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(Continued on back cover)

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Future OCEANS Conferences Abroad

by Pierre Sabathe
Vice President, International Activities

In the Fall of each year, the Oceanic Engineering Society Vice President for International Activities is invited to update the OES membership on Oceans Conferences and other OES activities organized outside North America. Therefore, I am continuing this activity initiated by Dr. Ferial El-Hawary, who is actively involved with OCEANS '97 MTS/IEEE to be held in Halifax, Nova Scotia. The theme of OCEANS '97, 500 Years of Ocean Exploration, celebrates the rich history of seagoing activities through the centuries from John Cabot to modern enterprises in aquaculture, space technology, ocean energy and seabed mining.

I am also pleased to announce a new OES event in Japan, Underwater Technology '98. It is the first IEEE/OES sponsored activity on the Pacific Rim. Organized by Dr. Joseph R. Vadus and Professor Tamaki Ura, it will be held at the Institute of Industrial Science, University of Tokyo, during April 20-23, 1998, the height of cherry blossom time. One of the main purposes of this Symposium is to better serve OES members who reside in this area, 10,000 miles away from the main OCEANS Conference series.

After the successful OCEANS '94 OSATES Conference held in Brest, France, the OES Administrative Committee decided to come back to Europe four years later. IEEE/OES will be the sole sponsor of OCEANS '98, to be held at the Acropolis in Nice, the South of France on the sunny Cote d'Azur, from Monday, September 28, 1998 through Thursday, October 1, 1998. The organization of the Conference will involve, as in OCEANS '94 in Brest, IFREMER and the IEEE/OES French Chapter. It is impressive that this OES Chapter, now including members from other European countries currently without an OES Chapter, includes over 300 members.

All of the above Conference activities are designed to better serve the international membership in the OES. We would also invite any suggestions from the OES membership as to additional activities which will accomplish this purpose.

Underwater Technology '98 Symposium Meeting at University of Tokyo's Institute of Industrial Science (July '96)

Symposium Committee, l to r: Ishii, Treasurer, OES Japan; J. Collins, OES V.P. Tech. Act.; T. Ura, Chairman, OES Japan; J. Vadus, OES, AdCom; Fujii, Secretary, OES Japan

Underwater Technology '98

UT 98

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OES

First Announcement

UNDERWATER TECHNOLOGY '98

The First IEEE Oceanic Engineering Society Pacific Rim Symposium on Underwater Technology
"Key Issues for Global Environment"
20 - 22 April 1998
Institute of Industrial Science, University of Tokyo
Tokyo, JAPAN

CALL FOR PAPERS

This symposium which is organized by the IEEE Oceanic Engineering Society (OES) and its Tokyo Chapter is the first in a new series to be sponsored by the OES and organizations in various host countries. These symposium will make OES services more available to the membership and provide a forum for underwater technology issues of particular relevance to Pacific Rim nations. The theme of this first symposium will highlight the Key Issues for Global Environment.

TOPICS

Sessions will cover various technologies and applications in the underwater environment. Topics may include but are not limited to the following areas:

Underwater Acoustics	**Underwater Observation**	**Underwater Telemetry**
Global Acoustics, Tomography	Imaging Systems	Data Transmission Systems
Acoustical Oceanography	Sensors	Video Transmission Systems
Sound Propagation & Scattering	Instrumentation Systems	Long Range Communication
Transducers & Arrays	GOOS-Coupled Systems	Submarine Cable Systems
Underwater Positioning	**Underwater Vehicles & Robotics**	**Signal & Information Processing**
Mapping & Guidance Systems	ROVs & AUVs	Detection & Estimation
GPS-Coupled Systems	Manned Submersibles	High Resolution Processing
Navigation & Tracking Systems	Underwater Robotics	Image & Signal Compression
Geodetic Measurement Systems	Underwater Platforms	Neural & Fuzzy Systems

The Symposium will include visits to area technical attractions including Japan Marine Science and Technology Center. Other area attractions include historical and cultural places around the Tokyo area. Moreover, if spring is on time in Tokyo, it is the period of cherry tree blossoms, a very beautiful occasion in this city.

ABSTRACT SUBMISSION

Prospective authors are invited to submit proposed abstracts (300-500 words) by E-mail or Fax. The initial section of the abstract should give the title, authors' name(s) (designate one author as contact), affiliation, postal and email addreses, and telephone and fax numbers. In the abstract, authors should define the problem that is to be addressed, indicate its importance and describe how this work contributes to underwater technology. Acceptance is by committee review of abstracts. The Official language of the symposium is English.

SEND ABSTRACT TO:

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THE IMPORTANT SCHEDULES FOR AUTHORS ARE:

Abstract Deadline: *October 15, 1997*
Notification of Acceptance: *November 15, 1997*
Camera Ready Paper Due: *February 1, 1998*

SHARING ACTIVITY LETTER

Letters to headquarters for sharing have been arriving on a regular basis. Wonderful! But, we're hearing mostly from Chapter officers with some letters arriving from Societies. We've just received a trickle from Sections. People will begin to think that nothing happens at the Sections, which you know is not true. We need to receive mail from all of you — from Chapters, from Societies and, of course, from Sections.

We'll start from my own Section where Paul Carr, of the Central New England Microwave Theory and Techniques (MTT) Chapter, reports eight lectures per year. Last year's lectures included talks on Penny Antennas and Nickel Filters from Director Martin Schneider, Validation of Passive Circuit Models by Slobodnik and Webster of Rome Laboratory and talks on features from Superconductor Filter Design to CAD systems. This is a very active Chapter, indeed.

From Asia, there is an appeal from Gilbert K.K. Li, Chairman of the joint Power Engineering and Industry Applications Society Chapters of the Hong Kong Section. He is running a busy schedule of meetings but worries that their finances are not strong enough to organize larger events. Hong Kong Section includes its meeting notices in its bi-monthly newsletter but he is seeking a discussion with Society or IEEE leaders in hopes of expanding operations. Perhaps something can be set up at a Region 10 meeting.

Shuichi Nitta, Chair of the Tokyo Section Reliability Chapter has listed the duties he believes of Chapters, to offer good service and chances for information exchanges both inside and outside of Japan (in his case) through the IEEE. As such he was appreciative of a talk by Paul Gottfried of the USA on Reliability and Safety Issues of Train Control. His other speakers came mainly from Japan. As are other Chapters, he is concerned about finances. His Chapter organizes several special lecture meetings each year in various locations around Tokyo. As might be expected, attendance varies with the location and the topics. They also support several study meetings of the Institute of Electronics, Information and Communication Engineers of Japan. Three such meetings were held last fall averaging almost 30 attendees per meeting.

A success story in the development of the Computer Chapter of the New Jersey Coast Section is described by Amruthur Narasimhan, Chapter Chair. With the help of a loan from their Section, the Chapter sponsored a Professional Development Seminar for students on Multimedia Communications. They hoped for more than 20 attendees and attracted over 100 — a sellout. He advises advertising in every way possible, through the newsletter, electronic mail, manual posting, the Internet. The three A's are advertise, advertise and advertise.

Cleveland's Vehicular Technology (VT) Chapter is riding on several good years of four or more programs per year. Michael Garvey, Chapter chair notes that tours are very popular with the members. His group visited the rapid transit control station. They almost went to the local airport control tower but got shut out due to security concerns. Lots of interest, however. He would like to know what other Chapters, especially VT Chapters, do in addition to technical programs and tours. Mike, I think you are doing fine as is but if someone has suggestions please contact him or us.

An inspiring report was received from Elya Joffe, Chairman of Israel's Electromagnetic Compatibility (EMC) Chapter. This is a new Chapter, only two years old, with 40 members. They not only held several lectures last year but they proposed, and had accepted by the EMC Society, the sponsorship of the International Symposium on EMC in Israel in the year 2003. The Chapter is already starting work. Elya is issuing an invitation to EMC members in the area, including all Palestinians, Jordanians, Egyptians, and as he says it, "Hopefully, very soon all the neighboring countries," to contact the Israeli Chapter to contribute to the success of the Symposium, the first to take place in the Middle East.

From the Ukraine comes a story by Alexander Nosich of the formation of an Antennas and Propagation (AP) Chapter in spite of "life being really hard in this country, especially for engineers and scientists. Institution budgets are zero or even negative, the industry is frozen and a simple postal letter to USA is not affordable for the majority of the population." Yet, as documented in the AP magazine issue of June 1995, the Chapter was formed and is organizing a conference on Antenna Theory and Techniques. Congratulations. Let's hope there can be some visits and funding for them soon.

