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Newsletter

OES

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IEEE OCEANIC ENGINEERING SOCIETY

OES Journal Associate Editors

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Message From The Vice President, Professional Activities

Oes Membership

How valuable is your membership in the Oceanic Engineering Society to you? Do you feel that you are gaining something from being a member of the Society? Each year in IEEE Membership runs a "terminator" program to purge the rolls of those members who haven't paid their dues for the new year. The news for OES was not good this year. Our membership at the end of April had declined to 1582 members world wide. Our membership has continued to decline inspite of the recruitment efforts that we have at the Offshore Technology Conferene, the OCEANS Conference, and the smaller conferences and workshops. For the past two years we have had special financial membership incentives at our Undersea Technology Conference, Offshore Technology Conference, and OCEANS Conferences. The statistics are rather interesting.

At UT 98 we offered a year free membership. We signed up 47 new members. At the end of April 2000, 18 were still members.

OTC 98 we offered 1/2 price or 1/2 year. We signed up 21 new members. Three were still members at the end of April 2000

OCEANS 98 we offered 1/2 price for a year. We signed up 11 new members. Ten were still members at the end of April 2000

OTC 98 we offered 1/2 price or 1/2 year. We signed up 12 new members. None of them renewed at the end of that time.

During this time period we had signed up 90 new members and have retained 31 members. At OCEANS 99 we offered half price memberships and gained 8 new members. It will be interesting to see how many we retain. It should be noted that the members we recruited were also new to IEEE membership as well as to the Society. It is also interesting to note that the majority of people who attend out conferences are not IEEE or OES members. They are interested in the undersea technologies and find what we have to offer at our conferences of value to them. It is hoped that our members also feel that our Conferences offer something of value also.

Are there any conclusions that we can draw from the membership data? Yes and no. We had hoped that a financial incentive would prove of value in recruiting new members. Obviously it does to a point, but the data would suggest that two thirds of those we sign up just enjoyed the free ride for the period. Should be continue this type of recruiting? We have had a long standing policy that the registration fee differential between members and nonmembers could be applied to dues to join IEEE and OES. MTS has this policy also and so we will retain this incentive. There are a number of IEEE members that belong to other IEEE societies that also show interest in out technologies. These are potential recruits. We have sent invitations to the TIP list in past years, but this has not been a large source of new members. There are no easy answers to the membership problem and it is not unique to OES or to IEEE. The one key to membership retention is that the members need to feel that they are getting something for their money.

There are two other membership categories that are vital to our survival, student members, and GOLD members. At the end of April we had 175 student members. 61 student members live in the USA or Canada. The other 114 live in regions 8 - 10. There are no large concentration of students in any given area. We need to provide them incentive to convert to full membership when their student membership term ends. Similarly we have 220 members worldwide that are GOLD members (Graduates of the Last Decade). These are younger members and it is vital to the society and to IEEE that we retain their membership. We need to involve them in the society operations. Currently we have three GOLD members on the AdCom and they are playing active roles in the society.

Membership in many ways is every members problem. We need all members to promote membership in the society. We need members to attend our conferences and workshops, and above all we need members willing to commit their time and talents to working on conferences and workshops and in leadership roles in the society. If you have ideas for membership recruitment, please pass them on to the Membership Coordinator, Dr. Jim Collins at *j.s.collins@ieee.org*. If you want to volunteer for other jobs, please contact me, Norman D. Miller, VP Professional Activites at *n.miller@ieee.org*.

Norman D. Miller

E-Mail Alias

Do you have a Personnal IEEE Email Alias? This is an excellent way to show your association with a Professional Society and establish a e-mail address that can stay with you regardless of your Internet Service Provider. IEEE allows all member to have an IEEE Personal Email Alias. You can sign up for it online. To do so just check *www.ieee.org/eleccomm*. It is easy to sign on and to update at any time. A great advantage of the IEEE alias is that all attachments pass through virus scanning software that is updated weekly. Sign up today!

Student Members Invited To Oceans 2000 MTS/IEEE

To encourage OES Student Members to get involved with the Society, OES will pay to Conference Registration fee for OES Student Members that wish to attend OCEANS 2000 MTS/IEEE. One Wednesday morning September 13, 2000 OES will sponsor a Student Breakfast for all Student Members at the Conference. This will be an opportunity for the student members to meet other student members as well as members of the OES Administrative Committee. OES has 175 Student Members. 61 Student Members live in the USA and Canada. Few have ever attended and OCEANS Conference. This an excellent opportunity for student members to see what an OCEANS Conference is all about. Student Members interested in taking advantage of this opportunity are urged to contact Norman D. Miller at n.miller@ieee.org to arrange for the complimentary conference registration.

Norman D. Miller, P.E.
VP Professional Activities
IEEE/OES

Oceans 2000 MTS/IEEE Providence, Rhode Island Where Science and Technology Meet

Before you know it, we'll be walking the streets of downtown Providence in search of the perfect burger, lunch salad or live blues club. This is the city that never sleeps and treats its guests like family. This is the Ocean State and it won't let you forget it. Attending Oceans 2000 MTS/IEEE in New England's up and coming city should not be missed.

The new Rhode Island Convention Center, located right downtown will be great for speakers, exhibitors and attendees. The large and comfortable meeting rooms are convenient to the exhibit hall, and there are ample areas to meet in the Center and adjoining Westin Hotel for discussions over a cup of coffee, drink or a meal. In addition to the Westin Hotel, rooms have been set aside for the show attendees at the Providence Biltmore and the Holiday Inn, both within easy walking distance to the Convention Center.

This year's Exhibition promises to be memorable. A sell out of the 182 booth spaces is assured. A crowd of nearly 3,000 from the twenty scientific institutions, and 300 marine technology firms within 90 miles of Providence is expected. Providence is located 20 minutes from TF Green International Airport, 1 hour from Boston's Logan airport and is just a 1.5 hour flight from New York City. Southwest Airlines and US Air are offering a 10% discount on certain flights.

We can all look forward to attending many of the 300 plus technical presentations that are expected. The Plenary Session which is scheduled to take place on Tuesday September 12 features Rear Admiral Dick West, Oceanographer of the US Navy, Dr. John Sirmalis, Technical Director of the Naval Undersea Warfare Center in Newport, RI and Thomas Dettweiler, Executive Vice President and Director of Ocean Engineering operations for Nauticos, Inc. of Maryland. Dr. Isaac Ginis is an Associate Professor of Oceanography at the University of Rhode Island's Graduate School of Oceanography (URIGSO) will speak about weather prediction and hurricanes.

Tutorial Chair, Fred Maltz of IEEE/OES has organized a star-studded tutorial line up on Monday September 11. Session topics include: Ocean Acoustics, Technological Forecasting for Competitive Technology Intelligence, A Practical Law Primer for Ocean Science and Technology, Model-based Ocean Acoustic Signal Processing, Hydrodynamics, Dynamics and Control of Undersea Vehicles, A Systematic Approach to Redundant and Fault Tolerant System Design, and Optimization of Space-Time Signal Processing for Moving Antennas. Register on line at *www.oceans 2000.co*m and ahead of time for tutorials. Space will fill up fast.

