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PROBLEM SUMMARY FOR SF-101-03-16/8132,(U)
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Problem Summary for SF-101-03-16/8132

Prepared for: G. E. Miller (NAVSHIPS/OOV1C)

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Cornell

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1.0 INTRODUCTION

This document is intended to supplement the program review discussions to be held with Mr. C. D. Smith, Mr. G. E. Miller (SHIPS OOV1C) and members of the Signal Recognition Division (NUWC-SD, Code S-3180).

1.1 Objective

To determine properties of acoustic signals, signal processing and display techniques, and terminal decision procedures which can be used effectively to detect and classify active sonar contacts. To provide in technical reports or as system design assistance, the bases for improved detection and classification techniques in operational systems. Provide technical assistance to NAVSHIPS and its contractors in program planning and research and development projects in above area.

1.2 Approach

Improvements in sonar detection and classification require search for better signal information and for ways to make more effective use of known information. Physical analysis and quantitative tests of raw and processed sonar signals from operational and experimental equipments are used to identify signal variables which show promise for detection and classification discrimination. Signal processing, computer simulation and electronic display techniques, together with supporting theoretical concepts of information processing, communication theory, and decision theory are applied to signal waveforms to establish the effectiveness and design requirements of automatic and semi-automatic detection and classification systems. Results of these applied research and exploratory development efforts are split-off into systems development as practical techniques are proven.

1.3 Background and Status

Previous classification work was centered primarily on two basic approaches to problem solution. The first approach was concerned with special purpose measurement equipments as characterized by MONOPPLER, ASPECT, and others. The second approach dealt with pattern recognition techniques and resulted in such systems as HHIP, MITEC, and TRESI being designed and tested for use with contemporary scanning sonars. The advent of more sophisticated

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measurement extraction techniques, advanced theoretical models of decision systems and a new generation of long range sonar systems called for a reorientation to a third approach, referred to as the analytical-experimental approach.

The analytical-experimental approach can best be described as the application of statistical communication to the sonar detection and classification problem. It is concerned with describing, in an analytical manner, the sonar communication channel in order to make use of all available a priori information for classification, and in confirming the hypothesized channel by means of experimentation with real-world data. Advantage is being taken of ideas advanced in the last five years in the areas of statistical estimation and decision theory. Some of these theories have been unified into a set of techniques testable against real-world data. While a data base representative of the future sonar systems problem is being accumulated, SQS-23/PAIR data and simulated data is being used for preliminary experimentation with theoretical models of classification channel components.

Existing efforts (described in detail in Section 2.0) include four main areas; applied research, data collection, facilities and consultation and auxiliary tasks. Within applied research, efforts include: a mathematical study of signal design; methods for accurately locating echoes in ambient and reverberation noise backgrounds for CW and FM transmissions; the application of Kalman filtering techniques for estimating target parameters of range, range-rate, bearing and bearing-rate; a mathematical study of optimum classification principles for deterministic reflected and/or radiated target signals; operational considerations and their effect on classification with long range sonar systems; mathematical and experimental studies concerned with linear, time-varying, random target models. This work in applied research will permit a logical advance in and a rapid evaluation of receiver designs for classification purposes. The ASDACS system to become operational in early FY 69 will support the above types of studies and together, with the effort in data collection, will provide a strong relationship between exploratory development and the Navy's operational sonar systems.

2.0 AREAS OF INVESTIGATION

2.1 Applied Research

2.1.1 Operational Considerations (Olson)

Ref [1] outlines an operational model of the active sonar classification problem. This reference does not consider all types of encounters, but it considers the very dangerous case of a well-defined, shallow thermocline resulting in below-layer detection ranges of 3000 yds or less. The effects of weapon ranges and contact times with possible submarine evasive tactics will require rapid classification. Doppler alone cannot provide as reliable a clue as size and shape. While sonars and classification techniques can use these clues at short ranges, the problem of short-term, longer-range contacts requires a different approach. This case arises when a periscope or passive sonar operation requires the submarine to come above the layer into the surface channel. The ranges for this type of contact are predicted as 10-24 kyds for time durations of approximately two minutes. At these ranges, familiar techniques for classifying by size and shape, such as SSI displays, profiling with high frequency, short-pulse sonars, or even Starlite, cannot provide significant classification capability. The long range, longer-term contact, on the other hand, can often be classified by track information.

As a consequence of our current knowledge of classification (short-range), we are investigating the feasibility of converting the long-range, short-term contact to a short-range problem--which we hope proves easier to implement. The surface ship can employ a sonar designed for close-in classification employing either techniques similar to mine-hunting or using other techniques (such as Starlite).

The longer-range contact will be changed to a short-range contact by moving a platform close to the contact. The platform should be reasonably safe from torpedo attack and capable of closing the contact very quickly--as location information will not continue if the target goes below a well-defined layer. Several candidate approaches will receive consideration as to feasibility. These approaches will be designated as DICLAS--Dispatched Classification Systems. A short list with some of the major considerations of each approach follows:

2.1.1.1 Ship-Launched Active Sonobuoys

Method of Delivery: Gun-fired or rocket-launched. Work with CLASP by NOTS [Ref 2] has proven the feasibility of launching a passive sonobuoy from a 5"38 deck gun and receiving the telemetered information at the ship. The MK 114 fire control system receives both sonar and radar inputs and controls the guns as well as the ASROC launcher. In this manner, a pattern over the contact or a pattern slightly offset can be rapidly delivered.

Classification Technique Proposed: The Starlite technique seems the best approach at this time. Studies as to optimum buoy placement to cover a wide range of submarine aspect angles, expected sonobuoy frequencies, signal waveforms and the ranges for underwater coverage will largely determine the feasibility. The ranges for buoy-ship telemetry will probably determine the maximum range of the system from the ship. As an example, line of sight ranges for various observation (antenna heights) are given for reference:

4ft. height	--2.3 mi. range
50ft.	--8.1 mi.
100ft.	--11.5 mi.

Additional Comments: Operationally, the geometry of the buoys relative to each other must be fairly well-known to provide the best performance. Computer techniques for interpreting buoy geometry and processing the telemetered information for classification decisions must be developed. Current active sonobuoys and those under development can provide initial inputs for the feasibility studies. If the technique (classification with active buoys) proves reliable, the problems of packaging for launch from surface ships and possibly submarines can be pursued.

2.1.1.2 Helicopters, VS/VP Aircraft--Active Sonobuoys

Comments: Essentialy, the same comments apply for the use of Starlite with active sonobuoys. However, the height of the platforms will permit much greater telemetry-ranges. VS/VP aircraft can then plant large fields of CASS (Command Activated Sonobuoys) to detect and classify the slow-moving submarine in the van of a convoy. The use of sonobuoys from helicopters has been studied from the approach of target localization and kill. In addition, this study appears encouraging for classification purposes [Ref 3]. After the computer techniques for processing the data are found

(Starlite is a strong candidate), these platforms could serve as receivers for ship-launched buoys also. These platforms might be able to determine buoy geometry more accurately with radar or optical measurement rather than sound delay information.

2.1.1.3 Hydrofoils

Vulnerability: While more vulnerable than airborne craft, a torpedo poses very little threat if the craft is foil-borne. Foil operation, however, requires approximately 25kts speed.

Classification Technique: Current configurations are considering a towed-body similar to VDS with higher operating frequencies $\sim$30kc/s. While more traditional techniques might be useful with this type of sonar, the use of a towed-array and Starlite-techniques might provide the best classification capability. Naturally, the system must work at speeds above 25kts.

Comments: The designers of hydrofoil craft are considering the sonar problem at high speeds. Evidently, they feel that a towed-body can function at these speeds. In the sonobuoy case the significant motion effects were all due to the submarine. An analysis of the effects of high platform speed on Starlite will add another factor to its complexity with hydrofoils. The trade-offs between the use of a single towed-body and a towed-array on the hydrofoil and sonar operation in general will also determine the eventual applicability of Starlite.

