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ENGINEERING RESEARCH DIVISION PUBLICATION REPORT

CALENDAR YEAR 1980

E. K. Miller, Division Leader

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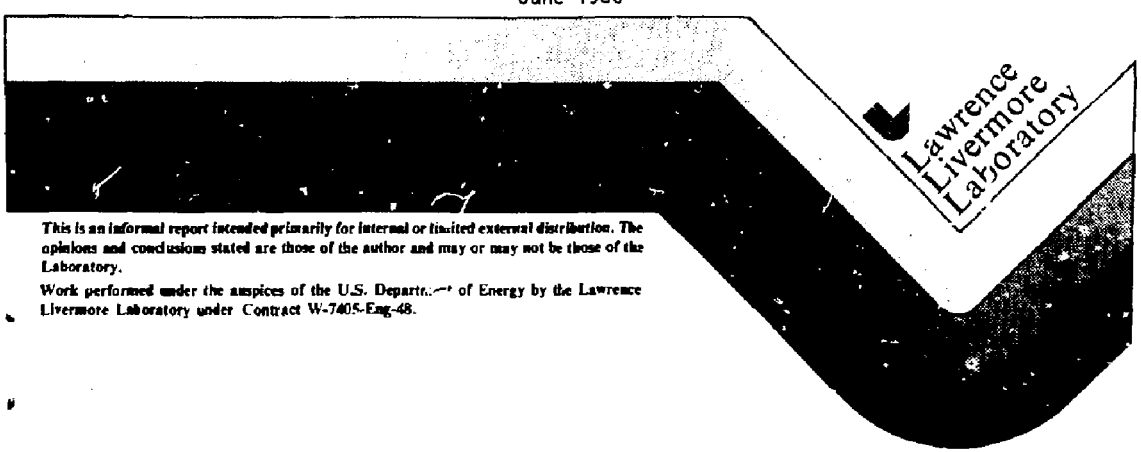
June 1980



ENGINEERING RESEARCH DIVISION
PUBLICATION REPORT - CALENDAR YEAR 1980

Introduction

Each year the Engineering Research Division of the Electronics Engineering Department has issued an internal report listing all formal publications produced by the Division during the calendar year.

80-1 ELECTRONICS ENGINEERING RESEARCH-FINAL REPORT FY 1979
UCID-18775, January, 1980

S. Weissenberger, Editor
A. S. Blum
H. S. Cabayan
J. V. Candy
L. Hatfield
R. J. Lytle
K. Mayeda
D. E. Miller
W. F. Rousseau
S. P. Swierkowski
R. E. Twogood
K. E. Vindelov

Computers
Decision Support Systems
Electromagnetics
Gallium Arsenide
Neutron Detectors
Remote Sensing
Signal Processing
Software Tools
Thin Films

Abstract

Accomplishments in Electronics Engineering Research (EER) during FY79 spanned a broad range of technologies, from high-speed microelectronics to digital image enhancement; from underground probing with electromagnetic waves to detecting neutrons with a small solid-state device; and from computer systems to aid engineers, to software tools to aid programmers. This report describes the overall EER program and its objectives, summarizes progress made in FY79, and outlines plans for FY80.

80-2 EMP COUPLING TO SHIPS
UCRL-52803, January, 1980

F. J. Deadrick
H. S. Cabayan
K. F. Kunz
R. M. Bevensee
L. C. Martin
R. W. Egbert

EMP
Scale Model Tests

Abstract

Scale-model tests were conducted to establish the adequacy and limitations of model measurements as tools for predicting electromagnetic pulse (EMP) coupling voltages and currents to the critical antennas, cables, and metallic structures on ships. The scale-model predictions are compared with the results of the full-scale EMP simulation test of the Canadian ASW ship, HMCS Huron. (The EMP coupling predictions in this report were made without prior knowledge of the results of the data from the HMCS Huron tests.)

This report establishes that the scale-model tests in conjunction with the data base from our EMP coupling modules* provides the necessary information for source model development and permits effective, low-cost study of particular system configurations.

*Module in this context denotes a self-contained package of information about the EMP response of a generic class of structures.

80-3 A JOINT GAUSSIAN PROBABILITY PLOT PROGRAM
UCID-18513, January, 1980

S. G. Azevedo
D. T. Gavel

Error Contour Plotting
Graphics
Parameter Estimation

Abstract

The analysis of joint-Gaussian distributions of two variables can be aided greatly by meaningful graphical techniques. The program described by this report performs such a task. Two elliptical equi-probability contour plots of the probability density function are produced; one using statistics from the raw data and the other using normalized (zero mean, unit variance) variables. Several separate data sets of the same variables may be plotted, for example, to compare estimators. The techniques discussed here for interpreting the plots enable the user to gain insight into the statistical information being displayed.

80-4 EFFICIENT DESIGN OF TWO-DIMENSIONAL RECURSIVE DIGITAL FILTERS
UCID-18819, January, 1980
Final Report for National Science Foundation Grant #ENG 78-04240

R. E. Twogood
S. K. Mitra

Two-dimensional Digital Filters
Two-dimensional Filter Implementations
Two-dimensional Filter Symmetry

Abstract

This report describes the work performed under NSF Grant ENG-78-04240. Seven different projects were addressed, each involving issues in the design and/or implementation of two-dimensional (2-D) digital filters. A brief discussion of each of these projects is given, including references to the technical publications which resulted from these studies.

80-5 DESIGN NOTES: SOLAR SURREY — L. D. Partain
LLL MISC. 00122, January, 1980

Solar Power Transportation

Abstract

The Solar Surrey is a solar cell powered electric vehicle that demonstrates a practical and useful solar energy system. In its first 18 months of operation, it has traveled over 1600 miles with more than 70 percent of its energy provided directly by the sun. It had a total purchase cost of $5500.

80-6 2-D DIGITAL SIGNAL PROCESSING WITH AN ARRAY PROCESSOR — R. E. Twogood
UCRL-83349, January, 1980
Presented at the 1980 IEEE International Conference on Acoustics, Speech, and Signal Processing, Denver, Colorado, April, 1980

Array Processing
Image Processing
Two-dimensional Fourier Transforms

Abstract

The applicability of array processor (AP) technology to 2-D digital signal processing is investigated in this paper. The AP-based image processing facility at LLL is described, with emphasis on our applications software package which utilizes the array processor.

Implementations of several key image processing algorithms are discussed and compared with other conventional processors, indicating that array processors are extremely cost-effective for image processing applications.

80-7 QUASI-FERMI LEVEL INTERPRETATION AS POTENTIAL ENERGY: DERIVATION OF GENERALIZED OHM'S LAW
UCRL-83737, January 2, 1980
Submitted to The Physical Review

L. D. Partain
J. F. Sheldon

Charge Transport
Quasi-fermi Level
Solid State

Abstract

A first principles derivation of the generalized Ohm's law is given that simultaneously treats the three driving forces of the current density equation for the first time, that provides an explanation of the negative Seebeck coefficient of n-type semiconductors independent of the Kelvin relation, and that gives a new and modified expression for the magnitude of the Seebeck coefficient. This latter property provides for an experimental test of the new predictions of the theory. The work also shows that quasi-Fermi energy is identical to potential energy and that carrier concentration gradients result in real physical forces being exerted on the free carrier ensemble. These latter properties provide consistent explanations for the terminal voltage of p-n diodes and solar cells, the non-measurable property of diffusion potentials, and the impetus for the alignment of quasi-Fermi levels in dissimilar materials. These latter considerations have been used for years to explain semiconductor phenomena but with justifications that were previously incomplete.

80-8 DEVICES FOR LAUNCHING 0.1-g PROJECTILES TO 150 km/s OR MORE TO INITIATE FUSION: PART 1, MAGNETIC-GRADIENT AND ELECTROSTATIC ACCELERATORS
UCRL-83729, January 9, 1980
Submitted to
Atomkernenergie/Kerntechnik

J. N. Brittingham

Fusion Accelerators
Magnetic Propulsion

Abstract

I studied the feasibility of using magnetic-gradient and electrostatic accelerators to launch a 0.1-g projectile to hypervelocities (150 km/s or more). Such hypervelocity projectiles could be used to ignite deuterium-tritium fuel pellets in a fusion reactor. For the magnetic-gradient accelerator, I explored several types of projectile: shield and

unshielded copper, ferromagnetic, and superconducting. My calculations revealed the superconducting projectile to be the best of those materials I studied. It would require a 3.2-km-long magnetic-gradient accelerator and achieve a 92% efficiency. Of the cases I studied, this accelerator-projectile combination would be the one most likely to launch a 0.1-g projectile to 150 km/s or more. I found the electrostatic accelerator to be impractical because of its excessive length of 23 km.

80-9 ON DEMONSTRATING BASIC ELECTROMAGNETIC PHENOMENA USING TIME-DOMAIN SOLUTIONS
UCRL-83893 Abstract, January 16, 1980

E. K. Miller
J. A. Landt
F. J. Deadrick
G. J. Burke

Electromagnetic Graphics
Time-domain Electromagnetics

Abstract

An especially valuable feature of transient electromagnetic solutions is the opportunity they provide for gaining insight into basic physical behavior. Concerning the direct time-domain treatment of wire objects, for example, we have found two kinds of data to be especially useful for this purpose when presented as contour plots. These are space-time contours of current and charge on the object, and angle-time contours of its far field. Current and charge contours exhibit the effects of phenomena such as radiation damping, dispersion, and reflection from impedance discontinuities. Far-field contours indicate the location from which radiation occurs on the object. In both cases, it is the property of time separation which makes possible these interpretations.

In this paper, contour plots are presented for a set of wire objects chosen for their suitability to illustrate fundamental properties of EM behavior. These objects include straight unloaded and loaded dipoles, a circular loop, wires with bends and junctions, and a conical spiral. The effects of varying an object's geometry (e.g., wire radius, bend angle, curvature) and electrical parameters (impedance load, time variation of the exciting field) are studied. Besides illustrating the qualitative understanding made available by contour plots like those presented, the possibility for also deriving quantitative results such as the frequency-dependent reflection coefficient for a wire bend are demonstrated.

80-10 ADDITIONAL RESULTS OF POLE-ZERO PATTERN SYNTHESIS
UCRL-83894 Abstract
January 16, 1980

D. M. Goodman
E. K. Miller

Electromagnetic Radiation
Pattern Synthesis
Pole-zero Modeling

Abstract

We have demonstrated previously (E. K. Miller and G. J. Burke, "Linear Array Synthesis Using Prony's Method," presented at the National Radio Science Meeting/Bioelectromagnetics Symposium, June 18-22, 1979) the use of pole-zero modeling for synthesizing line arrays of isotropic sources which produce specified radiation patterns. This approach requires no a priori choice of source locations (or aperture size), all of which, together with the complex source amplitudes, are outputs of the pole-zero model; only the number of sources needs to be selected. Source locations are provided by the poles and source amplitudes by the zeros, of the model.

One difficulty which arises in using this approach is that the poles, or source locations, can be complex. The occurrence of complex poles implies that directive sources are needed to produce the desired pattern. Thus, it is desirable that some way be found to constrain the poles to be purely imaginary without otherwise upsetting the synthesis procedure. A necessary, but sufficient, condition for the poles to be imaginary is that the characteristic equation (polynomial) from which the poles are obtained be self-inversive. A further extension which does guarantee imaginary poles is a method similar to Levinson recursion. Techniques such as these will be discussed concerning their application to pole-zero synthesis.

Several other aspects of pole-zero synthesis also remain to be explored. These included: (1) how best to specify the radiation pattern (e.g., amplitude and phase, amplitude and zero phase, magnitude only); (2) behavior of synthesized arrays with frequency and angle scanning; (3) effect of overdetermining the pattern-data matrix on achieving a pattern match; (4) applicability of the technique to other geometries such as circular arrays; (5) comparison of pole-zero synthesis with other methods. Recent results addressed to resolving such issues will be reported.

80-11 REVIEW OF ARTICLE "A CASE FOR SUBMICROSECOND RISE-TIME LIGHTNING CURRENT PULSES FOR USE IN AIRCRAFT INDUCED-COUPLING STUDIES" BY D. W. CLIFFORD, E. P. KRIDER AND M. A. UMAN
UCID-18871, January 17, 1980

H. S. Cabayan
J. E. Zicker

Coupling Effects
Electromagnetics
Lightning

Abstract

The paper summarizes the general consensus on the state-of-the-art in understanding lightning phenomenology as far as high frequency content is concerned.

80-12 ITERATIVE RAY TRACING BETWEEN BOREHOLES FOR UNDERGROUND IMAGE RECONSTRUCTION
R. J. Lytle
K. A. Dines
UCRL-83002, Rev. 1, January 23, 1980
Presented at the IEEE Transactions on Geoscience Electronics.

Electromagnetics
Geotomography
Image Reconstruction
Seismic Refraction

Abstract

A computerized method is described for calculating an image of the refractive index distribution in a plane bounded by two underground boreholes. The scanning geometry is assumed to be limited to probing from borehole to borehole, with rays at numerous depths and angles to effectively cover the cross section between holes. A geometrical optics model is assumed for the transmission data. We stress situations where significant bending of electromagnetic or seismic rays occurs. Image reconstruction involves an iterated sequence of numerical ray tracing and linear system inversion. A similar approach, discussed in the literature, sometimes fails to converge. We report here our refinements of this method, including use of a smoothness constraint.

80-13 ALTERNATE APPROACHES TO SYSTEM EMP RESPONSE ASSESSMENT
R. M. Bevensee
UCID-18522, January 25, 1980

EMP Assessment
Scale Model Tests

Abstract

The outlined assessment approaches of system EMP response as developed by LLL are based on either experimental low-level simulator excitation or surface current injection testing. The advantages and disadvantages compared to electromagnetic pulse (EMP) assessment techniques by other organizations are noted. Subthreat excitation of a full-scale system or of scale model on a transient electromagnetics facility is described. This assessment yields the linear external or internal response. A proposed procedure for surface current injection testing (SCIT)

of either a full-size or scale model system at the subthreat level or a full-size system at the threat level is discussed. The full-threat testing enables assessment of the system nonlinear internal response. Some of the modeling errors involved in the assessment of EMP response for a real system in a threat environment are briefly discussed.