The conference schedule has been set, with extended exhibit floor hours, and 45 minute coffee breaks morning and afternoon in the exhibit all. This will assure plenty of time to trade ideas with customers, show products, and discuss sales.

The entire event will be enhanced Wednesday September 13 in grand style in a way you never thought possible. Water Fire is an extravaganza not

Oceans 2000 MTS/IEEE Local Planning Committee toils over details of upcoming event. L-R-L Exhibits Chair - Bob Lobecker, Tutorial Chair - Fred Maltz, Arrangements Chair - Mike Cunningham, MTS Representative - Richard Butler, Co-Chair - Chris Casagrande, Financial Chair - Les Stevens meet in the RI Economic Development offices at the Providence Convention Center.

to be missed. Amid the warmth of twenty bon fires ignited simultaneously just at twilight one can be transported to another world. There is a hush before the roar of flames is ignited and synchronized music filters in. Just when the time is right, the Oceans crowd will promenade to a riverside restaurant to enjoy a great meal with friends and colleagues.

Exhibitors Showcase: This year Oceans Exhibitors will be participating in the technical sessions by giving presentations about their new technologies and products. On each of the three days of Oceans, September 12, 13 and 14 there is a full line up of company speakers.

The kick-off Exhibitor's Reception will be held on Tuesday, September 12. It boasts a great menu of local foods, ample beverages, a drawing for prizes, which include dinner certificates, and historical marine technology displays. Students are us: Thanks to a generous grant from the US Office of Naval Research Oceans 2000 will host at least seventeen top notch student papers/posters. These posters and papers will be displayed throughout the conference and exhibit hall. "We must invest in the future of our industry, said Jack Heller, Oceans 2000 co-chair, what better way than by supporting some bright young minds in their quest to address tough marine research questions."

The 3rd Ocean Technology Job Fair will take place in conjunction with Oceans 2000 MTS/ Providence, RI Sept. 12-14. University of Rhode Island's Ocean Engineering Dept and Graduate School of Oceanography, Massachusetts Ocean Technology Network and the New England Section of the Marine Technology Society are organizing this event within an event. Candidates are expected from the many colleges and universities in the area. Mid-career job seekers will be included as well. For more information on the Job Fair contact: MOTN at *Martrep@aol.com* or 781-740-1456.

For information on all aspects of the event, contact J. Spargo and Associates at (703) 449-6418 OR FAX: 703-631-7258. or visit the oceans web site at *WWW.OCEANS2000.com*.

Brand New, state of the art conference center, RI Convention Center where Oceans 2000 MTS/IEEE will take place Sept. 11-14, 2000. Make your reservations early. You want to be sure to stay in one of the :"show hotels" located within a short walking distance to the show.

Tutorials Offered at Oceans 2000 Conference

Monday, September 11

Tutorial T1 (full day, 8:30 am-5:00 pm; break 12:00 pm-1:30 pm)
"Ocean Acoustics"
William. A. Kuperman, Michael B. Porter and Henrik Schmidt

This course is designed for people who are interested in the Ocean Technology area and would like to know more about Ocean Acoustics and Signal Processing. It will be based upon the book (not provided) "Computational Acoustics" by Jensen, Kuperman, Porter, Schmidt, Springer-Verlag (2000). A technical background of Basic Physics and Calculus would be helpful.

Instructors are all active researchers in Ocean Acoustics and Signal Processing.

W. A. Kuperman, Professor and Director of the Marine Physical Laboratory, Scripps Institution of Oceanography, University of California, San Diego

M. B. Porter, Science Applications International Corporation, on leave of absence: Professor of Mathematics, New Jersey Institute of Technology

Henrik Schmidt, Professor, Department of Ocean Engineering, Massachusetts Institute of Technology

The purpose of this course is to give as intensive an introduction into the area of ocean acoustics and signal processing as is possible in one full day. The course should be of interest to people who would like to:

- understand more about the underlying principles of sonar;
- understand how ocean acoustic instruments work;
- know more about how acoustic predictions are made;
- interpret the results of acoustics models or predictions (including units);
- understand how ocean sounds from marine animals propagate;
- understand how acoustic arrays perform in complex ocean environments;
- understand the basics of matched field processing;
- know more about the technical issues of ocean acoustic communications;
- know more about hydroacoustics with respect to the Comprehensive Test Ban Treaty

Tutorial T2 (full day, 8:30 am-5:00 pm; break 12:00 pm-1:30 pm)
"Technological Forecasting for Competitive Technology Intelligence"
Richard P. Mignogna

This tutorial, which is offered in two parts, focuses on the application of technological forecasting and competitive technology intelligence in strategic technology planning. In achieving this goal, it covers both quantitative and qualitative analytical techniques for assessing the technical capability of your competitors and for predicting future directions and likely developments in a given technology. The emphasis is on exposing participants to the broad range of techniques available to them.

The tutorial begins with an introduction to technological forecasting and competitive technology intelligence and their role in strategic planning for the enterprise. This is followed by a discussion of technology life cycles and the underlying dynamics of technological advance. A subsequent presentation of surveillance techniques is then followed by a comprehensive review of the most valuable sources of technology intelligence data. Rounding out Part I of the tutorial is an overview of technology forecasting methodologies that aid in technology intelligence analysis.

In Part II of the tutorial, we delve deeper into the techniques for performing technological forecasting and analyzing technology intelligence data. We begin this exploration of technological forecasting methods with techniques for analyzing and extrapolating technology trends based on the well known technology s-curve. In this portion of the tutorial, you will learn how these techniques are applied to:

1. assess the present state of the art and competitor capabilities,
2. analyze trends in technological capabilities and performance, and
3. predict the substitution of a new technology, innovation, or product for an existing one.

But obviously, the diffusion of technology is more than a simple curve fitting exercise. Therefore, we will also examine how the attributes of an innovation impact its diffusion in the marketplace and how these attributes may be used to assess the acceptance of new product introductions - yours or your competitor's.

In Part II of the tutorial, we also present judgmental and expert opinion-based techniques for the development of technology intelligence. In this portion, participants will learn how to use the Delphi technique, nominal group technique, morphological analysis and impact wheels for eliciting expert opinion. Throughout this portion of the tutorial, we will refer back to an integrative TF/CTI Abstract case study to illustrate how the respective technology forecasting techniques may be applied in real world science and technology intelligence analysis. This daylong tutorial (Parts I and II together) has previously been conducted as a pre-conference workshop at the annual meetings of the Society of Competitive Intelligence Professionals (in the U.S., Canada, and most recently in Europe) and at Oceans'99 in Seattle. It is also offered in greater depth as an in-house course and as a public course in a 3-day format.

Richard P. Mignogna, Ph.D., P.E., is president of Technology/Engineering Management, Inc., a consulting firm specializing in strategic technology planning, technology forecasting and assessment, competitive technology intelligence, and technology transfer.

Tutorial T3 (full day, 8:30 am-5:00 pm; break 12:00 pm-1:30 pm)
"A Practical Law Primer for Ocean Science and Technology"
Richard T. Robol

This tutorial focuses on the key legal principles important to ocean science and technology. Its purpose is not to provide an exhaustive treatment of admiralty law, of theory, or of the law of the sea, but rather to outline the main practical issues that each person engaged in ocean science and technology may confront.