1. D. G. Olson, "Operational and Tactical Considerations of Active Sonar Classification (U)," Proceedings of Naval Ships Systems Command Symposium on Active Sonar Classification, October 1967, (CONFIDENTIAL).

2. J. R. Olmstead, J. W. Taylor, "Investigation of a Ship-Projected Sonobuoy System to Aid Target Classification (CLASP)," 24th Navy Symposium on Underwater Acoustics 29 November-1 December 1966 (CONFIDENTIAL).

3. S.S. Tobe, W. J. Kruse, "Effects of Active Sonobuoys and Towed Sonar Employment on the Attack Capability of a Single SH-3A Helicopter (U)," NADC-AW-6326, 2 December 1963 (CONFIDENTIAL).

2.1.2 **Medium Effects**

2.1.2.1 Multipath Prediction (open)

Kramer's recent work has convinced us that even in a short range situation 1,000 yards to 1,500 yards, multipaths can be expected. Based on a linear increase in temperature from 55°F at the surface to 70°F at 300 feet, with the submarine at 250 feet, a surface bounce echo was delayed by 2.9 msec with respect to the echo along the direct path for R = 1,000 yards. At R = 1,500 yards, the delay was 1.3 msec. These results suggest that classification systems based on the hypothesis of discrete specular target models must incorporate knowledge of the velocity gradient from bathy-thermal measurements in order to look for multipath effects separate from multiple reflections.

The PERT chart submitted to NAVSHIPS shows a main task of acoustic path studies. There is not a man available for this work at the present time and consequently, we will have to rely on Kramer for this until one becomes available. However, since the study in Par: 2.1.3.1 makes use of path structure, this work is essential. We are requiring an additional acoustician to work closely with Dr. Watson in FY '69 to support this vital area.

2.1.2.2 Detectors for Echo On-Set (Teeter)

2.1.2.2.1 FY '67

The report (to be published) "Detection for Active Sonar-An Experimental Study" documents an analysis of three detectors--the noise-weighted linear correlator, the linear correlator and the polarity-coincidence correlator--with respect to an ensemble of 42 short-pulse CW active sonar signal returns. The purpose of the experiment was two-fold: (1) to experimentally investigate the assumptions of gaussian and stationary noise with respect to the ensemble of signal returns; and (2) to experimentally determine performance curves for the three detectors as functions of the nonstationary noise process represented by the ensemble of signal returns.

From the results it was concluded there is good reason to believe that the active sonar background noise process is approximately gaussian. The approximation was found to improve after the reverberation component of the noise disappeared. The stationary noise assumption was found to be good only when the noise is void of reflections of the transmitted signal.

The empirical performance curves indicated that the linear correlator provides a performance gain of 4 to 7 dB over the polarity-coincidence correlator for detection in reverberation, ambient noise and/or bottom reflections. The noise-weighted linear correlator was found to provide a performance gain (2.5dB) over the linear correlator only when the noise was void of reflections of the transmitted signal. Based on these results, use of the linear correlator over the polarity-coincidence correlator is warranted, but use of the noise-weighted linear correlator over the linear correlator is not.

2.1.2.2.2 FY '68

(a) Repeat investigation of the gaussian and stationary noise assumption with a larger ensemble (at least 200) of CW signal returns, as well as with equally large ensembles of high time-bandwidth product FM and pseudo-random signal returns.

(b) Investigate the known signal and gaussian signal assumptions with respect to an ensemble of (at least) 200 CW transmitted signals as seen by the target and an equally large ensemble of CW submarine echoes. If data is available this investigation will be extended to include large time-bandwidth FM and pseudo-random transmitted signals. The above ensembles will also be used to investigate the transfer function of the forward-path communication channel and the combined transfer function of the target and return-path comm. channel, as time permits.

(c) Determine performance curves for the noise-weighted linear, linear and polarity-coincidence correlators as functions of the background noise process represented by ensembles of (at least) 200 CW and high time-bandwidth product FM and pseudo-random signal returns. If the results of (b) above indicate that the gaussian signal assumption is reasonable, then performance curves will also be found for the quadratic "noise in noise" correlator--characterized by the matrix operator $(R_n^{-1} - R^{-1}_{s+n})$ where R_n and R_{s+n} are the noise and signal plus noise autocorrelation matrices, or $(R_n^{-1} - C^{-1}_{s+n})$ where C_{s+n} is the signal plus noise covariance matrix if the signal has a non-zero mean.

(d) If large ensembles of CW, FM and pseudo-random signal returns are available for each of a variety of target aspect angles, then they will be analyzed to investigate the relationship between aspect angle and echo structure.

2.1.2.2.3 Bendix Contract

Work closely with Bendix on contract N00024-67-Q-3362 (S). Keep G. E. Miller (NAVSHIPS) informed of their progress.

2.1.3 Recognition Systems

2.1.3.1 Optimum Classification Principles (Stradling)

This study will consist of two parts; Part I: Deterministic Reflections and Part II: Random Reflections. The work is intended to apply the concepts and methods of random processes, together with the a posteriori probability viewpoint of decision making, to the problem of optimum classification receiver design. Part I will establish the necessary and sufficient conditions for classification when the reflected signal implies a particular target class (deterministic) and is received over an additive guassian noise channel. Main emphasis will be placed on developing theoretical ROC curves for the hypothesized target classes as a function of S/N ratio (range). Specific examples will include the theoretical minimum probability of error for CW and FM waveforms, their relationship to the N-dimensional vector communication channel, and a comparative analysis of the two for classification purposes. Multivector channels (more than one receiver-bistatic) will be considered and the relationship of the channels to the theoretically derived ROC curves will be shown. The effects of multipaths which are resolvable and time-invariant will also be established theoretically.

Part II represents a considerable extension of Part I in terms of the mathematical difficulty. Here, the necessary and sufficient conditions for classification are derived when the reflected signal does not imply a particular target class, the reflection is itself a random process and hence, design is based on the effects of such random variables as; amplitude of reflection, time delays due to aspect, number of reflections and other descriptors. Essentially, the ROC curves obtained theoretically in part two can be compared to those in part one, and the degradation in optimum performance assessed.

In all cases, the structure of the optimum classifier will be derived so that ASDACS can be used to simulate the design. Experimentally obtained results using real-world data for a given structure will be compared to the theoretically predicted results. All results, either good or bad, can be traced to the corresponding assumptions made in I and II and changed accordingly. Reports will be published on I and II. It is expected that Part I can be finished before third quarter FY '68. Part II may be completed before FY '69. However, experimentation can begin as soon as Part I is complete.

2.1.3.2 Estimation Study (Turton)

The purpose of this study is to apply the principles of estimation theory to the classification problem in order to obtain accurate target parameter estimates and parameter error estimates. Also, several assumptions, problem constraints and goodness criteria are presented for which certain estimation procedures are optimum.

Estimation procedures based on both single and multiple ping target models are to be investigated. It is felt that both types of models must be considered and are complementary. Single ping estimates most often are made with a minimum amount of reliable data and, hence, are heavily weighted by a-priori probabilities. Single ping also serves to initiate multiple ping estimation procedures and determine, to a large extent, how quickly a multiple ping system can "converge" to the true parameter values. The multiple ping system serves to shift the emphasis from a-priori knowledge to experimental evidence as more data is received.

Thus far in this study, the multiple ping Kalman discrete time recursive filter has received the greatest attention because its development is straightforward and it lends itself well to the sonar estimation problem. It has, in fact, been applied to the sonar tracking problem. It is hoped that the results of this research can be extended to provide useful information to the ASW classification problem. Remaining work to be done includes specifying the needed target parameters based on current target models and developing a good single ping initial estimate technique. Also, current dynamic target models may be improved, possibly to incorporate adaptive features to allow more flexibility to accomodate environmental changes.