80-14 DIRECT TIME-DOMAIN TECHNIQUES FOR TRANSIENT RADIATION AND SCATTERING FROM WIRES
UCRL-82322 Rev. 1, January 29, 1980
Submitted to Proceedings of IEEE

E. K. Miller
J. A. Landt

Integral Equations
Transients
Wire Modeling

Abstract

This is a brief tutorial introduction to transient electromagnetics, focusing on direct time-domain techniques. We examine physical, mathematical, numerical and experimental aspects of time-domain methods, with emphasis on wire objects excited as antennas or scatterers. Numerous computed examples illustrate the characteristics of direct time-domain procedures, especially where they may offer advantages over the more familiar frequency-domain techniques. These advantages include greater solution efficiency for many types of problems, the ability to handle nonlinearities, improved physical insight and interpretability, availability of wide-band information from a single calculation, and the possibility of isolating interactions among various parts of an object using time-range gating.

80-15 BLOCK ADAPTIVE FILTERING
UCRL-83931, February, 1980
Presented at the 1980 IEEE International Symposium on Circuits and Systems, Houston, Texas, April 28-30, 1980

G. A. Clark
S. K. Mitra
S. R. Parker

Adaptive Filtering
Block Filtering

Abstract

Block filtering implies the calculation of a block or finite set of filter outputs from a block of input values. A procedure for doing this with adaptive filters is developed along with

analyses of convergence properties and computational complexity. It is shown that the block approach can offer advantages in convergence speed, accuracy and computational complexity over conventional adaptive filtering techniques under the proper circumstances.

80-16 TWO-DIMENSIONAL RECURSIVE FILTER DESIGN--
A SPECTRAL FACTORIZATION APPROACH
UCRL-82130, Rev. 1, February, 1980
IEEE Trans. Acoustics, Speech, and Signal Procesing, Vol. ASSP-28, No. 1, February, 1980, pp. 16-26.

M. P. Ekstrom
R. E. Twogood
J. W. Woods

Nonlinear Optimization
Two-dimensional Digital Filters
Two-dimensional Spectral Factorization

Abstract

This paper concerns development of an efficient method for the design of two-dimensional (2-D) recursive digital filters. The specific design problem addressed is that of obtaining half-plane recursive filters which satisfy prescribed frequency response characteristics. A novel design procedure is presented which incorporates a spectral factorization algorithm into a constrained, nonlinear optimization approach. A computational implementation of the design algorithm is described and its design capabilities demonstrated with several examples.

80-17 A REPOSITORY POST-SEALING RISK ANALYSIS USING MACRO
UCRL-82236, February 14, 1980
Presented at the Waste Management '80 Symposium, March 10-14, 1980, Tucson, Arizona

A. M. Kaufman
L. L. Edwards
W. J. O'Connell

MACRO Computer Code
Nuclear Waste
Pollutant Transport
System Performance Assessment

Abstract

MACRO, a code to propagate probability distributions through a set of linked models, is currently under development at Lawrence Livermore Laboratory. An early version of this code, MACRO1, has been used to assess post-sealing dose to man for simple repository and site models based on actual site data.

80-18 EVALUATION OF THERMOMETRICS THERMISTORS FOR USE AT CRYOGENIC TEMPERATURES — W. J. Orvis
UCRL-84263, February 19, 1980
Submitted to Nuclear Instruments and Methods

Cryogenic Temperature
Thermistor

Abstract

Two types of Thermometrics, Inc. thermistors have been evaluated at cryogenic temperatures by calibrating them against a type T thermocouple. They are both bare bead thermistors types BB25JE350R and BB25JE020M. The resistance of the thermistors was measured using a Hewlett-Packard 3467A Logging Multimeter which uses a constant current method of resistance measurement. Favorable results were obtained for the second type of thermistor down to the boiling point of liquid nitrogen (-196° C) by decreasing the interrogation current of the multimeter. This decrease was necessary to minimize self-heating effects.

80-19 A NEW QUASISTATIC REPRESENTATION FOR HORIZONTAL MAGNETIC DIPOLES NEAR A LOSSY HALF-SPACE — J. N. Brittingham
UCRL-83836, Abstract, February 26, 1980

Lossy Earth
Maxwell's Equations
Quasi-static Approximations

Abstract

In a previous paper ["New Quasistatic Representation for Sommerfeld Integrals," J. N. Brittingham and G. J. Burke, URSI, National Meeting, June 18-22, 1979], a method was developed to find a more exact representation for the field from electric dipole near lossy half-spaces. This method consisted of separating the original Sommerfeld integrals into two separate parts. Near the interface, one part can be shown to dominate the other. This dominating term can be written analytically.

This paper will present the magnetic field from a horizontal magnetic dipole near a lossy half-space found from this new approach. The new results will be compared with work presented previously.

80-20 2-D FFTS OF LARGE IMAGES WITH THE AP-120B — R. E. Twogood
UCRL-83674, February 29, 1980
Presented at the 1980 Floating Point Systems Users Group Meeting, San Francisco, California, April 1980

Array Processing
Image Processing
Two-dimensional Fourier Transforms

Abstract

This paper investigates the issues involved in implementing a 2-D FFT on the FPS AP-120B array processor when the data memory available is less than the image size. After a brief review of the alternative techniques that have been proposed in the literature (with matrix transposition, without matrix transposition, vector radix), a recently developed "two-level" implementation is described. An analysis of the CPU and I/O requirements is given, showing that this algorithm is significantly superior to existing methods due to the reduced I/O requirements.

80-21 INSPECTION METHODS FOR PHYSICAL PROTECTION PROJECT: QUARTERLY REPORT, SEPTEMBER-NOVEMBER, 1979
UCID-18123-79-3, March, 1980
Prepared for U.S. Nuclear Regulatory Commission, Washington, D. C. 20555, NRC FIN No. A-0143

R. T. Bradley
D. D. Bowden
A. W. Olson
F. Rogue
J. W. Savage
S. Scala

IMPP
Physical Protection Inspection Methods

Abstract

This is the third quarterly report to the U.S. Nuclear Regulatory Commission (NRC) of progress at Lawrence Livermore Laboratory in the *Inspection Methods for Physical Protection* project. Besides presenting the activities and findings of the project's third quarter, this report details additional changes in the tasks and deliverables as requested by the NRC offices of Nuclear Regulatory Research (RES) and Inspection and Enforcement (IE).

80-22 INSPECTION METHODS FOR PHYSICAL PROTECTION PROJECT: QUARTERLY REPORT, MARCH-MAY, 1980
NUREG/CR-1610 Vol. 1 No. 1
UCID-18123-80-1
Prepared for U.S. Nuclear Regulatory Commission

D. D. Bowden
R. T. Bradley
A. W. Olson
F. Rogue
J. W. Savage
S. Scala
R. W. Thatcher

IMPP
Physical Protection Inspection Methods

Abstract

This is the fifth quarterly report to the U.S. Nuclear Regulatory Commission (NRC) on the progress at Lawrence Livermore National Laboratory (LLNL) in the Inspection Methods for Physical Protection (IMPP) project. Besides reporting on trips for field tests and data acquisition, the feasibility studies for field evaluation of procedures, and the progress of the E-field intrusion detector training film, the report details the production status of the 23 procedures in the draft module 81100 replacement series already delivered to NRC and the status of 28 procedures now being written for transportation of irradiated fuel and for possession and use of formula quantities of strategic special nuclear materials (SSNM).

80-23 THE INSIDER THREAT TO SECURE FACILITIES--A SYNOPSIS OF NINE INTERVIEWS

R. S. Schechter

UCRL-52729, March, 1980
Prepared for SAFER U.S. Nuclear Regulatory Commission, Washington, D. C. 20555, NRC FIN No. A0132

Insider Adversaries
Nuclear Safeguards

Abstract

A series of nine interviews was conducted with recognized experts in the field of institutional internal security, for the purpose of gaining insight into the insider threat to nuclear facilities. The results of these interviews included the defining of fundamental problems in internal security, the identification of typical bases of conspiracy formation, and the naming of possible options for improving the quality of nuclear safeguards, both through personnel policies and internal controls.

80-24 THE SAFEGUARD VULNERABILITY ANALYSIS PROGRAM (SVAP)

F. M. Gilman
M. H. Dittmore
W. J. Orvis
P. S. Wahler

UCRL-82244 Abstract/Summary, March 4, 1980
Presented at the Institute of Nuclear Materials Management Twenty-first Annual Meeting, Palm Beach, Florida, June 30-July 2, 1980

SVAP

Abstract

This report gives an overview of the Safeguard Vulnerability Analysis Program (SVAP, developed at Lawrence Livermore National Laboratory. SVAP was designed as an automated method of analyzing the safeguard systems at nuclear facilities for vulnerabilities relating to the theft or diversion of nuclear materials. SVAP addresses one class of safeguard threat: theft or diversion of nuclear materials by nonviolent insiders, acting individually or in collusion.

SVAP is a user-oriented tool which uses an interactive input media including a data handbook and mini-computer for preprocessing the large amounts of safeguards data. Its output includes concise summary data as well as the detailed vulnerability information. The paper discusses the unique elements of the SVAP methodology including an overview of the input phase, processing phase, and output phase.

SVAP has been applied in the assessment of two licensed facilities. Representative results and their interpretation are presented.

80-25 THE STRUCTURED ASSESSMENT APPROACH A PROCEDURE FOR THE ASSESSMENT OF FUEL CYCLE SAFEGUARD SYSTEMS

A. A. Parziale
C. J. Patenaude
P. A. Renard
I. J. Sacks

UCRL-82222, March 6, 1980
Presented at the 2nd Esarda Symposium on Safeguards and Nuclear Materials Management, Edinburgh, Scotland, March 26-28, 1980

Computational Assessment
Nuclear Safeguards
Safeguards Assessments

Abstract

Lawrence Livermore National Laboratory has developed and tested for the United States Nuclear Regulatory Commission a procedure for the evaluation of Material Control and Accounting (MC&A) Systems at Nuclear Fuel Facilities. This procedure, called the Structured Assessment Approach, SAA, subjects the MC&A system at a facility to a series of increasingly sophisticated adversaries and strategies. A fully integrated version of the computer codes which assist the analyst in this assessment was made available in October, 1979. The concepts of the SAA and the results of the assessment of a hypothetical but typical facility are presented.

80-26 PARAMETER IDENTIFICATION IN GROUNDWATER FLOW: A FEASIBILITY STUDY
UCID-18575, March 11, 1980

S. G. Azevedo
T. A. Doerr
J. V. Candy
K. D. Pimentel

Groundwater Model
Model Order Reduction
Parameter Estimation

Abstract

A set of first-order differential state equations is developed from taking finite differences of the partial differential equation that describes groundwater flow during a pump-drawdown test. The number of states in the model is a direct function of the number of discrete spatial segments used in the approximate model. This number of states is studied to determine a reasonably low-order model that preserves the accuracy of resulting simulations when compared with an available analytical solution. The resulting reduced-order model is then used in an extended Kalman filter for combined state and parameter estimation. This report summarizes work done in a recent pilot study to demonstrate the feasibility of these techniques in groundwater research and points the way toward other approaches to this problem area now under study.

80-27 IN-SITU MEASUREMENTS OF HIGH FREQUENCY CONDUCTIVITY AND PERMITTIVITY OF OIL SHALE
UCRL-84306, March 17, 1980
Submitted to Mining Engineering

E. F. Laine
R. J. Lytle

Cross-borehole Probing
Electromagnetic Probing
In-situ Oil Shale

Abstract

The in-situ electrical conductivity and permittivity of Colorado oil shale were recently measured. The measurements were made by transmitting a high frequency electromagnetic signal from one borehole to adjacent boreholes arranged in line. The in-situ electrical conductivity and permittivity were then calculated from transmission measurements from the transmitter borehole to two receiver boreholes spaced in a line away from the transmitter borehole. The differential signals between the two receiver boreholes were used in our calculation.

80-28 SAFEGUARDS RESEARCH AT LAWRENCE LIVERMORE LABORATORY
UCRL-82224, March 20, 1980
Presented at the 2nd Annual Symposium on Safeguards and Nuclear Material Management, Edinburgh, Scotland, March 26-28, 1980

D. R. Dunn
J. G. Huebel
A. J. Poggio

Material Control & Accounting
Physical Protection Inspection Methods
Safeguards Assessments

Abstract

The safeguards research program at Lawrence Livermore Laboratory is reviewed. Each of the major projects is described as are their goals and progress. The breadth and scope of the program is clearly delineated.

80-29 REAL TIME LOSS DETECTION FOR SNM IN PROCESS
UCRL-82225, March 20, 1980
Presented at the 2nd Annual Symposium on Safeguards and Nuclear Material Management, Edinburgh, Scotland, March 26-28, 1980

J. V. Candy
D. R. Dunn
D. T. Gavel

Material Estimation
On-line Detectors
Safeguards Design

Abstract

In this paper we discuss the basis of a design for real time special nuclear material (SNM) loss detectors. The design utilizes process measurements and signal processing techniques to produce a timely estimate of material loss. A state estimator is employed as the primary signal processing algorithm. Material loss is indicated by changes in the states or process innovations (residuals). The design philosophy is discussed in the context of these changes.

80-30 SEPLOT--A POST PROCESSOR PROGRAM FOR STATE ESTIMATION CODES
UCID-18617, March 30, 1980

D. L. Lager
S. G. Azevedo

Graphics
Kalman Filter
State Estimation

Abstract

The computer program SEPLOT is described which reads data files produced by Kalman filter state estimation codes and produces time history plots of states, coveriances, measurements, forcing functions, etc. Plots are also made of various performance measures of the filter such as the estimation error and innovations whiteness. The format of the data files and the command language for SEPLOT are given. SEPLOT executes on the CDC7600 and can be used in a batch or teletype interactive mode.

