Functional Area 3 - Modeling, Simulation, Stimulation, and Analysis

PSI Contract N00167-02-D-0038 DO 11, 16: The Naval Surface Warfare Center Carderock Division (NSWCCD) is upgrading the measurement capabilities of the South East Alaska Acoustic Measurement Facility (SEAFAC) to measure modern quiet submarines. Part of this task involves modeling the performance of high-sensor-count volumetric arrays in the specific noise conditions of Behm Canal. The results of this modeling will contribute to the decision on what array design to use for the SEAFAC upgrade. To perform this task, PSI built mathematical models of the various array designs under consideration and the desired performance of the array. PSI then modeled how different beamforming methods and beamforming coefficient generation methods performed for the different array designs. This modeling was performed by building a MATLAB based model of the coefficient generation methods. The resulting coefficients were then fed into a MATLAB model that calculated the resulting beampatterns. Finally, the resulting beampatterns were compared to the mathematical model of the desired array performance. This modeling task required intimate knowledge of the physics of Sonar arrays, wave propagation, and beamforming. This task also required detailed knowledge of signal processing. Finally, this task required the ability to create a valid mathematical representation of a physical array system deployed in a unique ambient noise environment. At this time, this investigation is still underway. However, interim modeling results are available. Two robust array designs have been identified, dual cone and embedded cylinder. Robust in this sense means that the designs yield similar performance when different beamforming methods and/or coefficient generation techniques are applied. Yielding similar results from different and independent techniques is an important element in the SEAFAC Upgrade Program's risk reduction plan. If a single modeling method was applied, undetected errors in that method could lead to erroneous conclusions.

Applying multiple modeling techniques to the same problem is a more rigorous approach and will lead to a lower risk array design.

PSI Contract F29601-03-C-0013: PSI is working on a Phase II SBIR project to simulate improvements to target imaging systems by incorporating polarization technologies. The goal is to simulate environmental and systems aspects relevant to target discrimination within a cluttered background from space-borne or airborne platforms. PSI is developing physics-based algorithms and models to describe various aspects of polarization phenomenology, and is linking them through a comprehensive graphical user interface (GUI) for input control. Algorithms are called in real-time and model results are displayed. Multiple runs may be conducted interactively and quickly. PSI scientists have extended this technology to support a Raytheon ship-mounted infrared system. PSI developed an ocean scene generator in which up to 10 floating targets can be placed for assessment of system performance.

PSI Contract F2960-03-C-0230: PSI is extending and transitioning technologies developed under SBIR Phase I and II work for the PowerSail program, which is sponsored by the Air Force Research Laboratory. The objective of the PowerSail program is to model, develop, and integrate the components needed to demonstrate a complete, flight-ready surface structure system that is modular and low-mass, and can be packaged efficiently. The focus of PSI's work is on deployment, identification, and control technologies for the large, flexible structural arrays that will be used in space systems. Under this tasking, PSI engineers and scientists are responsible for management, requirements definition and, execution of feasibility and performance studies related to the mechanical and electronic components to be used in a flight experiment. During the modeling phases of this work, PSI engineers are addressing reliability and required redundancies, system autonomy, space-rated materials and components, host satellite interface concepts, data organization and handling, and operations concepts.

PSI Contract N00014-00-D-0106: For this Office of Naval Research (ONR) effort for Code 321SS, PSI developed probe pulse waveforms designs and innovative acoustic parameter extraction processing techniques to facilitate development of an environmentally adaptive ASW capability for the SQS-53C hull-mounted sonar. We developed major modifications to the CASS model to allow calculation of coherent reverberation Lloyd Mirror patterns that replicated those found in observed data. PSI also developed a coherent pressure version of CASS that allows computation of the coherent reverberation at the input and output of matched filter processing, and can generate non-Rayleigh reverberation probability amplitude distributions that replicate those found in actual reverberation data after matched filtering. During extensive evaluation of both the model revisions and parameter estimation techniques, PSI processed and analyzed a number of available 53C data sets. Among these data set where those that PSI collected as participants of SHAREM 110 and SHAREM 140 in the Persian Gulf and Gulf of Oman. These exercises and other available data sets yielded over one thousand pings of Kingfisher reverberation data that was processed as part of the model validation and analysis effort.

APS Contract N00167-03-D-0016: Assisted the development of wave transmission line models of a piping system tested at ISMS. Provide critical assistance regarding the development of a mathematic approach for converting an experimentally determined mobility matrix into a scattering matrix, finalizing scattering matrix coordinate transformation approach, and representation of component interaction loads. Developed array processing performance models to select the final array configurations to be used for an acoustic motor test. Developed a variety of analytic models and assessed experimental data to evaluate flow excitation and radiation from a hull structure. Analytic models were developed to assist efforts to assess the results of a series of experimental evaluations and to assist test planning activities. Served on an Integrated Product Team directed by NSWCCD Code 70 in Carderock.

Additional Contracts:

APS Contract N00167-03-M-0786, Contact W. Martin 301-227-1534
ASTM Contract N00174-95-D-0005, Contact Dale Thomas, 301-744-2225
NTI Contract N00167-01-D-0016, Contact Dr. W. Blake, 301-227-1879
AHA Contract N00024-98-D-8124, Contact Peter Troll - 443-778-5312
AHA Contract N00024-00-C-4125, Contact Tom Higgins-202-781-2892
AHA Contract N00024-99-C-6304, Contact John Dennard-703-604-6013