2.1.4 Target Models

2.1.4.1 Kinematical Relationships (NELC-3350C)

The effects of target motion on the reflection of a sonar signal and its processing receive attention in the signal analysis work. The magnitude of own ship's motion, target motion and the importance of different components of these motions depend on the characteristics of the targets and sensor platforms. Better techniques for computing all the terms of the general equations of motion are necessary to examine their effects on the sonar detection and classification problems.

The effects of certain terms depends on the exact sonar problem. In this respect, the study will supply inputs for signal processing with respect to correlator performance and some considerations of Starlite performance. In this respect, the outputs of the study may be first applied to a particular problem. The equations of motion for a target with dimension (not a point reflector) became very complicated without simplifying assumptions. Therefore, the study output may not consist of one overall report, but a series of solutions incorporated in other reports which deal with particular problem formulations. Further study, however, might permit a more comprehensive presentation.

After approximately six months of searching for a qualified new-hire to work in this area, we have been unable to find one. The work is vital and hence, we have decided to create a job-order for in-house work by the Advanced Control Systems Division for one man-year of effort.

Recent investigations in active sonar exploratory development have revealed a high degree of similarity between problems in communication theory and in modern control theory. Specifically, research states that a requirement exists for describing the reflected signal process (the plant's output) as a function of both the transmitted signal (the input control function) and the reflective characteristics and dynamics of the target vehicle (plant's state vector). The Advanced Control Systems Division is well qualified to provide assistance on this problem and will assure that the techniques of treating target motion and track are consistent with the best practices of modern control theory.

The problem requires derivation of the kinematical relationships between own ship and target when 3-dimensional motion occurs on transmit and receive for own-ship and reflection for the target vehicle. Briefly stated, the problem can be formulated as:

(i) Given: The surface ship transmits in the direction of the target which is at a range R_g (range to target's center of gyration) and own-ship has angular rotation and both linear velocity and acceleration in 3-dimensions.

(ii) Find: Equations relating own-ship to the submarine's coordinate system.

(iii) Given: A submarine modeled as a long slender body of rotation, composed of a finite number of discrete specular reflectors.

(iv) Find: With respect to the submarine's coordinate system (center of gyration), a description of the vectorial velocities and accelerations of the k^{th} reflector when there is vectorial angular rotation, linear velocity and linear acceleration.

(v) Given: The surface ship tows two hydrophones separated by a distance (X) and subject to motion at time of reception.

(vi) Find: The kinematical equations relating target and transmit motion to own-ship; a coordinate system for own-ship as a function of range, both receive bearing angles and time.

The results of this analysis can be used for detection, classification and tracking studies as they relate to motion, range and time. Simulation can be run on ASDACS to determine the effect of motion on the received waveform. For example, STARLITE can be simulated to determine its degradation in performance when high speed turns of the vehicle are occuring at time of reflection.

2.1.4.2 Line Target Reflection Analysis (Ball)

Since a submarine has a high length-to-diameter ratio, one of the first target models that comes to mind is the line segment reflector. The impulse response of the line reflector is a rectangular pulse whose length is a function of the aspect angle.

For analysis purposes, the aspect angle is considered a random variable with an assumed probability density (e.g. uniform, cosine, etc.). For each assumed density, the expected echo and correlation functions will be calculated for various sonar signals. Wherever possible, analytical solutions will be obtained. In any case, all results will be supported by computer simulation.

Although the line reflector model is too simple to entirely represent a submarine target, it is expected that useful experience and insight gained with this model can be applied to more complex situations in the future. Additionally, it is expected that the line reflector model will later be combined with other models to form a more complete representation of the submarine.

A NUWC report on the line reflector model is expected to be completed by 1 January 1968.

2.1.4.3 Discrete Target Analysis (Turton)

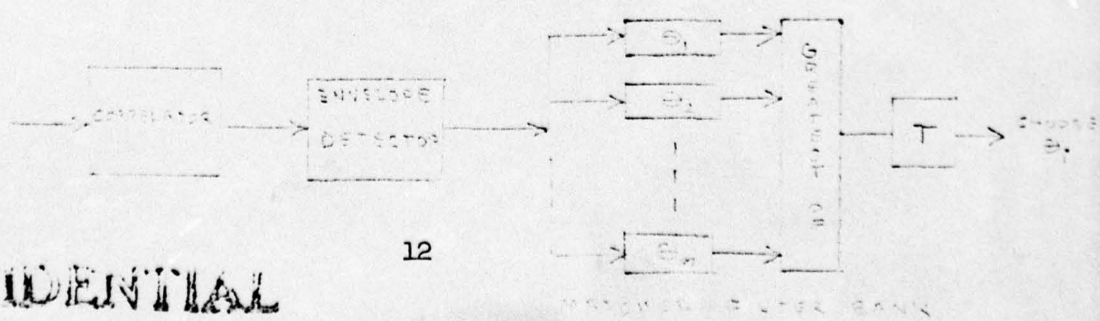
Using a large ensemble of 2 M.S. CW echo returns, develop a target highlight model as follows:

(a) Define a highlight-i.e. correlation function envelope length and duration above a preselected threshold level.

(b) Determine the presence of fixed highlights-i.e. highlights maintaining consistent relative positions for all aspects.

(c) Investigate presence of highlights not present at all aspects.

(d) Using (a), (b), (c), develop a matched filter for several aspects for estimating relative target aspects.



2.1.5 Signal Design

2.1.5.1 Signal Representation (Weill)

The report, "Linear Representation of Sonar Signals," presently in progress, deals with the problem of mapping sonar signals into vectors for further data processing in ASW active sonar systems. Many types of mappings can be used, and the special properties of each, affect the information content of a received signal in different ways. Thus the detection and classification performance of a sonar system may depend heavily upon the mapping employed.

The primary intent of the report is that of deepening the engineer's understanding of what linear representation is, rather than the solution of specific problems. Engineers have a tendency to think of representation in terms of Fourier series or time sampling and are often not aware of the many other possibilities which might prove more suitable in certain situations.

Specifically, the report contains (1) an exposition of the basic concepts behind linear signal representation, (2) the development of three basic types of linear representation mappings based on function space, normed space and Hilbert space structures for the signal ensemble, and (3) a listing of some historically developed basis functions which can be used to represent or approximate functions.

Mr. Weill is a summer employee and will return to teaching and graduate study in mathematics at San Diego State College, and should receive his M.S. degree in Mathematics in February, 1968. He plans to start doctoral work the following fall in Applied Mathematics or Electrical Engineering. Although no decision has been made regarding his future association with NUWC, his present goal is to teach and do research at a university; involvement with ASW would be advisory rather than full-time. Because of Mr. Weill's impending loss, we should try to hire an engineer or mathematician who can discern the real problems where the theory can be applied.

2.1.5.2 Analysis of Active Sonar Signals (Olson)

The preliminary work on this problem is included in a recent report* which uses analog-recorded sonar signals to generate ambiguity functions relating target velocity and range for wide-band signals. The experimental technique A/D converts analog recordings and artificially generates a delayed-and Dopplerized version in a general purpose computer for cross-correlation. The envelope of the cross-correlations were used to generate the ambiguity function.

This technique doesn't require an analytical representation of a signal--only the recording. In this manner, the actual signal characteristics as a function of target motion can be compared with the theoretical characteristics. In addition, the technique permits the analysis of non-cooperative signal sources and biological sound sources such as dolphins.

Future work will attempt to extend the application of the ambiguity function to include parameters such as target aspect changes, target acceleration, uncompensated own-ship's motion and the use of electronically-phased receiving arrays on the detection and parameter estimation problems with different types of transmit signals.