For this reason, the tutorial surveys the issues and rules of law that confront an individual or business engaged in ocean science and technology. By the end of the tutorial, each participant will (1) have an understanding of the nature and scope of legal issues of ocean science and technology, (2) appreciate the functional considerations that differentiate the legal rules for ocean science and technology from other fields of law, and (3) know where to go for more detailed information. Participants will have the opportunity to discuss specific legal issues they may currently confront, or may anticipate.

The tutorial will cover 9 overall topics. These include (1) an overview of the law applicable to ocean science and technology, (2) contracts and deal-making, (3) protecting intellectual property, (4) risk management, (5) financing, (6) property rights, (7) public law, (8) law of the sea, and (9) where to go for help and how to deal with emergencies.

The Introduction will cover the sources of law and jurisdiction affecting ocean science and technology. The Section on Contracts will expand on this foundation, covering the important elements of structuring deals. It will address not only the elements of contracts, but also the special types of contracts affecting ocean science and technology.

The Sections on Intellectual Property and Risk Management will discuss practical issues especially important to ocean science and technology. Intellectual property topics will include legal techniques for protecting ideas and innovations, trade secrets, patents, copyrights and the internet. Risk Management will describe the peculiar liabilities that may arise from ocean science and technology and practical methods for evaluating and minimizing risk. Among the specific topics will be personal injury and death, products liability, unseaworthiness, marine pollution, and marine insurance. The Section will also discuss the special procedures applicable to risk management.

The Sections on Financing and Property rights will deal with practical issues for financing and ownership rights in ocean science and technology. Topics will include the choice among sole proprietorships, corporations, partnerships, limited liability companies financing vehicles and personification.

The Section on Public Law and Law of the Sea will discuss elements of governmental regulation of ocean science and technology. This will include discussions of taxation, criminal law, customs and rules affecting navigation, living, natural and cultural resources.

The final Section will discuss practical approaches to spotting and solving legal problem affecting ocean science and technology. Participants will learn what to do when lightening strikes and where to go for further assistance.

The intended audience includes the broad range of individuals, private companies and governmental entities (civilian and military) engaged in ocean science and technology. Since the focus of the seminar will be practical legal issues, the presentation will cover matters that should be of interest to anyone involved in the area. The material should be of special interest to businesses and their leaders.

The tutorial will be useful in giving participants the basic knowledge of law required for their day-to-day work. By attending the tutorial, participants will acquire or enhance their ability both to understand legal aspects of ocean science and technology and to know where to go for additional information.

Richard T. Robol is the Executive Vice President and General Counsel of Columbus-America Discovery Group. He is also an adjunct Professor of Law at the University of Dayton Law School, where he teaches the upper level course in admiralty.

Tutorial T4 (8:30 am - 12:00 pm)
"Model-Based Ocean Acoustic Signal Processing"
Edmund J. Sullivan and James V. Candy

It has recently been recognized that the incorporation of a mathematical model that accurately represents the phenomenology under investigation can vastly improve the performance of any processor, as long as the model is accurate. This course describes the development and application of such "model-based processors'' that incorporate propagation models within their framework to improve the overall system performance. More specifically, model-based processing is concerned with the incorporation of environmental, measurement, and noise models, along with measured data, into a sophisticated processing algorithm capable of detecting and filtering (estimating) parameters of the acoustic environment (model) and sources of the acoustic energy in a complex ocean environment. It also offers a well-founded statistical approach for comparing propagation and noise models to measured data, and is not constrained to a stationary environment, which is an essential ingredient of any realistic processing scheme in a hostile ocean environment. That is, not only does the processor offer a means of estimating quantities of high interest (modes, pressure field, sound speed, etc.), but it also provides a methodology to statistically evaluate its performance on-line, which is especially useful for model validation experiments.

The approach is based on a state-space structure which enables access to the residual or innovation sequence associated with model-based processors (Kalman filter estimators/identifiers) thereby permitting the performance of the embedded models to be monitored as well as providing the potential of on-line refinement of these models by adaptively using these innovations. The state-space formalism can be considered to be a general framework that already contains the signal processing algorithms and it is the task of the user to master the art of embedding the models of interest. Thus, in this sense, the user is not practicing signal processing per se, but is actually dealing with the problem of representing the models within the state-space framework.

This tutorial begins with an introduction that includes a short history of this recently developed methodology. This is followed by a short review of the state-space modeling formalism required for a full understanding of the model-based processing. The next section defines the actual model-based processor structure and discusses the issues of detection and identification (estimation) within this framework. This is followed by several case studies, most of which are based on real data. The final section comprises a summary along with a discussion of on-going work.

Edmund J. Sullivan's present position is that of Senior Staff Scientist for the Physics and Technology Division at the Naval Undersea Warfare Center in Newport, RI.

James V. Candy is the Chief Scientist for Engineering and Director of the Center for Advanced Signal & Image Sciences at the University of California, Lawrence Livermore National Laboratory.

Tutorial T5 (8:30 am - 12:00 pm)
"Hydrodynamics, Dynamics and Control of Undersea Vehicles"
Douglas E. Humphreys

This seminar will emphasize the practical aspects of hydrodynamics, dynamics and control of undersea vehicles. The intent is to provide a brief survey of the current modeling methodology and then present a detailed treatment of undersea vehicle dynamics. Attendees will come away with a better understanding of the concepts used in modeling and simulation of undersea vehicles. Approaches for estimating coefficients for hull, fins and fin-hull combinations will be covered. The use of Bode plots and root locus to gain insight into vehicle design trends will be demonstrated. The tradeoff between stability and control will be discussed along with design examples.

Douglas E. Humphreys is President and Senior Design Engineer at Vehicle Control Technologies, Inc.

Tutorial T6 (1:30 pm - 5:00 pm)
"A Systematic Approach to Redundant and Fault Tolerant System Design"
Philip Babcock

A systematic and practical approach to applying analysis to guide the design of redundant and fault tolerant systems is presented. The tutorial moves from an introduction to the world of fault tolerant systems to how analytical evaluation can play a role in the design of these systems. The use of "0th order" models, qualitative models, and quantitative models are demonstrated on real-world designs, and in the process the usefulness of Markov diagrams and models are shown. This foundation is extended into modeling that incorporates cost, and a systematic and very efficient approach to design optimization is presented. The role of sensitivity analysis in systematically guiding the design process to meet program requirements, which is a multi-critertia optimization, is shown in detail. The additional benefits of sensitivity-based analysis, such as providing a decision trail for design modifications/evolution, handling uncertainty, demonstrating resulting design robustness, and how the sensitivity analysis can be used to quantify elements of design, development, and operational risk is demonstrated. Real-world examples, such as an autonomous navigation system for an unmanned underwater vehicle, a railroad control system, an expendable launch vehicle, and the Space Station, are used to demonstrate and explain the concepts. Students are provided with additional texts that provide an introduction to Markov modeling of fault tolerant systems and methods to solve these models by inspection.

This course is intended for system and subsystem designers and integrators, system engineers, and technical managers and anyone who desires to develop a more global view of fault tolerant systems. The tutorial does not require any background in specific modeling methods; algebra is used in the modeling solutions.

Dr. Babcock is the head of Systems Engineering at The Charles Stark Draper Laboratory, Inc.