The next report comes from the other side of the world, from V.L. Narasimhan, Chairman of the Queensland, Australia Computer Chapter. The Chapter has grown from cold start in 1992 to over 400 members, the biggest Chapter in the Section. They hold from four to six technical meetings per year and in 1995 hosted the First IEEE International Conference on Algorithms and Architecture for Parallel Processing. Great going!

We received a request from Jim Ziobro of the Rochester Section. He heads the Information Committee and would like to move to electronic access. He would like to develop an electronic network with other of the same mind. The email alias is eic-tech@ieee.rochester.ny.us.

Other electronic access providers, start networking. It's about time we moved more into electronics communications.

How about going to Kuala Lampur next? We hear from Hussein bin Ahmid of the Power Engineering Chapter, Malaysia Section that, in the absence of an EMC Chapter there, the Power Engineering Chapter organized a conference on Electromagnetic Compatibility last year. "Healthy and Quality Environmental Through EMC" was the topic with about 80

participants. Papers were received from almost 15 countries around the world. Let's hope it promoted the development of an EMC Chapter as well.

The German Chapter of MTT has concentrated on a series of conferences and workshops throughout Germany. They held them in Duisburg, Reisenburg, Sindelfingen, Darmstadt, Starnberg and even moved one into Switzerland, holding a workshop in Zermatt. Their next one is planned for Erlangen in September. This is a wonderful method of attracting members from a diverse Chapter where constant commuting to a single location could be bothersome. By the way, Dr. Arndt, past Chair, announces that his successor will be Nigel Keen. We know the programs will continue.

Here's information on the doings of the Signal Processing (SP) Society from Mercy Kowalczyk, SP Executive Director. She reported on a breakthrough meeting last fall wherein the Society hosted a dinner discussion on signal processing with representatives from the U.S. Congress, Federal agencies, academia and private industry. With the purpose of raising the profile of signal processing and the Society among the various leadership, it was the first of its kind hosted by an IEEE Society and, reports Mercy, was very successful. Both outgoing President Tariq Durrani and his replacement, Don Johnson, plan to continue and extend this concept.

The next report comes from Mexico City, from Angel Zapata, Region 9 Coordinator for the Engineering in Medicine and Biology Society. Angel outlines a full series of meetings that he has held throughout Mexico with Student Branches. He points out the benefits of getting Mexican students turned on to the IEEE and ends with a request to have distinguished speakers visit to talk to the students. Contact the Mexico Section for further information.

That's all for this report. We hope that some of the experiences recounted herein will help you in your Chapter operations. Let us also hear about your activities. They might provide incentive for another group. We're waiting to hear, also, from you Section officers. Send your information to Jayne Cerone at the TAB office in Piscataway.

That's it for now.

Best regards,

Harold S. Goldberg
Chair, TAB Public Relations Committee

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Upcoming Conferences

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First International Symposium and Exhibition, CIVIL OR MILIARY ALL ELECTRIC SHIP
Paris, France 13 & 14 March 1997
Contact: Frank Cipollone, SEE, 48 rue de la Procession-75724 PARIS Cedex 15 - FRANCE
Tel: +33 1 44 49 60 60/17 Fax: +33 1 44 49 60 44

OFFSHORE TECHNOLOGY CONFERENCE
Houston, Texas 5-8 May 1997
Contact: OTC (214) 952-9494 Fax: (214) 952-9435

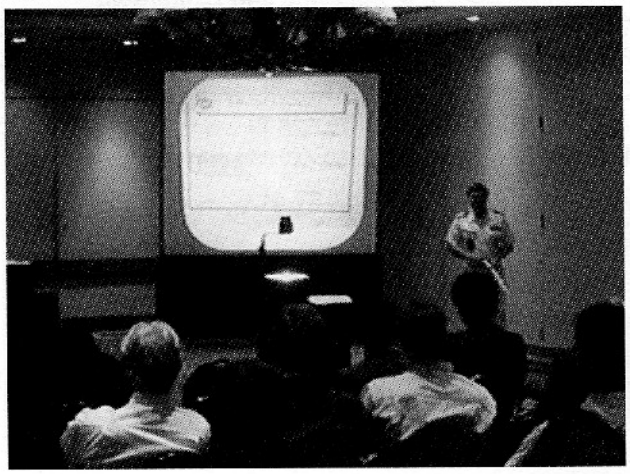
SIGNAL & IMAGE PROCESSING (SIP'97)
San Francisco, CA 2-5 November 1997
Contact: Nader M. Namazi, Dept. of Electrical Engineering, The Catholic University of America, Washington, C.D. 20064

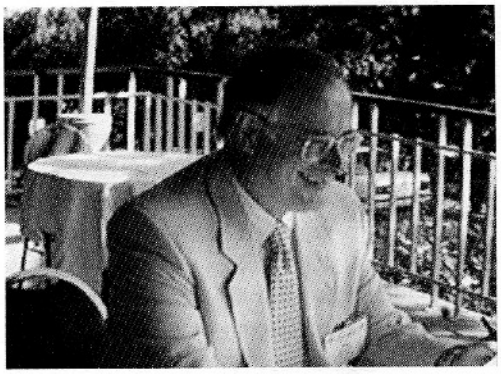
OCEANS '97 MTS/IEEE
Halifax, Nova Scotia 6-10 October 1997
Contact: Dr. Ferial El-Haway
(902) 443-2400 Fax: (902) 445-5110

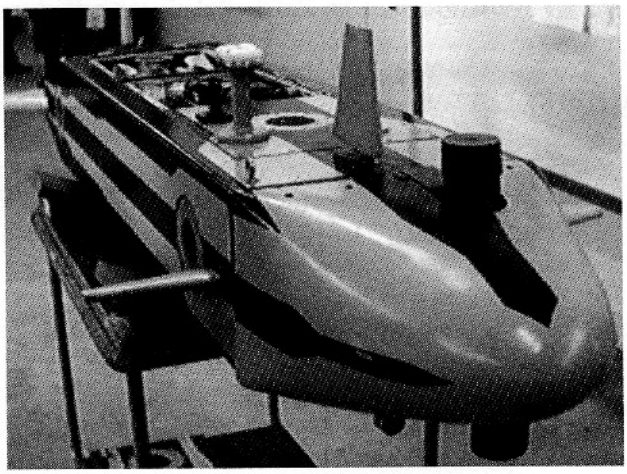
UNDERWATER TECHNOLOGY '98
Kokyo, Japan 20-22 April 1998
Contact: Prof. Tamaki Ura, ura@iis.u-tokyo.ac.jp, Fax +81-3-3401-6259 or Dr. James S. Collins, j.s.collins@ieee.org, Fax: +1-604-721-6052

Scenes from AUV'96

Naval Postgraduate School and Hyatt Regency, Monterey, Calif.

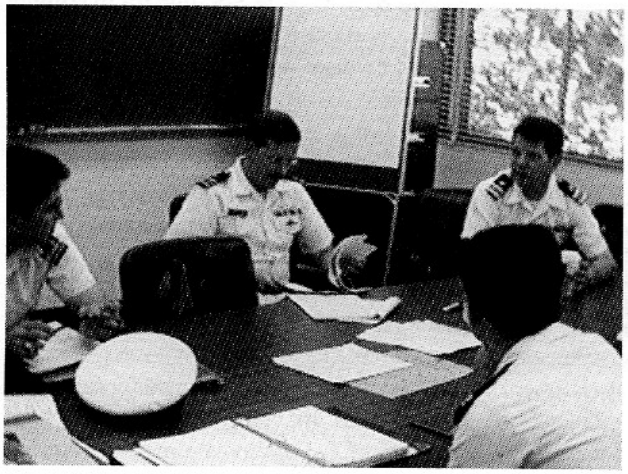


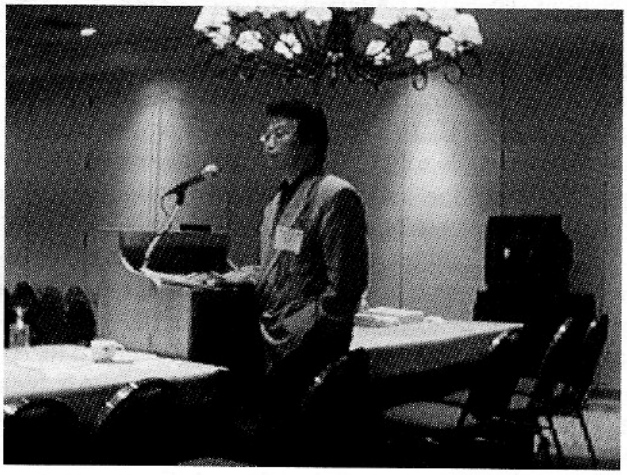




Scenes from AUV'96

Naval Postgraduate School and Hyatt Regency, Monterey, Calif.





