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ENGINEERING RESEARCH DIVISION
PUBLICATION REPORT

E. K. Miller, Division Leader
P. L. Livingston, Editor

July 1983

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ABSTRACT

This bibliography with abstracts lists citations of 118 formal reports in electronics engineering. (LEW)

ENGINEERING RESEARCH DIVISION PUBLICATION REPORT

CALENDAR YEAR 1982

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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.

ENGINEERING RESEARCH DIVISION
PUBLICATION REPORT - CALENDAR YEAR 1982

- 82-1 CAPACITIVE AND INDUCTIVE IRISES IN
RECTANGULAR WAVEGUIDE: A NEW SOLUTION
UCRL-87204, January 1982
1982 Joint International IEEE/APS
Symposium, National Radio Science
Meeting, and Nuclear Electromagnetic
Pulse Meeting at the University of
New Mexico, Albuquerque, May 24-28,
1982

K. F. Casey

Electromagnetic Theory
Waveguide Theory

Abstract

Techniques for the solution of dual series equations arising in potential theory are extended and applied to the solutions of two classical problems in waveguide theory: the capacitive and inductive iris problems. It is found that the normalized iris susceptances can be obtained from a rapidly convergent set of linear equations in the modal amplitudes and that new approximate expressions can be obtained from these equations by analytical means. The key to the procedure is expressing the modal amplitudes in terms of certain Jacobi polynomials. Numerically exact and approximate results are presented and compared, both against each other and against extant approximate results obtained by variational means. Applications of the method to other guided-wave problems of more current interest are also discussed.

- 82-2 "STOP:" A FAST PROCEDURE FOR THE EXACT
COMPUTATION OF THE PERFORMANCE OF COMPLEX
PROBABILISTIC SYSTEMS
UCRL-53230, January 1982

G. C. Corynen

Probability Computation
Set-theoretic Method

Abstract

A new set-theoretic method for the exact and efficient computation of the probabilistic performance of complex systems has been developed. The core of the method is a fast algorithm for disjointing a collection of product sets which is intended for systems with more than 1,000 components and 100,000 cut sets. The method is based on a "divide-and-conquer" approach, in which a multidimensional problem is progressively decomposed into lower-dimensional subproblems along its dimensions. The method also uses a particular pointer system that eliminates the need to store the subproblems by only requiring the storage of pointers to those problems.

Examples of the algorithm and the divide-and-conquer strategy are provided and comparisons with other significant methods are made. Statistical complexity studies show that the expected time and space complexity of other methods is $O(m^n)$, but that our method is $O(nm^3 \log(m))$. Problems which would require days of Cray-1 computer time with present methods can now be solved in seconds. Large-scale systems that can only be approximated with other techniques can now also be evaluated exactly.

82-3	NUMERICAL MODELING OF A PRIMITIVE SIEGE SIMULATOR UCRL-87198/Abstract, January 1982 To be presented at 1982 Joint International IEEE/APS Symposium, National Radio Science Meeting, and Nuclear Electromagnetic Pulse Meeting at the University of New Mexico, Albuquerque, May 24-28, 1982	E. K. Miller H. S. Cabayan G. J. Burke W. A. Johnson

Electromagnetic Modeling
EMP Simulator
Interface Problem
NEC Applications

Abstract

The capability of modeling buried and partially buried wires has recently been added to the Numerical Electromagnetics Code (G. J. Burke, et al., "An Efficient Numerical Method for Modeling Buried and Partially Buried Antennas," National Radio Science Meeting, Boulder, Colorado, January 1982). This capability will be used to analyze a primitive model of a SIEGE simulator. This model consists of a horizontal wire with voltage source. The ends of this wire terminate on a vertical twin wire transmission line which penetrates the earth to a finite depth. Performance studies of this model will be made as both the simulator and earth parameters are varied.

