IEEE

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NEWSLETTER

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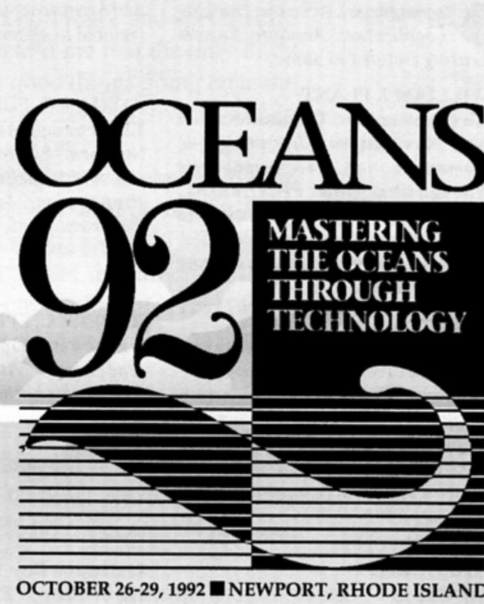

OCTOBER 26-29, 1992 ■ NEWPORT, RHODE ISLAND

CALL FOR PAPERS

CALL FOR TUTORIALS

IEEE OCEANIC ENGINEERING SOCIETY

(Continued on inside back cover)

IEEE Oceanic Engineering Society Newsletter is published quarterly by the Oceanic Engineering Society of the Institute of Electrical and Electronics Engineers, Inc. Headquarters: 345 East 47th Street, NY 10017. $1.00 per member per year (included in Society fee) for each member of the Oceanic Engineering Society. Printed in U.S.A. Second-class postage paid at New York, NY and at additional mailing offices. Postmaster: Send address changes to IEEE OCEANIC ENGINEERING SOCIETY NEWSLETTER, IEEE, 445 Hoes Lane, Piscataway, NJ 08854

President's Message

Glen N. Williams

Howdy from Texas again! This will be a short note concerning some happenings within the OES.

I just returned from three weeks of IEEE related travel which included Newport, Rhode Island (Oceans '92); Honolulu, Hawaii (Oceans '91); and Cancun, Mexico (IEEE Technical Activities Board). It was good to see many of you at Oceans '91. There were about 700 attendees to hear over 350 technical presentations in 80 sessions. There were also 30 exhibitors from several countries and their support and presence are much appreciated by the IEEE OES. I have heard only positive comments about the conference and specifically the technical quality and, in fact, Dana Yoerger of Woods Hole told me that the only thing wrong with the technical program was that there were too many good things going on at the same time. The next issue of the Newsletter will highlight the conference activities but, in summary, Oceans '91 was the place to have been on October 1-3, 1991.

The Oceans '92 committee meeting which I attended in Newport was chaired by the Oceans '92 Executive Chairman Dr. Stan Chamberlain of Raytheon. Based on reports from finance, local arrangements, exhibits and other subcommittee chairs, Oceans '92 is in good hands and well on its way to success. The Technical Program, under the direction of Dr. Tom Mottl of TASC promises to be truly outstanding, as Tom is instituting new review and presentations procedures towards increasing the quality of the Technical Program in the Oceans Conferences.

The Cancun TAB was generally administrative in nature and I will keep you informed of any TAB actions which effect the OES membership.

For your future reference, Oceans '93 planning and coordination in Victoria, British Columbia is well underway under the leadership of Dr. Jim Collins. At its Oceans '91 meeting, the OES Adcom also approved a preliminary proposal to hold Oceans '94 in Brest, France. More on those two conferences later.

The survey which was sent to the OES membership concerning possible joint sponsorship of future Oceans Conferences with the Marine Technology Society achieved a 20 percent return. The message was clear — Reinitiate the MTS relationship. Therefore, the OES Excom has been tasked with this assignment. Please be assured that any future agreement between the two Societies will be based on mutual understanding and trust, and will be beneficial to both organizations. We will keep you informed of any developments in this arena.

As always the OES is "looking for a few good men or women." If you and/or your colleagues wish to volunteer and take part in OES activities, please let me know.

Glen N. Williams
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Glen N. Williams
President, Oceanic Engineering Society

OCEANS 92

MASTERING THE OCEANS THROUGH TECHNOLOGY

OCTOBER 26-29, 1992 ■ NEWPORT, RHODE ISLAND

A Call for Participation by OES Members

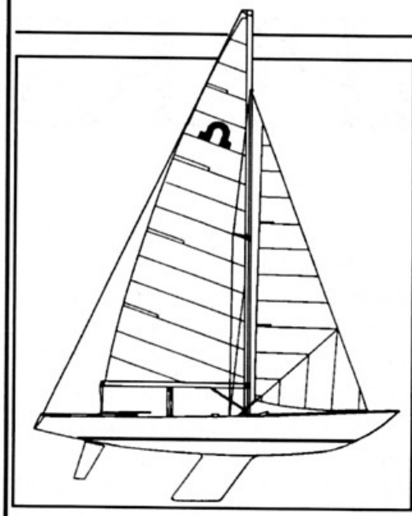
The annual OCEANS Conference is the Flagship Conference of the IEEE Oceanic Engineering Society. As such, it has established a long standing reputation for technical excellence and as an outstanding forum for the exchange of ideas among oceanic engineers and scientists.

However, only a small percentage of IEEE Oceanic Engineering Society members attend the Conference each year. In 1992, a special effort is going towards attracting OES members to the OCEANS 92 Conferences, which will be held on October 26-29, 1992. The Conference Committee is taking advantage of this being a year in which the Conference is sponsored by only one national society, the IEEE OES, to provide the following attractions.

- The technical program will be focused towards the technical interests of OES members, especially as expressed in the specialty areas addressed by the OES Technical Committees. The OCEANS 92 Technical Program Committee is comprised of the Chairpersons of the OES Technical Committees, plus a Chairperson and Vice-Chairperson.
- While previous OCEANS Conferences have had high technical quality, we are seeking to raise the quality level even higher in OCEANS 92. This will be done in part by requesting more information from the authors to allow the best possible grouping of papers into appropriate sessions, by performing a higher level of abstract screening and by requiring all papers presented to be published in the Conference Proceedings.
- The Conference is also being held in the very attractive environment of Newport, Rhode Island.
- As an additional incentive to attend, all IEEE members (including current OES members) who attend OCEANS 92 will receive free membership in OES for 1993.
- For those with appropriate interests, the *1992 OCEANS Classified Conference*, sponsored by the U.S. Navy, will be held on the day following the OCEANS 92 Conference.

Why not plan now to attend and participate in the stimulating exchange of ideas that will occur during the OCEANS 92 Conference. For the technical areas to be addressed, see the Call For Papers that appears elsewhere in this newsletter.

Stanley G. Chamberlain
OCEANS 92 Executive Chairman



The Oceanic Engineering Society of the IEEE
and
The New England Chapter of OES / IEEE
The Providence Section of the IEEE
The New England Section of the Marine Technology Society

Present the

OCEANS 92 Conference

OCTOBER 26 THRU 29, 1992 IN NEWPORT, RHODE ISLAND

Advanced Technology Focus ■ High Quality Papers ■ Key Technology Tutorials ■ Technical Exhibits ■ Autumn in Newport

CALL FOR TUTORIALS

As part of the OCEANS 92 focus on advanced technology, the Conference Committee solicits proposals for half day (4 hour) or full day (8 hour) tutorials in technology areas related to those highlighted in this 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 materials useful for evaluation of tutorial merit and content. Instructors will be compensated in accordance with tutorial registration. Tutorial proposals must be received before **February 1, 1992** in order to be considered for acceptance. Tutorials will be presented on Monday, October 26, 1992. Submit tutorial proposals or requests for further information on related issues to:

OCEANS 92 Tutorials
Suite #300
655 Fifteenth Street, N.W.
Washington, D.C. 20005
(202) 347-5900
Attn: Suzanne Kuntz

OCEANS 92 CALL FOR PAPERS

MASTERING THE OCEANS THROUGH TECHNOLOGY

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Consultant
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Executive Secretary
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Woods Hole Oceanographic Institution
(508) 457-2000 x2990

OCEANS 92

OCTOBER 26-29, 1992 ■ NEWPORT, RHODE ISLAND

The IEEE Oceanic Engineering Society and sponsoring local chapters of MTS, OES/IEEE and IEEE solicit prospective authors for papers dealing with new technology concepts, developments and applications which provide a basis for advances in science and engineering in the ocean environment. The theme for OCEANS 92, *Mastering the Oceans through Technology,* places heavy emphasis on high technology content and high quality in the technical program. Proposed technical sessions at OCEANS 92 will be focused on the following areas:

Computing and Information Management
- Modeling, Simulation and Databases
- Knowledge-based Systems and Neural Networks
- Geographic Information Systems

Sensing and Processing Technologies
- Satellite Remote Sensing
- Underwater Acoustics
- Nonacoustics

Communications and Navigation
- Autonomous Vehicles
- Manned Platforms
- Acoustic Telemetry

Instrumentation and Measurements
- Laboratory and Analytical Techniques
- In situ Techniques
- Climate Monitoring
- Severe Environments

Technology Advances
- Underwater Robotics
- Data Compression and Storage
- Power Sources
- Vehicles
- Materials

Prospective authors should submit paper titles and 500 word extended abstracts for consideration in the above or related subject areas (diagrams may be included as additional materials). A cover sheet should be attached showing paper title, author(s) name(s), affiliation, address and telephone number (in the case of coauthored papers, the principal author or designated author should be named as single point of contact), and answers to the following questions:

- Describe the problem that you have addressed.
- Why is the problem important?
- How does this work contribute to the field.
- Are the author(s) of this paper also authors or coauthors on other papers? Which papers?
- Into which of the listed categories does the paper fit? (List the order of preference).
- If you have a definite preference for a particular technical session, please indicate. (Requests for specific sessions will be considered but placement cannot be guaranteed).