(Reprinted from AUV '96 Proceedings)

High Resolution Array Signal Processing for AUVs

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Abstract—**Future successful operations conducted with Autonomous Underwater Vehicles (AUVs) will include several mission functions that will rely heavily on high performance, high resolution forward looking sonars (FLS) coupled with high performance embedded signal processors. These mission functions include object detection, localization and classification (DLC), sea bottom mapping and feature extraction for navigation guidance and control and obstacle avoidance.**

This paper will describe the efforts associated with both the High Resolution Array (HRA) currently under development at the Naval Undersea Warfare Center (NUWC) in Newport, RI and the Unmanned Underwater Vehicle Signal Processor (UUVSP) currently under joint development by the Sanders Division of Lockheed Martin Corporation and NUWC. The HRA, sponsored by the Office of Naval Research, is a 1272 element, 20 wavelength planar array designed for use as a forward looking sonar in 21-inch diameter vehicles.

The HRA combines an 80 degree horizontal by 40 degree vertical transmit beam, for full volume coverage, with steerable three degree receive beams. The UUVSP, sponsored by the Advanced Research Projects Agency (ARPA), is an embedded signal processor based on ARPA's high performance scalable computing (HPSC) technology. A 24 giga-floating point operation (GFLOP) unit (scalable to 256 GFLOPs) designed to fit in a 21-inch diameter vehicle will be demonstrated in the first quarter of fiscal year 1998.

I. INTRODUCTION

In the future, successful reconnaissance operations conducted with Autonomous Underwater Vehicles (AUVs) will include several mission functions that will rely heavily on a high performance, high resolution, forward looking sonar (FLS) coupled with a high performance, low power, embedded signal processor. These mission functions include object detection, localization and classification (DLC), sea bottom mapping and feature extraction for navigation guidance and control (NG&C) and obstacle avoidance. The sonar must provide good probability of detection, classification, and accurate object localization while striving to meet the often conflicting performance requirement of high search rate. DLC performance is a function of spatial processing gain and temporal signal processing gain. For a reverberation limited environment, temporal signal processing gain is a function of signal bandwidth while spatial processing gain is primarily a function of the ratio between wavelength and sonar aperture. For a fixed aperture, spatial gain is achieved with smaller wavelengths (higher frequency of operation) resulting in narrower receive beams. In addition, multiple narrow receive beams are effective in shallow water areas characterized by a highly variable acoustic environment dominated by high levels of boundary reverberation, multipath propagation, and coherent returns from bottom features. Search rate is a function of both detection range and coverage in azimuth and elevation angle. Azimuthal coverage should be as wide as possible for maximum search rate, while wide vertical coverage requirements are driven by those imposed by deep water operation. Therefore, superior DLC performance drives the sonar design toward multiple narrow receive beams and search rate requirements drive the design toward large angular coverage. A FLS with wide transmit coverage and narrow receive beams can also be used to perform sea bottom mapping and feature extraction for NG&C and obstacle avoidance.

For several years, the Office of Naval Research (ONR) and the Navy's Advanced Systems & Technology Office (ASTO) have sponsored the development of NUWC's high resolution array (HRA). The HRA is a planar array designed for operation in a 21-inch diameter vehicle. Its current design consists of half-wavelength elements of 1-3 composite material configured in a 20 wavelength circular aperture. Recently, NUWC has embarked on the development of algorithms that rely on the wide transmit coverage and narrow receive beams of the HRA to provide high resolution images of the bottom, objects on the bottom and objects in the volume. The processing requirements necessary to provide this imaging capability are being addressed under the Advanced Research Projects Agency (ARPA) high performance scalable computing (HPSC) program. Under this program, the Sanders Division of Lockheed Martin Corporation will develop a scalable embedded unmanned underwater vehicle signal processor (UUVSP) for use in a 21-inch diameter vehicle that will host NUWC's imaging algorithms. This paper is designed to present an overview and status of the ongoing HRA and UUVSP efforts and associated algorithm development. The paper is organized as follows. First, a system description of the HRA/UUVSP will be given. This includes array parameters and high level signal processor design. Next, the detection performance of the HRA will be discussed. Finally, processed results from in-water data

collected with a prototype HRA will be presented. These results will focus on sea bottom mapping and feature extraction for NG&C.

II. SYSTEM OVERVIEW

The HRA is a forward looking planar array designed for operation in a 21-inch vehicle. It has evolved from a receive-only array constructed from polyvinylidene fluoride (PVDF) [1] to its current design that consists of 1272 half-wavelength elements of 1-3 composite material (PZT-5H) configured in a 20 wavelength circular aperture (design frequency of 87 kilo-Hertz (kHz))[1]. A subset of the elements consisting of two rows of 32 elements each are chosen to provide single ping transmit coverage of approximately 80 degrees in azimuth by 40 degrees in elevation with a source level of at least 210 decibels (dB). Wide angle azimuthal transmit coverage is achieved by means of element phase shading.

Receive beams are formed from a subset of 511 of the remaining 1208 elements. These elements are chosen and fixed during the design process to yield the lowest peak sidelobe level (_ 20 dB down from the peak mainlobe level) while constraining the mainlobe to be nearly three degrees wide for beams steered over the transmit coverage region [2]. Complete single ping receive coverage over this region can be provided by forming approximately 2048 receive beams.

Processing load calculations for conventional single ping processing of these beams (element level matched filtering, narrowband beamforming, 3-D normalization, threshold detection, object formation and classification) revealed that a minimum of 20.3 GFLOPs of processing power are required for the UUVSP. In order to achieve the necessary reconfigurability and programmability to accommodate typical applications such as bottom mapping, obstacle avoidance and object DLC, the UUVSP will rely on the embedded HPSC dual-processing node (DPN) technology developed by Lockheed Martin Corp. [3]. The architecture of the DPN is based upon the ADSP-21060 general purpose digital signal processor and Myricom's uniform hierarchical packet-switching network technology. The HPSC DPN consists of two clusters of four ADSP-21060s and associated static random access memory (SRAM). Each ADSP-21060 will provide 120 MFLOPs computational power and 4 megabits internal SRAM. This capability combined with 1 megabyte (MB) of associated SRAM per cluster provides for a total capability of 1 GFLOP computational power and 6 MB SRAM for each DPN. The baseline UUVSP design will combine eight DPNs interfaced to a Myrinet network on one 16- by 6-inch board. The Myrinet technology permits the UUVSP to utilize flexible network topologies that are easily reconfigurable. Three boards will be configured about a radial core in a 16-inch length of 21-inch diameter shell section for a total computational power of 24 GFLOPs. With this architecture, there exists the potential to expand to 256 GFLOPs in the same 16-inch shell section.

1 See companion paper, "A Forward Looking High Resolution Imaging Sonar," in these proceedings for details.

III. SYSTEM PERFORMANCE: MODEL RESULTS

In order to evaluate the detection performance of the HRA, a series of analyses were conducted with the Generic Sonar Model [4]. A set of five shallow water environments with water depths ranging from 12 to 90 meters, varying sound speed profiles (SSPs), and bottom types ranging from silty sand to gravel were chosen for the test. Small target strength targets (-20 dB) were placed on the bottom, near the bottom, and in the water column in each of the environments. Signal excess predictions as a function of range were calculated in each environment for each of the target locations assuming a processing gain of 20 dB and a detection threshold of 13 dB. The detailed results of the analyses are covered in [5]. In summary, detection ranges of 685 to 1143 meters were obtained except in one case where the strong negative gradient of the SSP limited the detection range to 228 meters.