Tutorial T7 (1:30 pm - 5:00 pm)
"Optimization of Space-Time Signal Processing for Moving Antennas"
Igor I. Gorban

The tutorial is oriented to scientists and engineers interested the problem of space-time signal processing, and also - to designer developed new hydroacoustic technique. The course is self-contained, however, a general knowledge on space-time signal processing is desirable.

Objectives:

- presentation the basis of modern space-time processing for moving antennas,
- description the new principles of fast multichannel space-time signal processing with a few calculating efforts,
- discussion the profits connected with using the new approaches in optimization for new hydroacoustic technique.

Contents: A lot of underwater acoustic space-time signal processing (STSP) systems are exploited in complicated dynamic conditions. Because of the streams, pitching, rolling, and other destabilized factors there are antenna motion with continuous changing the place of the antenna, its orientation in space, and sometimes even changing its form. The tutorial presents new approaches in complex optimization of STSP. It will be discussed two aspects of the problem. The first aspect is the development of optimum and near optimum STSP methods that take into consideration complicated antenna motion, noises, and medium together. The second aspect is realization the complicated STSP in millions channels with a few calculating efforts. The profit connected with using the new approaches will be discussed.

Igor I. Gorban is Principal Scientist at the Institute of Mathematical Machines and Systems, National Academy of Sciences of Ukraine.

A separate registration fee is required for each Tutorial. See registration form for details.

Environmental Technology Committee

Because of the heightened interest among the ocean community for amelioration of the impact of electrotechnolgy on the ocean environment, the OES has established a committee to address issues that have been and will be raised by emerging technological developments. The Environmental Technology Committee has been chartered to address the impact that emerging sensors and systems will have on the ocean environment as well as the more familiar considerations of the impact on performance of the systems. Accurate performance prediction techniques are critical to both aspects, e.g., bathymetry interaction with active sonar and the disturbance level to mammals that high energy sonars can produce. The committee is interested in providing a forum for new and novel approaches to address the issues raised for emerging/enabling technologies.

Recent efforts in system performance enhancements have focused on techniques to adapt the system to the local environment. This can be thought of as the sensor measuring the medium and setting system parameters to take advantage of the situation. Shallow water littoral regions present a challenge to accomplish this in real time as the environment changes in time and space very rapidly. This variability has been determined to be on the same scale as time on station (O (hr.)) and size of the area of interest (O (km)). In addition the impact is more pronounced than in deep water. Ongoing efforts such as ONR's Environmentally Adaptive Sonar Technology (EAST) program are attempting to develop a procedure to improve system performance by the use of in situ through-the-sensor measurements to allow adaptation to the local environment. The ultimate objective is to develop an automated, environmentally adaptive system to optimize system performance. Techniques presently being considered include neural nets, various inversion concepts and genetic algorithms. This list is by no means inclusive and all concepts are welcome for consideration and discussion.

Jim Barbera

The second area of interest is the impact on the environment of the energy introduced into the water column by present and emerging technologies. Physical interaction with mammals, interference with habitats, changes in behavior, and physiological effect issues at the forefront. Standard procedures to mitigate negative effects are needed to allow for the testing and operation of high energy ocean systems. All countries with seacoasts have instituted statutory processes to require such mitigation. Prior to testing/operational use of the new systems a plethora of documentation can be required to show that minimal impact on the natural environment. Presently procedures such as lookouts and predicted standoff ranges are used. It is reasonable to assume that some automated approach may be used in the near future. Some examples of the documentation are an Environmental Impact Statement(EIS), Environmental Assessment (EA) and take permits. Each of these has a specific purpose and criteria for use. Technologies to accurately establish standards and processes to measure them at sea are areas that OES is interested in providing a platform for discussion and ultimate acceptance by the community. For instance, what is the standard energy level to cause hearing damage to mammals and how would it be measured at sea. The Environmental Committee is interested in establishing a dialogue for the ocean community to address such issues.

OES has two formal mechanisms to accomplish these objectives, OCEANS conferences and the JOE. Peer reviewed papers, tutorials, and presentations are welcomed and encouraged. The July 2001 issue of JOE will have a special section devoted to the topic of the impact of the interaction of man made sound in the ocean with marine mammals. Papers will be accepted through 1 August 2000.

If you have an interest in assisting with this committee please contact Jim Barbera — email — *j.barbera@ ieee.org*

Jim Barbera
Environmental Technology
Committee Chairman

UT 2000 Repeats Successful Tokyo Venue

Underwater Technology 2000 was a big success, as the second, biennial International Symposium in Tokyo at the New Sanno Hotel from May 23 to 26. The symposium was sponsored by IEEE Oceanic Engineering Society(OES), U.S. Office of Naval Research Asian Office, and The Institute of Industrial Science(IIS), University of Tokyo. Symposium Co-chairs were Joseph Vadus, OES Vice President and Hisaaki Maeda, OES AdCom. The OES-Japan Section was the hosting and supporting organization. Opening addresses by sponsors were given by: Glen Williams, OES President, Hassan Ali, Associate Director of the U.S. Office of Naval Research Asian Office and Professor Uomoto, Deputy Director, IIS, University of Tokyo. The University of Tokyo announced the establishment of the new Research Institute for Underwater Technology directed by Tamaki Ura, the OES Japan Chapter Chair.

There were over 160 in attendance.The ocean community sent in 133 abstracts from 19 countries. 82 papers were incorporated, including keynote lectures by: Glen Williams, Texas A & M University on Autonomous Under water Vehicle Controller" ; Spencer King. Nauticos Inc. on" Midway : The Survey of a Historical Battle Site" ; H. Momma, JAMSTEC on “Search and Recovery of NASDA s H-II Rocket Flight No.8 Engine”; J. M. Zhu on “Underwater Research Activity in China” and J. R. McFarlane, International Submarine Engineering on"ROV’s and AUV’s: Tools for Exploring, Exploiting & Defending the Ocean Frontier."

This symposium series is focused on the Pacific Rim countries and aimed at bringing together the international leaders and experts on underwater technology to exchange and share research and development findings on the leading edge of technology. The sym[osium theme was, Advan ced Underwater Technologies for the 21st Century and consisted of technical sessions on: Underwater Observation, Underwater Acoustics, Underwater Vehicles & Robotics, Signal & Information Processing, Underwater Posi

tioning, Underwater Activities, and Underwater Construction. Underwater technology provides the means to explore the ocean and its underwater world, and facilitates the wise utilization of its vast resources.

All the members of the UT Executive Committee brought considerable experience on underwater technology: Technical Program Chairs , Tamaki Ura and Robert Wernli; and Hassan Ali, Teruo Fujii, Yasuyoshi Ishii and Chang Kyu Rheem. A Technical Tour took 43 participants to the experimental site of the huge 1000 meter long Mega-Float proto type airport and the JAMSTEC (Japan Marine Science and Technology Center) featuring underwater facilities such as: Shinkai 6500, the new AUV “Urashima”, and experiments for the wave power device “Mighty Whale”.

After careful consideration of all proposals for Underwater Technology 2002 by the UT Executive Committee, it was decided to hold the next conference at the New Sanno Hotel in Tokyo once again in 2002. This deci sion was hard to arrive at with such excellent proposals submitted from Taiwan and Singapore.With a successful conference in Tokyo in 2002, the venue will move outside of Japan in 2004, if acceptable proposals are received.