80-31 SAFEGUARD VULNERABILITY ANALYSIS PROGRAM (SVAP) DATA-GATHERING HANDBOOK VOLUME I UCRL-52731, Vol. I, April, 1980 — P. S. Wahler

SVAP
Vulnerability Safeguards

Abstract

The data-gathering procedure for Safeguard Vulnerability Analysis Program (SVAP) is demonstrated on a simplified, hypothetical nuclear facility. Data typical to any safeguard assessment are gathered from the facility and entered in the handbook--an example of which makes up the appendix of this report--in response to a sequence of questions. The data so gathered are then rearranged in the second part of the handbook--a process called recording. The recorded data are in a form suitable for entering on a Tektronix 4051 computer keyboard. In a subsequent phase of SVAP, computer programs return results to the analyst on vulnerabilities in the facility's safeguard system.

80-32 SAFEGUARD VULNERABILITY ANALYSIS PROGRAM (SVAP) DATA-GATHERING HANDBOOK VOLUME II UCRL-52731, April, 1980 — P. S. Wahler

SVAP
Vulnerability Safeguards

Abstract

The purpose of this volume is to provide the safeguards analyst with prototypes of the forms used in a SVAP analysis. These forms are essential to an accurate, well-organized, and well-recorded study of a facility's safeguard system. Copies of these forms may be made by the analyst as needed; the number of copies required depends on the facility's size and the number of safeguards components. For example, if a facility has thirty monitors, then the analyst will need thirty monitor data-collection forms.

A cover sheet has been added to the forms to help identify the separate assessments and record for quick reference certain details of each assessment.

The function of each of the forms is fully described in the SVAP Data-Gathering Handbook, Volume I.

80-33 SAFEGUARD VULNERABILITY ANALYSIS PROGRAM (SVAP) EXECUTIVE SUMMARY
UCRL-52724, April, 1980
Prepared for SAFER, U.S. Nuclear Regulatory Commission, Washington, D. C. 20555, NRC FIN No. A-0115

F. M. Gilman
M. H. Dittmore,
W. J. Orvis
P. S. Wahler

SVAP
Vulnerability Safeguards

Abstract

The steps involved in making a Safeguard Vulnerability Analysis Program (SVAP) application to a nuclear facility are summarized. NRC analysts are expected to execute SVAP on nuclear facilities, to check facility safeguard systems for soundness, and to reveal vulnerabilities, if any. The ultimate objective is to create safeguard systems that will effectively deter theft or diversion of special nuclear materials. The Input Phase of a SVAP application consists of data-gathering, data-recording in an handbook, and data-entering into a Tektronix computer. At that point, the facility data are transferred to a main frame computer for processing, and in the Output Phase, the main frame computer delivers a complete descriptive analysis of the facility's safeguard system, disclosing its vulnerabilities.

80-34 PRELIMINARY ASSESSMENT OF THE ELECTROMAGNETIC ENVIRONMENT IN THE IMMEDIATE VICINITY OF THE ETA ACCELERATOR
UCID-18631, April 1980

H. S. Cabayan
E. J. Bogdan
J. E. Zicker
D. M. Wythe
G. J. Burke

E-beam
EMC
EMP

Abstract

The electromagnetic fields in the immediate vicinity of the Experimental Test Accelerator (ETA) at the Lawrence Livermore Laboratory have been characterized. Various EM sensors that cover the frequency band from the very low frequencies up into the GHz region have been used. The report describes in detail the probes, the test set-up and the data processing techniques.

80-35 DASLL (DESIGN AUTOMATION SYSTEM AT LAWRENCE LIVERMORE) USER'S REFERENCE MANUAL
UCID-18741, April, 1980

W. G. Magnuson, Jr.
G. W. Willett

Design Automation
Printed Circuit Board Layout
Routers

Abstract

This manual shows how to use the DASLL system to lay out printed circuit boards using the OCTOPUS CDC 7600 computer system and other equipment at Lawrence Livermore Laboratory. This information also will be found very useful for those converting or analyzing the DASLL system.

80-36 REACTIVELY SPUTTERED THIN FILM Cu_xS/CdS PHOTOVOLTAIC DEVICES
UCID-18592, April 2, 1980

L. D. Partain
G. A. Armantrout
J. H. Yee
J. Y. Leong
D. Okubo

Reactive Sputter
Solar Cells
Thin Films

Abstract

Analytical and theoretical advances over the past year have provided the first determinations of several crucial transport parameters for sputtered Cu_xS/CdS solar cells that indicate that device behavior is dominated by entirely different physical mechanisms than previously considered and that further efforts to control and improve performance should focus in new directions. The characterization capabilities extended to measure sputtered film properties have shown that several anticipated variations do not take place and that important unanticipated effects play primary roles. This has first order implications for the fundamental problems of fabrication reproducibility and device stability. This work can be summarized with nine key questions listed in the paper and by the indicated brief answers that directly follow. These answers are of varying degrees of completeness. The details are given in the body of the report.

80-37 ULTRATHICK PHOTORESIST PROCESSING
UCRL-83587, April 3, 1980
Semiconductor Microlithography V
Society of Photo-Optical Instruments Engineers, San Jose, California, March 17-18, 1980

D. R. Ciarlo
N. M. Ceglio

Electroplating
Photo Resist
Zone Plate

Abstract

Diazo-type positive photoresists are commonly used for pattern replication by the integrated circuit industry in a thickness range ≈ 0.3-3μm. We are using these same resists at thicknesses as great as 40μm to form electroplating molds for the fabrication of micro-Fresnel zone plates. Difficulties are encountered when films thicker than 15-18μm are used for pattern replication. Most significant of these difficulties are: i) the occurrence of bulk microfractures throughout the resist volume, ii) loss of UV sensitivity, and iii) sidewall taper in high aspect ratio structures. These difficulties, with the exception of the sidewall taper, can be overcome with appropriate resist processing schedules.

80-38 GEOTOMOGRAPHY APPLIED AT THE STRIPA MINE IN SWEDEN
UCRL-52961, April 7, 1980

J. T. Okada
E. F. Laine
R. J. Lytle
W. D. Daily

Electromagnetic Probing
Geophysics
Geotomography
Nuclear Waste

Abstract

LLNL made ultrahigh-frequency (450-MHz) electromagnetic borehole-to-borehole transmissions in the Stripa Mine near Guldsmedshyttan, Sweden, in April 1979. Transmission loss measurements were made between four sets of 76-mm boreholes 30 m long, located at the end of a drift. Distances between the boreholes varied from 2 to 22 m. More than 25,000 data points were taken. A geotomograph was constructed to show the variation of attenuation between boreholes. The observed spatial variation of electromagnetic attenuation may be related to the expected stress relief created by the mine. Transmission loss measurements were also made between two converging boreholes drilled from the surface to points near the mine. Data taken at 21 MHz show a nearly uniform attenuation within this sampled region. These experiments demonstrate that geotomographic data collection/interpretation provides high-resolution images of the underground environment and can provide useful input to those charged with providing the detailed site characterizations needed for both shortand long-term monitoring of underground nuclear waste repositories.

80-39 COMPUTER GRAPHICS APPLICATIONS IN ELECTROMAGNETIC COMPUTER MODELING
UCRL-84540
Presented at The Institution of Electrical Engineers Second International Conference Antennas and Propagation, University of York, UK (England) April 13-16, 1981

E. K. Miller
J. A. Landt
F. J. Deadrick
G. J. Burke

Computer Modeling
Electromagnetics
Graphics

Abstract

The use of computer graphics as an integral part of the solution process in electromagnetic computer modeling is as yet relatively undeveloped. In this paper we consider how and in what ways computer graphics might be employed in EM modeling. First, we summarize plotting quantities, variables, and formats that can be used. Then, we provide a selection of representative examples to illustrate various graphics applications. It is our hope to stimulate increased attention to an area that we believe can contribute significantly to the more effective use of computer modeling.

80-40 ELECTROMAGNETIC EMISSION FROM ACCELERATORS AND ELECTRON BEAMS
UCRL-84305, April 15, 1980

H. S. Cabayan
J. E. Zicker

Accelerators
Electromagnetic Effects
Electron Beams

Abstract

As the use of electron beam accelerators increases, issues of electromagnetic compatibility will have to be looked into. In this paper, we describe an experimental program that was conducted to measure the electromagnetic emissions from a 5 MeV Experimental Test Accelerator (ETA) at the Lawrence Livermore Laboratory. In addition, estimates will be presented of ionizing and non-ionizing radiation from a 5 MeV electron beam in air.

As part of the experimental program, a variety of EM probes have been used that cover the frequency band from the very low (kHz) to the very high frequencies. In addition to the results of the measurements, the various probes and their EM characteristics will be described.

This accelerator when completed will produce a 5 MeV electron beam that can travel a certain distance in air. This beam is accompanied by a photon shower of high intensity and local electromagnetic fields. In addition, radiated fields are produced. Estimates of amplitudes of both ionizing and non-ionizing fields will be derived.

These fields from the accelerator and the electron beam are a necessary input when shielding design are being considered both for diagnostic equipment and for the protection of other nearby electronic equipment.

80-41 NOISE CHARACTERIZATION OF THE LINEAR CCD — C. F. McConaghy
UCID-18622, May, 1980

Charge-related Noise
Output Noise
System Noise

Abstract

This report summarizes work done in evaluating the noise performance of the linear CCD. The noise determines the minimum amplitude signal the CCD is capable of capturing and, therefore, is one of the prime parameters in determining dynamic range. The noise after correlated double sampling and correction of some ground loops will be shown equivalent to 150 rms electrons at the floating diffusion sensor on the CCD.

80-42 VERIFICATION OF TIMING CONSTRAINTS ON LARGE DIGITAL SYSTEMS — T. M. McWilliams
UCRL-52995, May, 1980
(Ph.D. Thesis)

Design Verification
Digital Systems
Hierarchical Design
Logic Simulation
Timing Constraints

Abstract

A new approach to the verification of timing constraints on large digital systems has been developed. The assosicated algorithm is computationally efficient, and provides early and continuous feedback about the timing aspects of synchronous sequential circuits as they are designed. It also provides means for conveniently verifying the design section-by-section for designs which are too large to examine as a unit.

This approach is new in that it uses a "stable value" to represent signals in the large majority of instances in which it is unnecessary to know whether the signals are true or false in order to examine satisfaction of the timing constraints. For the remaining instances, it represents the full value behavior of signals, allowing it to evaluate compliance with the remaining timing constraints. This use of the "stable value" greatly reduces the number of states through which a digital system needs to be taken in the process of verifying its timing constraints, which in turn greatly reduces the amount of computing effort required, relative to that needed to verify the timing constraints via more traditional logic simulation. Not needing to know the values of most signals also greatly reduces the size of the data base needed to drive the verification process, relative to that required in doing logic simulation. Both of these savingss are of exponential order. This approach thus makes feasible for the first time the exhaustive examination of complex digital circuits for satisfaction of timing constraints.

A system has been implemented using this approach which takes a digital logic design specified in the SCALD Hardware Description Language, and verifies all of the timing constraints specified within it. This system has been used in the design of a very high performance central processing unit, the S-1 Mark IIA processor. The use of the Timing Verifier allowed timing errors to be identified early in the design process, while it was still easy to correct them. Such timely error elimination has permitted the design to be completed more rapidly, and has also supported the creation of a design which will perform more rapidly without timing errors, when it is implemented in hardware.

80-43 *SIMPLIFIED GROUNDWATER FLOW MODELING: AN APPLICATION OF KALMAN FILTER BASED IDENTIFICATION*
UCRL-82649, May, 1980
Published in the Proceedings of the International Federation of Information Processing Working Conference on Simulation and the Environment, Bangor, North Wales, September 18-20, 1979

K. D. Pimentel
J. V. Candy
S. G. Azevedo
T. A. Doerr

Distributed Kalman Filter
Groundwater Model
Parameter Estimation

Abstract

The need exists for methods to simplify groundwater contaminant transport models. Reduced-order models are needed in risk assessments for licensing and regulating long-term nuclear waste repositories. Such models will be used in Monte Carlo simulations to generate probabilities of nuclear waste migration in aquifers at candidate repository sites in the United States.

In this feasibility study we focused on groundwater flow rather than contaminant transport because the flow problem is more simple. A pump-drawdown test is modeled with a reduced-order set of ordinary differential equations obtained by differencing the partial differential equation. We determined the accuracy of the reduced model by comparing it with the analytic solution for the drawdown test. We established an accuracy requirement of 2% error at the single observation well and found that a model with only 21 states satisfied that criterion. That model was used in an extended Kalman filter with synthesized measurement data from one observation well to identify transmissivity within 1% error and storage coefficient within 10% error. We used several statistical tests to assess the performance of the estimator/identifier and found it to be satisfactory for this application. This feasibility study highlighted problems known to others who have attempted to apply modern systems methods to hydrological problems and has led to related research studies at our laboratory.

80-44 COMPUTER MODELING OF ANTENNAS NEAR THE GROUND
UCID-18626, May 13, 1980

G. J. Burke
E. K. Miller
J. N. Brittingham
D. L. Lager
R. J. Lytle
J. T. Okada

Antennas Near Ground
Computer Modeling
Sommerfeld Problem

Abstract

An accurate and efficient numerical method based on the rigorous Sommerfeld theory is described for modeling antennas near an interface such as the ground. The Sommerfeld integrals are evaluated by numerical integration along contours in the complex plane and two-dimensional interpolation is used subsequently to obtain the many Sommerfeld integral values needed for the moment-method solution of an integral equation. These methods permit modeling an antenna within 10-6 wavelengths of the ground for about two to four times the computation time for the same antenna in free space. Results showing currents and radiation patterns are included.