2.2 Data Collection

2.2.1 Background

One of the most difficult areas in exploratory development is data collection. Data is collected to support or reject a hypothesis set forth by an experimenter. What is applicable for one experiment may not be for another. Hence, when a data collection trip is undertaken, everything possible should be done to insure that the data base suits the needs of a great majority of experimenters. This requires that considerable coordination and sufficient lead-time be available to the data collectors. Since ASDACS will be available for use by other Navy Contractors, it is logical to assume that those individuals working with ASDACS assist in the coordination of these data gathering sea trips.

2.2.2. FY '68 Assistance (Jackson, Bolks, Ball)

Prime importance will be given to a summary of future sea test plans with regard to the data gathering experiment, use of

* D. G. Olson, and L. R. Weill; "Analysis of Active Sonar Signals, (U)," NUWC TP-7, 28 July 1967 (CONFIDENTIAL).

available equipment, the availability of ships and supporting equipment. Exploratory development, in order to effectively interface with advanced development and systems work, must be cognizant of data collection for: PAIR, NSS/FCS, C/PA, AGDE, BAYA, AUTEC and others. By being aware of developments in these areas, it may be possible to inject requirements for exploratory development at an early enough point in time to obtain data meaningful for exploratory development purposes.

Of secondary importance, and evolving from the above, will be an investigation of instrumentation techniques, beginning with analog/digital recording techniques. Two interesting analog/digital techniques are in proposal stages: a direct digital recording system and an optical recording technique. These combine the advantages of a large channel capacity with high density packing. In conjunction with recording techniques will be an investigation of ship's motion. This will require the evaluation of stabilization devices for the measurement of motion with six degrees of freedom. It will also require an evaluation of devices to interface such equipments to both the recorder and the sensor system.

2.2.3 FY '69 Assistance (Jackson)

Although considerable instrumentation is required for at-sea recording, it is expected that we will work in conjunction with other groups such as DRL, and those determined by Section 2.2.1. However, in order to ensure the usability of the data for ASDACS, the purchase of some items in FY '69 is required. A relatively small, rugged recorder is required for shipboard instrumentation. The AMPEX AR-1600 is one possibility. Cost would be approximately $20,000. A time code generator is required for accurate timing of the tape channels and for automatic search of the recorded tape with ASDACS. If recording were also being done on the submarine, two units would be required with a means for synchronizing them. Cost of each unit is about $13,000.

In the area of shipboard digital recording, Code S-3180 personnel are very interested in the Universal Data Recorder (UNIDAR), which is the result of a design study by General Dynamics Electronics, and feel NAVSHIPS 1622 may also be interested in this novel system. If further investigation indicates the UNIDAR system is feasible, it is hoped that a limited capability version could be developed contingent upon a market for it as determined by the summary results.

2.3 Facilities

2.3.1 ASDACS (Jackson, Bolks , Ball, Schumacher)

The information contained here is a chronological report on the status of the procurement of the Active Sonar Data Analysis and Conversion System.

2.3.1.1 August 1966-September 1966

A survey and review of the state-of-the-art analog-to-digital and data analysis facilities was made. Investigation of facilities at NOTS Pasadena, California; Edwards Air Force Base, California; USNUSL, New London, Connecticut; California Technical Computation Center, Pasadena, California; Scientific Data Systems, Santa Monica, California; Astrodata Corp., Anahiem, California, and Redcor Corp. provided basic information needed for the specification preparation.

September 1966-November 1966

The performance specification for ASDACS was written and a request for qualifications was advertised in the Commerce Business Daily on 19 October 1966.

November 1966-December 1966

Qualification information was received from thirty-eight (38) vendors. Fifteen (15) vendors were qualified, based on requirements set in the RFQ, to submit proposals on a two-step procurement procedure (firm-fixed price). Request for proposals were mailed 19 December 1966.

February 1966-13 March 1966

Three (3) vendors responded to the RFP, Adage; Incorporated; Mass. Westinghouse Electric Corporation, New York and Control Data, La Jolla Div., California. It was necessary to change the procurement procedure to a negotiated firm-fixed price procedure, because Adage and Westinghouse proposed a control processor that could not meet the "real-time" requirements of the specification. Negotiations were started. Components that would incur high development costs were eliminated from the basic system, because it was not felt that CDC could actually provide these to meet specifications.

March 1966-April 1967

Several conferences with Control Data Corp. were held to assure that specification and concept of ASDACS was clearly understood.

May 1966-June 1967

Request for a cost proposal was made and evaluation and negotiation scheme was established.

July 1967

Negotiations were started at NPOLA. After considerable discussions, Control Data reconsidered their position and submitted a revised cost proposal, significantly reduced in price.

August 1967

A contract, N00123-68-C-0299, for ASDACS, effective 18 August 1967, was awarded to Control Data Corp, La Jolla Div., San Diego, Calif. The length of the contract is one year.

2.3.1.2 Contract Monitor Schedule

The chart on page 17A is a tentative contract monitor schedule for ASDACS. A more definite schedule will be outlined after the initial conference with Control Data.

2.3.1.3 FY '68

2.3.1.3.1 Procurements

Under the present contract with CDC, work change orders will be initiated to include the tape search and desk console options in the ASDACS system. The cost for these items is $3,639.

A work change order will be required for the interface of the Ampex FR-1800 analog recorder in addition to the CEC VR-3800 unit. A slight additional charge may be incurred due to differences in control circuitry.

An Ampex FR-1800 analog instrumentation recorder (14 channel) will be purchased for the ASDACS system. From our investigations we have found this recorder to be the most suitable for our purposes. The cost will be $30,000 to $40,000, depending on the options and the number of amplifiers required. The recorder will be purchased prior to 1 March 1968.

2.3.1.3.2 Maintenance

Since the maintenance portion of the ASDACS contract has been deferred, a need for some sort of technician services will exist within the next year. One alternative is to contract with CDC for maintenance of ASDACS. However, under this plan only equipment supplied under the ASDACS contract would be

18 August 1967 | September | October | November | December | January 1968 | February | March | April | May | June | July | August | 18 August 1968 | September | October | November | 18 November 1968

I Contract Award

II System Definition (Hardware)

III. System Design

A. System Layout
B. Special Equip. Design
C. System software Definition
D. Software Design
E. Test Proceedure

IV Assembly of Hardware and Software

A. Mech. Skeleton
B. Software

V System Assembly & Integration

A. Hardware & Software
B. System Manuals
1. rough
2. finished
C. Training
D. System Modification & Test

VI Acceptance Tests

A. Notification of In-House Tests
B. In-House Tests
C. Installation
D. NEL 1230 on Line Tests

VII Maintenance

ASDACS CONTRACT MONITOR SCHEDULE

included in the maintenance contract. Any additions or modifications to the system made by NUWC personnel would not come under the contract.

The other alternative is to have NUWC personnel perform the maintenance. This would require the hiring of a full-time technician. There are several advantages to this approach: (1) direction of the technician by NUWC personnel; (2) full-time availability of technician for purposes other than just maintenance (e.g. modifications, additions to system); (3) availability of technician for maintenance and operation of all equipment, whether or not purchased under the original ASDACS contract; (4) availability of technician for design studies and data collection projects.

Technician services will be required by FY '69 and the cost would run $15,000-$30,000 per year depending on the type of services required. A decision will have to be made in FY '69 in order to insure the system is adequately maintained when the 3 month warranty runs out.

2.3.1.4 FY '69

Tentative plans for operations of ASDACS will be that of editing and catalouging data, as well as analysis studies in classification and detection. Some work will be required to develop data analysis procedures. The operation of the system will require some form of data storage facility for sensitive data.

System evaluation studies will be made to determine calibration factors pertinent to data correction, improved analysis techniques, and development of improved control functions for the man computer interface. Investigations will be made to optimize the use of channel capacity. Hopefully, an automatic-check out system (software) will also be developed.

The original ASDACS contract will cover the rental of the disk file unit until approximately the end of FY '69. The rental for FY '70 will be about $8,600.