Symposium Co-Chairmen:

Prof.Hisaaki Maeda
Institute for Industrial Science
University of Tokyo, Japan

Mr. Joseph R. Vadus
Vice President, Technical Activities
IEEE Oceanic Engineering Society,
USA

UT 2000 Tokyo, Japan

Tamaki Ura, Program co-chair describing his UT logo design (pair of jeans & T-shirt on a clothes line). Looking on: Ms. Hiromi and Y. Ishii UT Treasurer.

Members of UT Excom and UT advisors toasting the success of UT 2000.

Prof. Fong-Chen Chiu and the Taiwan Delegation.

Symposium co-chairs Hisaaki Maeda and Joe Vadus.

Left to right members of UT Excom: Hassan Ali, Bob Wernli, Tamaki Ura, and Teruo Fujii.

Welcome address by Glen Williams, OES President.

Left to right: Joe Vadus, OES Vice President and OES President Glen Williams at the reception's sushi table.

UT 2000 Tokyo, Japan

John and Catherine Potter of Singapore, Jerry Carroll, U.S. Navy and Prof. Emeritus, N. Nasu, Univ. of Tokyo.

Model-Based Signal Processing in the Ocean

J. V. Candy

Introduction

The detection and localization of an acoustic source has long been the motivation of early sonar systems. With the advent of quieter and quieter submarines due to new manufacturing technologies and the recent proliferation of diesel powered vessels, the need for more sophisticated processing techniques has been apparent for quite some time. It has often been contemplated that the incorporation of ocean acoustic propagation models into signal processing schemes can offer more useful information necessary to improve overall processor performance and to achieve the desired enhancement/detection/localization even under the most hostile of conditions. For our problem in ocean acoustics the model-based approach is shown in Figure 1. The underlying physics is represented by an acoustic propagation model depicting how the sound propagates from a source or target to the sensor measurement array of hydrophones. Noise in the form the background or ambient noise, shipping noise, uncertainty in the model parameters etc. is shown in the figure as input to both the propagation and measurement system models. Besides the model parameters and initial conditions, the raw measurement data is input to the model with the output being the filtered or enhanced signal.

Model-based techniques offer high expectations of performance, since a processor based on the predicted physical phenomenology that inherently has generated the measured signal must produce a better (minimum error variance) estimate then one that does not [1,2]. The uncertainty of the ocean medium also motivates the use of stochastic models to capture the random and often nonstationary nature of the phenomena ranging from ambient noise and scattering to distant shipping noise. Therefore, processors that do not take these effects into account are susceptible to large estimation errors. This uncertainty was discussed by Tolstoy [3], in the work of Carey [4] when investigating space-time processing, and in the overviews by Sullivan and Middleton [5] and Baggeroer [6]. However, if the model embedded in this processor is inaccurate or for that matter incorrect, than the model-based processor (MBP) can actually perform worse. Therefore, it is necessary, as part of the MBP design procedure, to estimate/update the model parameters either through separate experiments or jointly (adaptively) while performing the required processing [7].

Incorporating a propagation model into a signal processing scheme was most probably initiated by the work of Hinich [9] in 1973 who applied it to the problem of source depth estimation. However, as early as 1966, Clay [10] suggested matching the modal functions of an acoustic waveguide to estimate source depth. The concept of matched-field processing (MFP), that is, comparing the measured pressure-field to that predicted by a propagation model to estimate source range and depth was introduced by Bucker [11] in 1976. In MFP, the localization problem is solved by exhaustively computing model predictions of the field at the array for various assumed source positions. The final position estimate is the one achieving maximum correlation with the measured field at the array. Many papers have been written exploiting and improving on the MFP and are best summarized in the text of Tolstoy

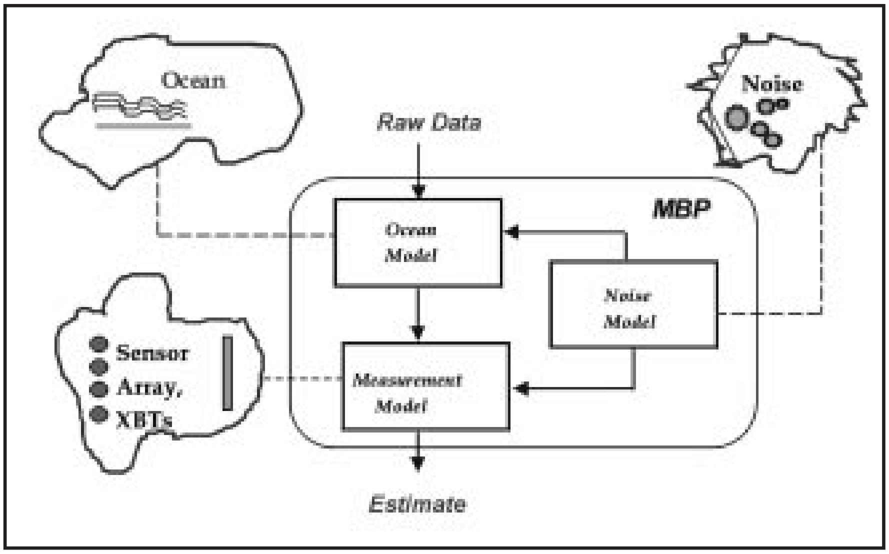

Figure 1. Model-Based Approach: Structure of the model-based processor showing the incorporation of propagation (ocean), measurement(sensor array), and noise (ambient) models.

[3] and the special issues of Doolittle [12] and Stergiopoulos [13]. However, matched-field is primarily aimed at the localization problem, indeed most estimators implemented by MFP are focused on seeking an estimation of localization parameters.

In ocean acoustics there are many problems of interest other than localization that are governed by propagation models of varying degrees of sophistication. Our discussion will eventually lead to adaptively adjusting parameters of the propagation model to "fit" the ever-changing ocean environment encompassing our sensor array [14]. In fact, one way to think about this processor is that it passively listens to the ocean environment and "learns" or adapts to its changes. It is clear that the resulting processor will be much more sensitive to changes than one that does not, thereby, providing current information and processing. One recent paper utilizes such a processor as the heart of its model-based localization scheme [15].