80-45 ENGINEERING RESEARCH DIVISION REPORT ON REPORTS 1979 — E. K. Miller
UCID-18728, June, 1980

Abstract

This is an internal report listing all formal publications produced by the Engineering Research Division of the Electronics Engineering Department during calendar year 1979.

80-46 INVESTIGATIONS INTO THE ELECTRONIC PROPERTIES OF EMERGING SOLAR CELL MATERIALS — W. J. Orvis, J. H. Yee
UCRL-84560, Abstract, June, 1980
Presented at the CUBE Symposium, Lawrence Livermore National Laboratory, Livermore, California, October 22-24, 2980

Computers
Solar Cells
Solid State

Abstract

As part of our theoretical investigations of solar cells, we need to know the electronic properties of the crystalline materials of which they are made. These properties include: energy band structure, absorption coefficient, dielectric constant, carrier lifetime, reduced masses and mobilities. Since our investigations are into the emerging solar cell materials (i.e., $ZnSnP_2$, BAs, Zn_3P_2), little or no data is available as to these electronic properties.

Starting from first principles, we generate and solve the Hamiltonian equation of motion for an electron in the crystalline solid. Once solved, we use the results to calculate the other crystalline properties listed above. As a final calculation, we determine the operating parameters (i.e., efficiency and I-V characteristics) of a solar cell made with these materials.

80-47 GEOTOMOGRAPHY APPLIED TO NUCLEAR WASTE REPOSITORY SITE ASSESSMENT — R. J. Lytle, J. T. Okada, E. F. Laine
Abstract/Viewgraph presentation
URSI/Quebec City, Canada, June, 1980

Electromagnetic Probing
Geophysics
Geotomography
Stress Relief

Abstract

Electromagnetic borehole-to-borehole transmissions were mac in the Stripa Mine near Buldsmedshyttan, Sweden in April 1979 Transmission loss measurements were made between five sets of 76 mm boreholes 30 meters long located at the end of a drift. Spacings of the boreholes varied from 2 meters to 20 meters. Greater than 25,000 data points were taken. A geotomography was constructed to show the variation of attenuation between boreholes. The observed spatial variation of electromagnetic attenuation appears to be consistent with the expected stress relief created by the mine. Transmission loss measurements were also made between two boreholes drilled from the surface to near the mine. Data taken at 21 MHz shows the nearly uniform attenuation character of this sampled region. These experiments demonstrated that geotomographic data collection/interpretation provides high resolution images of the underground environment. These experiments have indicated that geotomographic remote probing procedures can provide useful input to those charged with providing the detailed site characterizations needed for both short and long term monitoring of underground nuclear waste repositories.

80-48 ELECTRONIC AND OPTICAL PROPERTIES OF POLYCRYSTALLINE Cu_xS and Cu_xS/CdS Solar Cells
UCRL-83761, June, 1980
Submitted to Journal of Electrochemical Society

J. Y. Leong
L. D. Partain
J. H. Yee

Cu_xS/CdS Solar Cells
Polycrystalline Cu_x

Abstract

Polycrystalline thin film Cu_xS and Cu_xS/CdS solar cells were prepared by a reactive sputtering process. The optical absorption spectrum of the Cu_xS, derived from transmittance and reflectance data, identified an indirect gap at 1.16 eV and a direct gap at 1.31 eV. Hole concentration and mobility in the p-type films from 80OK to 300OK were determined to vary over the 10^{18} to 10^{19} cm^{-3} and the 5 to 9 cm^2/V-sec ranges, respectively, by Hall effect studies. The temperature dependence of the mobility was fitted to ionized impurity and polar optical phonon scattering. Minority carrier diffusion lengths of 0.26μm in Cu_xS and 0.43μm in CdS, a space-charge-region collection efficiency of 50%, and a Cu_xS surface recombination velocity of 1.0 times the diffusion velocity were measured by a non-destructive SEM-EBIC technique.

80-49 ANTENNA DESIGN FOR GEOPHYSICAL APPLICATONS — H. M. Buettner
Presented at URSI/Quebec, Canada, June, 1980

Directional Antenna
Geophysical Probes

Abstract

Electrically short, highly directional antennas can be very useful for down-hole, electromagnetic probing of geophysical features. The electrical shortness of the antennas enables one to resolve fine subsurface features, while the directionality improves system signal to noise ratio and enables one to locate subsurface anomalies from a single borehole. This presentation outlines the results of work which has produced electrically short, directional antennas operating in the 10 to 200 MHz region for use in a borehole environment.

80-50 COMMENTS ON THE PAPER: "RESOLUTION OF COHERENT SOURCES INCIDENT ON A CIRCULAR ANTENNA ARRAY" BY M. P. MOODY — E. K. Miller
UCRL-84466, June 2, 1980
Proceedings of the IEEE

Array Antennas
Pole-zero Modeling
Prony's Method

Abstract

In the above paper, a technique is presented for using a circular array of N equally spaced antennas to obtain the azimuths and strengths of M ($M \leq N/2$) far-field sources. The procedure involves two basic steps: 1) use of a FFT (assuming N is a power of 2) to transform the N individual antenna-element strengths; 2) solution of an Mth-order linear system composed of the transformed data to find the coefficients of an Mth-order polynominal whose roots provide the azimuth angles.

80-51 A MAXIMUM ENTROPY INVERSTION OF UNDERGROUND ELECTROMAGNETIC AND SEISMIC DATA — R. M. Bevensee
UCRL-85611,
Presented at the URSI and IEEE/AP-S International Symposium, Quebec, Canada, June 2-6, 1980

Entropy
Inverse Electromagnetic and Seismic Methods

Abstract

Solutions of underdetermined problems of data inversion to obtain underground parameter profiles of dielectric constant, wave velocity, or conductivity are described in the context of the "First Principle of Data Reduction" (J. G. Ables), to the effect that data processing shall be maximally noncommittal relative to unavailable data. The ME solution for a two-dimensional subsurface profile from cross borehole measurements is described. The most probable parameter distribution in square cells is obtained, subject to the constraints of fixed total amount of parameter and the observed ray data. The ME method reveals unexpected capability for locating anomalies in vastly underdetermined situations.

80-52 CURRENT TRANSPORT IN LOSSY HETEROJUNCTIONS: THEORY AND SEM EBIC DATA ON Cu_xS/CdS — L. D. Partain

UCRL-84481, June 4, 1980
Submitted to the Journal of Applied Physics

Current Transport
Cu_xS/CdS
Lossy Hetrojunction
Solar Cells

Abstract

A theoretical treatment has been developed to describe the current transport properties of junctions where the losses of minority carriers and their energy are so strong that the device characteristics are significantly modified. It is shown that three dimensional problems can be treated with one-dimensional analysis without loss of generality as long as samples with planar geometry are considered. One-dimensional analysis of the lossy junction case shows that the behavior can be described in terms of a velocity v* that is characteristic of charge transport through the junction region and that direct loss of device terminal voltage results from junction recombination. When v* is on the order of, or less than the diffusion velocity, suppression of current, as described by junction collection efficiency, is predicted. Analysis of EBIC data measured on a polycrystalline Cu_xS/CdS heterojunction indicated that this junction collection efficiency varied between 10 and 80 percent during 180°C heat treatment in a hydrogen-argon ambient gas. Similar results were found for single crystal Cu_xS/CdS samples treated at 120°C and 200°C in air.

80-53 DOE WORKSHOP ON DESIGN AUTOMATION AND COMPUTER AIDED DESIGN
UCID-18649, June 10-11, 1980

W. G. Magnuson, Jr.

Computer-aided Design
Design Automation

Abstract

The aims and objectives in organizing this two-day workshop were to discuss the needs, activities, and plans for DA and CAD of engineering systems within the DOE laboratories and major DOE contractors. The intent has been to provide a forum to exchange information and ideas and to foster DA/CAD communications among DOE laboratories and contractors. It is hoped that by sharing experiences and future plans, the DOE community would be better able to identify problem areas so that research and development in DA and CAD can be better organized, supported, and made available.

80-54 EVALUATING PHYSICAL PROTECTION SYSTEMS OF LICENSED NUCLEAR FACILITIES USING SYSTEMS ENGINEERED INSPECTION GUIDANCE
UCRL-82248, June 23, 1980
Presented at the INMM Conference
Palm Beach, Florida, June 30,
July 1-2, 1980

R. T. Bradley
A. W. Olson
R. Rogue
S. Scala

IMPP
Physical Protection Inspection Methods

Abstract

The Lawrence Livermore National Laboratory (LLNL) and the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Regulatory Research (RES) have applied a systems engineering approach to provide the NRC Office of Inspection and Enforcement (IE) with improved methods and guidance for evaluating the physical protection systems of licensed nuclear facilities.

80-55 INSPECTION METHODS FOR PHYSICAL PROTECTION PROJECT:
QUARTERLY REPORT, JUNE-AUGUST, 1980
NUREG/CR-1610, Vol. 1, No. 2
UCID-18123-80-2
Prepared for U.S. Nuclear Regulatory Commission

D. D. Bowden
R. T. Bradley
C. Minichino
A. W. Olson
F. Rogue
J. W. Savage
R. W. Thatcher

IMPP
Physical Protection Inspection Methods

Abstract

This is the sixth quarterly report to the U.S. Nuclear Regulatory Commission (NRC) on the progress at Lawrence Livermore National Laboratory (LLNL) in the Inspection Methods for Physical Protection (IMPP) project. Besides reporting on one data-gathering trip, the evaluation methodology for use by physical protection inspectors in the field, and the progress of the E-Field intrusion detector training film, the report details the production status of the procedures in the replacement modules for physical protection of power reactors, nonpower/research reactors, SSNM fixed sites, and transportation of special nuclear materials.

80-56 CHARACTERIZATION OF MATERIAL DEFECTS FROM SCATTERED ULTRASONIC SIGNALS
July, 1980

B. W. Maxfield
E. K. Miller
J. L. Opsal
G. D. Poe

Defect Characterization
Signal Processing
Ultrasonic NDE

Abstract

We propose a program of research on elastic wave scattering theory and signal processing for application to nondestructive evaluation (NDE). While some of our elastic wave scattering work will be concerned with finding solutions to interesting unsolved direct scattering problems, our major goal will be to develop useful and efficient inversion algorithms for ultrasonic NDE application. Eliminating unwanted signals and noise from a set of ultrasonic test data and subsequent processing to extract pertinent information is, of course, an essential prerequisite to actually applying any inversion scheme. A significant part of our effort will, therefore, be to develop improved signal processing methods for ultrasonic NDE. Among other things, this will include investigating the feasibility of extending to ultrasonics existing techniques in electromagnetics based on resonances which are independent of a target's excitation.

80-57 MXLKID, A MAXIMUM LIKELIHOOD PARAMTER IDENTIFIER
UCID-18744, July, 1980

D. T. Gavel

Maximum Likelihood
Parameter Identification
System Identification

Abstract

MXLKID (MaXimum LiKelihood IDentifier) is a computer program designed to identify unknown parameters in a nonlinear dynamic system. Using noisy measurement data from the system, the maximum likelihood identifier computes a likelihood function (LF). Identification of system parameters is accomplished by maximizing the LF with respect to the parameters.

In the main body of this report, we briefly summarize the maximum likelihood technique and give instructions and examples for running the MXLKID program. MXLKID is implemented in LRLTRAN on the CDC7600 computer at LLNL. We include a detailed mathematical description of the algorithm in the appendices.

80-58 SEAS--A STATE ESTIMATION ALGORITHM FOR SMALL-SCALE SYSTEMS — S. G. Azevedo
UCID-18743, July 17, 1980

Kalman Filter
State Estimation

Abstract

In this report, we discuss the computer code SEAS (State Estimation Algorithm for Small-Scale Systems) written in FORTRAN IV. SEAS is a first-generation program developed at the Lawrence Livermore National Laboratory to calculate state estimates of a linear dynamic system from noisy measurement data. The SEAS code is available on both PDP11/70 and CDC-7600 computers (called SEASUD on OCTOPUS). A formatted output data file is generated for a plotter/post-processor (SEPLOT [3] on OCTOPUS; SEPL [Appendix C] on PDP11/70). This post-processor file contains the state estimates and other filter-generated quantities.

SEAS is a compact implementation of a sophisticated on-line state estimation algorithm: a computationally stable version of the linear Kalman filter for small word-length computers. The program is modular in design to facilitate straight-forward interfacing with user-supplied subroutines.

This user's manual describes the algorithm, program structure, operation, special features, and the various problems which SEAS can solve. SEAS is applied to a simple linear example and graphical outputs are presented. The program is easily adaptable to solve estimation problems involving multiple-input and/or multiple-output systems of varying dimension. The case of correlated process or measurement noise statistics can also be solved.

A linear system simulation code (SEASIM) was developed concurrently on the CDC-7600 to provide input for SEAS. In addition, a stabilized linear Kalman filter program (SEALKF) was also developed for testing SEAS output. These have both become excellent design tools and are described in Appendices A and B.

80-59 COLLECTION AND PROCESSING TECHNIQUES FOR HIGH SPEED TRANSIENT EM DATA
UCRL-84377 Abstract,
Presented at 1980 NEM Conference,
August, 1980

J. E. Zicker

Signal Processing
Transient Signals

Abstract

Instrumentation that can digitize analog signals with frequencies into the Gigaherz range has proved useful in acquiring transient electromagnetic field data. The digital processing of this type of data requires knowledge of signal processing techniques, the acquisition instrumentation and the characteristics of the experiment. The results of this combination of specialties are several data processing algorithms that prove useful in analyzing transient electromagnetic data. Some of the methods used are digital filtering and least mean squares estimation.

The acquisition instrumentation tends to introduce measurement noise and spurious data points. The measurement noise can, for example, drastically affect the various methods of estimating the frequency spectra from the time domain data. One parameter estimation technique may work well for one problem and poorly for another.

We present the practical methods and the techniques gained from experience on two different problems. The two problems both involved the measurement of transient electromagnetic fields. The data was collected with two different acquisition systems. In both cases we were able to reliably eliminate or compensate for the unwanted effects introduced by the acquisition instrumentation through improved experimental or signal processing techniques. We concentrate primarily on the estimation of the frequency spectrum.