IV. IN-WATER RESULTS

Active acoustic HRA data were collected from 9 through 18 September 1995 at the Gould Island Test Facility in Newport, RI. The HRA was deployed on an elevator and lowered to a 9 meter depth in 20 meters of water. A sidescan sonar image of the test area is shown in Fig. 1. The Gould Island test area is characterized as a nearly flat, silt bottom bowl, with a seven meter high, curved rim to the south and east of the facility. This rim is clearly evident along the bottom and right-hand sides of the sidescan image.

The elevator is located at the northeast corner of the pier complex seen near the lower left-hand corner of the sidescan image. The origin of the coordinate system is centered on the HRA, located geodetically at 41° 32' 45.0" North, 71° 20' 42.6" West.

The HRA was mounted on a pan system that allowed the array to be mechanically rotated from a heading of 327° to a heading of 87°. Two distinct tests were conducted for each of six transmit waveforms: 10 millisecond (ms) 87 kHz continuous wave (CW), 10 ms 1000 Hz bandwidth linear frequency modulated (LFM), 10 ms 3000 Hz LFM, 10 ms 6000 Hz LFM,

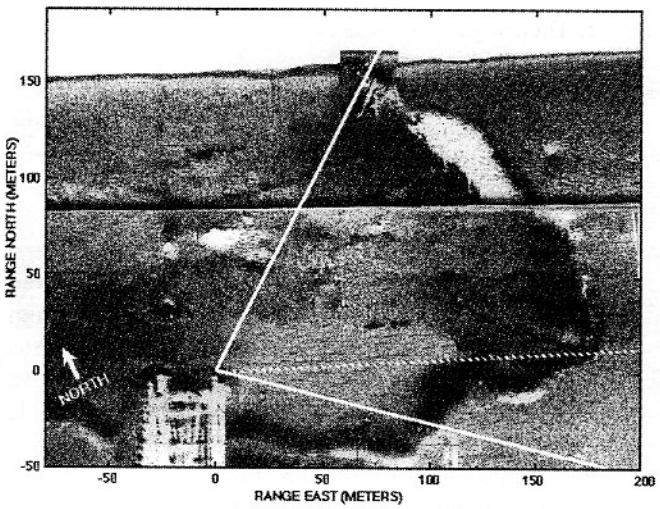


Fig. 1. Sidescan sonar image of the Gould Island test area.

20 ms 1000 Hz LFM, 20 ms 3000 Hz LFM, and 20 ms 6000 Hz LFM. All of the LFM waveforms were centered at 87 kHz. A limited experiment was conducted to determine the best combination of transmit waveform and element-level processing. The LFM waveforms were processed with and without matched filtering. The CW waveform yielded the poorest performance, while the results with the LFM waveforms suggest using the widest bandwidth possible and matched filtering. To date, only the 3000 Hz LFM data has been extensively analyzed, therefore, bathymetry estimation results using only that waveform will be discussed in this paper.

During the first test the HRA was rotated from a heading of 327° to a heading of 87° in 15° increments. Three consecutive pings were collected at each of the nine look angles, at a repetition rate of 20 seconds per ping. Bathymetric maps for each ping were constructed and averaged to form a single composite map. Details of bathymetric map construction follow. For the second test, the HRA was rotated to a heading of 27°, which corresponds to straight out from the elevator, then ten consecutive pings were collected at a repetition rate of 20 seconds per ping. The objective of this test was to determine depth estimation stability by forming a bathymetric map for each ping, overlaying all ten maps, and computing the variance at each map cell, again, details follow.

A. Single Ping Map Construction

The algorithms developed for the creation of single ping bathymetric maps from forward looking sonars are an extension of the signal processing techniques used in downward looking, wide swath bathymetric sonars [6]. A sonar cycle begins with the transmission of a large-angle transmit pulse. The horizontal and vertical transmit beam patterns used with the HRA are shown in Fig. 2(a) and 2(b), respectively.

At each received time sample the received element-level sonar data are matched filtered, shaded with two-dimensional Chebyshev weights, and electronically steered, via phase-delays, to a particular azimuth angle. Vertical beamforming is then performed with a spatial Fast Fourier Transform [7]. Vertical angles where detections occur are those angles whose corresponding magnitudes are greater than 6 dB above the average magnitude across all the vertical angles for that time sample. The rough vertical detection angles and magnitudes are refined by fitting a least squares parabola to the initial detection angles, and the refined angles, refined magnitudes, and sample numbers are stored in equal angular bins. Only the maximum refined magnitude response is retained in each equal angular bin, along with its corresponding refined angle and sample number.

After all of the samples in a receive cycle have been systolically processed, as summarized above, the raw bottom profile map for a particular azimuth angle is converted from vertical angle and sample number coordinates to a depth versus range profile. This converted profile is then filtered to remove outliers in both magnitude and space. Fig. 3 shows a sample bottom profile from the Gould Island test area. This profile was taken at a heading of 107°, its direction is indicated by the dashed white line emanating from the elevator in the sidescan image (Fig. 1).

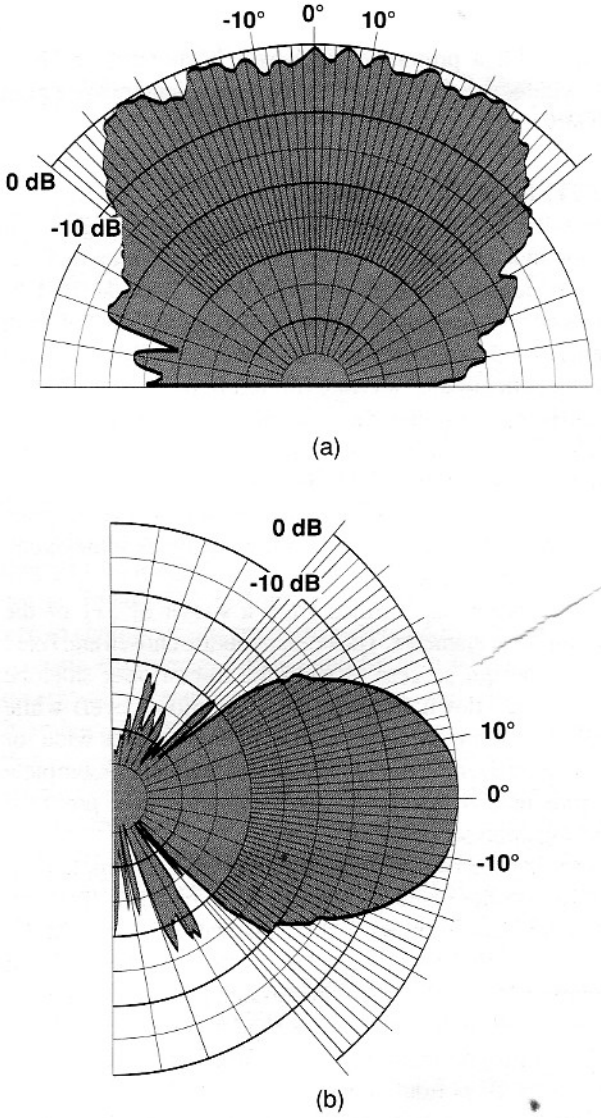


Fig. 2. HRA transmit beam patterns: (a) horizontal; (b) vertical.

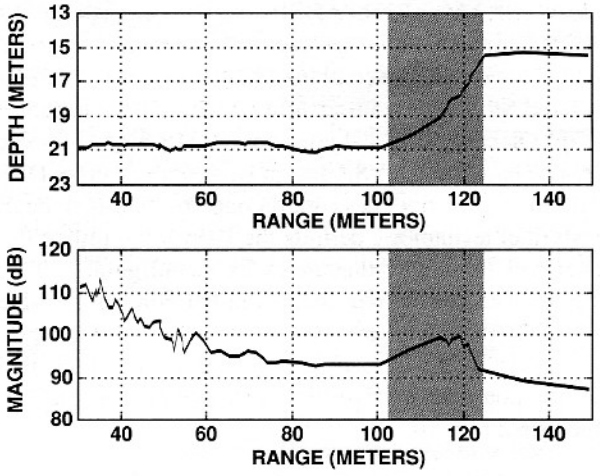


Fig. 3. Sample bottom profile from the Gould Island test area.