2.3.2 Heterodyne Design Study (Howard)

As a result of a preliminary design study on the Balanced Switching Modulator (an NUWC Tech. Memo in press), it was found that a carrier rejection of at least 30 db is obtainable over wide signal level ranges. On the basis of this and conversations with B. L. Pennoyer of the PAIR project office, 60 db rejection should be obtainable with further work.

Therefore, the design study will be continued and the application of FET switches to improve performance will be investigated. A technique, developed by L. R. Weill, which provides for the elimination of third harmonic spurious responses will be tried. Finally, the filter design requirements will be investigated.

If in-house filter design is feasible or if inexpensive commercial units are available, one prototype heterodyne unit will be constructed for evaluation with ASDACS.

The design study will operate under the constraint of no large outside purchases. If filters prove to be too expensive, the study will be terminated.

M. Howard will perform the major portion of the work with assistance from T. F. Ball and L. R. Weill.

2.4 Consultation and Auxiliary Tasks

2.4.1 NAVSHIPS Classification Panel (Stradling, Olson)

During FY '67, no extensive contractor survey trips took place such as the one in April 1966. This was probably due in part to the fact that work was pressing and the need was not as great. NUWC panel members did provide reports as required on proposals submitted and work in progress. The following lists the contributions by the panel during FY '67:

(a) 2 August 1966; ltr on 18 companies surveyed in FY '66.

(b) 25 October 1966; comments on Raytheon and Melpar proposals.

(c) 14 November 1966; presentation to Signal Physics Committee on Panel's work.

(d) 18 January 1966; ltr. on Exploratory Development goals and efforts in classification.

(e) 8 February 1966; comments on TEMPO Report 66-TMP-104.

(f) 27 February 1967; draft of ltr to NSS/FCS.

(g) 18 May 1967; comments on Honeywell and Autonetics proposals.

The above list does not reflect dates or times of travel nor the meetings held at NUWC with the various investigators. The worth of the panel is unquestioned and should be continued. It provides assistance to NAVSHIPS managers without interfering with their responsibility and at the same time, allows the technical people to keep abreast of developments in the field.

2.4.2 NAVSHIPS Classification Symposium

Six papers were submitted to DRL for publication and reflect direct labor hours under El-11: see Par: 3.4 for list of papers.

The deadline for the Symposium papers provided an impetus to formalize work done. A direct charge to El-11 was incurred by contracting for typing services in order to meet the 15 August deadline; approximately 1.5K was expended. Additional money will be expended for travel to the Symposium; approximately 1K total.

3.0 ADMINISTRATIVE

3.1 Personnel

The following Personnel are associated with SF-101-03-16/8132. Their resumes are given in the Appendix.

T.F. Ball GS-11
D.J. Bolks GS-11
G.M. Howard GS-04
E.G. Jackson GS-12
D.G. Olson GS-12
G.P. Schumacher GS-12
M.A. Stees (CAI Contract)
C.S. Stradling GS-13
J.L. Teeter GS-11
G.A. Turton GS-09
J.E. Watring (CAI Contract)
L.R. Weill GS-11

3.2 Future Plans

3.2.1 Balance of FY '68

(a) Run computer simulations to estimate variability and expected patterns of range-rate acceleration and bearing. Report on results and include with feasibility study on Dispatched Classification System (DICLAS).

(b) Begin computer simulations for estimating signal parameters. Apply Kalman's discrete time varying recursive filter to multiple ping estimation.

(c) Begin analysis of background statistics by computing time-varying covariance functions for broad-band ensembles of SQS-23 data.

(d) Report on optimum classification principles for deterministic reflections.

(e) Report on effects of own-ship and target motion as developed under kinematical relationships.

(f) Summarize results of line target reflection analysis.

(g) Analyze SQS-23 data using a matched filter to develop a discrete target model.

(h) Publish report on the mathematics of representing sonar signals by linear functional forms.

(i) Summarize sea-test plans regarding future data gathering experiments.

(j) Monitor ASDACS Contract.

3.2.2 FY '69

(a) ASDACS operational, begin experiments for simulating sonar receiving systems.

(b) Report on optimum classification principles for random reflections.

(c) Extend the ambiguity function to include such factors as target aspect changes, target acceleration and own-ship motion.

(d) Apply results of echo-onset detector to broad-band data for real-time simulations.

(e) Participate in sea-tests for gathering samples from future sonar systems.

3.2.3 FY '70

(a) Report on results of ASDACS experiments; consider applicability of new classification system to the chosen future sonar system.

(b) Consider feasibility of joint classification and detection system using both active and passive receivers.

3.3 Financial

3.3.1 Summary

	FY 68	FY 69	FY 70
Investigative Man-Years	9.0	11.0(2)	11.0
Total Direct Labor Man-Years	9.5	11.5	11.5
Total Labor & Overhead $	200 K	283 K(3)	283 K
Normal Material & Travel $	20 K	24 K	24 K
Major Procurement	304 K(1)	113 K	134 K(4)
Planning Estimate	524 K	420 K	441 K
Additional Funds Required	0 K	0 K	

(1) Includes additional funding of 170 K for ASDACS.

(2) New hires for Medium Effects (Par: 2.1.2.1) and Signal Design (Par: 2.1.5.1).

(3) Best estimate is 24.6 K per man-year based on NUWC-NELC separation, could be less.

(4) See note on major procurements (Par: 3.3.2).

3.3.2 Major Procurements

FY	Item	COST & QTR. COMMITTED 1st	2nd	3rd	4th
68	1. ASDACS Contract	205 K			
	2. Programming Services	50 K			
	3. ASDACS Work-change Order		9 K		
	4. Tape Recorder and Play-back Electronics			40 K	
	FY 68 TOTAL 304 K	255 K	9 K	40 K	
69	1. Time Code Generator	13 K			
	2. Programming Services	50 K			
	3. ASDACS Maintenance (on-call) and Spare Parts		25 K		
	4. Test Instrumentation			25 K	
	FY 69 TOTAL 113 K	63 K	25 K	25 K	
70	1. Disk File Rental	9 K			
	2. Programming Services	75 K			
	3. ASDACS Maintanence (on-call) and Spare Parts		25*K		
	4. Test Instrumentation			25 K	
	FY 70 TOTAL 134 K	84 K	25 K	25 K	

* May not be necessary if Code S-3180 hires its own technician (Par: 2.3.1.3.2).

3.4 Active Contracts

Control Data Corporation, La Jolla Division, 4455 Miramar Road, La Jolla, California, 92037; N00123-68-C-0299 for an Active Sonar Data Analysis and Conversion Systems (ASDACS).

3.5 Technical Reports Issued Since January 1967

3.5.1 NAVSHIPS Symposium

The following papers will be published in the Proceedings of the Naval Ship Systems Command Symposium on Active Sonar Classification:

(a) J. L. Teeter; "Detectors For Active Sonar-An Experimental Study."

(b) G. P. Schumacher; "Summary Analysis of Clue Evaluators: HHIP and MITEC, (U)." CONFIDENTIAL

(c) E. G. Jackson; "An Active Sonar Data Analysis and Conversion System."

(d) D. G. Olson; "Operational and Tactical Considerations of Active Sonar Classification, (U)." CONFIDENTIAL

(e) G. A. Turton; "Target Parameter Estimation."

(f) C. S. Stradling; "Active Sonar Target Classification: Basic Approaches to Problem Solution, (U)." CONFIDENTIAL

3.5.2 Additional Reports

(a) C. S. Stradling; "The False Alarm Probability of a Quadrature Clipper Correlator For a Poisson Noise Process," USNEL Report 1458, 28 April 1967.

(b) D. G. Olson and L. R. Weill; "Analysis of Active Sonar Signals (U)," NUWC TP-7, 28 July 1967 (CONFIDENTIAL).

(c) C. S. Stradling; "ROC Curve Analysis of the TRESI Classification System (U)," JUA, 17, April 1967 (CONFIDENTIAL).