80-60 CRYOTRAPPING VACUUM PUMPING SYSTEM DESIGN FOR A HELIUM NEUTRAL BEAM INJECTOR
UCRL-84006 Rev. 1, August, 1980
Submitted to Nuclear Technology

M. A. Hoffman
A. S. Blum

Helium Cryotrapping
Neutral Beams
Vacuum System

Abstract

The conceptual design of a vacuum pumping system to handle a large gas flow on the order of 2.31 Pa-m^3/s (17.3 std Torr-litre/s) of helium gas in the pressure range from about 3.1 x 10^{-2} down to 4.0 x 10^{-4} Pa (2.3 x 10^{-4} down to 3 x 10^{-6} Torr) is described. The neutral helium gas originates partly as leakage from the plasma ion source and partly as additional gas required in the neutralizer duct of the neutral beam injector. The vacuum pumping design is based on the recently demonstrated process of cryotrapping the helium in a frost layer of argon formed by spraying the argon onto a liquid-helium-cooled cryopanel surface. About 10.6 m^2 of cryopanel area in the ducts and chambers of the injector are required for an allowed frost thickness of 1 mm. The design is based on preliminary experimental results that indicated that about 15 atoms of argon were needed to pump and cryotrap each helium atom, and that the specific pumping speed of the fully baffled cryopanels would be about 31.5 std m^3/m^2-s (3.15 std-litre/cm^2-s). Preliminary estimates of costs indicate that this vacuum system may cost as much as 74% of the entire neutral beam injector and that the LHe cryo-refrigerator alone may cost 24% of the total direct cost. The design points up the problem areas of cryotrapping helium and the need for clever new design concepts and improved performance to reduce costs.

80-61 SIX KILOWATT, RESIDENTIAL, PHOTOVOLTAIC POWER SYSTEMS STUDY: DESIGN, PERFORMANCE, ECONOMICS, MARKET POTENTIAL
UCID-18776, August 4, 1980
L. D. Partain

Photovoltaic

Abstract

This study investigates the system problems of designing and building a flat plate, six kilowatt peak, photovoltaic power system for installation on a residential rooftop to provide electric power at 120 VAC and 60 hertz. Seven commercial manufacturers of terrestrial solar cells were surveyed as to the cost, performance and availability of their products for this application.

80-62 PROOF OF A GENERALIZED LOCASSO CONJEXURE
UCRL-84373,
Presented at the EMP Nuclear Meeting, Ananeim, California, August 5-7, 1980
R. M. Bevensee

Confidence in Reliability of Errors
Reliability of Errors

Abstract

This conjecture concerns the confidence in an R-reliability interval of a sum X of independent normally distributed random variables x_i, each with zero mean and unknown variance, given R-reliability intervals and their confidences. The proof is carried out assuming no knowledge of the probability distribution of the variance of X (which is not true since the probability distributions of the variances of x_i are assumed uniform over finite intervals), in which case an R-reliable interval for X is found such that the confidence in it is bounded by the maximum and minimum confidences in the R-reliable intervals for the x_i.

80-63 PARAMETER ESTIMATION FROM NOISY TRANSIENT ELECTROMAGNETIC MEASUREMENTS
UCRL-84437, August 5-7, 1980
Presented at the Nuclear EMP Meeting, Anaheim, California

J. T. Gavel
J. V. Candy
D. L. Lager

Electromagnetic Pulse
Parameter Identification

Abstract

The study of EMP phenomenon has promoted the development of techniques to investigate transient electromagnetic response data. Characterization of the EMP transient response information is necessary to evaluate the performance of the system in a hostile environment. An efficient technique to characterize this performance is to fit an electromagnetic model to the data.

In this paper we describe the performance of three different signal processing techniques applied to parameterize a body from noisy experimental electromagnetic transient response data. We briefly describe the techniques which range from the well-known Prony method to the more sophisticated extended Kalman filter and finally to the highly sophisticated maximum likelihood identifier. We compare the performance of these algorithms and discuss their tradeoffs.

80-64 A MAXIMUM ENTROPY TECHNIQUE FOR ELECTROMAGNETIC OR SEISMIC INVERSION
UCRL-84281,
Presented at the International URSI Symposium, Munich, Germany
August 26-29, 1980

R. M. Bevensee

Entropy
Inverse Electromagnetic and Seismic Methods

Abstract

We describe the application of a maximum ntropy method (MEM) not to spectral analysis but rather to inversion of an underdetermined constitutive parameter (electrical conductivity, refractive index or reciprocal wave velocity) profile in a two dimensional region probed by ray data. In accord with the First Principle of Data Reduction, we maximize the probability of the distribution subject to measurement constraints and consistent totality of that parameter. An MEM algorithm is outlined and examples given of the inversion of synthetic ray data in a cell model of the earth. Computational properties of the algorithm relative to convergence, ray redundancy and noise in the ray data are described. We extend logically the MEM to include curved rays or to solve the more difficult problem of underground conductivity inversion from surface potential measurements.

We believe the examples herin of this particular MEM suggest an unsuspected capability for resolving two dimensional parameter profile anomalies from a minimum of ray data. The success of our algorithm invites further analysis and application to practical field inversion problems.

80-65 A MODIFIED ALPHA-ROOT TECHNIQUE FOR IMAGE PROCESSING
UCRL-84975, September, 1980
Submitted to the Computer Graphics Science Journal

J. H. McClellan

Image Enhancement
Image Processing
Two-dimensional Fourier Transforms

Abstract

Image enhancement using Fourier transform coefficient rooting (often referred to as alpha-rooting) suffers from certain objectionable artifacts due to the processing. Such artifacts are caused by well-defined high contrast edges within the image. A modification of the usual alpha-rooting process is proposed whereby these artifacts are suppressed while the desirable enhancement features of the processing are retained.

80-66 PROBABILISTIC APPROACH TO EMP ASSESSMENT
UCRL-52804, Rev. 1,
September, 1980

R. M. Bevensee
H. S. Cabayan
F. J. Deadrick
L. C. Martin
R. W. Mensing

EMP
EMP Effect on Systems

Abstract

The development of nuclear EMP hardness requirements must account for uncertainties in the environment, in interaction and coupling, and in the susceptibility of subsystems and components. Typical uncertainties of the last two kinds are briefly summarized, and an assessment methodology is outlined, based on a probabilistic approach that encompasses the basic concepts of reliability. It is suggested that statements of survivability be made compatible with system reliability. Validation of the approach taken for simple antenna/circuit systems is performed with experiments and calculations that involve a Transient Electromagnetic Range, numerical antenna modeling, separate device failure data, and a failure analysis computer program.

80-67 MOCK SITE RADIONUCLIDE TRANSPORT ASSESSMENT
NUREG/CR-1553
UCRL-52718, September, 1980
Prepared for U.S. Nuclear Regulatory Commission

T. R. Donich
W. A. Murray
W. J. O'Connell

Nuclear Waste
Pollutant Transport
Site Assessment
System Performance Assessment

Abstract

A process for selection, characterization, and performance analysis of a mock site for a nuclear waste repository is assessed against the qualitative and quantitative criteria set forth in the NRC draft rule 10CFR60. The performance analysis for long term radionuclide transport from the repository to the accessible environment utilized simplified models of resaturation/repressurization, package breach time, dissolution function, and radionuclide transport in groundwater. The transport model is a series of one-dimensional stream tubes leading from the repository to a discharge point at the ground surface. Model parameters were determined from field or generic data by simplified methods such as contour sketching and flow mass balance. The impact of parameter uncertainties was assessed by a Monte Carlo method. The mock site, located in a sedimentary rock sequence of low permeability at a depth of approximately 350 meters below ground surface, was qualitatively satisfactory for most of the 10CFR60 criteria, but was determined to be unsatisfactory because of economically exploitable resources and extensive borehole exploration in the area. Quantitatively, the overall performance was found to be unsatisfactory because of the short breakthrough times (less

than 1000 years) of technetium and iodine to the accessible environment. A nonparametric correlation analysis showed that the parameters for the waste dissolution/leaching rate and canister breach time control the uncertainty in the breakthrough time for these isotopes. For the actinides and most fission products, the regional geologic parameters--retardation factors and effective porosity--were most important.

80-68 ON-LINE FAILURE DETECTION OF VIBRATING STRUCTURES
UCRL-84844, September, 1980

S. G. Azevedo
J. V. Candy
D. L. Lager

Non-destructive Evaluation
Parameter Identification
Vibrating Structure

Abstract

Non-destructive evaluation of vibrating structures for failure detection has been an area of interest at the Lawrence Livermore National Laboratory. Recent advances in signal processing and analysis of vibrating structures has been applied to this problem with promising results. The techniques used are recursive on-line algorithms which include stochastic models for noise sources.

An experiment was designed to investigate the feasibility of signal processing procedures for failure detection. A given structure was excited and its shock response measured using an accelerometer. The response data was digitized and processed.

80-69 NUCLEAR WASTE MANAGEMENT: STORAGE AND DISPOSAL ASPECTS
UCRL-84918, September, 1980
Presented at the Specialty Conference, Civil Engineering and Nuclear Power, September 15-17, 1980 American Society of Civil Engineers and University of Tennessee, Knoxville

B. D. Patterson
S. A. Dave
W. J. O'Connell

Nuclear Waste

Abstract

Long-term disposal of nuclear wastes must resolve difficulties arising chiefly from the potential for contamination of the environment and the risk of misuse. Alternatives available for storage and disposal of wastes are examined in this overview paper. Guidelines and criteria which may govern in the development of methods of disposal are discussed.

80-70 COMPACT, DIRECTIONAL, VHF ANTENNAS — H. M. Buettner
UCRL-84902, September 3, 1980
Submitted to Electronics Letters

Directional Antennas
Ferrites
Geophysical Probes

Abstract

The prototype of a compact, directional antenna for geophysical diagnostics from a borehole has been constructed and tested. The prototype consists of a wire monopole antenna placed next to a ferrite cylinder which "loads" the antenna thereby changing its characteristics. At its resonant frequency of 230 MHz, the ferrite-loaded antenna has an input resistance of 19Ω, and is physically shorter by a factor of 2.57 when compared to an unloaded monopole resonant at 230 MHz. The antenna radiation pattern is directional with a front-to-back ratio of 8.5 db, and a -3 db beam width of 146o at 249.6 MHz.

80-71 THE SYSTEMATIC COMPUTATION OF THE PERFORMANCE OF PHOTOVOLTAIC CELLS BASED ON FIRST PRINCIPLES — J. H. Yee, W. J. Orvis
UCID 18041-80 Pt. 1,
September 10, 1980

Energy Band Structure
Solar Cells
$ZnSnP_2$

Abstract

In this report we consider the theoretical optical and the transport properties of Zn_3P_2 and $ZnSnP_2$. The parameters which we calculate are: the optical absorption coefficient, the mobilities, the diffusion length, the minority life time, and the effective mass of the free carriers.

In addition, we analyze the optical transition matrix elements between the conduction and valence bands for $ZnSnP_2$. The result of this calculation shows that $ZnSnP_2$ is a direct-gap material, like InP. This conclusion is in agreement with the reflectivity measurement in $ZnSnP_2$.

Based on our theoretical analysis and the results of photoluminescence and optical absorption experiments we conclude that Zn_3P_2 is an indirect-gap material. This is in contrast with the early belief that its gap is direct.

We also make some calculations for diffusion length for the minority carriers in $ZnSnP_2$ and Zn_3P_2.

80-72 THE SYSTEMATIC COMPUTATION OF THE PERFORMANCE OF PHOTOVOLTAIC CELLS BASED ON FIRST PRINCIPLES
UCID-18041-80 Pt. 3 & 4, September 11, 1980

J. H. Yee
G. J. Burke
R. G. Harvey

Absorption Coefficient
$CdSiAs_2$
Mobility
Solar Cells
$ZnSiAs_2$

Abstract

In this report, the optical and transport properties derived from theory are presented for BAs, $CdSiAs_2$, and $ZnSiAs_2$. The physical specific parameters calculated are: the optical absorption coefficient, the carrier mobilities, the effective masses, and the diffusion length of the electrons and the holes.

Also, optical transition matrix elements between different conduction and valence bands of the $ZnSiAs_2$ and $CdSiAs_2$ compounds are theoretically analyzed. The theoretical results are in agreement with the experimental findings that $CdSiAs_2$ has a direct band-gap and $ZnSiAs_2$ has a pseudodirect-gap. In the case of BAs, it has been established that the band-gap is indirect, in contrast to the existing experimental conclusion that the band-gap of the BAs is direct. Comparison between the diffusion lengths of these compounds with those of GaAs and Si are discussed.

Based upon our calculation, the optical properties of the Si are far superior than that of BAs, and the optical and the transport properties of $CdSiAs_2$ are better than that of $ZnSiAs_2$. In terms of both of the optical and transport properties, $CdSiAs_2$ is similar to that of GaAs.

80-73 GEOTOMOGRAPHY OF OIL SHALE
UCRL-85025, September 15, 1980
Presented at the EOS/American Geophysical Union, San Francisco, California, Fall Meeting, December 8-12, 1980

W. D. Daily
E. F. Laine
F. J. Deadrick
J. T. Okada

Electrical Conductivity
Geotomography
In-situ Permittivity
Oil Shale

Abstract

The in-situ electrical conductivity and permittivity of oil

shale has been measured at the Occidental Oil Shale Inc. demonstration mine at Logan Wash near De Beque, Colorado. Radio frequency electromagnetic signals were transmitted between two boreholes drilled in oil shale. Measurement of differential phase change with frequency and signal attenuation permitted calculation of the effective permittivity and conductivity along many ray paths between the boreholes. From this data, tomographic images were constructed of the oil shale which map the electrical skin depth and permittivity in a plane 12 m high and 17 m wide. These tomographs were made of the virgin oil shale and of the same region after it had been rubblized.