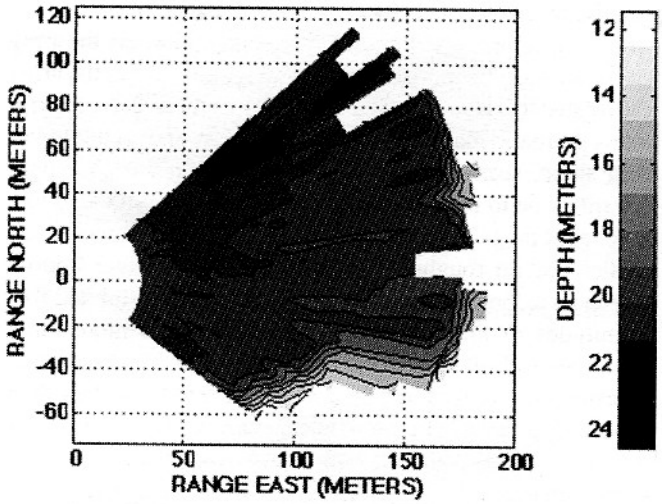


Fig. 4. Single ping bathymetric map from the Gould Island test area.

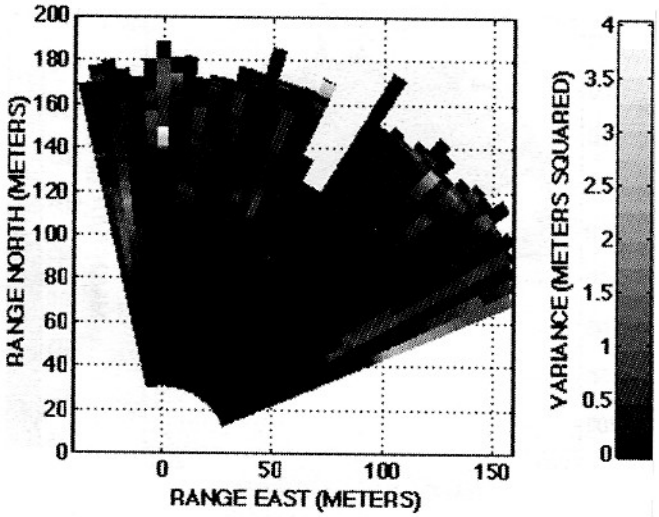


Fig. 5. Variance map derived from ten consecutive pings.

Clearly evident in the depth profile are the nearly flat bottom, and the rim, highlighted in gray. The magnitude profile illustrates a gradual roll off with range induced by propagation effects and decreasing grazing angle, as well as a sharp increase due to the rise of the rim.

In each sonar cycle 21 individual azimuth profiles (from -40° to 40° from array boresight in 2° increments) are concatenated to form a single ping bathymetric map. This 80° wide angular swath corresponds to the effective horizontal transmit area of the HRA transmitter, as seen in Fig 2(a). An example map is depicted in Fig. 4. The area mapped is bounded by the two solid white lines on the sidescan sonar image (Fig. 1). The contour interval is one meter.

Portions of the southern and eastern rim are clearly seen, as well as the slight increase in bottom depth towards the northeast of the map. Approximately 3 GFLOPs were needed to construct this single ping bathymetric map.

B. Map Precision

Before discussing the construction of multiple ping bathymetric maps, it is important to first consider map precision. Map precision refers to the ability of a mapping system to consistently obtain nearly the same resultant map when data are collected under comparable conditions. To address the issue of map precision, individual maps were constructed for each of ten consecutive pings, collected at a repetition rate of 20 seconds per ping, with an array heading of 27°. The ten separate maps were overlaid, and the variance in each map cell was computed. The resultant variance map is shown in Fig. 5.

Over most of the map the variance ranges between 10 centimeters squared (cm^2) and 20 cm^2. The mean variance over the entire map is 17 cm^2. A few larger variances are clearly visible at the longer ranges, where small grazing angles produce poor bottom backscatter and limit depth estimation performance. Larger variance values are also evident at the azimuthal angle extremes, where the transmit beam is weakest, again contributing to poor energy backscatter and degraded system performance.

C. Multiple Ping Map Construction

A composite bathymetry map, created from 27 distinct gridded pings, three pings at each of nine look angles, is presented in Fig. 6.

The rim, as expected, is the predominant feature in the multi-ping bathymetric map. Also of interest are the small hump 75 meters north and 10 meters east of the array (seen also on the sidescan image, Fig. 1), the general downward slope to the west of the array, and the slight upward slope to the east of the array leading to the rim. The corresponding composite magnitude map is illustrated in Fig. 7.

Noticeable features from the magnitude map are the higher magnitudes due to the rise of the rim, and to a lesser degree, the hump. Of particular interest is the character of the magnitude roll off versus array heading. In general, the magnitudes to the west of the array start at higher values, roll off more quickly, and fall to lower values than the magnitudes to the east of the array. To further illustrate this trend, Fig. 8 depicts

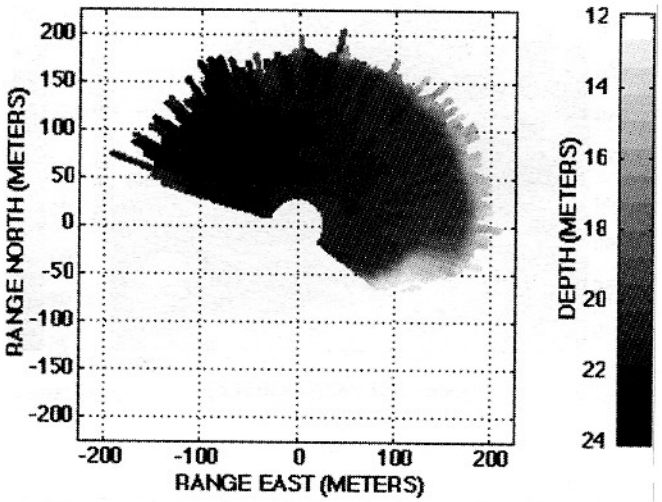


Fig. 6. Multiple ping bathymetric map constructed from 27 individual pings.

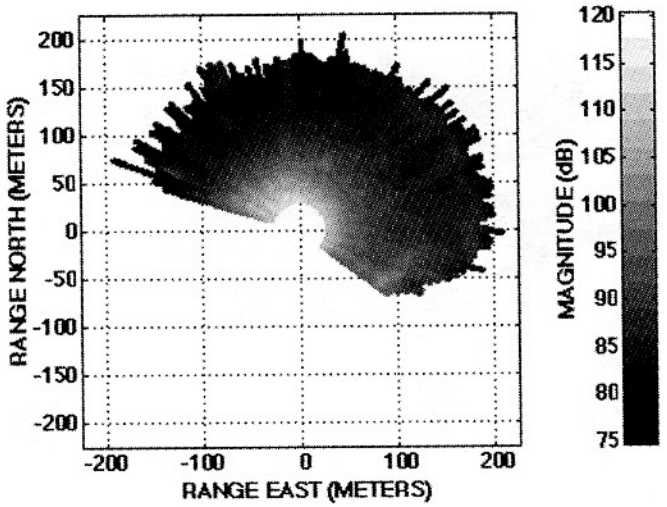
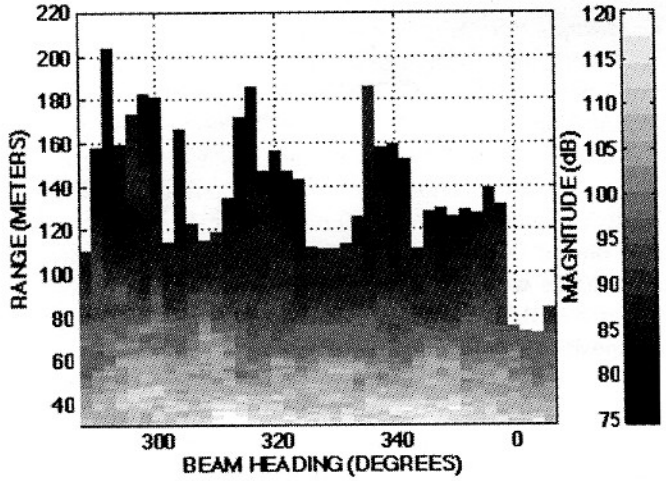
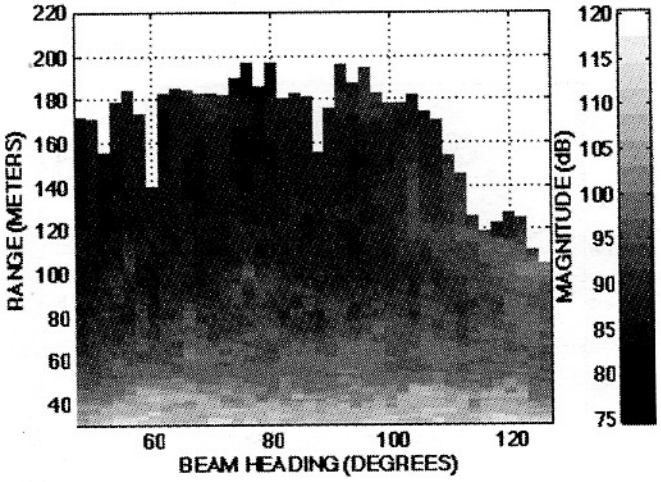


Fig. 7. Multiple ping magnitude map constructed from 27 individual pings.