The schedule for authors is

- Abstracts deadline—**February 1, 1992**
- Notification of acceptance to authors—April 1, 1992
- Camera-ready paper (6 pages max) deadline—June 15, 1992
- OCEANS 92 Conference (October 26-29, 1992)—20 minute presentation

The OCEANS 92 Technical Committee will select papers for presentation and organize the final program following receipt of abstracts. Ten copies of abstracts and supporting information should be mailed to:

OCEANS 92
Suite #300
655 Fifteenth Street, N.W.
Washington, D.C. 20005
(202) 347-5900
Attn: Suzanne Kuntz

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS
OCEANIC ENGINEERING SOCIETY

AUV 92

CALL FOR PAPERS

SYMPOSIUM ON AUTONOMOUS UNDERWATER VEHICLE TECHNOLOGY
June 2 and 3, 1992

The IEEE Oceanic Engineering Society is sponsoring a symposium on Autonomous Underwater Vehicle Technology, to be held in the Washington, D.C. metropolitan area at the Dulles Airport Marriott Hotel on June 2 and 3, 1992. The objective of the symposium is to disseminate knowledge of recent technological advances and to identify technological shortfalls.

TECHNOLOGIES

The Symposium will focus on technologies that are related to the AUTONOMOUS OPERATION OF UNDERWATER VEHICLES, such as:

- Mission planning, control and management
- Sensors and signal processing
- Simulation
- Energy systems
- Launch and recovery systems
- Communication and telemetry
- Navigation
- Reliability
- Vehicle design

ABSTRACTS

Abstracts should be limited to 300 words and must include the title of the paper and be accompanied by full names of the author(s), with affiliations(s), complete address(es), telephone number(s), and telecopier number(s) if any. Relevance to the topic of autonomous underwater vehicles must be made clear in the abstract.

DEADLINES

The proceedings will be distributed at the symposium. Material must be received by the following dates in order to make advance printing possible. Papers that miss these deadlines will be dropped from the program.

1 October 1991:	300 word abstract due — mail to Gordon Raisbeck, 40 Deering Street, Portland, Maine 04101-2212
15 November 1991:	Corresponding author will receive notice of acceptance or rejection
1 March 1992:	Original manuscript due in photo-reproducible form

CONFERENCE STEERING COMMITTEE

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Technical Program Chairperson:	Dan Steiger, Naval Research Laboratory
Executive Secretary:	Gordon Raisbeck

INFORMATION

For further information, call:

Gordon Raisbeck, (207)773-6243
Dan Steiger, (202)767-3265

H. Troy Nagle
1990 IEEE Vice President for Technical Activities

A New TAB Structure

The year 1990 has seen a number of changes in the Technical Activities Board (TAB) and the Technical Activities Department (TAD). First was a new structure for TAB volunteers that places greater responsibility upon Society Presidents and increases their involvement in the decision making processes of TAB. In the new structure, five Society Presidents are now members of the TAB Administration Council. All thirty seven Technical Society/Council Presidents actively participate in setting the goals and operating plans for TAB. They also participate in a Society Presidents' Forum/Workshop at each TAB meeting in which they select topics of interest, organize working groups, and establish action plans to accomplish their goals. The new procedures and organizational structure have created a synergistic, constructive atmosphere during the TAB meetings.

The new TAB structure has two new volunteer administrative units, the TAB Publications Products Council and the TAB Liaison Council. The Publications Products Council is an outgrowth of the very successful Book Broker program, which sells Conference Proceedings to libraries and individual IEEE members. The Council is exploring new product opportunities and services for our members, such as repackaging conference proceedings into "theme" volumes and the electronic delivery of publications to libraries and IEEE members through electronic media, such as CD-ROM. The Liaison Council is a policy coordinating body for TAB. It has catalogued all the relationships between IEEE Technical Societies and non-IEEE entities around the world.

Increased Emphasis on Long Range Planning

Another new feature of TAB this year is its Strategic Planning and Review Committee (SPARC). This Committee is composed of three past Society Presidents and three past Division Directors. It elects its own Chairperson and thereby remains very independent from the rest of the TAB volunteer structure. SPARC recommends a set of approximately 20 operating goals for TAB in any given year. TAB modifies this plan and sets milestones for its various Councils and Committees. SPARC then serves an independent evaluation role by giving TAB a performance rating at the end of the year. Another important role for SPARC is the review and evaluation of the vitality of our Technical Societies.

1990 Operating Goals

Fernando Aldana
1991 IEEE Vice President for Technical Activities

In 1990, TAB completed 17 of its 20 operating goals, with the remaining three being carried over into 1991. Some major accomplishments were the conversion of all magazines and some Transactions to electronic publishing, the development of a new conference registration software package for use by IEEE entities, and the expansion of the Computer Society office in Brussels to include TAB staff. Some ongoing major projects in TAB are a series of training videotapes describing IEEE operations for Society volunteers and paper tracking software packages for conference and journal editorial committees.

Relocation of TAD to Piscataway

Another significant change in 1990 has been the relocation of TAD from New York City to Piscataway, NJ. The move has been accomplished with only minor disruptions in service. Every TAD staff member now has a new PC and his or her own private, electronic mailbox reachable from most of the networks in use around the world. You may address most TAB volunteers and members of the TAD staff by his or her first initial, a period, his or her last name, followed by @ieee.org (eg., t.nagle@ieee.org and f.aldana@ieee.org).

International Activities

In September, 1990, TAB conducted a Colloquium in South America. The Colloquium was organized as a technical meeting, university/industry visits, Section/Chapter round table discussions, and a Chapter Chairs workshop. Fourteen Technical Societies and five Sections participated in this very successful meeting.

Plans for 1991

New goals for 1991 include the development of applications-oriented periodicals for IEEE members, a centralized conference management service for Society conferences, electronic paper submission procedures for journal and conference authors, electronic database access for Society member and financial records, and a local speakers database for Sections and Chapters.

Concluding Remarks

The year 1990 was a banner year for TAB. The new TAB structure is proving to be very effective in helping the Societies develop new and exciting technical initiatives for improving services for IEEE members. The 1990s will be a truly exciting decade for TAB and IEEE.

(Reprinted from Oceans '90 Proceedings)

ACOUSTIC TRANSIENT DATA ACQUISITION AND PROCESSING OF A PC SYSTEM

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Erhard Dettmann, Visiting Scientist
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Abstract

The use of a PC-based system in the acquisition, analysis, and modeling of multichannel transient data will be discussed. Emphasis will be centered on the system's ability to perform real time digital recording of transient signals and almost real time processing such as matched filtering, spectral analysis, and deconvolution. Almost real time measurements of ocean impulse response functions (IRF) will be shown.

I. Introduction

This work discusses the use of an MS-DOS compatible Personal Computer (PC) system in the acquisition and processing of acoustic transient data. This system is built around a Compac 386/25 machine with a MetraByte DAS-20 A/D board (or an Analog Devices RTI-860 A/D board in later versions) with software written in Fortran, C, Pascal, and assembler programming languages. The data collected and analyzed in this paper was gathered on an engineering test of the system during March 1989 in the Atlantic Ocean. The location of this test is shown in Figure 1.

II. Data Acquisition

The signals for the recorded data were produced by an HLF-2AH acoustic source which cycled through a variety of FM signals. The experimental geometry is shown in Figure 2. The array consists of a 16-element Versatile Experimental Kevlar Array (VEKA) deployed in approximately 915 m of water.

Data capture on the PC is configured using a menu driven system which solicits the required parameters. These values include the recording time duration, the output file name, the output storage device, and the selection of dynamic range.