Results indicate that geophysical tomography can be used to monitor electromagnetic properties of oil shale between 1 and 40 MHz, and measure changes in these properties after rubblization. Prior to rubblization, the measured electrical skin depth at 20 MHz ranges from 2.2 - 4 m and the relative permittivity ranges from 4 to 9. Both of these parameters have a horizontally layered distribution. Both skin depth and permittivity measured after rubblization have a measurably different distribution, indicating that high frequency geotomography may allow monitoring of rubble characteristics such as void content.

80-74 A MODEL FOR THE ELECTRICAL CONDUCTIVITY DISTRIBUTION DURING IN-SITU OIL SHALE RETORTING

A. G. Duba
W. D. Daily
R. J. Lytle
A. J. Piwinskii

UCRL-85013, September 15, 1980
Presented at the EOS/Geophysical Union, San Francisco, California, Fall Meeting, December 8-12, 1980

Electrical Conductivity
In-situ Oil Shale
Retort In-situ

Abstract

A model of the electrical conductivity distribution in an in-situ oil shale retort has been developed. The model is based on the temperature distribution calculated for in-situ retorting of rubblized oil shale. This temperature distribution was used to calculate the conductivity profile of the retort using laboratory electrical conductivity measurements by several investigators for oil shale rock up to 1000°C. Assuming that laboratory conductivity measurements of the solid (rock) phase alone represent the complex chemical and physical environment of a retort, we find that the combustion zone should provide an electrical anomaly 10^9 more conductive than the preretort shale. Injection of air to drive the retort produces a

calculated temperature profile with a highly conductive region increasing in thickness from 5 to 15 meters between days 5 and 10 after the retort begins. Injection of a mixture of 50% air and 50% steam results in a narrower high temperature region and a resulting electrical anomaly of 2-3 m thickness which is nearly independent of time during the retort. The magnitude of the electrical conductivity changes associated with retorting of oil shale indicates that electrical techniques can be employed as a remote monitoring and diagnostic tool.

80-75 SHIP EQUIPMENT INTERFERENCE SIGNALS DUE TO EMP
UCRL-83427, Abstract
International Conference on Electromagnetic Compatibility
September 16-18, 1980

F. J. Deadrick
H. S. Cabayan
K. F. Kunz

Electromagnetics
EMP
Interference
Scale Model Tests
Ships
Transients

Abstract

This paper describes predictions of currents and voltages on structures and cables of a ship due to an incident transient electric field based on measurements performed on a scale model. These predictions were made without access to the data from actual simulation tests. (Ref. 1) Comparisons between test data and predictions are performed to show the relevance of this simple predictive tool to performing coupling assessment to complex metallic structures.

80-76 SUSCEPTIBILITY DETERMINATION UNDER UNCERTAINTY
UCRL-85809
Presented at the International Conference on Electromagnetic Compatibility, September 16-18, 1980, Southampton, England

L. C. Martin
E. J. Bogdan
H. S. Cabayan

Susceptibility
Uncertainties

Abstract

The determination of the susceptibility of systems, equipment, or components to external electromagnetic stimuli is confounded by uncertainties. A probabilistic approach to such determination is outlined and discussed. This approach recognizes variation in the uncertainties, makes use of the

probability distribution in describing this variation, and relies heavily on computer-oriented models for the interaction phenomena. In practical application, fairly extensive computer program tools are necessary for the Monte-Carlo systems and circuit analyses required.

80-77 AN APPLICATION OF A LARGE SCALE STATE ESTIMATOR TO THE VIBRATIONAL RESPONSE OF A MECHANICAL STRUCTURE
UCID-18824, September 18, 1980

D. L. Lager

Kalman Filter
State Estimation
Vibration

Abstract

The SEALS (State Estimator for Large Systems) computer code was applied to the estimation of displacement time histories of points on a vibrating mechanical structure given "noisy" measurements at two locations on the structure. The goal was to demonstrate the feasibility of determining the motion of internal members of the structure given only noisy measurements from the exterior and a finite-element model of the structure.

This study was done in four distinct phases:

*Model development
*Simulation of displacements vs. time
*Acquisition of noisy measurement data (computer simulated)
*Estimation of displacements from measurements

The model was developed from the geometry of the structure using the ZONE finite-element mesh generator to produce an axi-symmetric finite-element model consisting of 15 elements and 32 nodes. The SAP4 code was used to translate the geometry and material properties into a 2nd order matrix differential equation (with matrices of size 87 by 87) which was then transformed into 174 state space equations (i.e., first order differential equations) for input to the SEALS state estimation code. A model check feature of SEALS was used to simulate displacement time histories at all the nodes of the finite-element model given an initial displacement for one of the nodes. Noisy measurements at two exterior locations on the structure were simulated by adding Gaussian white noise to the appropriate simulation waveforms. The standard deviation of the noise was chosen to give an approximate signal-to-noise ratio of 40. The SEALS code was used to reconstruct the displacement time histories of all the nodes of the model given the measurements, and erroneous initial values for both the initial condition displacement and the measurement noise covariance. Plots of displacement time histories at selected nodes of the model for simulation, measurement, and state estimation (reconstruction) are given.

80-78 ELECTROMAGNETIC RAILGUN ACCELERATORS: RESULTS OF RECENT LANSL-LLL EXPERIMENTS
UCRL-84953, September 29, 1980
Presented at the Aeroballistic Range Association, California Institute of Technology, Pasadena, California, October 7-8, 1980

R. S. Hawke
A. L. Brooks
J. K. Scudder
C. M. Fowler
D. R. Peterson

Magnetic Propulsion
Railgun Applications

Abstract

This paper summarizes the results of recent experiments jointly performed by LLNL and LANSL. The experiments are the beginning of a project aimed at exploring the potential of electromagnetic railguns to accelerate projectiles to hypervelocities. We used magnetic flux compression generators to power railguns and accelerate 3- and 165-g projectiles to velocities of about 10 and 0.35 km/s, respectively. This paper includes a description of the system design and diagnostics and a summary of the results. These preliminary experiments indicate a very promising future, for electromagnetic propulsion is at hand.

80-79 INSPECTION METHODS FOR PHYSICAL PROTECTION PROJECT: ANNUAL REPORT MARCH 1979 THROUGH FEBRUARY 1980
NUREG/CR-1258 Vol. 2
UCID-18123-79-4, October, 1980
Prepared for U.S. Nuclear Regulatory Commission

R. T. Bradley
D. D. Bowden
A. W. Olson
F. Rogue
J. W. Savage
S. Scala

IMPP
Physicl Protection Inspection Methods

Abstract

This is the annual report to the U.S. Nuclear Regulatory Commission (NRC) of progress at Lawrence Livermore National Laboratory (LLNL) during the first year of the Inspection Methods for Physical Protection project. This report details the activities of the first year of work that culminated in delivery of field-test drafts of new procedures for inspecting the physical protection systems at nuclear power reactor sites.

80-80 SITE CHARACTERIZATION: A SPATIAL ESTIMATION APPROACH
UCID-18688, October, 1980

J. V. Candy
N. Mao

Nuclear Waste
Site Characterization
Spatial Estimation

Abstract

In this report we consider the application of spatial estimation techniques or kriging to groundwater aquifers and geological borehole data. We investigate the adequacy of these techniques to reliably develop contour maps from various data sets.

The estimator is developed theoretically in a simplified fashion using vector-matrix calculus. The practice of spatial estimation is discussed and the estimator is then applied to two groundwater aquifer systems and used also to investigate geological formations from borehole data. It is shown that the estimator can provide reasonable results when designed properly.

80-81 RAILGUN ACCELERATORS FOR GRAM-SIZED PROJECTILES
UCRL-84623, October, 1980
Presented at the Sixth Conference on the Application of Accelerators in Research and Industry, November 3-5, 1980, Denton, Texas

R. S. Hawke

Equation of State
Impact Fusion
Magnetic Propulsion
Railgun Applications

Abstract

In this paper, we describe the operation and critical parameters of railguns, we compare the potential and actual performance with other types of macroparticle accelerators, and we discuss their research and industrial applications.

80-82 CHARACTERIZATION OF ERRORS INHERENT IN SYSTEM EMP VULNERABILITY ASSESSMENT PROGRAMS
UCRL-52954, October 1, 1980

R. M. Bevensee
H. S. Cabayan
F. J. Deadrick
L. C. Martin
R. W. Mensing

EMP
System Vulnerability to EMP

Abstract

The overall objectives of the DNA-funded program at LLNL are to provide a measure of accuracy of currently used EMP vulnerability assessment methodology. In addition, system tools are to be provided to improve the confidence in assessment efforts, which in turn will result in improved confidence in establishing hardening requirements. During Phase I, assessment techniques currently used by the EMP community are surveyed and the sources of uncertainty are identified. Typical data are presented for quantifying the major sources of uncertainty in all phases of the assessment effort.

During this phase, a statistical methodology to assess the impact of uncertainty on the survivability of a system has been partially validated with a simple system test.

80-83 DASLL - AN AUTOMATIC PRINTED CIRCUIT BOARD LAYOUT SYSTEM
UCRL-84640, October 1-3, 1980
Presented at the 1980 IEEE International Conference on Circuits and Computers (ICCC 80), New York, New York

W. G. Magnuson, Jr.

Design Automation
PCB Routing
Printed Circuit Board Layout

Abstract

DASLL stands for Design Automation System at Lawrence Livermore and is a system of computer programs to automatically lay out printed circuit boards. The focus has been on two-sided PCB fabrication aids; primarily drill tape, documentation, and artwork generation (including etch, silkscreen, and drill schedule artwork). Limited four-layer PCBs are also possible with the program. DASLL can be used in either batch-interactive or batch mode of operation by technicians, draftsmen, designers, or engineers. Flexibility in being able to accommodate a diversity of trimline geometries and component shapes and placements was a goal in the design of the software. The system is also very flexible in its capability to deal with physical design rules. A principal objective for the system has been low-volume, quick turn-around response for low and medium density custom printed circuit boards.

80-84 A METHODOLOGY FOR NUCLEAR SAFEGUARDS DECISION-MAKING*
UCRL-83889, Abstract
Submitted to the 1980 International Conference on Cybernetics and Society, October 8-10, 1980, Cambridge, Massachusetts

R. Al-Ayat
S. Weissenberger

Adversary
Decision-Analysis Safeguards

Abstract

The problem of safeguarding special nuclear material (SNM) is a challenge which encompasses public policy, management science, and engineering design. This paper presents a quantitative approach for evaluating the effectiveness of nuclear safeguards systems an guiding resource allocations to various safeguard functions. The resultant methodology is of assistance to decision-makers in the government and the nuclear industry for

arriving at judgements on the best regulations and on their most effective implementation.

The core of the approach is the development of a comprehensive model on a relatively aggregated level. This model characterizes the major factors in the safeguards problem: the adversary; the interaction between the safeguard system and the adversary; the consequences of diverted SNM; and the costs of the safeguard operation. It further describes uncertainties in all these elements in a quantitative way, and the decision-analytic integration of this information produces various measures of system effectiveness. Major issues addressed in the paper are both methodological and applied, and include the characterization of the adversary; perspectives in arriving at various effectiveness measures; data requirements; and results of the application of the model to the problem of regulation setting. Also discussed will be model validity and credibility, and, in this context, issues involving its appropriate use.

80-85 ANALYSIS OF ELECTRICAL CONDUCTIVITY IMAGING

K. A. Dines
R. J. Lytle

UCRL-83318-R-1, October 10, 1980
Submitted to Geophysics

Conductivity Distribution
Numerical Inversion

Abstract

We investigate the feasibility of imaging the electrical conductivity in a cross section of an object (such as a core sample) by numerical inversion of low-frequency, electromagnetic boundary data. Current flow is assumed to be confined to the cross section, which is modeled as a network of resistors. The network serves as a discrete approximation of the distributed-parameter system that is described mathematically by Maxwell's equations for steady current flow in a nonhomogeneous medium. A complete set of linearly independent voltage vectors is applied to the peripheral nodes, and the resulting node currents serve as the measured data for estimating the internal conductivity pattern (image). We generate estimates of this conductivity image by using an iterative process on network equations that are linearized in the unknown conductance variables.

The mathematical feasibility of this approach is demonstrated by computer simulation studies using data generated from the network model. Reconstructed images are presented for sample conductance patterns under both ideal and noisy data conditions. An error analysis is performed to relate data noise to image-estimation error.

80-86 AN ARRAY PROCESSOR-BASED INTERACTIVE IMAGE PROCESSING SYSTEM
Abstract, 1980 CUBE Symposium, LLNL, October 22-24, 1980

R. J. Sherwood
M. R. Portnoff
C. H. Journeay
R. E. Twogood

Array Processing
Image Processing

Abstract

Sophisticated techniques for digital processing of image data have significantly impacted many aerospace, scientific, industrial and biomedical applications. Such applications include compensation for sensor and transmission errors from satellites and deep space probes; and resolution improvement, contrast enhancement, and motion blur removal from scientific, industrial and biomedical imagery such as radiographic, thermographic, ultrasonic and radionuclide images. Further processing is often performed for the enhancement and detection of specific features such as fractures or tumors within a given image, or changes in such features among an ensemble of images.

This paper discusses a software system for interactive image processing using a minicomputer and a high-speed array processor. A major design objective was to design a flexible system, not only suited to the development of new image processing algorithms, but also to the routine "production" processing of images. Because many image processing problems typically involve application of one or more "standard" algorithms as well as novel or problem-specific techniques, we have developed and are continuing to expand a library of such standard algorithms. In addition, we have provided a means whereby new algorithms may be easily incorporated into the system.

The image processing system operates under the control of a supervisor program that provides a uniform interface to the applications software. The user has the option of executing his functions in an interactive mode with the system prompting for input, when required, or in a macro mode in which a predefined sequence of commands is executed.