(a)



(b)

Fig. Fig. 8. Magnitude versus receive beam heading and range: (a) array center rotated to 327° heading; (b) array center rotated to 87° heading.

magnitude maps versus receive beam heading and range for two pings, collected 10 minutes apart, Fig. 8(a) where the array was rotated to a heading of 327°, and Fig. 8(b) where the array was rotated to a heading of 87°. Two principal factors give rise to this dramatic magnitude difference. First, the slight downward slope, seen to the west of the array versus the slight upward slope to the east of the array (Fig. 6) would lead to a more rapid magnitude roll off. Second, and more important, a smaller bottom roughness to the west, and a larger bottom roughness to the east, causes the western areas to exhibit higher magnitudes in the near-specular region, and a more rapid magnitude roll off as grazing angle decreases. Also note that the estimation ranges in Fig. 8(a) are generally far less than those in Fig. 8(b). The automated mapping algorithms presented here stop estimating bathymetry when the character of the bottom profile begins to become unstable. The magnitudes in Fig. 8(a) fall off much faster versus range (and decreasing grazing angle) than those in Fig. 8(b), hence they fall into the noise more quickly and cause the algorithm to halt at shorter ranges.

A direct comparison of two magnitude profiles, one extracted from each of the above pings in Fig. 8, is shown in Fig. 9. Both of the magnitude profiles correspond to -6° from array boresight. The gray profile was taken from the ping where the array center was rotated to a 327° heading, and the black profile from the ping where the array center was rotated to a heading of 87°. Since each profile was taken from the same azimuth angle relative to array boresight, the difference in magnitude roll off character between the profiles is attributable to bottom interaction effects and not to transmit or receive beam pattern differences.

For visualization purposes, the multiple ping bathymetric and magnitude maps from Fig. 6 and Fig. 7, respectively, are represented below as artificially lighted surface models. The view is from the west, looking east, and 20° above the plane of the bottom. The light emanates from the southwest, 50° above the plane of the bottom. The depth axis has a tenfold multiplier applied. Fig. 10 depicts the multiple ping bathymetric map where depth has been encoded to gray level. Fig. 11

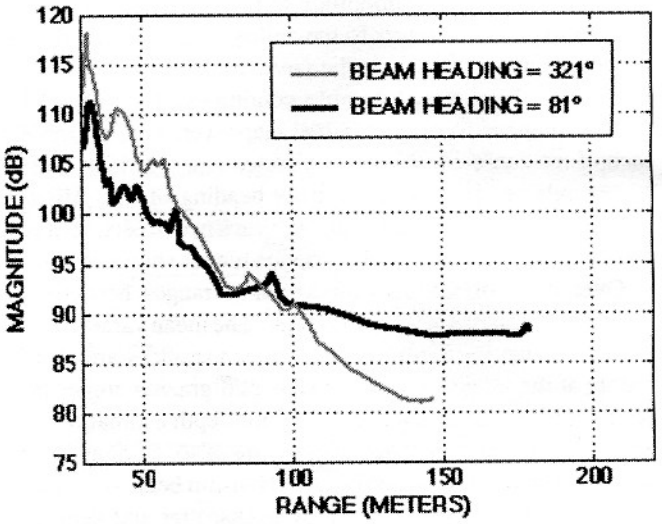


Fig. 9. Comparison of two magnitude profiles.

Fig. 10. Artificially lighted multiple ping bathymetric map.

Fig. 11. Artificially lighted multiple ping magnitude map.

presents the multiple ping magnitude map in which magnitude has been encoded to gray level.

D. *Feature Extraction*

The multiple ping bathymetric and magnitude maps shown in Fig. 6 and Fig. 7, respectively, accurately reflect the depth and bottom backscatter characteristics of the Gould Island test area. However, an AUV controller, with a finite amount of processing ability, would need to be presented with a small set of extracted features from these maps in order to carry out NG&C and obstacle avoidance tasks. From an obstacle avoidance standpoint, bottom features would be objects that approach, or are shallower than, the operating depth of the vehicle. From a magnitude perspective, an area that is brighter than its surroundings could be a feature. Lastly, from a shape point of view, any area that protrudes from, or descends into, the local bathymetry may be a feature. The features extracted from the Gould Island test area multiple ping bathymetric map (Fig. 6) and the corresponding magnitude map (Fig. 7) are depicted in Fig. 12. The features shown in Fig. 12 are derived from a linear combination of absolute depth, relative magnitude, and relative gradient.

For this example the all of the weights used in the linear combination were unity. These weights can easily be adjusted to suit the priorities of a particular mission, i.e. any combination of finding bright spots, identifying small holes or projections, and avoiding obstacles may be obtained. Evident in the feature map are the rim, the hump, and several smaller protrusions also seen in the sidescan sonar image (Fig. 1).

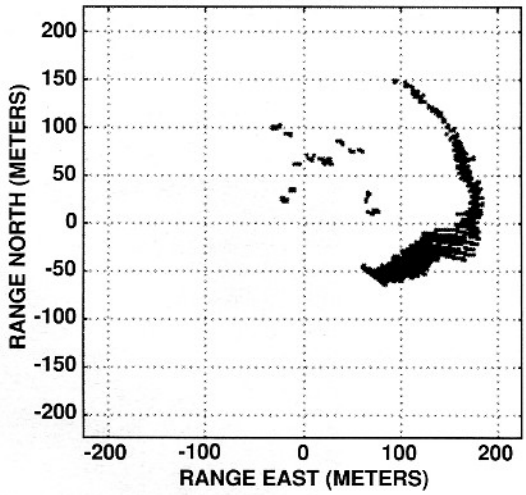


Fig. 12. Features extracted from the multiple ping bathymetric and magnitude maps.

V. CONCLUDING REMARKS

This paper presented an overview and status of efforts related to the design and development of a forward looking sonar system for use in AUV reconnaissance missions. The system consists of a planar transmit/receive array that relies on wide transmit coverage and multiple narrow receive beams. This approach was shown, via modeling efforts, to provide good detection performance against very small target strength objects, and a series of in-water results were presented that highlighted the systems ability to provide an accurate measure of bottom bathymetry and bottom features. A signal processing architecture designed to process the array outputs was also discussed.

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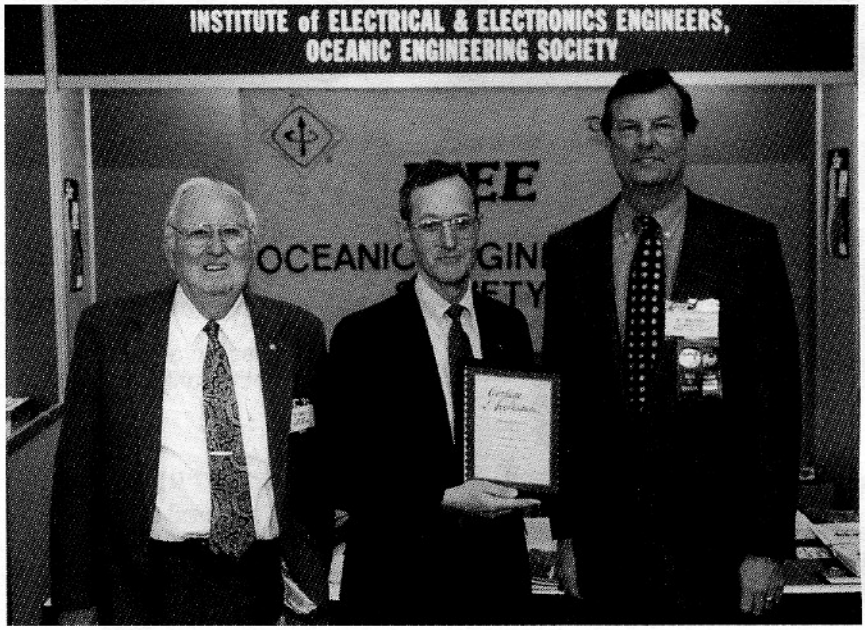
OTC '96 Conference

An award was presented to John Lucey of Houston, Texas, who has handled the IEEE booth at the OTC conferences for many years.