The processing and acquisition electronics, located on the source ship, are shown in Figure 2. At the start of each signal, a trigger is sent to the A/D board to start the A/D recording of the data. The data is sampled from the filter bank at a 500 Hz rate. The digitized data is written to a single file in multiplexed format and used later for data analysis. While the data is being gathered, the operator may display any two of the array channels on the PC screen. This allows for a real time check of the experimental operation. After the data is digitized, it is written to a 600 Mb read/write optical disk cartridge. Approximately 260 Mb of data were digitized during the engineering test.

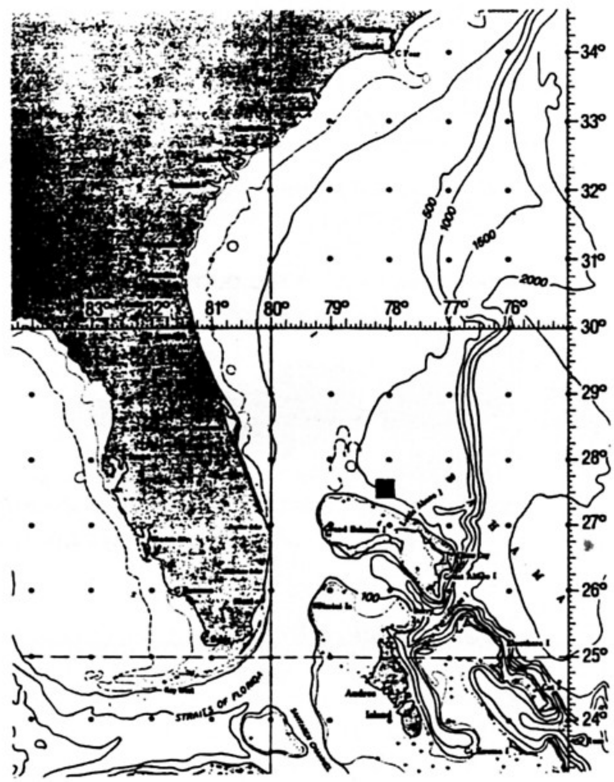

Figure 1. Experimental site.

In addition to the binary/integer data contained in each datafile, the files also contain a header which stores experimental parameters such as date, time of recording, sampling frequency, number of samples in each channel, and the dynamic range setting of the board.

III. Data Processing

Once data has been recorded in the multiplexed format, it is possible to analyze the data in the field using the same PC system. The functions supported for analysis are browsing, scaling and compression, windowing, truncation, filtering, setting of the FFT size, correlation, power spectrum, smoothing, deconvolution, lotting, and storage of results.

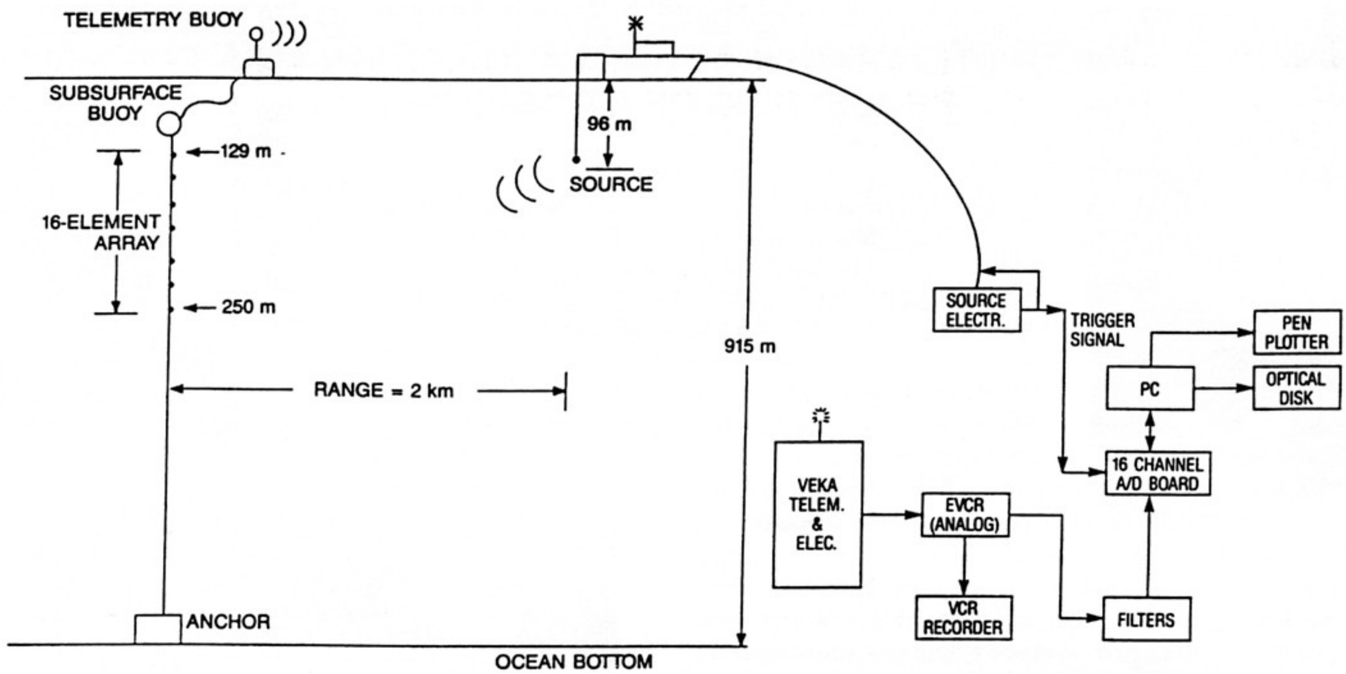

Figure 2. Experimental geometry and setup.

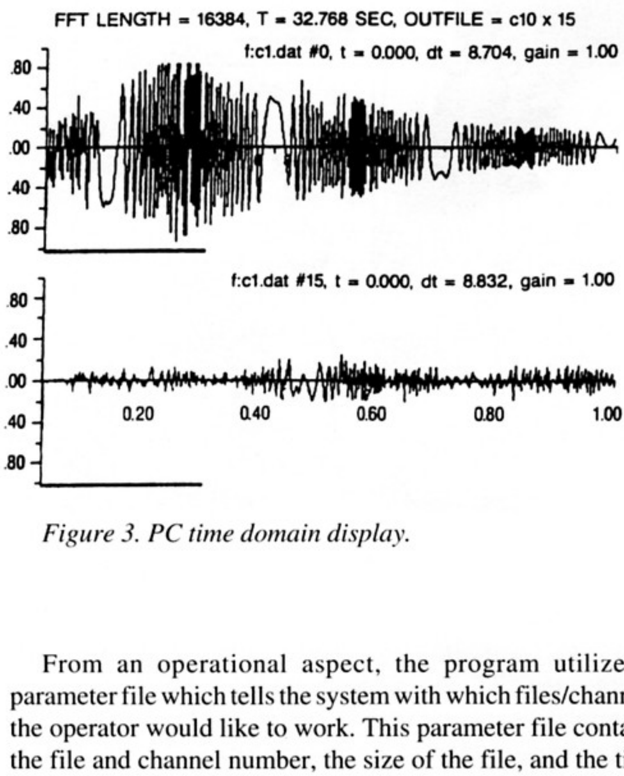

Figure 3. PC time domain display.

From an operational aspect, the program utilizes a parameter file which tells the system with which files/channels the operator would like to work. This parameter file contains the file and channel number, the size of the file, and the time where to start previewing the data which is displayed on the screen.

When the program is executed, the two channels in the parameter file will be displayed on the screen. An example of this is shown in Figure 3. This screen shows the relevant processing information with channel #0 shown in the top part of the screen and channel #15 shown in the bottom part. The horizontal scale is a decimal delineation of the horizontal axis with the time at the left of the window displayed at the top of each plot, here t = 0.000 seconds for each plot. The time, dt, at the top of each plot represents the amount of time spanned by the solid line at the bottom of the plots, dt is 8.704 and 8.832 seconds for the top and bottom plots, respectively. The verticle scale represents the fractional part of the full gain. For a gain = 1.00, a full vertical scale reading of 1.0 represents +5V.

IV. Examples

The following example from the experiment demonstrates the system's real time use for a transient source extraction problem. The source ship is at a range of 2.0 km from the hydrophone array. The HLF-2AH source begins transmitting identical FM signals while the source ship tries to maintain station at the 2.0 km range. The source waveform is recorded from a monitor hydrophone along with the 16 VEKA channels telemetered back to the source ship. The source waveform is cross-correlated with the received VEKA data. The result of this correlation is a band-limited IRF, which can be used to extract the source autocorrelation.

This example shows the use of the PC system to determine the range changes on extracting the source autocorrelation. Figure 3 displays the time domain signals for channels #0 and #15. Channel #0 is the output of the source monitor hydrophone (i.e., the transmitted signal). Channel #15 is the output of the deepest VEKA hydrophone (250 m). The corresponding Power Spectra for channels #0 and #15 are displayed in Figures 4a and 4b respectively. The FFT size is 16384 points.