Appendix:

Resumès of Cognizant Personnel

TRACY F. BALL

ELECTRONICS ENGINEER

Education

University of California (Berkeley), B.S., Electrical Engineering, 1964.

University of California (Berkeley), M.S., Electrical Engineering, 1965.

Additional Courses since M.S.E.E.:

University of California Extension (San Diego), Introduction to Oceanography, 1966.

Navy Electronics Laboratory, Integrated Circuits Seminar, 1967.

Bolt, Beranek & Newman, Inc., Random Processes, 1966-67.

Position

Electronic Engineer (general), Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California.

Performs as an Electronic Engineer in the development and Testing of signal processing techniques and equipment in the field of active sonar.

Professional Experience

Nov. 1966-Present:

Provide assistance, particularly in the analog areas, for the specification and procurement of the Active Sonar Data Analysis and Conversion System (ASDACS). Perform analytical investigations of signal processing techniques.

June 1965-Nov. 1966:

Communication Techniques Division, NEL; responsible for design and construction of automatic test subsystem for a high frequency communications spectrum occupancy system. Performed analytical investigations of matched filter processing techniques. Participated in design and construction of an IF matched filter receiver.

Related Experience

June 1961-Sept. 1962:

Marine Environmental Division, NEL; served as oceanographic technician responsible for the mechanical and electrical maintenance of the NEL Thermistor Chain. Performed as scientist-in-charge on three oceanographic cruises aboard the USS MARYSVILLE (EPCER 857).

June 1959-June 1965:

Employed during summers and school vacations by U.S. Navy Electronics Laboratory in Student Cooperative Program. Served as Electronics and/or oceanographic technician.

Honors, Citations, Recognition

Eta Kappa Nu

Tau Beta Pi

Professional Societies

IEEE

Professional Papers

"Shallow Water Turbidity Studies", T. F. Ball and E. C. La Fond, NEL Report 1129.

"Turbidity of Water off Mission Beach", T. F. Ball and La Fond, p. 37-44 in Pacific Science Congress, 10th, Honolulu, 1961. Physical Aspects of Light in the Sea: A Symposium. John E. Tyler, Editor. Honolulu, University of Hawaii Press, 1964.

DONALD J. BOLKS

ELECTRONIC ENGINEER

Education

San Diego State College, B.S. (Electrical Engineer), 1962

Additional Courses since B.S.:

Navy Guided Missile School, Talos Fire Control Computer, 1962

FAAWTC, Machine Language and Computer Programming, 1964

Navy Electronics Laboratory, UNIVAC Computer Maintenance and Engineering, 1964

University of California Extension, Man-Computer Systems, 1965

Navy Electronics Laboratory, Basic Supervision, 1966

Army Management Engineering, Design & Analysis of Experiments, 1967

Position

Electronic Engineer (general), Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California. Responsible for the design, development and modification of major subsystems for complex sonar signal analysis equipment.

Professional Experience

August 1966-Present:

Responsible for a major portion of the specification and procurement of an Active Sonar Data and Conversion System.

March 1965-August 1966:

Deputy supervisor of Technical Systems Support for Applied Systems Development and Evaluation Center. Responsible for the design, and development of digital circuits to interface experimental digital and analog systems.

February 1964-March 1965:

Involved in the planning, installation and testing of digital computer systems and equipment used in Navy Tactical Data Systems.

June 1962-February 1964:

Employed at Naval Repair Facility Weapons Branch, San Diego, Calif. Electrical Engineer assisting in the planning and design of fire control systems arrangements and installations. Assist in making investigations, equip test and gathering information in preparation for reports and instruction manuals.

Related Experience

March 1962-June 1962:

Engineer Draftsman for Electrical Branch of Naval Repair Facility, San Diego, California. Assisted in recording data to be incorporated in BUSHIPS drawings of electrical and electronic systems aboard ship. Prepared drawings.

GEORGE M. HOWARD

ENGINEERING TRAINEE (ELECTRONIC)

Education

University of California, Berkeley; Senior (Electrical Engineering)

Position

Engineering Trainee (Electronic), Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California. Involved, as a Junior Engineer, in design, testing and specification of computer software and peripheral hardware for exploratory development in the field of active sonar.

Professional Experience

June 1967-Present:

Junior Engineer involved in design and testing of hardware devices and software for inclusion in a computer system that converts and analyzes active sonar data.

June 1966-September 1966:

Engineering Trainee responsible for the specification of a portion of a computer system that converts and analyzes active sonar data.

June 1965-August 1965:

Engineering Trainee involved in the construction of special purpose digital equipment to allow entry and display of sonar classification data in a computer controlled sonar system.

Professional Papers

"A Balanced Switching Audio Modulator with High Carrier Rejection", G. M. Howard, USNUWC Tech. Mem., Ready for publication.

E. GLEN JACKSON

ELECTRONIC ENGINEER

Education

Michigan College of Mining and Technology (Presently Michigan Technological University), B.S., Electrical Engineering, 1962.

Additional Courses since B.S.E.E.

UCLA Extension, Logical Design of Digital Computers, 1962.

UCLA Extension, Statistical Theory of Communication, 1963.

UCLA Short Course. Underwater Acoustics, 1964.

RCA Institutes, Digital System Engineering, 1966.

Harbridge House, Advanced Defense Procurement Management Seminar, 1967.

Position

Electronic Engineer (general), Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California.

Project Engineer for Data Analysis and Collection Facilities.

Professional Experience

June 1966-Present:

Project Engineer for the specification and procurement of a computer system for the conversion and analysis of active sonar data. Participates in sonar data collection at sea.

August 1965-June 1966:

Principle engineer responsible for the specification of a study contract to investigate digital recording techniques for the at-sea collection of sonar data.

January 1964-August 1965:

Principle engineer responsible for the design and construction of special purpose digital equipment for the display and entry of sonar classification data in conjunction with a computerized sonar system. Also involved in data collection at sea and the design and construction of axis crossing measuring equipment.

January 1963-January 1964:

One of two engineers responsible for the installation, testing and maintenance of a computer-aided display. Aided in the design and specification of sonar signal processing devices.

June 1962-January 1963:

General Dynamics/Astronautics, Associate Engineer; participated in the design and testing of airborne telemetry systems on Atlas space launch vehicle.

Related Experience

June 1954-September 1958:

U.S. Navy, Fire Control Technician; served on two destroyers where main responsibility was the maintenance and operation of fire control radars, computers and stabilizers.

Patents

Authorized patent disclosure, "Improved Keyset Apparatus," July 1967.

Professional Papers

"An Active Sonar Data Analysis and Conversion System (ASDACS)," to be given at Active Sonar Classification Symposium, October 1967.

DAVID G. OLSON

PHYSICIST (GENERAL)

Education

Purdue University, B.S., Engineering Sciences, 1961

Massachusetts Institute of Technology, M.S., Oceanography, 1963

Additional Courses since M.S.:

Fleet ASW School, San Diego, Operations in Coordinated ASW Nov. 1965

AN/SQS-26BX Sonar PCO/PXO Indoctrination, June 1967

UCLA, Extension, Conceptual Bases & Applications of the Communication Sciences, 1965

Measurement & Analysis of Random Data for Engineering Applications, 1966

USNEL/Naval Postgraduate School Inter Laboratory Course-Control Systems, 1966

Bolt, Beranek & Newman-Random Processes 1967

North Island Naval Air Station-Federal Leadership Laboratory, 1966

Position

Physicist (general), Naval Undersea Warfare Center (NUWC), San Diego, California. Works in exploratory development program for detection and classification processes in active sonar.

Professional Experience

July 1965-Present:

Employed continuously at the U.S. Navy Electronics Laboratory (NUWC after July 1, 1967). Work included operational analyses for inputs into follow-on design of the SQS-26CX, a study of target tracking, and the operational and tactical considerations of active sonar classification. Other work included the application of the ambiguity function to analog-recorded, wide-band sonar signals and a study of submarine kinematics and possible effects on the reflected signal.