L to R: Ed Early, John Jucey, Al Williams

Science Chairman Makes Push for Space Commercialization

Having announced his retirement at the end of the 104th Congress, House Science Committee Chairman Robert Walker is pushing hard for passage of space commercialization legislation. Formally introduced on Aug. 1, Walker's Space Commercialization Promotion Act of 1996 (H.R. 3936) was the subject of hearings on July 31. Mark-up is planned in early September in the hopes that the House will pass the bill before Congress adjourns on Oct. 4. Senate action is unlikely in the absence of a companion bill.

According to Walker, "this bill will help get the government out of the private sector's way when it comes to developing space commercially."

The bill includes provisions requiring NASA to study roles for commercial support and use of the International Space Station; directing the Department of Transportation to establish a regulatory framework for licensing commercial space activities; authorizing states to license space ports; reaffirming the policy of making the U.S. Global Positioning System the world standard; helping NASA space shuttle employees shift to private contractors; and mandating that NASA purchase space science and remote sensing data, as well as space transportation services from U.S. commercial sources to the maximum extent possible.

At the July 31 hearing, Lionel "Skip" Johns, Assistant Administrator for Technology in the President's Office of Science and Technology Policy, noted a number of areas in the bill which "can form the basis for common ground" with the Administration, including space commercialization, commercial space ports, global position system policy and remote sensing.

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New from IEEE Educational Activities:

Effective Communication Series

The Effective Communication Series includes four videos on business writing, office meetings, effective presentations, and job interview techniques and a book on report writing.

Writing Reports to Get Results, by Ron S. Blicq and Lisa A. Moretto, provides sample reports and proposals for all types of situations, from inspecting a contractor's work to proposing a new computer system. The video teaches step-by-step how to write more easily, clearly, and effectively through the unique Pyramid Method.

Sharpening Your Business Writing Skills teaches viewers how to write letters, memos, reports, and proposals using the Pyramid Method. The video's five dramatized sequences show employees learning how to plan an write messages that get action. Special features include:

- clear, easy-to-remember guidelines for organizing letters, reports, and proposals
- real-life people engaged in relevant events and activities
- dramatized scenarios combined with instructional sequences to create an entertaining but realistic atmosphere
- contemporary computer graphics
- demonstrations of how letter and report parts are integrated to form coherent, cohesive documents

6 Around the Table: Taking Part in Office Meetings helps you contribute more effectively to the meetings you and your staff attend. By the end of this 23-minute video meeting, you will know how to:

- prepare information for presentation
- highlight main points
- capture and hold participants' attention
- use visual aids to enhance a presentation
- deal with interruptions
- ask and respond to questions

So, You have to Give a Talk? Shows how even the most inexperienced speaker can make an effective presentation and overcome the anxiety that many people feel over public speaking. Viewers will see how successful speakers:

- identify their audience
- plan a talk
- prepare speaking notes
- design slides and transparencies
- come to terms with nervousness
- practice the presentation
- make a pre-platform check
- stand up and speak

Sell Yourself Well: Job Interview Techniques That Work! Show how thorough preparation paves the way to a successful job interview. Short, dramatized sequences will show how to:

- prepare for an interview
- create a strong initial impression
- use body language to good effect
- dress correctly yet comfortably
- answer questions in sufficient depth
- cope with awkward questions
- ask questions
- ask for a specific wage or salary
- do a post-interview follow-up

These videos include guidelines for a seminar leader and a handbook highlighting key points of the programs.

The video (NTSC Product Number HV6942; PAL Product Number HV6943) is available to IEEE members for only **$99.00** and to nonmembers for **$124.00**. The charge for shipping and handling is $15.00. The package may be ordered from the IEEE, 445 Hoes Lane, PO Box 1331, Piscataway, New Jersey 08855-1331. Make checks payable to IEEE. For single sales call (800) 678-IEEE; for company or institutional sales, call (800) 701-IEEE; or fax (908) 981-9667.

Call for overseas Air Freight charges. Credit card orders (Master Card, Visa, American Express, and Diner's Club) are accepted.

Does JLS Really Help Members Find Jobs?

Can you believe it? We are approaching our second anniversary of the Job Listing System (has it only been two years?).

In this article, we will review our progress to-date and try to answer the question posed in the title. Please, help us to pass the word along to members and the employers of electrical, electronics and computer engineers.

Two years of JLS

Since it's introduction in August 1994, the JLS has experienced exponential growth. We posted our 1000th job in July 1995 and our 2000th job only 6 months later.

And, since the JLS went up on the Web in March 1995, we have averaged almost 10,000 "hits" each month, making it the most frequently visited IEEE Web site.

So, we know the jobs are posted and IEEE members are looking at them — but are any of our members actually landing these jobs?

We don't know ... exactly. We have a statement at the beginning of each job file asking members to let us know if they get one of the jobs - but no one does. We do know that one of our Committee members got a JLS posted job.

So, earlier this year, we approached the problem from the other end and began sending survey questionnaires out to employers posting on JLS. This was marginally successful. Because the questionnaires went out with the invoices for the ads, we were getting only preliminary data. However, disappointing in some areas, the results, in many ways, have been encouraging. The employers' responses can be summarized as follows:

- The quantity of resumes received was smaller than expected
- Overall, the quality of responses was good
- The price is very attractive
- Despite the low number of responses, more than 50% of companies have or expect to interview one or more respondents
- And, overwhelmingly, companies say they will use the system again and will recommend the service to others

One company summed it up:

"Overall, I have been pleased with the response we have had to our listing. The quantity of responses has not been huge, but the quality of respondents has been good. Unlike a print ad, responses were slow to start but picked up after the first week. Your questionnaire arrived at my office much too early, hence my initial review was not good."

Another commented:

"Next to the free listings, we got the most bang for the buck from your service. Yours also gave us better quality. I must admit that the free services bring in resumes from desperate people shooting at anything. I expect that your service will only get better in time as more people from both sides use it."

Another company, in response to the question, "Were any respondents interviewed as a result of the ad?" not only checked "yes" but added the comment "and hired!"

And, finally, one recruiter said:

"I received about a dozen responses to the three placements we ran during October. I consider this an excellent response since they are all highly-qualified people with extensive education and experience."

And, another recruiter,

"I am extremely impressed with your service. Every listing has produced excellent results: fast response and top-quality applicants. Recently, I filled an extremely difficult position through the Job Listing Service, yielding better than a 5000% return on my investment."

So, in answer to the question: "Are members getting jobs through the JLS?" — YES! Some are definitely getting jobs, but how many — we don't know, and probably never will.

But, to keep building on our successes, we need your help to get the word out to members. Please, continue to encourage all of your job seeking members to check out the JLS. And,

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notify the companies in your area that the JLS is THE place to find their next engineer.

Here are some tips for both employers and job-seekers to help them take advantage of the JLS.

Employers: How to get the most from your JLS ad

The primary reason why employers use the JLS is the audience. IEEE is the world's largest professional, technical organization and the only one that targets electrical, electronic and computer engineers - more than 300,000 of them. The JLS is, quite simply, THE best place to advertise electronically to this group.

And, priced as it is, the JLS gives the advertising company coverage across the entire nation (indeed the world) for less than $100.00 for thirty days. This service is particularly useful for those companies or recruiters who have not made the investment required to establish an electronic presence. The JLS provides an electronic recruiting capability for a small investment of time and money.

The key to getting good responses from job postings on the JLS is to provide specific, detailed job descriptions.

- Quote specific minimums for requirements such as experience. There is probably no way to eliminate student responses to a posting, but tailoring descriptions to actual requirements will tend to discourage of them.
- Set realistic salary ranges. Experienced engineers will tend to avoid jobs with wide salary ranges, not wanting to be caught at the bottom of that range.
- If citizenship is a requirement or a security clearance will be necessary, include a statement in the posting. The Internet is borderless. A company can expect to receive responses from anywhere in the world.