82-4	SURFACE CHARGE AND CURRENT DENSITIES ON A VERTICAL PERFECTLY CONDUCTING CYLINDER PENETRATING THE AIR EARTH INTERFACE UCRL-87197/Abstract, January 1982 To be presented at 1982 Joint International IEEE/APS Symposium, National Radio Science Meeting, and Nuclear Electromagnetic Pulse Meeting at the University of New Mexico, Albuquerque, May 24-28, 1982	W. A. Johnson D. G. Dudley

Electromagnetic Modeling
Interface Problem

Abstract

Applications of the Numerical Electromagnetics Code (G. J. Burke and A. J. Poggio, NOSC TD 116, Jan. 1981) to the analysis of thin wires penetrating the air-earth interface requires a characterization of the behavior of both the wire's surface charge and surface current densities at the air-earth interface. A brief analysis shows that the current density is continuous across the interface. The ratio of the charge density in air just above the interface is equal to the earth's relative dielectric constant.

To obtain a detailed knowledge of the charge and current densities near the interface, the boundary value problem for a vertical cylinder penetrating the air-earth interface is solved. To avoid excessive complications, an azimuthally symmetric excitation is chosen. The resulting system of integral equations is put in a form similar to those used by Glisson and Wilton to analyze a stepped-radius antenna (A. W. Glisson and D. R. Wilton, "An Accurate Numerical Investigation of the Stepped-Radius Antenna," National Radio Science Meeting, Boulder, Colorado, Nov. 1978). The charge and current densities on a tubular cylinder are first considered. Next a solid cylinder with end caps is studied to quantify "how thin is thin enough for thin wire theory to hold in a lossy medium."

82-5   DEVELOPMENT OF CRITERIA FOR PROTECTION OF
            HIGH EFFICIENCY VLF AMPLIFIERS

UCRL-87193/Abstract, January 1982
To be presented at 1982 Joint
International IEEE/APS Symposium,
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982

J. C. Logan
L. C. Martin
V. C. Martins
J. C. Peterson

Amplifiers
EMP
VLF Communication

Abstract

The Very Low Frequency (VLF) transmitting stations are key to Navy strategic communications with submarines. The existing VLF transmitting systems are in the process of being replaced with technologically new high efficiency, high power (megawatt) amplifiers which are potentially vulnerable to the threat from the high altitude nuclear electromagnetic pulse (HEMP). Preliminary hardening criteria or guidelines have been established through consideration of some of the general aspects of all the fixed VLF sites, analysis of a specific site antenna configuration, and prior work on other communication facilities. The criteria presented are to provide a basis for future development work for the amplifier systems under consideration.

- 82-6 EMP DAMAGE AND CURRENT MODE SECOND BREAKDOWN
IN EPITAXIAL PLANAR TRANSISTORS L. C. Martin
UCRL-87196/Abstract, January 1982 J. H. Yee
To be presented at 1982 Joint J. C. Koo
International IEEE/APS Symposium, J. C. Peterson
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982

EMP
Semiconductor Breakdown

Abstract

EMP damage thresholds in semiconductor junction devices have been investigated much during the past decade with attention given to relatively simple thermal models and empirically determined parameters. Discrepancies between model predictions and/or a considerable spread in threshold values are evident from test results in many cases. This work reviews the mechanisms of second breakdown with presentation of computations and experimental data which shows relatively clear evidence that the current mode second breakdown (CSB) may dominate at shorter pulse widths with consequent lowering of damage threshold below that predicted by a thermal second breakdown (TSB) process.

- 82-7 TRANSIENT SCALE MODEL MEASUREMENTS FOR H. S. Cabayan
AIRCRAFT COUPLING ASSESSMENT H. G. Hudson
UCRL-87200/Abstract, January 1982 E. J. Bogdan
To be presented at 1982 Joint
International IEEE/APS Symposium,
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982

Aircraft EMP
EMP
Scale Models
Transient Measurements

Abstract

Electromagnetic transient measurements of scale models can serve as useful complements to full-scale tests for performing NEMP coupling assessment of military systems. For relatively modest costs, scale model tests can provide pre-test estimates and the means for evaluating the impact of modifications on coupling issues after the full-scale tests have taken place.