With this background in mind, we discuss the development of a "model-based processor," that is, a processor that incorporates a mathematical representation of the ocean acoustic propagation and can be used to perform various signal processing functions ranging from simple filtering or signal enhancement, to adaptively adjusting model parameters, to localization, to tracking, to sound speed estimation or inversion. In all of these applications the heart of the processing lies in the development of the MBP and its variants. Clearly each of the MFP methods described above can be classified as model-based, for instance, the MFP incorporates a fixed (parametrically) propagation model. However, here we will emphasize the recursive, state- space, forward propagation scheme of Candy and Sullivan [7]. We choose to differentiate between the terms model- based processing and matched-field processing, primarily to emphasize the fact that this discussion is based on the existing state-space framework that enables access to all of the statistical properties inherited through this formalism such as the predicted conditional means and covariances [1,2]. This approach also enables us access to the residual or innovation sequence associated with model-based processors (Kalman filter estimator/identifiers) permitting us to monitor the performance of the embedded models in representing the phenomenology (ocean acoustics, noise, etc.) as well as the on-line potential of refining these models adaptively using the innovations [7,8]. The state-space formalism can be considered to be a general framework that already contains the signal processing algorithms and it is the task of the modeler to master the art of embedding his models of interest. Thus, in this sense, the modeler is not practicing signal processing per se, but actually dealing with the problem of representing his models within the state-space framework. Furthermore, this framework is not limited to localization, but because of its flexibility, tomographic reconstructions can be performed to directly attack the mismatch problem that plagues MFP [3,12]. This can be accomplished by constructing an "adaptive" MBP that allows continuous updating of the model parameters and is easily implemented by augmenting them into the current state vector. That is, unlike the conventional view of the inverse problem, where the functional relationship between the measurements and the parameters of interest must be invertible, we simply treat these parameters as quantities to be estimated by augmenting them into the state vector. In MFP, most of the techniques employed to "correct" this mismatch problem usually achieve their result by a desensitization of the algorithm. Adaptive MBP does not sacrifice any potential information available in the model, but actually refines it by *adaptively* or recursively updating parameters. In this way the original states and the augmented states are updated by the recursive processor in a self-consistent manner. The fact that the relationship between the original states and the parameters of interest may be complicated and/or nonlinear is not an issue here, since only the "forward" problem is explicitly used in each recursion via the measurement relations. Thus, the usual complications of the inverse problem are avoided at the expense of creating a higher dimensional state-space. All that is necessary is the parameters of interest be observable or identifiable in the system theoretic sense [8,15].

Much of the formalism for this model-based signal processing has been worked out [7]. It is concerned with the incorporation of environmental (propagation, seabed, sound speed, etc.), measurement (sensor arrays) and noise (ambient, shipping, surface, etc.) models along with measured data into a sophisticated processing algorithm capable of detecting, filtering (enhancing) and localizing an acoustic source(target) in the complex ocean environment. This technique offers a well-founded statistical approach for comparing propagation/noise models to measured data and is not constrained to a stationary environment which is essential in the hostile ocean. Not only does the processor offer a means of estimating various quantities of high interest (modes, pressure-field, sound speed, etc.), but it also provides a methodology to statistically evaluate its performance on-line. Although model-based techniques have been around for quite a while, [1,2] they have just recently found their way into ocean acoustics. Some of the major advantages of model-based processors are that they are:

- *recursive*,
- *statistical*, incorporating both noise and parameter uncertainties,
- capable of incorporating *non-stationary* statistics,
- capable of incorporating both *linear/nonlinear space-time varying* models,
- capable of *on-line processing* of the measured data at each iteration,
- capable of *filtering* the pressure- field as well as simultaneously *estimating* the modal functions and/or sound speed (inversion/tomography),
- capable of *monitoring* their own performance by testing the residual between the measurement and its prediction, and easily extended to perform *adaptively*.

First let us examine the inherent structure of the model-based processor. Model-based processing is a direct approach that uses in-situ measurements. More specifically, the acoustic measurements are combined with a set of preliminary sound speed and other model parameters usually obtained from a priori information or a sophisticated simulator (such as SNAP [16], the SACLANT normal-mode propagation model) that solves the underlying boundary value problem to extract the initial parameters/states in order to construct the forward propagator and initialize the algorithm. The algorithm then uses the incoming data to adaptively update the parameter set jointly with the acoustic signal processing task (detection, enhancement, and localization). In principle, any propagation model can be included in this method. There are basically three advantages to this approach. First, it is recursive and, therefore, can continuously update the estimates of the sonar and environmental parameters. Second, it can include the system and measurement noise in a self consistent manner. By noise, is meant not only acoustic noise, but also errors in the input parameters of the model. Third, one of the outputs of the MBP is the so-called innovation sequence, which provides an on-line test of the "goodness of fit" of the model to the data. This innovation sequence plays a major role in the recursive nature of this processor by providing information that can be used to adaptively correct the processor and the propagation model itself, as well as provide the input to a sequential detector [7]. Along with the ability of this processing scheme to self consistently estimate parameters of interest along with the signal processing task, stand-alone estimators can also be used to provide refined inputs to the model. Further, estimates can be refined as demonstrated in a new towed array processing scheme [17].

Model-Based Processing

Next we discuss the basics of the model-based approach to signal processing. Formally, the model-based approach is simply "incorporating mathematical models of both physical phenomenology and the measurement process including noise into the processor to extract the desired information." This approach provides a mechanism to incorporate knowledge of the underlying physics or dynamics in the form of mathematical propagation models along with measurement system models and accompanying uncertainties such as instrumentation noise or ambient noise as well as model uncertainties directly into the resulting processor. In this way the model-based processor enables the interpretation of results directly in terms of the physics. The model-based processor is really a modeler's tool enabling the incorporation of any a-priori information about the problem to extract the desired information. The fidelity of the model incorporated into the processor determines the complexity of the model-based processor. These models can range from simple implied non-physical representations of the measurement data such as the Fourier or wavelet transforms to parametric black-box models used for data prediction to lumped mathematical physical representations usually characterized by ordinary differential equations to full physical partial differential equation models capturing the critical details of wave propagation in a complex medium. The dominating factor of which approach is the most appropriate is usu-

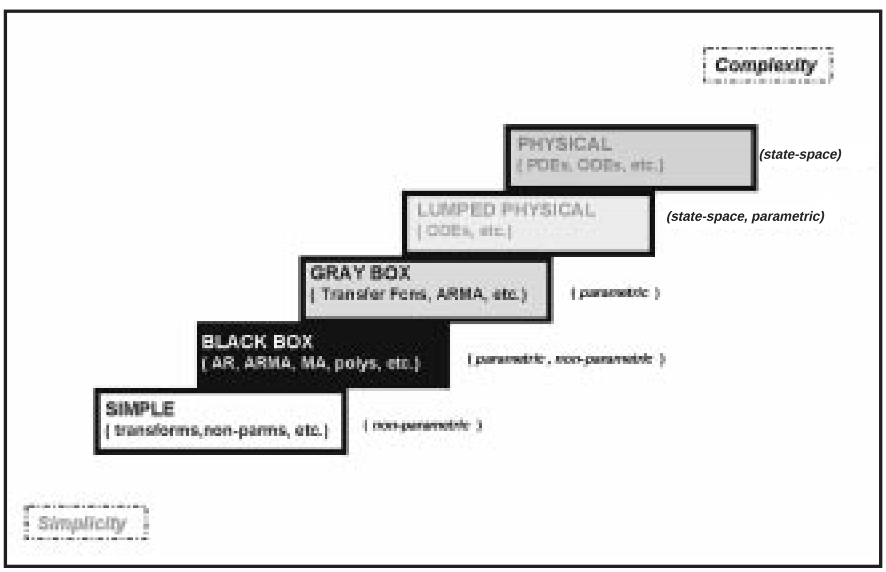

Figure 2. Fidelity of the embedded model determines the complexity of the resulting model-based processor required to achieve the desired SNR: (a) Simple implied model (Fourier, Wavelet, etc.). (b) Black-box model (data prediction model). (c) Gray-box model(implied physical model). (d) Lumped physical model (differential equations). (e) Full physical model (partial differential equations).

ally determined by how severe the measurements are contaminated with noise and underlying uncertainties. If the signal-to-noise ratio (SNR) of the measurements is high, then simple non-physical techniques can be used to extract the desired information. This approach of selecting the appropriate model is depicted in Figure 2 where we note that as we progress up the "modeling" steps to increase the SNR, the complexity of the model increases to achieve the desired results.