March-July 1965:

Worked as chairman of a committee to prepare a rough draft outlining the functions and display types for the Multi-Mode Sonar Console (MMSC).

September 1964-March 1965:

Worked with the SPADE system to devise the software functions for detection and tracking displays. Specified the classification procedure to use with the SPADE system.

June 1963-August 1964:

Worked as a full-time professional staff member of the Center for Naval Analyses-Institute of Naval Studies (CNA-INS) in Cambridge, Massachusetts. Participated in studies of sea surveillance and command, control and communications.

September 1962-June 1963:

Worked as a part time staff member of CNA-INS while completing final year of graduate work.

June 1962-August 1962:

Worked as a full-time summer employee of CNA-INS between two years of graduate work.

Related Experience

June-July 1962:

Participated in sea surveillance exercise at COMOCEANSYSLANT and COMASWFORLANT in Norfolk, Virginia, to assemble and to correlate SOSUS contacts for a three day period.

Fall of 1963:

Spent approximately one week at COMASWFORLANT, COMOCEANSYSLANT and OPCONCENTER in Norfolk to study the relation of SOSUS, intelligence and other observation techniques for application to sea surveillance.

January 1964:

Traveled to OPCONCENTERS at Treasure Island and Kunia to study sea surveillance problem.

January 1966-Present:

Member of the NAVSHIPS Active Sonar Classification Panel. Advisory function for contractor review and evaluation.

Honors, Citations, Recognition

George Pullman Foundation Scholarship

Phi Eta Sigma

Tau Beta Pi

Letter of Commendation- NSIA ASW Subcommittee, 1966

Professional Papers

"Summary and Conclusions of the BUSHIPS/USNEL Active Sonar and Classification Survey (U)", C. S. Stradling and D. G. Olson, USNEL Letter Report No. 129, 30 September 1965, (CONFIDENTIAL).

"Automatic Classification Using Active Surface Ship Sonars: A Synopsis", University of Texas, Defense Research Laboratory, Acoustical Report No. 256, 28 March 1966 (CONFIDENTIAL).

"A Solution for the Minimum Allowed Pulse time of a Radar System", IEEE Trans. on Antennas & Propagation, AP-12#1, January 1964.

"Analysis of Active Sonar Signals (U)", D. G. Olson, L. R. Weill, NUWC TP7, 28 July 1967 (CONFIDENTIAL).

"Operational & Tactical Considerations of Active Sonar Classification (U)", D. G. Olson, Proceedings of Naval Ships Systems Command Symposium on Active Sonar Classification, October 1967 (CONFIDENTIAL).

GEORGE P. SCHUMACHER

ELECTRONIC ENGINEER

Mr. Schumacher's resumè was not available in time for transmittal.

MAE S. STEES

SENIOR PROGRAMMER

Education

University of Pittsburgh, B.S., Math, 1962.

Additional Courses:

Data Processing, 1965.

Information Retrieval, 1966.

Cybernetics, 1966.

American University, part-time study for M.B.A.

Position

Senior Programmer, Computer Applications, Inc., contracted to Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California.

Responsible for designing and writing computer programs to carry out various experiments on sonar signal waveforms.

Professional Experience

August 1967-Present:

Computer Programmer responsible for designing, writing and debugging programs for problems related to experiments on sonar signal waveforms.

October 1966-July 1967:

Senior Programmer/Analyst for Bendix Field Engineering Corporation, designed and implemented calibrations tests for signal processor of AN/FPS-85 Phase Array Radar System.

April 1965-October 1966:

Senior Programmer for UNIVAC Defense Systems, responsible for design and implementation of real-time programs for telemetry processing systems of APOLLO and GEMINI projects. Also aid in systems integration and checkout.

November 1964-April 1965:

Programmer for Computer Usage Co., wrote quality assurance programs for a special purpose computer. Also did business applications programming.

January 1964-June 1964:

Programmer for Bellcomm, Inc., responsible for scientific applications programs for various aspects of APOLLO project.

January 1963-December 1963:

Associate Engineer for the Boeing Co., responsible for maintaining and documenting a non-real-time simulator of DYNA-SOAR.

CORNELL S. STRADLING

ELECTRONIC ENGINEER

Education

Newark College of Engineering, B.S.E.E. 1961

University of Southern California M.S.E.E. 1963

Additional Courses since M.S.E.E.:

UCLA-Modern Linear Algebra 1964

UCLA Ext.-Modern Random Processes with Control System Applications 1965

UCLA Ext.-Analysis of Random Data 1966

North Island Naval Air Station-Federal Leadership Laboratory 1966

U.S. Naval Post Graduate School-Control Systems 1966

Bolt, Beranek, and Newman, Inc.,-Random Processes 1967

Harbridge House-Advanced Procurement Management 1967

Position

Research Electronic Engineer, Naval Undersea Warfare Center (NUWC), San Diego, Calif. Problem Manager of an exploratory development program for detection and classification processes in active sonar.

Professional Experience

1 January 1967-Present

Problem Manager responsible for planning, organizing and technically directing an applied research program in the fields of active sonar detection and classification. Studies involve the sonar transmission system, medium, reflective and dynamic properties of targets, signal measurement theories and decision sub-systems.

August 1963-31 December 1967

Employed continuously at the U.S. Navy Electronics Laboratory as an Electronic Engineer. Scientific fields include: the application of statistical communication theory to the Active Sonar Detection and

Classification Problems; analytical studies of matched filter signal processing and its effect in a reverberation environment; statistical analysis of pattern recognition systems using digital computer techniques; comparative analysis of automatic classification systems.

June 1961-August 1963

Member-of-the-Technical Staff; Hughes Aircraft Company, Aerospace Group. Member of Rotational Training Program while working towards M.S.E.E. Assignment included work in (1) guidance and controls for airborne fire control system (2) Solid State Circuit research for air-to-air missile (3) system design and analysis of airborme displays (4) technical coordinator for fellowship training program.

Related Experience

August 1963-October 1965

Participated in sea-tests aboard the USS WILKINSON, USS SARSFIELD, USS BAYA (FASOR I WEST PAC) and as sea-test director aboard USS PERRY in connection with SQS-23 improvement program.

September 1958-January 1961

Employed by Associated Testing Laboratories, summers and weekends during school year. Performed as a technician in areas of environmental testing; shock, vibration, circuit design.

1 January 1966-Present:

Member of the NAVSHIPS Active Sonar Classification Panel. Advisory function for contractor review and evaluation.

Honors, Citations, Recognition

Eta Kappa Nu

Who's Who in American Colleges and Universities (1961)

Hughes Master's Fellowship

Letter of Commendation - NSIA ASW Subcommittee (1966)

Letter of Appreciation - Manager, ASWSPO (1966)

Professional Societies

IEEE - Professional Group on Information Theory

Engineer-In-Training; Calif. Dept. of Professional and Vocational Standards.

Professional Papers

"Report on Sea Tests of the IBM Digital Matched Filter During the Period 16 through 20 November, 1964 (U)", C. S. Stradling, USNEL Letter Report No. 112, 11 January 1965. (CONFIDENTIAL)

"Analysis of the Hand-Held Information Processor (HHIP) (U)", C. S. Stradling and G. P. Schumacher, ONR Symposium Report ACR-110, 22nd Navy Symposium on Underwater Acoustics, 26-28 October, 1965; pp. 675-680. (CONFIDENTIAL)

"Summary and Conclusions of the BUSHIPS/USNEL Active Sonar and Classification Survey (U)", C. S. Stradling and D. G. Olson, USNEL Letter Report No. 129, 30 September 1965. (CONFIDENTIAL)

"A Performance Analysis of the TRESI Classification System Based on the Receiver Operating Characteristic Curves (U)", USNEL Tech. Mem.-876, 23 November 1965. (CONFIDENTIAL)

"Automatic Classification Using Active Surface Ship Sonars: A Synopsis", Univ. of Texas, Defense Research Laboratory, Acoustical Report No. 256, 28 March 1966. (CONFIDENTIAL)

"Status Report on the Active Sonar Data Analysis and Conversion Facility", C. S. Stradling and E. G. Jackson, USNEL Letter Report No. 145, 23 August 1966.