A 1/10 scale model of the A-7E Navy tactical aircraft has been built. The model includes all the major mechanical features both external and internal to the aircraft. Major cable bundles are modeled by representative wires routed appropriately. In this presentation, scale model and actual aircraft data will be compared. These will include both external and internal measurements.

- 82-8 IDENTIFICATION OF ANTENNA PARAMETERS FROM TIME DOMAIN PULSE RESPONSE DATA G. A. Clark
L. C. Martin
UCRL-87194/Abstract, January 1982
To be presented at 1982 Joint International IEEE/APS Symposium, National Radio Science Meeting, and Nuclear Electromagnetic Pulse Meeting at the University of New Mexico, Albuquerque, May 24-28, 1982

Antennas
Identification
Pole-Zero Model
Transient Measurements

Abstract

An accurate antenna model is important to the determination of the responses of electronic systems to nuclear EMP. In our work, a transient electromagnetic antenna range provides pulse measurements from which antenna impedance can be obtained. One modeling technique previously used computes antenna impedance from time domain reflectometry (TDR) measurements using Fourier transform operations. This paper describes a technique for obtaining a lumped parameter antenna impedance model directly from the time domain antenna range data. The method uses modern parameter identification techniques in which a pole-zero (autoregressive moving average or ARMA) model is obtained by recursively computing the model parameters which minimize time domain mean square error. The technique is described, and an example identification using actual antenna range measurements is given.

- 82-9 SHIPBOARD ANTENNA SYSTEM EMP DESIGN ALGORITHM S. T. Li
UCRL-87195, January 1982
To be presented at 1982 Joint International IEEE/APS Symposium, National Radio Science Meeting, and Nuclear Electromagnetic Pulse Meeting at the University of New Mexico, Albuquerque, May 24-28, 1982
J. C. Logan
J. W. Rockway
L. C. Martin
E. J. Bogdan

Antennas
EMP
Ship EMP

Abstract

A procedure for the design of shipboard antenna systems against the effects of electromagnetic pulse (EMP) is described. Exposure to EMP, especially that from a nuclear burst at high altitudes, can degrade the combat effectiveness of unhardened air-and-sea-based Navy communication systems. The design procedure, or EMP algorithm (EMPAL), is a computer-aided iterative process which relies on a blend of experimental and computational techniques. Scale modeling and a transient electromagnetic test facility (time domain range) are used to determine antenna system response functions. Lumped element models are used in combination with the circuit configuration and the EMP source as inputs to a circuit/systems simulation code (SPICE2) for response computations. The EMPAL procedure parallels the EMC (electromagnetic compatibility) design approach currently in use for Navy shipboard exterior RF communications systems design. EMPAL will thus augment the Navy's EMC design capability.

82-10 ASSESSMENT AND PROPAGATION OF UNCERTAINTIES
IN SYSTEM EMP RISK ASSESSMENT
UCRL-87199/Abstract, January 1982
To be presented at 1982 Joint
International IEEE/APS Symposium,
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982

R. W. Mensing

EMP
Reliability
System Assessment
Uncertainty Analysis

Abstract

The assessment of the risk of systems to an EMP threat involves uncertainties. There are the potential inherent random variations in the failure characteristics of components and systems as well as random uncertainties in the response of components caused by the EMP related stresses. Thus an analysis of the risk of a system to an EMP threat must allow for these random uncertainties. There are also uncertainties in the analysis and assessment of risk or vulnerability. For example, in most situations there is a lack of knowledge about the EMP source. There is also uncertainty in the transfer of the EMP induced stresses from the environment to the entry of the component/system. Finally, there is likely to be some uncertainty in knowing the parameter values associated with the random component failures. These uncertainties must also be considered in a risk assessment.