Figure 5 displays the vertically displaced autocorrelations of chanel #0, for 3 different transmissions while cross correlation results are shown in Figures 6a, 7a, and 8a. The IRFs shown in the figures are from the 3 different transmissions while the source ship tried to maintain station. Figure 5 il-

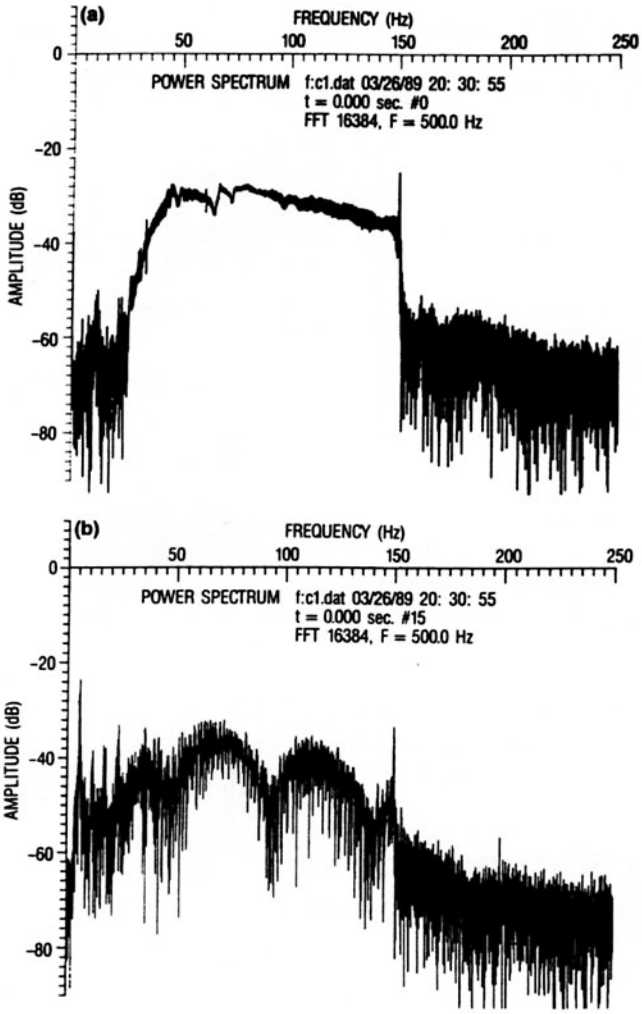

Figure 4. (a) Power spectrum of source signal, and (b) power spectrum of deepest hydrophone signal.

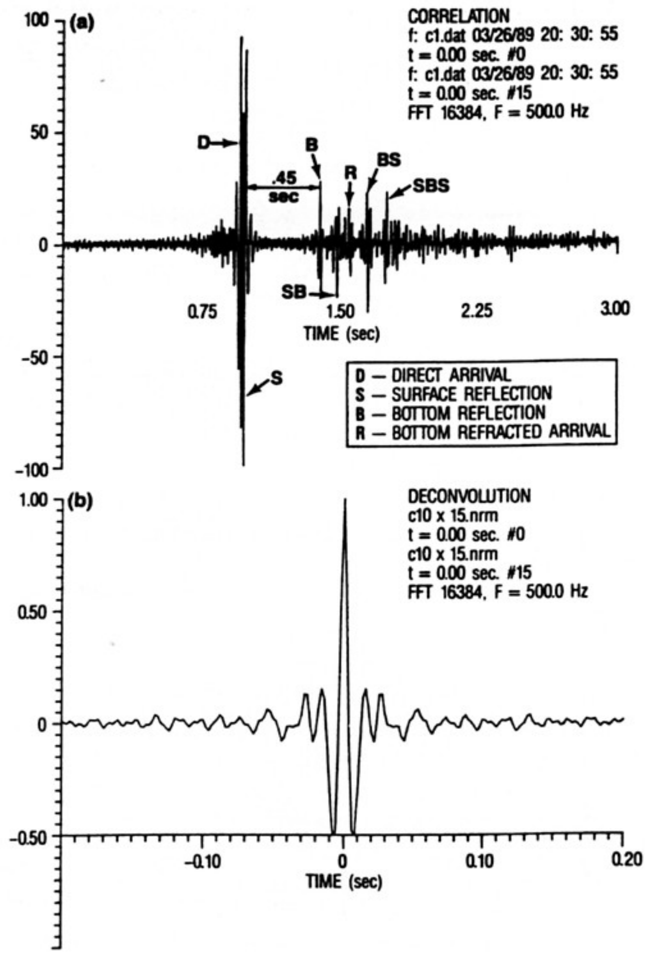

Figure 6. (a) Cross-correlation of source and deepest hydrophone at station C1 (2km), and (b) deconvolution of reference function with itself.

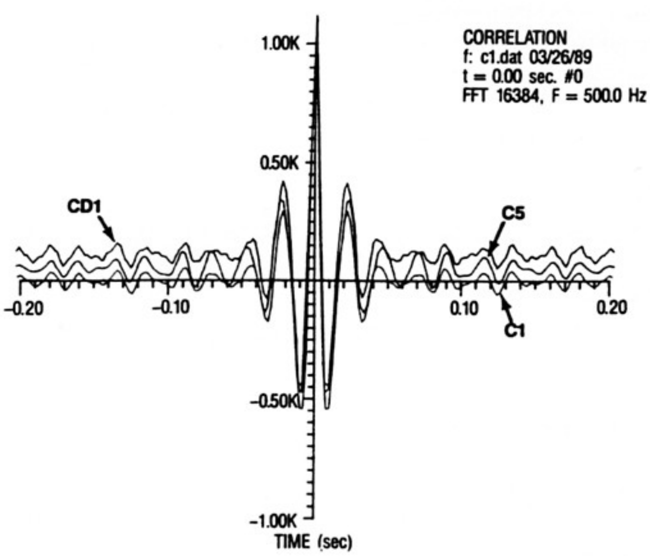

Figure 5. Comparison of source signal autocorrelation function for three different transmissions.

lustrates the ideal waveform which could be extracted from the cross-correlated results. It is against this waveform that the extracted waveform results will be compared. Deconvolved results are shown in Figures 6b, 7b, and 8b. Figure 6b is the reference deconvolution where the IRF shown in Figure 6a is used to deconvolve itself. Figure 7b and 8b are the results from deconvolving the IRFs of Figure 7a and 8a with the IRF of 6a (the reference IRF).

A change in range is found by analyzing the direct-path time arrival of the three supposedly spatially coincident stations (C1, C5, and CD1). Differing arrival times could imply a change in range provided other pertinent geometrical parameters remained unchanged. These parameters are the source depth, the source function, and the receiver location and depth. The source depth was continually monitored and it remained at a constant depth. The autocorrelation of the source functions for C1, C5, and CD1 are shown in Figure 5 and they are very similar. Finally, the receiving array was anchored to the ocean floor. Hence, if there is any significant change in arrival times, it would be attributed to source drift.

Figures 6a, 7a, and 8a show the IRFs for the three stations C1, C5, and CD1 which are supposedly spatially coincident.

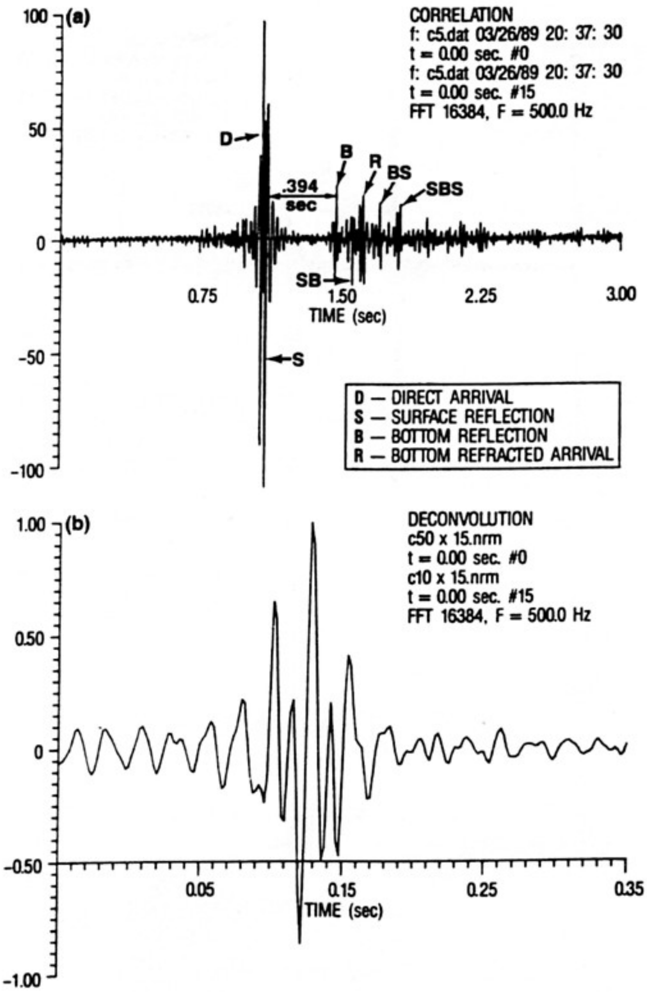

Figure 7. (a) Cross-correlation of source and deepest hydrophone at station C5 (2 km), and (b) deconvolution of station C5 result with reference function.

