INTERDISCIPLINARY RESEARCH IN PHYSICS

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LONG-TERM GOALS

From ONR's creation of this program in 1979, APL-UW's goal has been to pursue high quality fundamental research which brings together APL staff and University of Washington academic unit principal investigators in new collaborations, ultimately leading to a fuller participation of the Laboratory in research and supervision of graduate students and post-docs. A secondary goal is to establish continuing collaborative research programs which access expertise and facilities at the University of Washington which have otherwise not been applied to Navy-related problems.

RESEARCH COMPONENTS

PROPAGATION OF ELECTROMAGNETIC FIELDS IN THE COASTAL OCEAN WITH APPLICATIONS TO UNDERWATER NAVIGATION AND COMMUNICATION

Thomas B. Sanford and Robert H. Tyler (APL), Martin Unsworth (Geophysics)

We have examined the propagation of low-frequency electromagnetic waves in the coastal ocean produced by controlled or motional impressed sources. Results have been obtained both analytically and from a finite-element numerical model. We have focused on characterizing several new effects such as a `beach' propagation mode which have not previously been described in the literature. These results have been written up and are currently under review for the journal RADIO SCIENCE. In this paper we also discuss the importance of our results in designing navigation and communications applications for subsurface vehicles and instruments. This project supported a post-doctoral investigator (Tyler).

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ANALYSIS AND SYNTHESIS OF PHYSIOLOGICAL TIME SERIES USING FRACTALS

Donald B. Percival (APL), J.B. Bassingthwaighte (Bioengineering), Per Reinhall (Mechanical Engineering)

The focus of this effort is to develop ways of analyzing and synthesizing time series exhibiting fractal (self-similar) characteristics, with particular emphasis on their use with biomedical time series. We have investigated two new techniques for analysis (the scaled windowed variance and the wavelet variance) and are currently completing a paper that compares the statistical and computational properties of various synthesis techniques (in particular, the Davies-Harte method and a frequency domain method). This project supported a graduate student.

NUMERICAL MODELING AND LABORATORY TESTING OF SONOELASTIC IMAGING TECHNIQUES

Daniel Rouseff (APL), Roy Martin (Bioengineering)

An ordinary diagnostic medical ultrasound device relies on a contrast in acoustic impedance between a scatterer and the background to get a backscattered signal and produce an image. Sonoelasticity is an attempt to image based on contrasts in tissue stiffness and thus distinguish targets not accessible with conventional ultrasound. This is accomplished by applying stress to the medium. Our work has focused on using low frequency (less than 20 Hz) vibration for tissue deformation. At these frequencies, Doppler data acquisition can be synchronized with the vibration source to avoid aliasing. Measured changes in velocity within a sample are then mapped to changes in shear modules. A possible long-term application of the technique is to detect internal bleeding. Laboratory experiments have detected a blood-mimicking fluid embedded in an agar phantom. Numerical simulations have studied alternative methods of velocity detection. This project supported a graduate student.

INTELLIGENT OCEANOGRAPHIC AGENTS

Gregory Anderson (APL), O. Etzioni (Computer Science and Engineering)

The focus of this research has been to develop intelligent agent and workflow management tools that: (1) automate collection of meteorology and oceanographic information from the worldwide web, and (2) manage the flow of information to and from tasks in Navy METOC office tactical missions. An intelligent agent developed as part of this research, named "Flipper", is functioning and has been integrated with METOC workflow tools. To accurately understand and define METOC office information and processing requirements, the investigators established close liaison with the Commanding Officer, Navy Meteorological and Oceanography Facility, NAS-North Island, and his staff. Extending the scope of the research project, we also aided this office in their development of a

concept for a smart METOC center. This project supported both graduate and undergraduate research.

SURFACE AND STORMWATER ASSESSMENT OF BANGOR SUBMARINE BASE

Christopher May (APL)

The overall goal of this project was to improve water quality and enhance the ecological integrity of aquatic resources located within the Naval Submarine Base, Bangor. A specific objective of this study included the assessment of the current condition of aquatic resources, especially the native salmonid populations utilizing on-base streams, wetlands, and lakes. Based on this assessment, an in-stream habitat enhancement and rehabilitation plan was developed. A second objective of the project was to evaluate the existing stormwater management infrastructure, to include structural best management practices and non-structural components. Based on this evaluation, an integrated surface and stormwater management plan was developed. This plan is built around a watershed-based, resource-driven approach for protecting aquatic ecosystems from the impacts of human activities. This plan could serve as a model for other Department of Defense facilities in the Pacific Northwest region and could be adapted to other areas of the country. Application of new, innovative technologies for stormwater treatment and non-point source pollution control was a high priority.