- 82-11 THREE-DIMENSIONAL COMPUTER MODELING OF
ELECTROMAGNETIC FIELDS: A GLOBAL LOOKBACK
LATTICE TRUNCATION SCHEME
UCRL-87201, January 1982
To be presented at 1982 Joint
International IEEE/APS Symposium,
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982
- R. W. Ziolkowski
N. K. Madsen
R. C. Carpenter

Electromagnetic Modeling
Finite Difference
Time-Domain Modeling

Abstract

A new lattice truncation scheme for the finite difference time domain approach to the solution of Maxwell's equations has been developed. The problem space is truncated near the sources and the field components on its boundary are generated from those field values known at retarded times on an interior surface one cell from it with an integral representation of the electromagnetic field. The numerical implementation of this global lookback scheme is discussed. Examples which have been used to determine its characteristics and its validity are given.

- 82-12 POWER FLOW FROM HORIZONTAL DIPOLES LOCATED ABOVE
AND BELOW A LOSSY HALF SPACE
UCRL-87533/Abstract, January 1982
Submitted to European Association
of Exploration Geophysicists, 44th
EAEG Meeting, June 8-11, 1982
- R. M. Bevensee
C. G. Dease
R. J. Lytle
E. K. Miller

Dipole Radiation
Electromagnetic Power Flow
Interface Problem

Abstract

Power flow from a monochromatic vertical dipole located above and below a lossy half space has been treated previously. It was found that the power flow implied by the real part of the Poynting vector exhibits unusual features, including a circulating pattern indicating a turning of the flow lines in the earth back toward the axis of the current source.

82-13 ELECTROMAGNETIC SIGNAL PROCESSING: A
TRANSIENT IDENTIFICATION PROBLEM

J. V. Candy
J. E. Zicker

UCRL-87202, January 1982

To be presented at 1982 Joint
International IEEE/APS Symposium,
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982

Electromagnetic Signal Processing
Estimation
Identification

Abstract

Signals generated from the Lawrence Livermore National Laboratory, Electromagnetic Transient Facility yield a unique set of signal processing problems. The signals are transient in nature, noisy, and cannot be measured simultaneously with the excitation; therefore, the basic identification problem is further complicated.

In this paper we describe various approaches to solving the transient identification problem using existing techniques. We apply algorithms, both recursive (on-line) and off-line, to a representative noisy, transient, electromagnetic signal. The performance of each technique is evaluated using a criterion based on the resulting "fit" of the data set.

82-14 MAXIMUM ENTROPY ARRAY RESOLUTION OF
RADIATING SOURCES

R. M. Bevensee

UCRL-87192/Abstract, January 1982

To be presented at 1982 Joint
International IEEE/APS Symposium,
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982

Electromagnetic Target Imaging
Maximum Entropy

Abstract

The conventional MEM array method (R. N. McDonough, Geophys., 39, 843-851, 1974) resolves sources in direction by extrapolating the spatial autocorrelation function in a most probable sense and computing the resultant wavenumber spectrum by what is effectively autoregressive all-pole modeling (Burg method).

82-15 RELIABILITY-CONFIDENCE FAILURE
ANALYSIS OF SYSTEMS

R. M. Bevensee

UCRL-87191/Abstract, January 1982
To be presented at 1982 Joint
International IEEE/APS Symposium,
National Radio Science Meeting, and
Nuclear Electromagnetic Pulse Meeting at
the University of New Mexico, Albuquerque,
May 24-28, 1982

EMP Reliability
Failure Analysis
System Analysis

Abstract

Reliability-confidence failure analysis is important for large systems to assess the effects of disturbances such as EMP. Such analysis can be applied both to non-failure probabilities of network paths and to the probability of system failure over all disjoint paths of its network representation. For instance, the log-probability of non-failure over a network path is the sum of the log-probabilities of non-failure of the path components. The question then arises: given R-reliability intervals (an interval in which the log-probability is expected to lie 100R% or more "of the time" in an ensemble sense) for these component log-probabilities, and confidences in those intervals, what is a reasonable R-reliable interval for the path log-probability of non-failure and what is the confidence in it?