After a brief description of the hardware environment, we will discuss the structure and capabilities of the system, concluding with some examples of image processing applications performed using the system.

80-87 BLOCK PROCESSING ALLOWS COMPUTATIONAL SAVINGS FOR ADAPTIVE DIGITAL FILTERS
Abstract
Presented at the CUBE Symposium, LLNL, October 22-24, 1980

G. A. Clark
S. K. Mitra
S. R. Parker

Adaptive F
Block Filtering

Abstract

Block digital filtering involves the calculation of a block or finite set of filter outputs from a block of input values. This paper presents a block adaptive filtering procedure in which the filter coefficients are adjusted once per each output block in accordance with a generalized least mean-square (LMS) algorithm. Analyses of convergence properties and computational complexity are included. We show that block adaptive filters involve less computational complexity than conventional adaptive filters when implemented using efficient convolution algorithms on serial processors. It is expected that further gains in speed could be made if parallel processors were used.

80-88 DETECTION OF SMALL SEISMIC EVENTS BY ADAPTIVE PREDICTION
Abstract
Presented at the CUBE Symposium, LLNL, October 22-24, 1980

G. A. Clark
P. W. Rodgers

Adaptive Filtering
Seismic Signal Processing

Abstract

Small seismic events (earthquakes and nuclear tests) are difficult to detect and locate because of corruption by ambient background noise. The stability of the comprehensive test ban treaty depends for a large part on our ability to monitor such seismic events. This paper presents an adaptive digital filter based procedure for improving signal-to-noise ratio (SNR) and allowing improved detection of small events (SNR $\leq$ 1). The filter tracks nonstationary noise, and can be implemented on-line or as an off-line analysis tool. Examples are given.

80-89 MAGRAC--A RAILGUN SIMULATION PROGRAM
UCRL-84877, October 24, 2980
Presented at the ARRADCOM/DARPA -sponsored Electromagnetic Guns and Launchers Conference, San Diego, California, November 4-6, 1980

F. J. Deadrick
R. S. Hawke
J. K. Scudder

Railgun Applications

Abstract

We have developed and validated a computer simulation code at the Lawrence Livermore National Laboratory (LLNL) to predict the performance of a railgun electromagnetic accelerator. The code,

called MAGRAC (MAGnetic Railgun ACcelerator), models the performance of a railgun driven by a magnetic flux compression current generator (MFCG). The MAGRAC code employs a time-step solution of the nonlinear time-varying element railgun circuit to determine rail currents. From the rail currents, the projectile acceleration, velocity, and position is found. We have validated the MAGRAC code through a series of eight railgun tests conducted jointly with the Los Alamos Scientific National Laboratory. This paper describes the formulation of the MAGRAC railgun model and compares the predicted current waveforms with those obtained from full-scale experiments.

80-90 RESULTS OF RAILGUN EXPERIMENTS POWERED BY MAGNETIC FLUX COMPRESSION GENERATORS
UCRL-84875, October 24, 1980
Presented at the ARRADCOM/DARPA Conference on Electromagnetic Guns and Launchers, San Diego, California, November 4-6, 1980

R. S. Hawke
A. L. Brooks
F. J. Deadrick
J. K. Scudder
C. M. Fowler
R. S. Caird
D. R. Peterson

Magnetic Propulsion
Railgun Applications

Abstract

Researchers from LLNL and LANSL initiated a joint railgun research and development program to explore the potential of electromagnetic railguns to accelerate projectiles to hypervelocities. The effort was intended to 1) determine experimentally the limits of railgun operation, 2) verify calculations of railgun performance, and 3) establish a data base at megampere currents. The program has led to 1) the selection of a particular magnetic flux compression generator (MFCG) design for a set of initial experiments and 2) the design of smalland large-square bore railguns to match the expected MFCG power profile. The bore sizes are 12.7 and 50 mm, respectively. In this paper, we briefly describe the design of the railguns and the diagnostic and data reduction techniques, followed by the results of eight experiments with the two railgun types.

80-91 THE STRUCTURED ASSESSMENT APPROACH VERSION 1 ANALYSIS PACKAGE (EXECUTIVE SUMMARY)
NUREG/CR-1233, Vol. 1
UCRL-52735, Vol. 1, November, 1980
Prepared for U.S. Nuclear Regulatory Commission

A. A. Parziale
I. J. Sacks

Nuclear Material Control and Accounting Assessment
Nuclear Safeguards

Abstract†

A methodology, the Structured Assessment Approach, has been developed for the assessment of the effectiveness of material control and account (MC&A) safeguards systems at nuclear fuel cycle facilties. This methodology has been refined into a computational tool, the SAA Version 1 computational package, that was used first to analyze a hypothetical fuel cycle facility and used more recently to assess operational nuclear plants. The Version 1 analysis package is designed to analyze safeguards systems that prevent the diversion of special nuclear material (SNM) from nuclear fuel cycle facilities and to provide assurance that diversion has not occurred.

This report is the first volume, the Executive Summary, of a three-volume document. The purpose of this Executive Summary is to provide a general overview of the SAA Version 1 analysis package. The Executive Summary also discusses the organization of the overall document, including objectives associated with Volumes II and III.

80-92 THE STRUCTURED ASSESSMENT APPROACH VERSION 1 LICENSE SUBMITTAL DOCUMENT CONTENT AND FORMAT FOR MATERIAL CONTROL AND ACCOUNTING ASSESSMENT, VOLUME II
NUREG/CR-1233, Vol. II
UCRL-52735, Vol. II, November, 1980
Prepared for U.S. Nuclear Regulatory Commission.

A. A. Parziale
I. J. Sacks

Nuclear Material Control and Accounting Assessment
Nuclear Safeguards

Abstract

A methodology, the Structured Assessment Approach, has been developed for the assessment of the effectiveness of material control and accounting (MC&A) safeguards systems at nuclear fuel cycle facilities. This methodology has been refined into a computational tool, the SAA Version 1 computational package, that was used first to analyze a hypothetical fuel cycle facility and used more recently to assess operational nuclear plants. The Version 1 analysis package is designed to analyze safeguard systems that prevent the diversion of special nuclear material (SNM) from nuclear fuel cycle facilities and to provide assurance that diversion has not occurred.

This report is the second volume, the License Submittal Document Content and Format for Material Control and Accounting Assessment, of a four-volume document. It presents the content

and format of the LSD necessary for Material Control and Accounting (MC&A) assessment with the SAA Version 1. The LSD is designed to provide the necessary data input to perform all four stages of analyses associated with the SAA. A full size, but Hypothetical Fuel Cycle Facility (HFCF) is used as an example to illustrate the required input data content and data format and to illustrate the procedure for generating the LSD. Generation of the LSD is the responsibility of the nuclear facility licensee applicant.

80-93 THE STRUCTURED ASSESSMENT APPROACH VERSION 1 APPLIED DEMONSTRATION OF OUTPUT RESULTS VOLUME III
NUREG/CR-1233, Vol. III
UCRL-52735, Vol. III, November, 1980

A. A. Parziale
I. J. Sacks

Nuclear Material Control and Accounting Assessment
Nuclear Safeguards

Abstract

A methodology, the Structured Assessment Approach, has been developed for the assessment of the effectiveness of material control and accounting (MC&A) safeguards systems at nuclear fuel cycle facilities. This methodology has been refined into a computational tool, the SAA Version 1 computational package, that was used first to analyze a hypothetical fuel cycle facility (HFCF) and used more recently to assess operational nuclear plants. The Version 1 analysis package is designed to analyze safeguards systems that prevent the diversion of special nuclear material (SNM) from nuclear fuel cycle facilities and to provide assurance that diversion has not occurred.

This report is the third volume, Applied Demonstration of Output Results, of a four-volume document. It presents the outputs for each of the four levels of the SAA Version 1 computational package. Two types of outputs are discussed: detailed output findings and summary output tables. The summary output tables are used to aggregate the detailed output findings in a condensed form for NRC analyst consumption. Specific output results are presented for an HFCF, which is described in Volume II.

80-94 NUCLEAR WASTE REPOSITORY CHARACTERIZATION: A SPATIAL ESTIMATION/IDENTIFICATION APPROACH
UCRL-84163, November, 1980
Submitted to Automatica

J. V. Candy
N. Mao

Nuclear Waste
Site Characterization
Spatial Estimation

Abstract

In this paper we consider the application of spatial estimation techniques or kriging to a groundwater aquifer and geological borehole data. We investigate the adequacy of these techniques to reliably develop contour maps from various data sets.

The estimator is developed theoretically in a simplified fashion using vectormatrix calculus. The practice of spatial estimation is discussed and the estimator is then applied to a groundwater aquifer system and a deep geological formation. It is shown that the various statistical models must first be identified from the data and evaluated before reasonable results can be expected.

80-95 SURFACE FIELD MEASUREMENTS ON SCALE MODELS IN THE TIME DOMAIN
UCID-19037, November, 1980

H. S. Cabayan
J. Zicker
F. J. Deadrick
J. V. Candy
D. T. Gavel
E. J. Bogdan

Electromagnetics
EMP
Scale Model Tests
Transients

Abstract

Time-domain measurements have been performed of the surface densities of current and change induced on scale models when illuminated by a transient electromagnetic pulse in order to provide test points to validate numerical models. Three bodies--a cylinder, a crossed-cylinder, and a 1:100 scale-model 747 aircraft--were used in the experiments. Responses were measured for objects in a simulated free-space environment and in the proximity of a perfectly conducting plane. The measured time-domain data are Fourier transformed to the frequency domain, and analyzed via parameter estimation algorithms to extract the complex natural frequencies of the structures.

80-96 DESIGN AND FABRICATION OF LARGE- AND SMALL-BORE RAILGUNS
UCRL-84876, November 4-6, 1980
Presented at the ARRADCOM/DARPA Conference on Electromagnetic Guns and Launchers, San Diego, California

A. L. Brooks
R. S. Hawke
J. K. Scudder
C. D. Wozynski

Magnetic Propulsion
Railgun Applications

Abstract

A joint program between LLNL and LANSL was conducted to establish whether railguns could be operated at megampere currents, what the operating limits would be, and to provide data to validate the modeling of railgun technology. This paper discusses the 12.7- and 50.0-mm-bore railguns designed and fabricated for this program. The design criteria, the materials and fabrication methods, and the success of the designs are discussed in detail.

80-97 A REVIEW OF METHODS FOR EVALUATING R & D

K. G. Feller, Author
Contributors:
W. F. Rousseau
S. Weissenberger

UCID-1889[illegible] November 14, 1980
Prepared f U.S. Department of Energy, Office of Applied Conservation Technologies

R&D Assessment
R&D Portfolio Analysis

Abstract

Investments of national resources in energy R&D can provide valuable technical contributions to solving the nation's energy problems. However, the uncertainties and complexities associated with developing technologies complicate the problem of identifying effective allocations of resources to R&D.

In recognition of this problem several quantitative methods of R&D evaluation have been proposed in recent years. This report presents a review of these methods for the U.S. Department of Energy's Office of Advanced Conservation Technologies (ACT).

80-98 A MAXIMUM ENTROPY TECHNIQUE FOR UNDERGROUND SEISMIC INVERSION

R. M. Bevensee

UCRL-85612
Presented at the International SEG Meeting, Houston, Texas, November 16-20, 1980

Entropy
Inverse Seismic Methods

Abstract

The application of an algorithm for a special maximum entropy method (MEM) to invert an underdetermined constitutive parameter profile (reciprocal wave velocity, electrical refractive index or conductivity) has been described. The synthetic data examples suggest an unexpected capability for resolving two- (and, by inference, three-) dimensional parameter anomalies for

relatively few rays. For example, a 48-cell region probed with 25 straight rays, with one cell of parameter $p_1 = 50$ surrounded by $p = 5$ cells was quickly resolved by a maximum entropy solution of $p_1 = 39.5$, one neighbor of $p_2 = 15.8$, and the remaining neighbors in the range $2.26 \leq p \leq 8.11$. The anomaly remained sharply defined when all the ray data (traveltime, phase shift, or net attenuation, respectively) were perturbed by noise, uncorrelated and distributed uniformly over a ± 10 percent interval.

Starting with straight rays and an initial guess of the variational and constitutive parameters, the algorithm computes new parameter estimates, updates them by an implicit constraint, alters the raypaths, if curvature is accounted for according to Snell's law, computes changes in the variational parameters to obtain better agreement between measured and computed ray data, and then iterates this loop of computations until satisfactory convergence is attained.

80-99 DATA REQUIREMENT COMPARISON BETWEEN THE FIXED SITE UPGRADE RULE GUIDANCE COMPENDIUM AND THE STRUCTURED ASSESSMENT APPROACH LICENSEE SUBMITTAL DOCUMENT
NUREG/CR-1574
UCID-18671, December, 1980
Prepared for U.S. Nuclear Regulatory Commission

A. A. Parziale
I. J. Sacks

Nuclear Material Control and Accounting Assessment
Nuclear Safeguards

Abstract

We compared the Structured Assessment Approach's (SAA) Licensee Submittal Document (LSD) with the Fixed Site Physical Protection Upgrade Rule Guidance Compendium Standard Format and Content (SFC) Guide using correlation matrices to see how well the data requirements of the SFC Guide coincided with those of a specific automated vulnerability assessment technique for fixed-site nuclear fuel cycle facilities, namely, SAA. We found that a limited SAA assessment is possible using the SFC Guide, but significant and critical safeguards vulnerabilities might be missed. Also, it was found that in some cases the organization and format of the SFC Guide input data and information made the preparation of data for the SAA somewhat awkward.

80-100 DETECTION OF WATER-FILLED AND AIR-FILLED UNDERGROUND CAVITIES
UCRL-53127, December 1, 1980

E. F. Laine

Borehole Resistivity Probing
High Frequency Electromagnetics
Underground Cavity Detection

Abstract

Tunnel and cavern detection methods were tested at two experimental sites in Florida. Cross-borehole methods using high-frequency electromagnetic wave diffraction techniques were used over a frequency range of 1 to 100 MHz. A new cross-borehole method using direct current was also used. The experimental sites are karstic. The caverns and tunnels were water-filled at one site and dry at the other site.