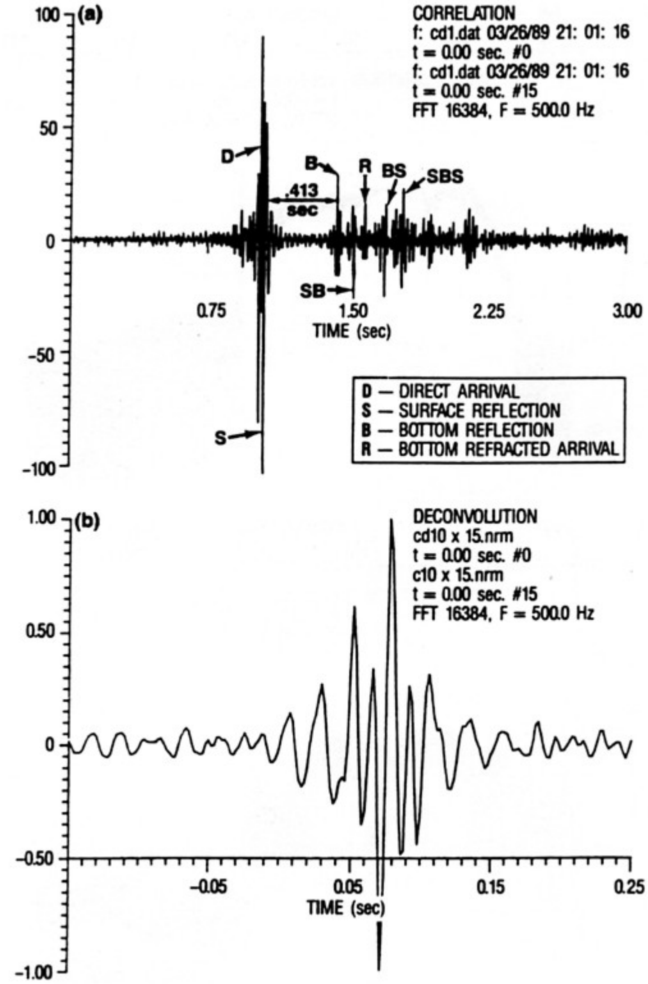

Figure 8. (a) Cross-correlation of source and deepest hydrophone at station CD1 (2km), and (b) deconvolution of station CD1 result with reference function.

However, upon examination of the arrival times of the main peaks, one finds a time difference between C1 and C5 of approximately 0.131 seconds. This corresponds to a drift of about 196 m assuming a 1500 m/s sound velocity. The drift in range is responsible for the degraded deconvolution shown in Figure 7b. At this point the source ship attempted to regain its initial position. A similar calculation for the time difference between stations C1 and CD1 shows a time difference of 0.075 seconds or about 112 m. This indicates that the source has come closer to C1, but not enough to restore the autocorrelation to the reference extraction (see Figure 8b).

The change in range is also indicated by the time difference between the direct arrival and the first bottom-reflected arrival. These differences are annotated on Figures 6a, 7a, and 8a. The closer the source is to the array, the larger this time difference will be. Hence, C1 (closer point to the array) has the largest time difference, followed by CD1, then C5. These times are in agreement with the changing experimental geometry.

The results shown here illustrate the use of the PC system to monitor experimental conditions in real time. Such monitoring allows for on-site corrections to changing experimental conditions. Further analysis of these results should yield more understanding of the physics of this situation, which will be the subject of future work.

References

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Numerical Recipes - The Art of Scientific Computing, Cambridge University Press.

Acknowledgements

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(Reprinted from Oceans '90 Proceedings)

PERFORMANCE OF NEURAL NETWORKS IN CLASSIFYING ENVIRONMENTALLY DISTORTED TRANSIENT SIGNALS

R. L. Field and E. J. Yoerger
Naval Oceanographic and Atmospheric Research Laboratory
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General Dynamics Electronics Division
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Abstract

Neural networks have been showing great promise in several areas[1], one of which is the classification of underwater acoustic transients. The classification of low-frequency underwater acoustic transient signals using a neural network based system is investigated. The received acoustic transients are simulated using a time-domain parabolic equation model. The neural network is trained on three source signals and tested by classifying the same signals at 25 different receiver locations in a noise-free, range-dependent (upslope) environment. Overall classification performance is above 90%.

Synthetic Waveforms and Model Simulations

The synthetic time waveforms which the network is trained on are shown in Figures 1a, b, and c. All signals are linear frequency modulated signals with a center frequency of 50 Hz and identical power spectra (Figure 1d). The signal shown in Figure 1a (class 1) is a 68 to 32 Hz downsweep, Figure 1b (class 2) is a 32 to 68 Hz upsweep and Figure 1c (class 3) is the minimum phase version of the 68 to 32 Hz downsweep.

Environmental distortion of the above signals is simulated in the range-dependent ocean shown in Figure 2 using a time-domain parabolic equation (TDPE) model[2]. The three signals are propagated out to a range of 5 km in 1-km range steps. The signals are received at each range on a 5-element vertical hydrophone array moored to the ocean bottom. The sensor separation is 25 m. The source depth for all three signals is 150 m. This simulation corresponds to the location of a transient experiment conducted about 40 nmi off the Califor-

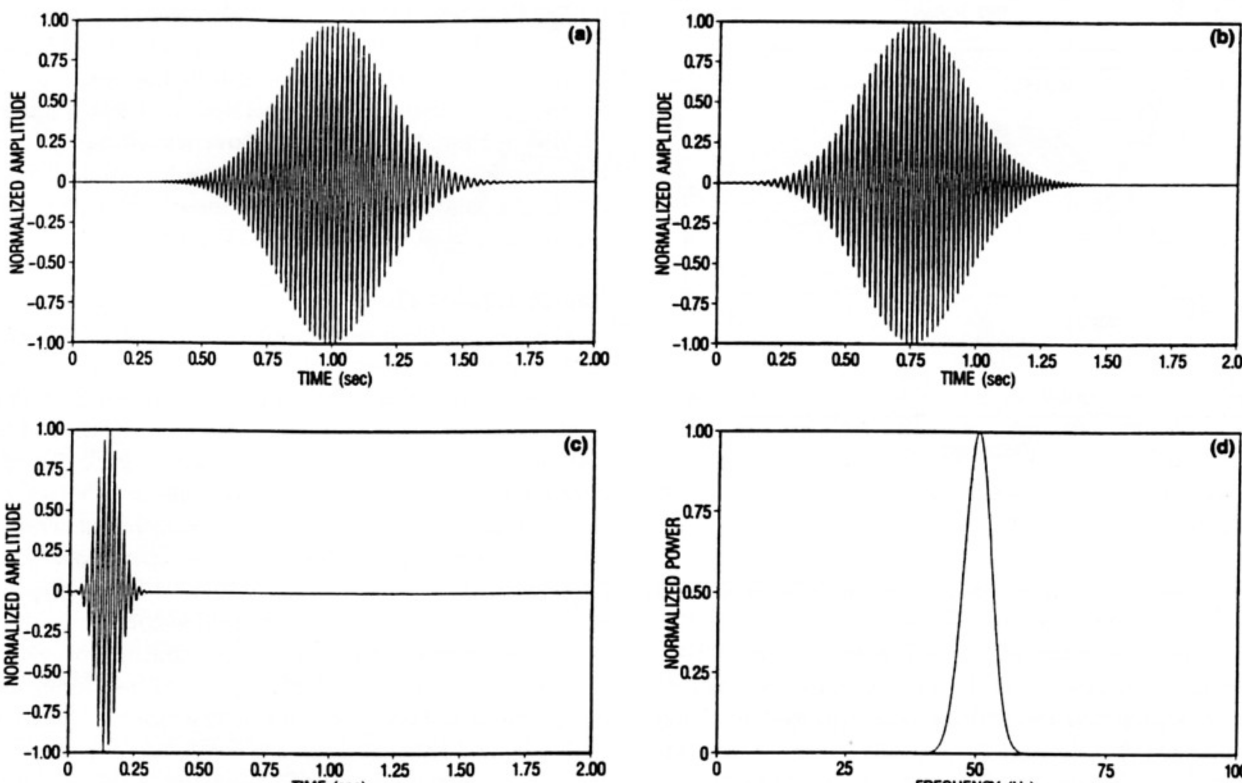

Figure 1. (a) Class 1: Linear FM downsweep 68-32 Hz, normalized time waveform; (b) Class 2: Linear FM upsweep 32-68 Hz, normalized time waveform; (c) Class 3: Minimum phase linear FM downsweep 68-32 Hz, normalized time waveform; and (d) Normalized power spectrum for classes 1, 2, and 3.