82-16 AN EFFICIENT NUMERICAL METHOD FOR
MODELING BURIED AND PARTIALLY BURIED
ANTENNAS
UCRL-86839/Abstract, January 1983
National Radio Science Meeting
University of Colorado, Boulder,
Colorado, January 13-15, 1982

G. J. Burke
W. A. Jokanson
R. W. Ziolkowski
E. K. Miller
J. N. Brittingham

Antennas
Electromagnetic Modeling
Interface Problem
NEC Applications

Abstract

When an antenna near or penetrating an interface between two media is modeled by the numerical solution of an integral equation, the kernel includes Sommerfeld integrals. Solution by the method of moments can often be limited by excessive computation time and numerical difficulties. This paper describes a solution procedure that is an extension of a method used for antennas above the ground (G. J. Burke, et al., Electromagnetics 1:29-49, 1981) combining interpolation in previously computed tables of Sommerfeld integrals with approximations valid at large separations of source and observer.

The above ground case involved bivariate interpolation for the Sommerfeld integrals. The singularity in the field was reduced analytically to permit modeling wires very close to the interface. This method was easily extended to buried antennas where the wave number in the source medium is complex. Extension to interactions across the interface required interpolation in three variables for the Sommerfeld integrals. At larger separations the field was evaluated by approximations involving ray optics and lateral wave formulas. Results have been obtained for antennas buried and penetrating the interface. The method is being incorporated into the method-of-moments computer code NEC.

82-17 FOCUS WAVE MODES IN HOMOGENEOUS WAVE EQUATION J. N. Brittingham
UCRL-86841/Abstract, January 1983
National Radio Science Meeting,
University of Colorado, Boulder,
Colorado, January 13-15, 1982

Electromagnetic Pulses
Focus-Wave Modes

Abstract

To begin the experimental study of three-dimensional, source-free pulses in electromagnetic waves which remain focused for all time, one needs a pulse solution to Maxwell's homogeneous equations. These pulse solutions need to move at light velocity in a straight line. The pulse functions must decrease in front, behind, and transversely to the axis of propagation as the pulses move through free space. Since singularities and discontinuities depict sources in classical electromagnetic theory, these solutions must not have either characteristic. Because the fundamental building block of all theoretical electromagnetics is the wave equation, it is natural to begin the study by searching for such solutions in the homogeneous wave equation.

This paper will present the mathematical solutions to the homogeneous wave equation which represents three-dimensional pulses propagating at light velocity in a straight line. The pulses' shape, which remains fixed for all time, decreases in front, behind, and transverse to the axis of propagation. The pulse functions are continuous with no singularities. Therefore, it is conceivable that these solutions might relate to source-free soliton.

82-18 STRUCTURED ASSESSMENT APPROACH (SAA) W. J. Orvis
INPUT PACKAGE
UCRL-53007, Vol. 3
January 2, 1982

Nuclear Safeguards
Structured Assessment Approach

Abstract

The operation and use of the Structured Assessment Approach (SAA) Input Package programming written for a Tektronix 4050 Series Computer is described. The programming consists of the Facility Description Program (described in this volume) and its continuation, the Accounting System Program (planned), plus several service routines. These programs generate the input files that are used by the SAA codes in a mainframe computer, such as the CDC 7600 at the Lawrence Livermore National Laboratory.