"ROC Curve Analysis of the TRESI Classification System (U)", C. S. Stradling and G. P. Schumacher, JUA, 17, April 1967. (CONFIDENTIAL)

"The False Alarm Probability of a Quadrature Clipper Correlator For a Poisson Noise Process", C. S. Stradling, USNEL Report 1458, 28 April 1967.

"Active Sonar Target Classification: Basic Approaches to Problem Solution (U)", C. S. Stradling, Proceeding of Naval Ships Systems Command Symposium on Active Sonar Classification, October 1967. (CONFIDENTIAL)

JAMES L. TEETER

ELECTRONIC ENGINEER

Education

University of Santa Clara, B.E.E., 1965

San Diego State College, M.S.E.E., 1967

Additional Courses:

U.C.L.A. Extension, Meas. & Anal. of Random Data, 1966

U.C.S.D. Enrolled in Ph.D. program, 1967

Position

Electrical Engineer (general), Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California. Responsibilities include independent analysis of sonar signals, sonar noise and sonar signal processing techniques.

Professional Experience

June 1965-Present:

Employed continuously at the U.S. Navy Electronics Laboratory as an Electronics Engineer. Responsibilities include: (1) The investigation of the properties of sonar background noise (2) The determination of the performance characteristics of (3) three detectors with respect to an ensemble of active sonar signal returns (3) The testing and maintenance of an experimental doppler measurement and display device (4) Design of experimental sonar signal processing devices.

Related Experience

June 1960-September 1964:

Enrolled in U.S.N.E.L. Student Trainee program while studying for B.E.E. at Santa Clara. Worked summers and two semesters as Data Analyst, Computer Programmer and Electronic Technician.

Honors, Citations, Recognition

Tau Beta Pi (National Engineering Honor Society)

Professional Papers

"Detectors for Active Sonar-An Experimental Study," Active Sonar Classification Symposium Proceedings, October 1967.

GARY A. TURTON

ELECTRONIC ENGINEER

Education

University of Minnesota, B.S., Electrical Engineering, 1963

University of Minnesota, M.S., Electrical Engineering , 1966

USNEL, Tech. Writing Course, 1966

Position

Electronic Engineer (Electro-Acoustic), Signal Recognition Division, Naval Undersea Warfare Center, San Diego, California. Responsible for analytical and experimental development of ASW classification methods, and for exploratory development of zero crossing measurement techniques.

Professional Experience

May 1966-Present:

One half of full time on hardware contract monitoring and experiment design for zero crossing interval research project. Also one half time on analytical development of ASW classification techniques for active sonar.

July 1965-May 1966:

Full time on testing and experimenting with special purpose doppler measurement device.

Related Experience

June 1964-September 1964

Employed at U.S. Naval Research Laboratory Sound Division, Washington, D. C. Involved in long range sonar tests off Bermuda. Assisted in data gathering and evaluation.

September 1963-June 1965:

Teaching assistant for Electronics Laboratory course at the University of Minnesota, given for senior Electronic Engineering students.

June 1962-September 1963:

Engineering assistant for Biomedical Research project at University of Minnesota Hospital. Performed living tissue impedance measurements.

Honor, Citations, Recognition

Tau Beta Pi, Engineering Honor Society

Eta Kappa Nu, Electrical Engineering Honor Society at the University of Minnesota.

Professional Societies

IEEE, Professional Group on Information Theory

Professional Papers

"Target Parameter Estimation", G. Turton, Active Sonar Classification Symposium Proceedings, October 1967.

"Thoracic Cage Impedance Measurements: Tissue Resistivity in Vivo and Transthoracic Impedance at 100KC/S," E. Kinnen, W. Kubicek, P. Hill and G. Turton. Tech. Doc. Rept. No. SAM-TDR-64-5, January 1964. USAF School of Aerospace Medicine, Brooks AFB, Texas.

"Thoracic Cage Impedance Measurements: Dynamic Characteristics of an Impedance Pneumograph," E. Kinnen, W. Kubicek, G. Turton, Tech. Doc. Rept. No. SAM-TDR-63-100, December 1963. USAF School of Aerospace Medicine, Brooks AFB, Texas.

JAMES E. WATRING

COMPUTER PROGRAMMER/ANALYST

Education

University of Arizona, B.S. Engineering Math, 1964.

University of California Extension, Dynamic Programming.

Position

Computer Programmer/Analyst, Computer Applications Inc., contracted to Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California.

Responsible for designing and writing computer programs to carry out various experiments on sonar signal waveforms. Also, to aid in the mathematical analysis of sonar models.

Professional Experience

September 1965-Present:

Computer Programmer/Analyst responsible for writing computer programs for any problem areas in Signal Recognition Division and to aid in any needed mathematical analysis.

June 1964-September 1965:

Assoc. Systems Design Engineer for UNIVAC Corp., responsible for designing, writing, debugging and maintaining NTDS Communication and Missle weapons system.

Honors, Citations, Recognition

Phi Kappa Phi

Tau Beta Pi

Phi Eta Sigma

LAWRENCE R. WEILL

MATHEMATICIAN

Education

California Institute of Technology, B.S.E.E., 1960

California Institute of Technology, M.S.E.E., 1961

San Diego State College, M.S. Mathematics 1968 (to be awarded).

Additional Courses:

University of California at Los Angeles, Communication Theory, 1964

Position

Mathematician, Signal Recognition Division, Naval Undersea Warfare Center (NUWC), San Diego, California. Responsible for mathematical formulation of sonar detection and classification techniques.

Professional Experience

June 1967-Present:

Responsible for investigation of the mathematical theory of linear signal representation to help guide its application in sonar classification.

September 1966-June 1967:

Graduate Teaching Assistant in Mathematics at San Diego State College. Taught advanced algebra and trigonometry.

August 1963-September 1966:

Electrical Engineer, Code 3180. Responsible for the design and specification of sonar signal processing instrumentation used in experimental studies. Projects included (1) Axis-crossing measurement device (2) Level-normalizing envelope detector for G. E. Preselector (3) Charactron sonar data display (4) Specification on CDC Active Sonar Data Analysis Conversion System (ASDACS).
Also aided in at-sea tests of active sonar systems.

August 1962-August 1963:

Electrical Engineer, Code 3195. Designed and specified buoyed telemetry systems for recording undersea explosions.

July 1961-July 1962:

Systems Analog Design Engineer, Beckman Instruments, Inc., Fullerton, California. Designed the analog portion of several high-speed data systems. The analog components included analog commutators, data amplifiers, signal conditioners and sample & hold devices. Also responsible for development and improvement of Beckman "FITGO" data amplifier (a carrier-type D.C. amplifier).

Related Experience

Self employed as a marine electronics technician during summers of 1955, 1958, 1959, 1960. Installed and serviced marine electronic equipment (marine radiotelephones, depth sounders, autopilots, direction finders, etc.)

Professional Societies

Member of Institute of Electrical and Electronic Engineers

Member of Mathematical Association of America

Professional Papers

A Constant Level Envelope Detector for the AN/SQS-26 Preselector, NEL Tech Memo, January 14, 1965.

An Analysis of Active Sonar Signals, NUWC Technical Report to be published August 1967 (Co-author: D. G. Olson).

Linear Signal Representation, NUWC Technical Report to be published September 1967.

Patents

"Automatic Direction Finder". Patent granted February, 1967.