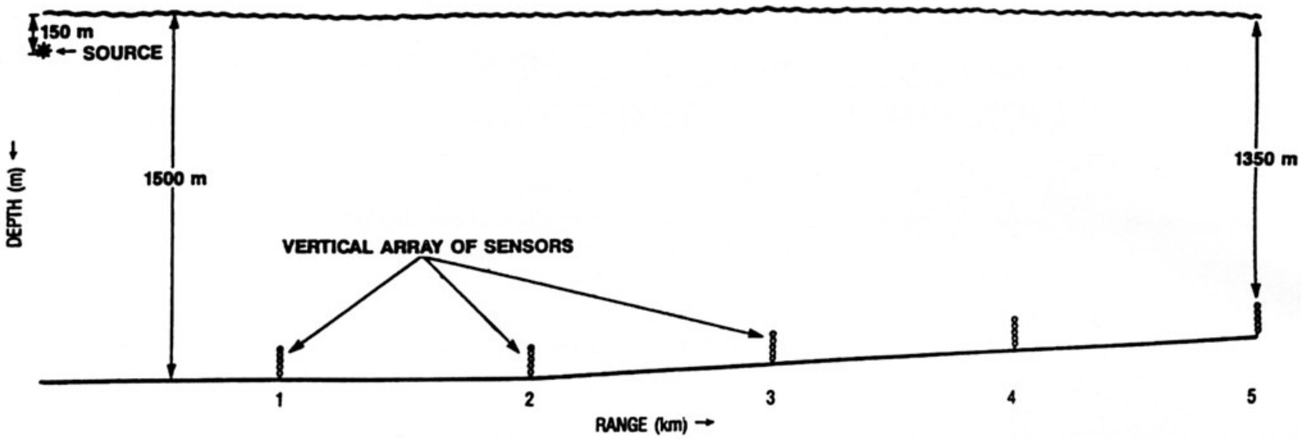

Figure 2. Distributed sensor field and range-dependent ocean environment.

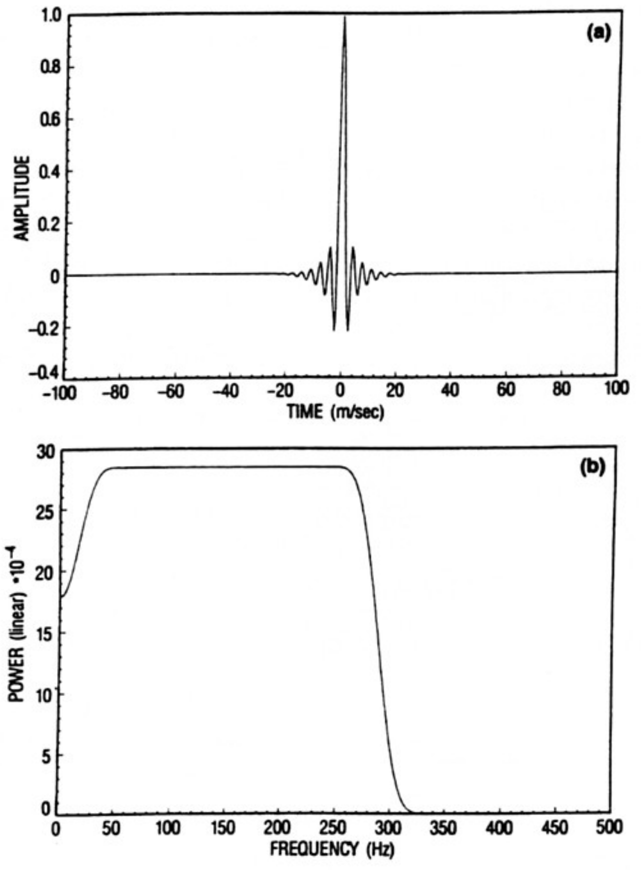

Figure 3. (a) TDPE source pulse, and (b) power spectrum of TDPE source pulse.

nia Coast. Environmental parameters typical of the continental slope in this area are used in the model.

The broadband pulse shown in Figure 3a is the TDPE source pulse. The power spectrum of this pulse is shown in Figure 3b. The received signals are generated by convolving the propagated broadband pulse with the source waveforms shown in Figures 1a, b, and c. Figures 4a, b, c, d, and e display the pressure field of the broadband pulse as a function of depth and relative arrival time at ranges 1 through 5 km, respectively. Figures 4a through 4e show the bottom depth changing as the pulse marches upslope. The boxes drawn on the ocean bottom represent the array aperture at the respective range. The array samples the wavefield in depth (given by the height of the box) and in time (given by the width of the box).

At the 1-km range, Figure 4a, there are two fronts, the direct arrival, D, and the surface-reflected arrival, S. At 2 km, Figure 4b, these two arrivals begin to refract back into the water column due to the relatively high sediment sound speed gradient. These refractions are labeled DR and SR for direct- and surface-reflected refractions, respectively. Distortion up to the 2-km range is due solely to the interference between the D and S paths. The bottom depth has not changed up to the 2-km range. At 3 km, Figure 4c, the smeared wavefront trailing the S wavefront consists of the first bottom bounce, B, the refracted fronts DR and SR that have re-entered the water column and the surface-bottom reflected arrival, SB. These fronts have become better separated at 4 km, Figure 4d. Finally, at 5 km, Figure 4e, the above wavefronts are almost fully developed. Signal distortion at each range and depth is due to the mutual interference of these multipaths and the source signal over the aperture of the array.

Neural Network Overview

The most difficult neural networks to build are those that recognize time-varying patterns (spatio-temporal patterns). General Dynamics has been working with neural networks for several years that deal explicitly with the recognition of time-varying signals buried in a great deal of noise[3]. The neural network that was used in these experiments is a product of this work. There are several aspects to the work presented here that are important to point out: (1) the spatio-temporal pattern recognition network is able to learn new spatio-temporal patterns without destroying any of the information concerning the previous spatio-temporal patterns; (2) the neural networks are able to respond very quickly both during training and during recall; and (3) the neural networks are able to generalize quite well.

The neural network used for these experiments is constructed in four parts: (1) feature extraction; (2) spatial pattern classification; (3) spatial pattern to spatio-temporal pattern transformation; and (4) spatio-temporal pattern classification. These four parts are shown in the block diagram in Figure 5.