82-19 PRESENTING INFORMATION IN SOUND
UCRL-87087, January 8, 1982
Presented at Human Factors in Computer
Systems, Gaithersburg, Maryland,
March 15-17, 1982

S. A. Bly

Computer Graphics
Computer Sound
Information Presentation

Abstract

In the past few years, the increase in interactive use of computers has led to an emphasis on human factors and the ways in which digital information can best be presented to user. Computer graphics has been at the forefront of this growth involving vision as an active aid in interpreting data. Bar charts, psuedo-color image processing, and 3-dimensional figures are but a few means of providing the viewer with data information.

82-20 DIGITAL IMAGE PROCESSING
UCRL-87132, January 21, 1982
Submitted for Publication in
IEEE Transactions on Nuclear Science

R. E. Twogood
F. G. Sommer

Image Processing
Medical Imaging
Radiography

Abstract

In this paper we give a tutorial overview of the field of digital image processing. Following a brief discussion of some basic concepts in this area, image processing algorithms are presented with emphasis on fundamental techniques which are broadly applicable to a number of applications. In addition to several real-world examples of such techniques, we also discuss the applicability of digital image processing to one particular field, that of medical radiography.

82-21 EFFICIENT REALIZATION OF ADAPTIVE DIGITAL
FILTERS IN THE TIME AND FREQUENCY DOMAINS

UCRL-86712, January 22, 1982
1982 IEEE Conference on Acoustics,
Speech and Signal Processing
Paris, France, May 3-5, 1982

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

Adaptive Filter
Digital Filter
Filters

Abstract

A unified approach to the efficient realization of FIR adaptive digital filters in both the time and frequency domains is presented. It is shown that previously published frequency domain implementations are contained within this unified approach. It is further shown that various combinations of implementations are possible, and that in working with data streams, care must be taken in using overlap-save and overlap-add selectioning procedures for proper frequency domain implementations.

82-22 THE ELECTRICAL CONDUCTIVITY AND TEMPERATURE
OF THE UPPER MANTLE AS ESTIMATED FROM
SATELLITE MAGNETIC FIELD DATA

UCRL-87187, January 28, 1982
Submitted to the Journal of
Geophysical Research

E. M. Didwall

Earth Conductivity
Electromagnetic Induction
Satellite Sensing

Abstract

The electrical conductivity of the upper mantle is estimated from low latitude magnitude field variations (magnetic storms) caused by large fluctuations in the equatorial ring current. The data base is derived from magnetic field magnitude data measured by satellites Ogo 2, 4, and 6 which offer better global coverage than land-based observatories. The procedures of analysis consist of i) separation of the disturbance field into internal and external parts relative to the surface of the earth, ii) estimation of a response function $Q(\omega)$ which relates the internally generated magnetic field variations to the external variations due to the ring current, and iii) interpretation of the estimated response function using theoretical response functions for known conductivity profiles. Special consideration is given to possible ocean and ionospheric effects.

Best estimates of the geomagnetic response function $Q(\omega)$ for 0.2 to 2.0 cycles/day tend to be lower than would be expected from Banks' geomagnetic deep sounding results. This response function indicates an upper mantle conductivity of order 10^{-2} S/m. This conductivity is more reasonable than any larger conductivity since such a value would correspond to a temperature that would melt the mantle.

82-23 DIRECTIONAL BOREHOLE PROBE FOR RADAR
INVESTIGATION OF SALT DOMES
UCRL-87215, February 1, 1982
Submitted to Geophysics

H. M. Buettner
C. G. Dease

Antennas
Directional Borehole Probe
Electromagnetic Measurement
Radar

Abstract

A unique, miniature, directional borehole probe has been designed for radar investigation of salt domes. The probe employs a ferrite cylinder 7.62 cm diameter and 25.5 cm in height with wire-dipole elements placed against the cylinder wall. This probe is approximately four times smaller in lateral extent than an "equivalent" free-space antenna array, and represents a significant improvement over conventional, omni-directional designs.

