AOFNC SAS12

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LONG-TERM GOALS

The long-term goal of this task is to develop a synthetic aperture sonar (SAS) for small underwater vehicles with the automated processing capability to detect and classify proud targets. The SAS must operate effectively in an autonomous vehicle and report back its findings.

OBJECTIVES

The objective is to develop a high performance SAS with the onboard processing capability to perform effective mine hunting of proud mines in the shallow water and very shallow water (SW/VSW) zones. Consequently, the SAS will be designed with the reverberation rejection and resolution necessary to provide detection and classification capabilities of proud targets. The design will also strive to produce a SAS that is volume, weight and power compatible with small unmanned underwater vehicles (UUV).

APPROACH

The approach of this task is to team with industry and academia to design and fabricate a self-contained SAS and to integrate and test it in a small autonomous underwater vehicle (AUV). Team members currently supporting this effort include Applied Research Laboratory/Penn State University (ARL/PSU), BlueFin Robotics, Dynamics Technology, Inc. (DTI), Vehicle Control Technologies, Inc. (VCT) and the Coastal Systems Station (CSS).

The SAS12 design concept to be developed by this effort is similar to that of the Small Synthetic Aperture Minehunter (SSAM) system. Deviations from this system include: a single high frequency operational band and a fully autonomous behavior (onboard SAS imaging, classification and identification processing).

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14. ABSTRACT

The long-term goal of this task is to develop a synthetic aperture sonar (SAS) for small underwater vehicles with the automated processing capability to detect and classify proud targets. The SAS must operate effectively in an autonomous vehicle and report back its findings.

15. SUBJECT TERMS

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The design considerations of SAS12 parallel those of the SSAM system. These include designing and testing the SAS using computer design procedures and simulations, which will include prediction of performance as a function of vehicle motions. Once the conceptual design is proven, a prototype will be fabricated and tested in a controlled acoustic test pool environment. Following successful operation in the pool, the next step will be to integrate and test the SAS in a small AUV. Attention must be devoted to characterize the small AUV and its dynamic characteristics in order to minimize motion errors since smaller vehicles inherently have higher frequency motion components. The embedded automated processing marks a major deviation from SSAM. This will require installation of an onboard SAS imaging processor and an automated detection and classification processor. These processors along with the vehicle processor will require a complex level of integration to generate SAS images of contacts and their location. These eventually will be transmitted via the AUV onboard acoustics and/or RF communication channels.

WORK COMPLETED

The Bluefin 12 AUV was selected as the target platform for this sonar. The Bluefin 12 AUV is a 12.75-inch diameter AUV in development by Bluefin Robotics.

The existing wavenumber beamformer code used for SAS image production was originally written in MatLab. That code has been successfully ported to C. However because the target processing hardware has not been finalized yet, code optimization has not been initiated. Once the onboard processing environment is finalized, a development platform will be obtained and code modifications and optimizations will commence.

The design of SAS12 has been finalized. The design and drawing of most electronic components, including power supplies, transmitters, analog conditioning, digital receivers, embedded data recording, and timing and control subsystems have been completed. Transducer and mechanical related drawings have also been generated.

Low-level efforts have been initiated to develop, refine and test automated detection and classification algorithms as well as data compression methods.

RESULTS

Porting the SAS processing code from MatLab to C resulted in a processing time speedup factor of 2 to 5, with the variability dependent on the computational precision and interpolation method used. These comparisons were made on the same platform, and suggest that embedded processing at full resolution would be possible.

IMPACT/APPLICATIONS

The small SAS sonar developed under this task will have the ability to process the data onboard and feed the resulting imagery to the automated detection and classification software. It will provide small autonomous vehicles with the automated capability to detect and classify proud targets in the SW/VSW zones. The SAS designed under this effort could be easily adapted to operate from a small craft as a towed SAS in place of less capable side looking sonar systems. The design concept is also suitable to be extended if longer ranges and/or faster speeds were needed to meet the requirements of some other application.

TRANSITIONS

This SAS is planned to transition, along with a SW/VSW compatible AUV, into a mine hunting system to be used by the U.S. Navy for SW/VSW mine hunting operations through either a United States Special Operations Command or a Very Shallow Water Mine Countermeasures Detachment program.

RELATED PROJECTS

The Coastal Systems Station has had a dual frequency SAS (currently known as SAS21) operational for several years. SAS21 has participated from a towed vehicle in a number of U.S. Navy exercises such as Kernel Blitz, MIREM and Fleet Battle Experiment (FBE)-Hotel. In FY03, SAS21 was successfully integrated and tested with the RELIANT AUV. The SAS21/RELIANT system is the first operational AUV based SAS system, of the several systems under development, and will be participating in a series of demos and exercises in FY04.

A dual frequency AUV compatible SAS is under development as part of the SSAM effort. That program is running concurrently with this one. This has allowed a number of hardware/software commonalities between the designs. These commonalties have resulted in significant risk and cost reductions.

Data collected with this system is expected to support research and development efforts in the areas of SAS technology development, MCM and Oceanographic research.

PUBLICATIONS

Although no direct publications have been produced, a few related publications are listed below.

Cook D.A., Christoff J.T., and Fernandez J.E., "Motion Compensation of AUV-Based Synthetic Aperture Sonar", to be presented at the MTS/IEEE Oceans 2003 conference, San Diego, CA, September 22-26, 2003.

Fernandez J.E., Christoff, J.T., and D.A. Cook, "Synthetic Aperture Sonar On AUV", to be presented at the MTS/IEEE Oceans 2003 conference, San Diego, CA, September 22-26, 2003.

Jim Christoff, JoEllen Wilbur and Dan Cook, " 3-D Acoustic Imaging of Broadband SAS data", to be presented at the MTS/IEEE Oceans 2003 conference, San Diego, CA, September 22-26, 2003.