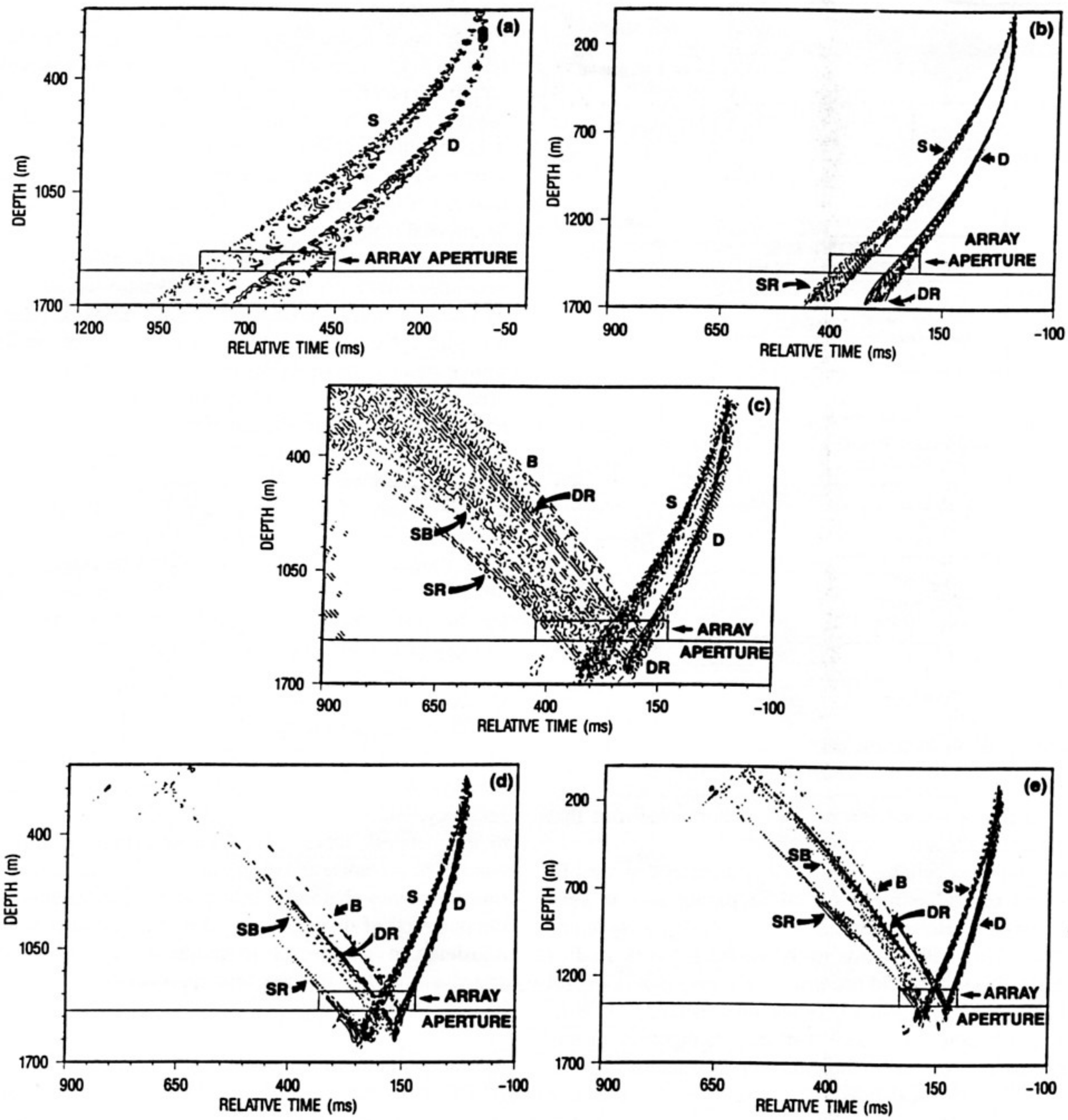

Figure 4. Pressure field for broadband pulse at ranges of (a) 1000 m, (b) 2000 m, (c) 3000 m, (d) 4000 m, and (e) 5000 m.

Several feature extraction techniques were considered including Fourier Transforms, Maximum Entropy Method Coefficients and Gabor Wavelets. We settled on the third transform as it provided an eloquent way of handling the low-frequency data. The transients are passed through a Gabor filter that is 64 sample points in length with an 8 point overlap. Each set of 64 points is called a time slice in this context. The spectral pattern created from each 64 point sample is 256 bins that represent the frequency range from 0 to 100 Hz. Because it is possible to precompute the coefficients for the Gabor transform filter in advance and place them into a matrix, it is possible to think of the Gabor transformation operation at Linear Associative Memory with hardwired weights. We use the Gabor Filter in this context, therefore it is considered to be the first part of this neural network.

The output of the Gabor transformation operation feeds directly to a neural network analog pattern classifier that crates classes of a predefined size from the spectral patterns. The neural network performing the classification is an on-line learning analog pattern classifier entitled the Fuzzy Adaptive Resonance Theory (Fuzzy ART) neural network. Fuzzy ART successfully synergizes the sophisticated adaptive resonance theory (ART) neural network with fuzzy theory to create a flexible, yet robust, pattern classifier that is able to add new pattern classes of a predefined size on-the-fly[4].

The output of the Fuzzy ART neural network is the pattern class of the spectral pattern. By keeping track of which classes that win and when they win, it is possible to create a spatial pattern that represents the spatio-temporal dynamics of the transient signal being presented. The resulting spatial pattern

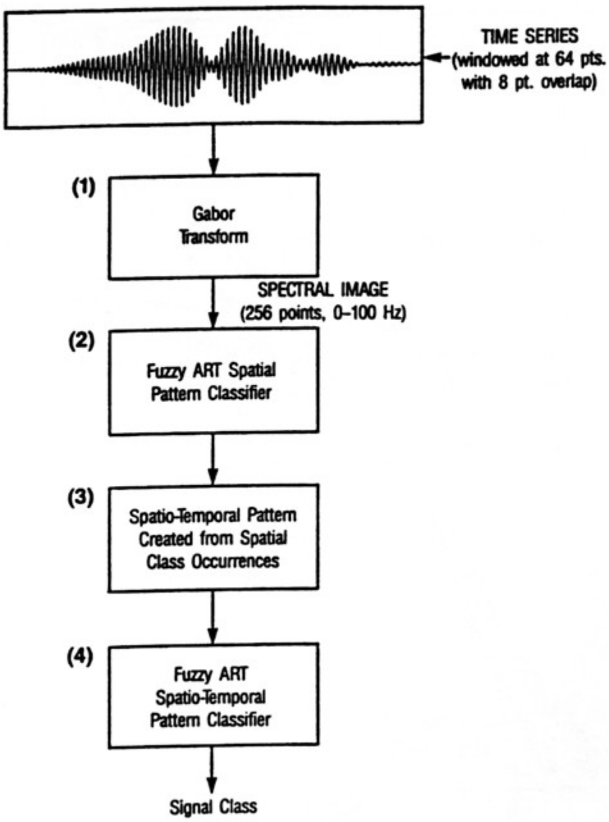

Figure 5. Block diagram of system.

is then fed to a second Fuzzy ART pattern classifier that determines the class for the transient.

Overall, this system has only three parameters that must be tuned and the adjustment for these parameters is very straightforward. Before discussing the results, two points should be made with regards to the neural network studied here. First, this system did not work with noisy data. General Dynamics has created neural network noise cancellation techniques that handle noisy data that are not included in this design. Second, the transient distortion encountered here is limited to the ranges, depths and environment studied. The results given below would undoubtedly change if these studies were extended to other ranges, depths and environments. The following results are preliminary.

Results of Experiments

The neural network is tested in two ways. First, classes 1 and 2 are used to train the network. Once these source signals are encoded into the network, 25 different received signals from each source signal (for a total of 50) are presented to the neural network. Each received signal is classified into one of two classes: class 1, downsweep and class 2, upsweep. Of the fifty received signals, all are correctly classified except for one (95% accuracy). Class 2 (upsweep) is incorrectly classified as class 1 (downsweep) at a range of 3 km and a receiver depth of 1425 m. Figures 6a and b show the time waveforms received across the array at the 3-km range. Figure 6a shows the received waveforms for class 1 (downsweep) and 6b shows the waveforms for class 2 (upsweep). (The top waveforms of Figures 6a, b, c, d, and e are the source signals displayed for reference. The vertical axis is scaled to the absolute maximum amplitude received over the five sensor depths. For example, in Figure 6a, the bottom sensor at 1450-m depth has the largest peak amplitude at this range over the 5-element array. The source signal amplitude is one. There is no significance to location of the signal in time. Therefore, arrival times cannot be inferred from the figures).

The next experiment demonstrates the ability of the neural network to nondestructively add new spatio-temporal patterns by adding a third signal to the neural network. This is the minimum phase signal, class 3, Figure 1c. Like the first two source signals, the signal also has 25 received signals that are used to test the network. The combined test set consists of 75 received signals, 25 from each of the source signals. Out of 75 received signals, only 7 are classified incorrectly. Two of the class 2 signals are classified incorrectly as class 3 signals at the 3-km range for receiver depths of 1400 and 1425 m. Compare Figures 6b, second test, and Figure 6c. Five of the class 1 signals are classified incorrectly as class 3 signals at the 1-km range for all receiver depths. Compare Figures 6d and 6e. All of the class 3 signals were correctly classified. Overall the classification performance was above 90%.

Conclusions

The results presented here are preliminary, but encouraging. With only knowledge of the source signal, the neural network was able to recognize the received signals with 90% accuracy. Although the received signals that were presented to the network were studied under limited environmental conditions (no noise and short range) they were similar in their time-frequency character. This indicates that the approach has the potential of distinguishing desired transients from noise transients. In addition, this technique allows new signals to be added on-the-fly, making this approach to transient signal identification look extremely promising.