82-24 ELECTROMAGNETIC PENETRATION OF A COMPOSITE
PANEL IN A PERFECTLY CONDUCTING SURFACE
UCRL-87231/Abstract, February 4, 1982
1982 IEEE International Symposium on
Electromagnetic Compatibility, Santa Clara,
California, August 8-10, 1982

K. F. Casey

Advanced Composites
Aperture Coupling
Electromagnetic Coupling

Abstract

The shielding effectiveness of a panel of advanced composite material in an otherwise perfectly conducting surface is determined theoretically by solving an appropriate electromagnetic boundary value problem. Non-zero contact resistance at the panel boundary is taken into account in the analytical model. It is found to contribute significantly to the penetrating electromagnetic field when it becomes comparable to the dc sheet resistance of the composite panel itself. The parameter characterizing the penetration is found to be an " L/R " time constant, where L depends upon the dimensions and R upon the sheet and contact resistances of the composite panel.

82-25 SOME RESULTS FROM A STATISTICAL
SCATTERING EXPERIMENT

E. K. Miller
J. T. Okada

UCRL-87235, Rev. 1, February 8, 1982
Submitted to 1982 IEEE International
Symposium on Electromagnetic Compatibility
Santa Clara, California, September 8-10,
1982

Electromagnetic Statistics
Statistical Electromagnetics
Transient Measurements

Abstract

The complex environments in which many electromagnetic systems must operate (consider the antenna arrangements found on typical navy ships) make their analysis in any rigorous sense largely impractical. Yet it is important that the perturbing effect of such environments be somehow accounted for in evaluating system performance. The purpose of this paper is to present some results from a statistical experiment conducted in the time domain to measure the effects caused by N nearby identical scatterers on a, the receiving properties of a given antenna. It is found that the variance of the peak antenna current at first increases, and then decreases as N increases, with the environment changing from a discrete to an essentially continuum or medium-like behavior. This mean peak current, on the other hand, decreases monotonically with increasing N .

82-26 EMP ALGORITHM FOR SHIPBOARD ANTENNA
SYSTEMS DESIGN APPLICATIONS

L. C. Martin
E. J. Bogdan
S. T. Li
J. C. Logan
J. W. Rockway

UCRL-87277/Abstract, February 9, 1982
Submitted to 1982 International
Symposium on Electromagnetic
Compatibility, Santa Clara, California
September 8-10, 1982

Antennas
EMP
Ship EMP

Abstract

The exposure of shipboard antenna systems to an electromagnetic pulse environment, especially that from a nuclear burst at high altitudes (NEMP) can degrade the combat effectiveness of unhardened air- and sea-based Navy communication systems. In this paper, we describe an overall algorithmic design procedure or EMP algorithm (EMPAL) as a computer-aided analysis tool which relies on scale modeling and computer modeling. This procedure will thus augment the Navy's EMC design capability.

82-27 CONTROL OF INFORMATION AS AN ELEMENT
OF NUCLEAR SAFEGUARDS

J. N. Green

UCRL-87250, Abstract/Summary
February 16, 1982
Submitted to Institute of Nuclear
Materials Management Twenty-Third
Annual Meeting, Washington, DC,
July 18-21, 1982

Nuclear Safeguards
Physical Protection

Abstract

Control of information as an element of physical protection has a long history in the field of national security. The nuclear industry is familiar with the constraints on proprietary information; and, with an effective date of October 1, 1980 for Parts 25 and 95 in Title 10 of the Code of Federal Regulations, certain activities had to cope with rules for safeguarding of classified information. In applying the rules it is important to understand the differences between national security information and restricted data, and how guidance is promulgated both by the Nuclear Regulatory Commission (NRC) and by the Department of Energy. More recently, with a fully effective date of January 20, 1982, the NRC published rules for the protection of unclassified safeguards information. The scope is much broader than for classified information. For example, the rules are applicable to power reactors. In this paper the directives which provide the details for compliance with all these rules are identified, and their application is discussed. NRC inspectors will be checking for compliance with the rules. Once problems of compliance are resolved, the more difficult question of evaluating the impact of information control procedures on the effectiveness of a physical protection system can be addressed.

