://safe.amrdec.army.mil/safe/) to John Kinzer at: john.kinzer@navy.mil, and to Michael Vitale at Michael.a.vitale.ctr@navy.mil.

IX. SUBMISSION OF QUESTIONS

Any questions regarding this announcement must be provided to the Technical Points of Contact and the Business Point of Contact listed above. All questions shall be submitted in writing by electronic mail.

Answers to questions submitted in response to this Special Notice will be addressed in the form of an Amendment and will be posted to the following web pages:

- Federal Business Opportunities (FEDBIZOPPS) Webpage – https://www.fbo.gov/
- ONR Special Notice Webpage - http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Special-Notices.aspx

Questions regarding **White Papers or Full Proposals** should be submitted NLT two weeks before the dates recommended for receipt of White Papers and/or Full Proposals. Questions after this date may not be answered.