A Simple Example

Consider the following example taken from ocean acoustics to motivate the approach.

Suppose we have a plane wave signal characterized by

$$s_k(t) = \alpha e^{i\beta_k \sin\theta_o - i\omega_o t},$$

where $s_k(t)$ is the space-time signal measured by the k^{th} sensor, α is the plane wave amplitude factor β, θ, ω_o, with the respective wavenumber, bearing, and temporal frequency parameters. Let us further assume that the signal is measured by a horizontal array. A simple but important example in ocean acoustics is that of a *50 Hz* plane wave source (target) at a bearing of *45°* impinging on a 2-element array at a *10 dB SNR* (see Figure 3 below). We would we like to solve the following basic ocean acoustic processing problem of extracting the source bearing, θ_o, and temporal frequency, ω_o parameters. The bearing/frequency estimation or equivalently localization problem can be considered a problem of estimating a set of parameters, $\{\theta_o, \omega_o\}$ from noisy array measurements, $\{p_k(t)\}$. We start with the following models:

Signal Model:

$$s_k(t) = \alpha e^{i\beta_k \sin\theta_o - i\omega_o t}$$

Measurement/Noise Model:

$$p_k(t) = s_k(t) + n_k(t).$$

The classical approach to this problem is to first take a sensor channel and perform spectral analysis on the filtered time series to estimate the temporal frequency, ω_o. The bearing can be estimated independently by performing classical beamforming on the array data. A beamformer can be considered a spatial spectral estimator which is scanned over bearing angle indicating the true source location at maximum power. The results of applying this approach to our problem is shown in Figure 4a demonstrating the outputs of both spectral estimators peaking at the correct frequency and angle parameters.

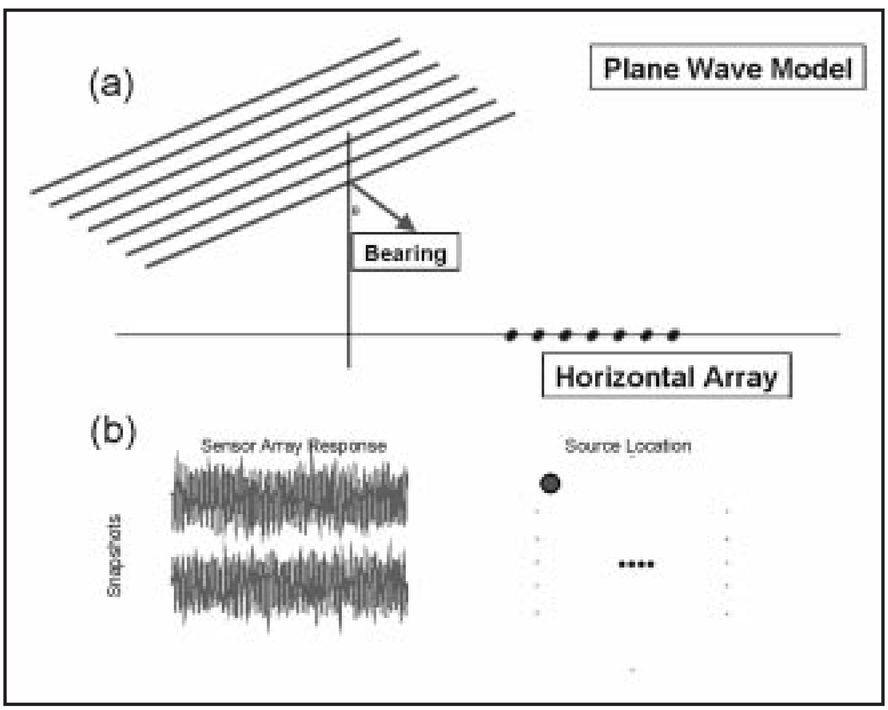

Figure 3. Plane Wave Propagation: (a) Problem geometry. (b) Synthesized 50 Hz, 45o, plane wave impinging on a 2-element sensor array at 10dB SNR.

The MBP is implemented by incorporating the plane wave propagation, hydrophone array, and noise models (as in Figure 1). However, the temporal frequency and bearing angle parameters are unknown and must be estimated. The solution to this problem is performed by augmenting the unknown parameters into the MBP structure and solving the so-called joint estimation problem [1,2]. This is the parameter adaptive form of the MBP used in most ocean acoustic applications. Here the problem becomes nonlinear due to the augmentation and is more computationally intensive; however, the results are appealing as shown in Figure 4b. Here we see the bearing angle and temporal frequency estimates as a function of time eventually converging to the true values (ω_o=50Hz,θ_o=45°). The MBP also produces the "residual or innovations" sequence, (shown in the figure) which is used in determining its overall performance, i.e., it must be statistically zero-mean and white for optimal performance [2].

We summarize the classical and model-based solutions to the frequency and bearing angle estimation problem. The classical approach simply performs spectral analysis temporally and spatially (beamforming) to extract the parameters from noisy data, while the model-based approach embeds the unknown parameters into its propagation, measurement, and noise models through augmentation enabling a solution to the joint estimation problem. The MBP also enables a monitoring of its performance by analyzing the statistics of its residual or innovations sequence. It is this sequence the indicates the optimality of the MBP outputs. This completes the example.

Summary

We have discussed the model-based approach to ocean acoustic signal processing and developed a simple example to demonstrate its application. When the underlying SNR of the measured data is low, a MBP can provide a physics-based solution to the problem.

It should also be noted that there is MBP software available SSPACK_PC,

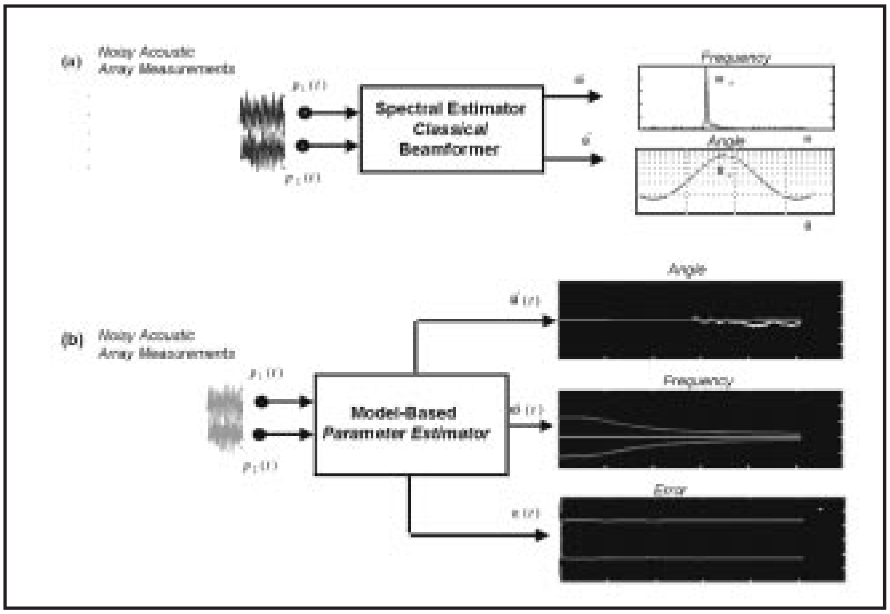

Figure 4. Plane Wave Impinging on a 2-element Sensor Array—-Frequency and Bearing Estimation Problem: (a) Classical spectral (temporal and spatial) estimation approach. (b) Model-based approach using parametric adaptive (nonlinear) processor to estimate bearing angle, temporal frequency, and the corresponding residual or innovations sequence.

which is a toolbox in MATLAB (see web and 3rd party site) [18,19]. Also there is an upcoming short course/tutorial entitled, "Model-Based Ocean Acoustic Signal Processing," at the OCEANS 2000 Conference in Providence, RI. For those interested in learning more about this approach and its applications be sure to sign up.