80-101 QUADRANTAL SYMMETRY CALCULATIONS FOR NONSYMMETRIC HALF-PLANE FILTERS — D. M. Goodman

UCRL-85156, Rev. 1, December 3, 1980
Presented at the 14th Asilomar Conference, Monterey, California, November 17, 1980

Two-dimensional Filter Symmetry
Two-dimensional Digital Filters

Abstract

The conditions under which an all-pole, stable, nonsymmetric half-plane filter has a quadrantally-symmetric magnitude response are investigated. It is shown that quadrantal symmetry is obtained if and only if the denominator of the transfer function can be written as the product of two functions; the inverse z-transforms of these two functions have different regions of support and one of them must obey a symmetry condition. The usefulness of these conditions in filter design algorithms is discussed.

80-102 FUND USAGE PROGRAM — W. J. Orvis

UCID-18846, December 23, 1980

Accounting
Mini-computer Program
Project Management

Abstract

The fund usage program is an accounting type program designed to print, plot and archive costs related to project management. Project costs are differentiated with four subaccounts: Consultants, Subcontracts Billed, Subcontracts Liens, and Internal. Data is accumulated monthly and is processed by account and by fiscal year. The number of accounts and the number of account data files is only limited by the capacity of a program tape. Plotting of data differentiates each subaccount, the total costs and the spending limit. These plots can be used to recognize trends in spending patterns, especially in relation to the spending limit. All input data is automatically archived and updated to maintain a complete record of all past trends.

80-103 INSPECTION METHODS FOR PHYSICAL PROTECTION PROJECT: QUARTERLY REPORT, SEPTEMBER-NOVEMBER, 1980
NUREG/CR-1610, Vol. 1, No.3
UCID-18123-80-3, December 31, 1980
Prepared for U.S. Nuclear Regulatory Commission

D. D. Bowden
C. Minichino
A. W. Olson
F. Rogue
J. W. Savage
R. W. Thatcher

IMPP
Physical Protection Inspection Methods

Abstract

This is the seventh quarterly report to the U.S. Nuclear Regulatory Commission (NRC) on the progress at Lawrence Livermore National Laboratory (LLNL) in the Inspection Methods for Physical Protection (IMPP) project. The report details the production status of the procedures in the replacement modules for physical protection of power reactors, nonpower/research reactors, strategic special nuclear materials (SSNM) fixed sites, and transportation of special nuclear materials (SNM). In addition to the replacement modules, new modules have been developed in personnel training and qualifications plan (Appendix B to 10 CFR 73) and in safeguards contingency plans (Appendix C to CFR 73). A new module containing regulation catalogs is also being developed for licensee implementing procedures. Trips, data-gathering tasks, and results of the October 15-16, 1980 Office of Research--Office of Inspection and Enforcement--Regions--IMPP meeting are discussed.

80-104 PATTERN SYNTHESIS USING POLE-ZERO MODELING
UCID-18590

E. K. Miller
D. L. Lager
J. T. Okada
G. J. Burke

Pole-zero Modeling
Prony's Method

Abstract

A procedure for synthesizing line-source radiation patterns based on pole-zero modeling (Prony's method) is outlined, and its application to various specified patterns is demonstrated. The most significant property of the techniques is that it requires no a priori selection of either array length or source spacing. Both are provided, together with the source strengths, from the pole-zero model. Only the number of sources (or poles) and the pattern to be synthesized need be specified by the user. Several issues related to using the technique are also discussed.

80-105 SURFACE FIELD MEASUREMENTS ON SCALE MODELS IN THE TIME DOMAIN
UCRL-84376, Abstract

H. S. Cabayan
J. E. Zicker

Aircraft
EMP
Errors
Scale Model Tests

Abstract

In order to provide a data base for comparison with calculation and additional insight into test object/simulator interactions, time-domain measurements have been performed of surface current and charge induced on three scale-model test objects at the LLL transient range simulator. The objects include a cylinder, a crossed-cylinder, and a 1:100 scale-model 747 aircraft. Responses were measured for objects in a simulated free-space environment and in the proximity of a perfectly conducting plane. The measured time-domain data are Fourier transformed to the frequency domain, and analyzed via a linear least-square estimator algorithm to extract the complex natural frequencies of the structures.

In this paper, the test object and experimental set up will be described. The time-domain and frequency-domain results in addition to the pole analysis will be presented. Finally, the data will be compared to CW data obtained at the University of Michigan and to available numerical predictions.

80-106 ELECTROMAGNETIC EMISSION FROM ELECTRON BEAMS
UCRL-84378, Abstract

H. S. Cabayan

Accelerators
Electromagnetic Effects
Electron Beams

Abstract

Relativistic electron beams radiate energy covering the electromagnetic spectrum from radio wave frequencies up and including gamma rays. For a given current amplitude, the proportion of the energy in each type of radiation depends on the energy of the electrons.

In this paper, radiation from electron beams in the radio wave and gamma ray portions of the spectrum will be examined. Simple approximate formulae for quantities of interest will be derived and applied for hypothetical beam parameter values. The intent is not to derive rigorous relations but rather approximate levels that will help point out problems that may arise in instrumentation implementation and other electromagnetic compatibility (EMC) issues.

80-107 E-BEAMS FOR SREMP SIMULATION
UCRL-84598, Abstract

H. S. Cabayan
J. N. Brittingham

E-beam
MX
Simulation
SREMP

Abstract

In this paper, the possible uses of high current and high energy electron beams for source region EMP (SREMP) simulation will be investigated. The electromagnetic fields and the gamma ray intensities from different beams will be compared with typical tactical and strategic environments. The design of converters to enhance the gamma intensity will be discussed.

80-108 EMP COUPLING ASSESSMENT WITH SCALE-MODEL TRANSIENT RANGE SIMULATORS
UCRL-84599, Abstract

H. S. Cabayan
J. V. Candy

EMP
Scale Model Tests
Transients

Abstract

In this paper, the uses of the LLNL Electromagnetic Transient Range Simulator for performing EMP Coupling Assessment will be described. Items that will be covered include: Uses and limitations of the scale-model simulator, simulator characteristics, validations of test predictions, examples of applications to systems of interest, and overview of signal processing techniques used.

80-109 UNCERTAINTIES IN HARDNESS SPECIFICATION
UCRL-82600, Abstract

R. M. Bevensee
H. S. Cabayan
F. J. Deadrick
L. C. Martin
R. W. Mensing

EMP Hardening
Uncertainties

Abstract

The specification of protection requires at the minimum an approximate knowledge of the environment and some measure of its effect on the sytem. In practice one must go further. Uncertainties exist in statements of the environment, particularly as this environment couples to and propagates through the system. Similarly, there are basic susceptibilities of the components, units, and subsystems which are subject to variation and are not always very well known.

This paper reviews briefly some of the identified uncertainties which will be present in many of the present DoD systems hardening problems. The specification of hardness indeed requires that these uncertainties be considered in some manner. This paper also suggests and outlines in some detail an approach which can deal with the problem of uncertainties in an assessment of the system for hardness specification.

80-110 UNCERTAINTIES IN WEAPON GAMMA OUTPUT AND EMP
UCRL-82599, Abstract

H. S. Cabayan

EMP
Uncertainties
Weapon Gamma

Abstract

This paper describes the ranges of expected gamma outputs from several types of weapons and the resulting ranges of EMP outputs. In addition, the issues of uncertainties inherent in evaluating gamma outputs will be addressed by presenting test data and computations performed by personnel at Lawrence Livermore Laboratory covering the period from 1967 to 1978. Issues related to EMP output from Foreign Weapons will also be addressed. The highest security level of this paper is anticipated to be Secret Restricted Data.

80-111 APPLICATION OF NEC AND NET-2 CODES TO ANTENNA RESPONSE UNCERTAINTIES
UCRL-84375

L. C. Martin
R. M. Bevensee
E. J. Bo_dan
G. J. Burke

Antennas Modeling
Circuits
EMP

Abstract

This paper presents an approach which utilizes two large computer programs and work on circuit modeling to analyze the problem of uncertainties in EMP coupling to an antenna system. The Numerical Electromagnetic Code (NEC)** is the principal tool which provides the variation of antenna performance parameters with ground effects. NET-2, a powerful circuit and systems simulation program, is then used in several ways. First, the optimization solution feature provides an approximation of antenna impedance and effective height with circuit parameters. Second, the transient response capability of NET-2 is used in a direct input-output manner with a specified input and load. Finally, the Monte Carlo solution feature of the program demonstrates the significance of uncertainties when parametes are specified by distribution entries. The approach is illustrated by application to a case of a "whip-on-box" antenna system with several cases for comparison.

80-112 ESTIMATING EMP COUPLING TO SHIPBOARD ANTENNA SYSTEMS
UCRL-84374, Abstract

L. C. Martin
R. M. Bevensee
H. S. Cabayan
F. J. Deadrick

EMP
Scale Model Tests
Ships
Testing

Abstract

The large size and extreme complexity in the electromagnetic response behavior of a surface ship presents a difficult problem for estimations of EMP coupling phenomena. This paper discusses techniques and presents some results pertaining to the estimation of EMP induced coupling levels for certain shipboard antenna systems and structures. The techniques discussed include the following: 1) The prediction of specific response levels based on use of data modules for external coupling of EMP to generic system structures,)2 the combined use of a transient electromagnetic range facility and scale models of ships, and 3) the synthesis of equivalent circuits with network response predictions.

The emphasis is on the use of the reduced-scale ship models in order to provide the type of responses required for hardening considerations. Scale-model tests on the transient range aid in establishing the accurancy and limitation of such ship model measurements as tools for predicting voltages and currents on the shipboard systems. Data is presented for comparison of techniques and thus illustrates some of the accuracy and flexibility of the scale-model approach. Results from tests on a 1/48 scale model indicate time domain response peaks generally are within ±6DB when compared to full-scale measurements.

80-113 EXPECTED RANGES IN WEAPON GAMMA OUTPUT AND HIGH-ALTITUDE EMP (U)
UCID-18639
(Title unclassified, report secret)

H. S. Cabayan
D. Smith

EMP
Uncertainties
Weapon Output

Abstract

This report examines the expected ranges of gamma outputs from different classes of weapons and the resulting ranges in high altitude EMP. In addition, EMP uncertainty issues related to employment and deployment will be examined. The report also addresses the issue of uncertainties in gamma output calculations by examining test data and predictions for several devices. The work is based in large part on test data and computations performed by personnel at Lawrence Livermore National Laboratory covering the period from 1967 to 1978.

This effort is part of a parallel unclassified effort funded by the Defense Nuclear Agency to develop methodologies for evaulating quantitatively the impacts of uncertainties on EMP assessment of military systems.

80-114 ELECTROMAGNETIC EMISSION FROM ACCELERATORS AND ELECTRON BEAMS
UCRL-85329

H. S. Cabayan
J. Zicker

E-beam
MX
Simulation

Abstract

The electromagnetic fields in the immediate vicinity of the Experimental Test Accelerator (ETA) at the Lawrence Livermore National Laboratory (LLNL) have been characterized. Various EM sensors that cover the frequency band from the very low frequencies up into the GHz region have been used. In this paper the experimental set-up and the measured data are presented.

80-115 1979 ANNUAL REPORT THE S-1 PROJECT
VOLUME I: ARCHITECTURE
UCID-18619

L. L. Wood
L. C. Widdoes, Jr.
E. J. Gilbert
S. Correll
R. Kovalcik

CAD
Computers
Multiprocessors
Operating Systems
Programming Languages

Abstract

The US Navy is one of the world's largest users of digital computing equipment having a procurement cost of at least $50,000, and is the single largest such computer customer in the Department of Defense. Its projected acquisition plan for embedded computer systems during the first half of the 80s contemplates the installation of over 10,000 such systems at an estimated cost of several billion dollars. This expenditure, though large, is dwarfed by the 85 billion dollars which DoD is projected to spend during the next half-decade on computer software, the near-majority of which will be spent by the Navy; the life-cycle costs of the 700,000+ lines of software for a single large Navy weapons systems application (e.g., AEGIS) have been conservatively estimated at most of a billion dollars.

80-116 1979 ANNUAL REPORT THE S-1 PROJECT
VOLUME II: HARDWARE
UCID-18619

W. R. Bryson
P. M. Farmwald
T. M. McWilliams
J. B. Rubin

CAD
Computers
Multiprocessors
Operating Systems
Programming Languages

Abstract

These drawings and the accompanying text providea preliminary look at a sampling of the hardware in the S-1 Mark IIA uniprocessor; the 1980 annual report will provide a complete set, corresponding to the system as built and debugged. The drawings, created with the D graphics editor, are used as input to the SCALD computer-aided design system, and they use the notation described in the SCALD II User's Manual elsewhere in this annual report.

80-117 1979 ANNUAL REPORT THE S-1 PROJECT
VOLUME III: SOFTWARE
UCID-18619

O. T. Anderson
J. M. Broughton
H. W. Chin
C. Frankston
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L. W. Robinson
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A. L. Lansky
F. Chow
G. Wiederhold
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CAD
Computers
Multiprocessors
Operating Systems
Programming Languages

Abstract

As the hardware bases of modern computer systems become more versatile and powerful, so must the associated operating systems, if the pull potential of the resulting systems is to be realized.

The S-1 multiprocessor system is intended to fulfill a wide range of requirements, and so must its Amber operating system. The power of its member processors may be used in real-time control applications and real-time signal processing as well as lengthy computation-intensive problems. The elegance and flexibility of the S-1 architecture can provide interactive access to a timesharing system suitable for program development, database queries and electronic communications. S-1 hardware can emulate the architectures of other existing machines in a cost-effective manner. In addition, anticipated compact uniprocessor versions of the S-1 architecture are suitable for embedded applications such as smart terminals, device controllers and distributed processing nodes.

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