Unlike a print ad in a newspaper or periodical, where a company will frequently give general job descriptions in a effort to retain flexibility, a JLS description needs to be specific. Our experience show that usually when a company complains that they are not receiving inquiries from the types of engineers they want it's because the description is not realistic. Keep in mind that the people using an online service to search for jobs electronically are looking more seriously than those just glancing at a newspaper or magazine.

The JLS is a great tool for finding a computer literate engineer. However, in all honesty, it is not so good for finding a busy executive manager. These people do not tend to "surf the 'Net" — they have assistants to do that for them. Employers should not expect to find their top executives by advertising electronically.

We provide the JLS as a service to our members. However, we also recognize that the more employers post openings on our system, the better we can serve those members. For this reason, we are committed to meeting the needs of the employers as well.

Members: How to take advantage of JLS

For the member, the JLS provides, free of charge, hundreds of detailed descriptions for actual job openings. All they have to do is access the Internet.

And, it pays to start 'surfing the 'Net.' Our survey of unemployed members last year showed that those with Internet access experienced 19 fewer weeks of unemployment than those without.

Using the listings in the JLS, members can take control of their job search. Rather than sending out dozens of resumes or posting with a referral service then waiting for the phone to ring, the JLS job-seeker takes the initiative and contacts the advertising company directly.

To get the most from the JLS, members should:

- Download the files to a personal computer. The job files are very large. Members, particularly those using a commercial online service such as America OnLine or CompuServe to access the listings, should first download the files to a simple word processing program. Then, off-line, they can perform key-word searches or browse the job postings at their leisure.
- Respond quickly to postings. Companies advertising electronically expect quick responses. Use fax or email when possible.
- On the other hand, do not ignore jobs that have been posted for more than a month. On the JLS, any posting remaining on the system more than 30 days is there at the request of the hiring company - they are still looking.
- Tailor the response to the job. The detailed descriptions in the JLS provide the perfect opportunity for the job-seeker to give the company exactly what it is searching for.
- Highlight IEEE membership and the fact that you are responding to a JLS posting. The employer or recruiter advertising on the JLS is doing so because he specifically wants IEEE members and their skill sets.

For additional information, contact Bill Anderson and check out the IEEE-USA Web page at http://www.ieee.org/usab.

IEEE-USA Salary Information On Web

Selected data from the *1995 IEEE-USA Salary and Fringe Benefits Survey* is now available on the IEEE-USA Web site at http://www.ieee.org/usab under the "Career and Member Services" section. At this location you will find charts for:

- Income by years of experience
- Income by highest degree earned
- Income by age
- Income vs. job function
- Income vs. level of responsibility
- Income vs. years with present employer
- Income vs. ethnic background
- Income by Primary Area of Technical Competence
- Income by IEEE-US Region
- Comparison of IEEE salary data vs. Engr. Workforce Commission data.

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As part of the Oceans '97 MTS/IEEE focus on advanced technology, the Conference Committee solicits proposals for tutorials that vary in length from half a day to one and a half days, in technology areas related to those highlighted in the Call For Papers. Interested individuals must submit a 500 word abstract on tutorial utility, focus and intended audience, a 200 word biography of the instructor, an outline of material to be presented and any supporting material useful for evaluation of tutorial merit and content. Instructors will be compensated in accordance with tutorials registration. Tutorial proposals must be received before 15 January 1997 to be considered for acceptance. Tutorials will be presented on Sunday and Monday 5&6 October 1997. Submit tutorial proposals or requests for further information on related issues (e-mail is preferred) to:

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Student papers will be highlighted in a special poster session in a prominent location. This will ensure them maximum exposure to their future colleagues. Students should use the same abstract form as for other papers, but submit them (e-mail is preferred) to:

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Signal & Information Processing

Communication & Control, Navigation, Mapping & Charting

Vehicles & Platforms, Advanced Technology

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Theme Related Topics:
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Prospective authors should submit a single page with title and abstract (300 to 500 words) in these or related subject areas. The single page Abstract Submittal Form must be completed in full. In the abstract, authors should describe the problem that is addressed, indicate its importance and describe how this work contributes to the field. Authors must indicate a primary subject category (from the topics above). Talks will be 20 minutes in length. The Oceans '97 MTS/IEEE Technical Committee will select papers for presentation and organize the final program following receipt of abstracts. Abstracts become the property of Oceans '97 MTS/IEEE. Six copies of abstracts and supporting information should be mailed or one copy e-mailed to the address below. E-mail is preferred, and abstracts received by e-mail will be published on the web.

To ensure authors are in attendance at the conference to present their papers, a non-refundable deposit of $75 u.s. is required with submission of abstracts. The balance of the registration fee (less discount for pre-registration) is required with the camera-ready paper. If the abstract is being sent by e-mail, the deposit should be sent by post with a note identifying the author and title of the paper.

The Schedule for Authors is:

Abstracts and Deposits
Deadline - 15 January 1997

Notification of Acceptance to Authors
14 March 1997

Camera-ready Paper (6 pages max.) and Balance of Fee
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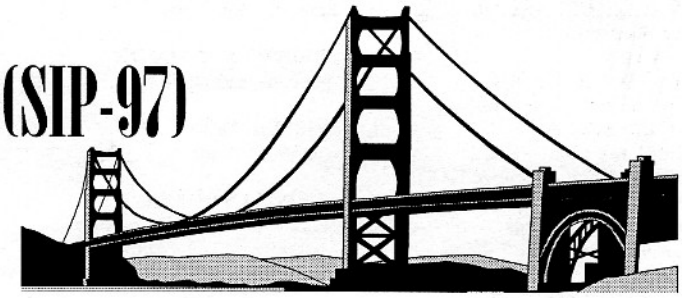

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SCOPE

Topics may include, but are not limited to, the following:

Image Processing

- ★ **Image coding and compression**
- ★ **Filtering, enhancement and restoration**
- ★ **Segmentation and representation**
- ★ **Multiresolution and multispectral processing**
- ★ **Motion detection and estimation**
- ★ **Image sequence processing**
- ★ **Computed imaging**
- ★ **Acoustic and radar imaging**
- ★ **Tomography, holography and MRI**
- ★ **Geophysical and seismic imaging**
- ★ **Quantization, halftoning and color reproduction**
- ★ **Image display and printing**
- ★ **Image quantity and visualization**
- ★ **Neural networks and fuzzy logic in image processing**
- ★ **Video technology, multimedia, HDTV and video communications**
- ★ **Vision**
- ★ **Applications of image processing to all fields including geoscience, medical, astronomy, ocean engineering, manufacturing and environmental science**
- ★ **Others**

Signal Processing

- ★ **Detection and estimation of signal parameters**
- ★ **Filter design and structures**
- ★ **Fast algorithms**
- ★ **Time-frequency signal analysis**
- ★ **Multiple filtering and filter banks**
- ★ **Signal reconstruction**
- ★ **Adaptive filters**
- ★ **Nonlinear signals and systems**
- ★ **DSP applications including communications, medical, radar and others**
- ★ **Spectral analysis**
- ★ **Higher-order statistical analysis**
- ★ **Speech processing**
- ★ **Neural networks for signal processing**
- ★ **Fuzzy logic**
- ★ **Wavelets**
- ★ **Multidimensional signal processing**
- ★ **Others**

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Authors are invited to submit five copies of their paper proposal. The proposal should be limited to 2-3 pages (including figures) and should include the title, technical area(s), contact author, address, telephone number, fax number and electronic mail address, and should be submitted by **March 3, 1997** to: **Professor Nader M. Namazi-Attn: SIP-97, Department of Electrical Engineering, The Catholic University of America, Washington, DC 20064 USA.**

Anyone interested in organizing a special session should submit a proposal by **March 3, 1997**, including the topic and a brief justification and description of the scope of the session.

In addition, proposals are invited for a special session on undergraduate research and design including innovative laboratory development, etc.

To be placed on the mailing list, contact the IASTED Secretariat, 1811 W. Katella Avenue #101, Anaheim, California 92804, USA. Tel: 1-800-995-2161 or 714-778-5463, email: iasted@orion.oac.uci.edu URL: http://iasted.deltanet.com/

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Notification of Acceptance	May 15, 1997
Preregistration and final manuscripts	July 15, 1997

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