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Biography of James V. Candy

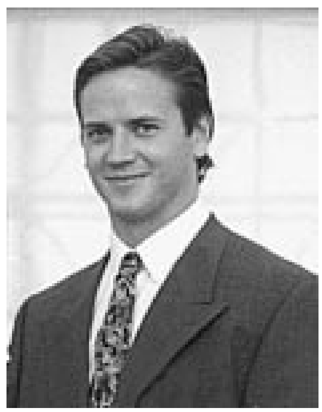
James V. Candy is the Chief Scientist for Engineering and Director of the Center for Advanced Signal & Image Sciences at the University of California, Lawrence Livermore National Laboratory. Dr. Candy received a commission in the USAF in 1967 and was a Systems Engineer/Test Director from 1967 to 1971. He has been a Researcher at the Lawrence Livermore National Laboratory since 1976 holding various positions including that of Project Engineer for Signal Processing and Thrust Area Leader for Signal and Control Engineering. Educationally, he received his B.S.E.E. degree from the University of Cincinnati and his M.S.E. and Ph.D. degrees in Electrical Engineering from the University of Florida, Gainesville. He received a commission in the USAF in 1967 and was a Test Director from 1967 to 1971. He is a registered Control System Engineer in the state of California. He has been an Adjunct Professor at San Francisco State University, University of Santa Clara, and UC Berkeley, Extension teaching graduate courses in signal and image processing. Dr. Candy is a Fellow of the IEEE and a Fellow of the Acoustical Society of America (ASA) as well as a member of Eta Kappa Nu and Phi Kappa Phi honorary societies. He was just elected as a "distinguished alumnus" by the University of Cincinnati and will be honored as such at a banquet in June, 2000. He has published over 125 journal articles, book chapters, and technical reports as well as written two texts in signal processing, "Signal Processing: the Model-Based Approach," (McGraw-Hill, 1986) and "Signal Processing: the Modern Approach," (McGraw-Hill, 1988). He has presented short courses sponsored by the IEEE in Applied Signal Processing and more recently Model- Based Ocean Acoustic Signal Processing for IEEE Oceans Society. He is currently the IEEE Chair of the Administrative Committee on "Sonar Signal Processing" and also the Chair of the ASA Interdisciplinary Technical Group on "Signal Processing in Acoustics". as well as being an Associate Editor for Signal Processing of ASA (online). His research interests include estimation, identification, spatial estimation, signal and image processing, array signal processing, tomography and biomedical applications.

Who's Who in the OES

Mr. Michael Ingram is a GPS Systems engineer for Charles Stark Draper Laboratory in Cambridge, Massachusetts. He was most recently elected as a member of the OES Administration committee this year.

Mr. Ingram attended Worcester Polytechnic Institute (WPI) in Worcester, MA for an electrical engineering degree. While working in a co-op position his junior year, his heart told him that he didn't want to be stuck behind a computer. This led him to search for other avenues that could incorporate his interest in electrical engineering with those of the outdoors. The hook into ocean engineering came at the 1992 Oceans Conference in Newport, RI. The combination of fascinating presentations on ocean research and the wide variety of ocean engineering company exhibitors, provided the ticket that incorporated great technological challenges while operating in a rough but beautiful environment.

Mr. Ingram graduated from WPI in 1993 and immediately went to study for a Masters of Science degree in Ocean Engineering at the University of Rhode Island, its campus ideally situated on the Atlantic Ocean. His concentration was on underwater acoustics and ocean instrumentation. Advised by Dr. Robert Tyce, Mr. Ingram was a research



Michael Ingram

assistant designing a ships motion sensor for wave compensation of Seabeam Instrument's acoustic mulit-beam sonar. This motion sensor incorporated inertial sensors and GPS blended together to provide attitude, speed and position. The project included designing and building a simulator platform that mimicked the motion of a vessel. He graduated with his masters in 1996 after working full-time at Seabeam for a year.

His work on ship's motion sensors and GPS lead him to the four corners of the earth with Seabeam and then with a new employer, Seatex Inc. in Seattle, WA. Seatex was a manufacturer of Motion Reference Units (MRUs) and DGPS systems for the offshore and hydrographic markets. Mr. Ingram also had the privilege to transfer to the Seatex headquarters in Trondheim, Norway for a year to work as a systems engineer. He managed two GPS projects for the European Union Government in testing the operation of the European Wide-area GPS correction system for ocean going vessels.

Mr. Ingram had the desire to move back to the states in the summer of 1999 but there was no longer a position to go back to in Seattle so he took a position with Draper Laboratory. His current work has been as a task leader for multiple projects including the Advances in GPS Development (AGD) sponsored by the DoD's Joint Program Office (JPO) and various autonomous systems. This new position has allowed Mr. Ingram to concentrate on research while organizing IEEE activities outside of the lab.

During this last year he established the Graduates of the Last Decade (GOLD) branch for the IEEE Boston Section. His positions within IEEE are Boston Section GOLD chair, support coordinator for the Student Professional Awareness Committee (SPAC), member of OES PACE GOLD and member of the OES Administration Committee. He has been a member of IEEE since 1990 and OES since 1992.

HPS 2000

Human Powered Submarine Contest

The San Diego Section of the American Society of Mechanical Engineers (ASME) and the Institute of Electrical & Electronics Engineers (EEEE) are hosting the **Human Powered Submarine Contest** to be in July 2000 in Escondido, California. The contest is open to Student sections of the ASME at all Universities and Colleges that can meet the minimum design and safety requirements as proposed in the rules of the contest.

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As of this writing, we have several confirmed entries from various Universities and Colleges that include:

- University of California at San Diego
- University of Michigan
- Virginia Tech University
- University of Washington
- Millersville University of Pennsylvania
- Ecole de Technology Superieure (Quebec)

Other Universities and Colleges have expressed interest in competing. These institutions include:

- San Diego State University
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- Texas A&M
- University of New Orleans (observers)
- University of Vera Cruz (Mexico)

More information is available at our web site:
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The contest is to be held at the Offshore Modeling Basin in Escondido, California. from July 20th through 23rd 2000.

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Last year, only 14.3% of student applications came in via the web, so the rate of Web usage among prospective Student members is increasing dramatically. If this pace continues IEEE could see nearly 26,000 Web applications in 2000. The web application form can be found at *http://www.ieeeusa.org/membership*.

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