Acknowledgement

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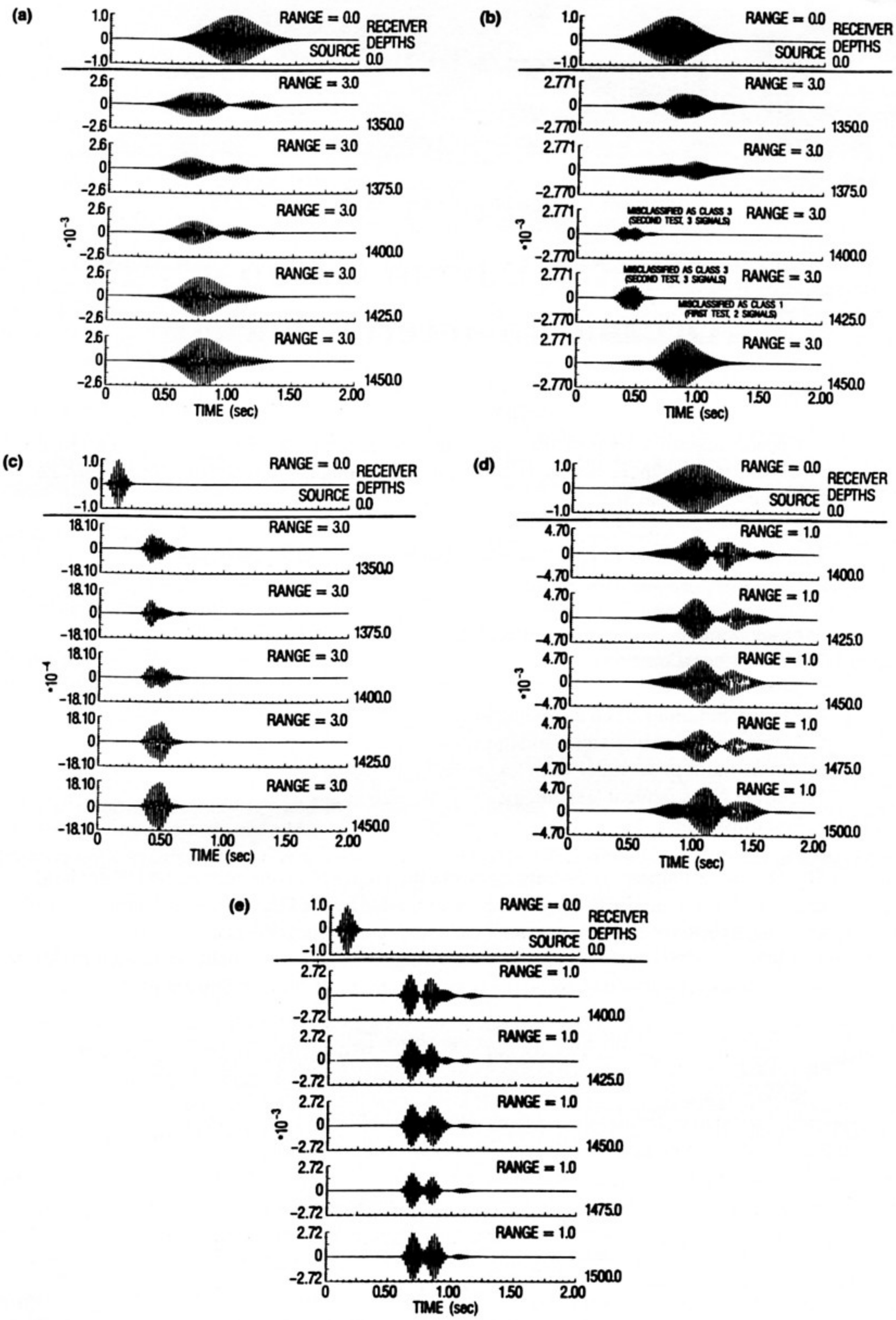

Figure 6. (a) Class 1, downsweep at R = 3 km upslope; (b) Class 2, upsweep at R = 3 km upslope; (c) Class 3, minimum phase downsweep at R = 3 km upslope; (d) Class 1, downsweep at R = 1 km upslope (misclassified all Class 1 as Class 3); and (e) Class 3, minimum phase downsweep at R = 1 km upslope.

Announcement

Special Interest Group – Oceanic Engineering Society

A Special Interest Group of the IEEE Oceanic Engineering Society (OES) has been formed here in Singapore and is looking for IEEE Singapore members who might be interested in joining the Society.

The scope of the Society is perhaps best, but not exclusively, described by its technical committees, which are as follows:

1) Oceanographic instrumentation and data acquisition
2) Underwater acoustics
3) Remote sensing
4) Marine communication and navigation
5) Databases, modeling and simulation
6) Autonomous underwater vehicles
7) Current measurement technology
8) Polar instrumentation

The Oceanic Engineering Society sponsors the OCEANS conferences, which are held annually in North America. Singapore has been invited by the OES Advisory Committee to submit a bid to host the first *international* OCEANS conference. Formation of a strong OES chapter in Singapore is the first step toward securing the bid for this conference and a pro-tem committee has been formed to guide the development of the OES in Singapore.

Any IEEE member with an interest in the above listed areas is encouraged to join the Oceanic Engineering Society. The OES membership fee is only U.S. $6 more than the IEEE membership dues. OES members receive the *Journal of Oceanic Engineering* and a quarterly newsletter. Please contact Nancy Penrose, 467-6552, Chair, Pro-Tem Committee of the OES Singapore Special Interest Group, for further information.

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IEEE-USA Testifies On Federal R&D Budgets

IEEE-USA's Technology Policy Council and its committees have completed their annual testimonies to Congress on the Administration's budget requests for agency research and development programs. Operating within guidelines set by the 1990 budget agreement, Congress is moving rapidly to finalize its budget authorizations and appropriations for Fiscal Year 1992. Support for Federal science and technology programs appears to be strong despite a severely constrained budget environment.

The National Institute of Standards and Technology (NIST) is the principal Federal laboratory assigned to advance U.S. competitiveness. In its testimonies, IEEE-USA's Engineering R&D Policy Committee endorsed the Administration's plans to double NIST's budget by 1996. To promote precompetitive technology development, the Committee called for $100 million in FY 1992 funding for NIST's Advanced Technology Program (ATP) but cautioned that support of ATP should not be at the expense of NIST's essential standards role. The Committee also endorsed proposed increases for NIST's programs in computer science and technology and in electronics and electrical engineering, urging additional support for U.S. participation in international standards bodies.

The Engineering R&D Policy Committee also testified in support of the Administration's plans to double the National Science Foundation (NSF) budget by 1994. The Committee signaled support for increases to NSF's engineering and computer science programs, as well as expanded NSF efforts in math and science education and human resources. Committee representatives expressed concern that NSF's Engineering Directorate was given no role in the Foundation's high-performance computing and communications and global climate change initiatives.

Funding of Space Station Freedom dominated the attention of Congress, as the budget request for the National Aeronautics and Space Administration (NASA) was considered. As the debate developed, IEEE-USA's Aerospace R&D Policy Committee cautioned Congress to consider carefully the impact of space station funding on other NASA programs. In particular, the Committee endorsed the principal recommendations of the "Augustine Commission on the Future of the U.S. Space Program" and urged Congress to support a balanced NASA program, with adequate emphasis on space applications programs that contribute to U.S. commercial and technological leadership.

Despite Department of Defense (DoD) budget cuts, defense spending on research, development, test, and evaluation still represents more than 60 percent of the total Federal R&D investment. In its testimony before Congress, IEEE-USA's Defense R&D Policy Committee recommended an increased emphasis on technology transfer and development of dual-use technologies to enhance the commercial benefits of that investment. The Committee also expressed concern over declining support for DoD's technology base programs in the budget request.

The Persian Gulf War helped to focus Congressional attention on the need for a national energy policy. In testimonies reviewing the proposed National Energy Strategy and the Department of Energy's budget request, IEEE-USA's Energy Policy Committee urged Congress to support research and development programs needed to ensure an adequate supply of reliable, low-cost, and environmentally acceptable energy for the future. The Committee placed specific emphasis on research related to improved energy efficiency, renewable energy, nuclear power, fusion, electric energy systems, and energy storage.

Copies of R&D budget testimonies and related IEEE-USA postion statements can be obtained by writing to the Technology Policy Council, IEEE-USA, 1828 L Street, N.W., Suite 1202, Washington, DC 20036.

PTO Proposed Fee Schedule Opposed

David Ostfeld, Chairman of IEEE-USA's Intellectual Property Committee, testified against the "Revision of Patent and Trademark Fees; Proposed Rule," at a U.S. Patent and Trademark hearing. The U.S. Patent and Trademark Office (PTO) proposed a new fee schedule for patents and trademarks in response to Federal legislation that would authorize appropriations for PTO. "The proposed rule goes far beyond the intent of the authorizing legislation on any current statute," Ostfeld said.

The proposed rule would do away with a two-tier fee system entitling small entities with fewer than 500 employees to pay half the large entity fee for patent administration. If the rule were to take effect, it would call for a 91 percent increase in small-entity fees. Under the new rule, there would be no distinction between small and large entities, except for patent application filing fees and initial claim fees associated with filing.

IEEE-USA's Intellectual Property Committee has been actively lobbying Congress because these fees cannot be put into effect until the Federal legislation authorizing appropriations is passed. The Committee has met with the staff of the Senate Subcommittee on Patents, Copyrights, and Trademarks and the House Subcommittee on Intellectual Property and Judicial Administration. Both the Senate and House Subcommittee staff have assured IEEE-USA that the authorizing legislation will be amended so that the two-tier fee system will remain.