82-28 A FRAMEWORK FOR ANALYZING SAFEGUARDS
ALARMS AND RESPONSE DECISIONS

R. A. Al-Ayat
B. R. Judd
R. K. McCord

UCRL-86215, February 16, 1982
Institute of Nuclear Materials Management
Twenty-Third Annual Meeting, Washington, DC,
July 18-21, 1982

Nuclear Safeguards
Safeguards Alarms

Abstract

This paper describes a quantitative approach to help evaluate and respond to safeguards alarms. These alarms may be generated internally by a facility's safeguards systems or externally by individuals claiming to have stolen SNM. This approach can be used to identify the most likely cause of an alarm--theft, hoax, or error--and to evaluate alternative responses to alarms. Possible responses include conducting investigations, initiating

measures to recover stolen SNM, and replying to external threats. Based on the results of each alarm investigation step, the evaluation revises the likelihoods of possible causes of an alarm, and uses this information to determine the optimal sequence of further responses. The choice of an optimal sequence of responses takes in consideration the costs and benefits of successful thefts or hoaxes. These results provide an analytical basis for setting priorities and developing contingency plans for responding to safeguards alarms.

82-29 CROSS-BOREHOLE SEISMIC PROBING TO LOCATE
HIGH-CONTRAST ANOMALIES
UCID-19247, February 19, 1982

R. J. Lytle
M. R. Portnoff

Borehole Measurements
Compressional Waves
Seismic Probing
Shear Waves

Abstract

Seismic probing between boreholes is useful for locating high-contrast geophysical anomalies such as an abandoned tunnel. Theoretical studies of continuous-wave components of a swept-frequency or pulse seismic wave interaction with a tunnel show that both the signal minima and the phase structure of the received signal can be used for locating the anomaly. The theoretical studies show that as the source and receiver are lowered in separate boreholes straddling the anomaly, the signal minima and the phase structure can be easily interpreted to yield both the lateral and vertical positions of the anomaly. Plane waves of compressional, horizontally polarized shear, and vertically polarized shear wave types incident on a cylindrical horizontal anomaly have been considered. All components of the total seismic field have been calculated using an exact formulation. The variation of the response is studied as a function of the ratio of anomaly diameter to wavelength. The resulting fields in the receiver borehole are an effective diagnostic when a wavelength in the surrounding medium is less than or equal to the diameter of the anomaly. These results are analogous to the corresponding electromagnetic case which has been studied previously.

82-30 ANALYSIS OF THE ROLE OF AN INTERFACILITY SNM
ACCOUNTING SYSTEM
UCID-19126, February 22, 1982

J. L. McDonnell
P. D. Chilton
G. E. Kufahl
A. A. Vergari
C. R. Dunn

Material Accounting System
Nuclear Safeguards

Abstract

Lawrence Livermore National Laboratory (LLNL) undertook the task of analyzing the actual and potential value of an interfacility NRC material accounting system in deterring and detecting both material diversion and facility material accounting data falsification. The most important conclusion is that only relatively minor changes are needed to upgrade the current NRC interfacility reporting system. The emphasis of the task was on evaluating the usefulness of an NRC-monitored material accounting information system in providing protection against accounting fraud at the plant management or corporate level.

The Nuclear Materials Management and Safeguards System (NMSS) and the NRC Safeguards Status Report System (SSRS), the principal constituents of the current interfacility NRC material accounting information system, are described. Their relationship is shown in two information flow diagrams. Deterministic accounting checks and balances are discussed, both for the current NRC interfacility material accounting system and for an upgraded system. Detection mechanisms are described that would use currently available data and that could be exercised by the NRC in its safeguards management role. Additional checks and balances are recommended, with corresponding changes in data reporting requirements, to upgrade NRC interfacility material accounting system.

82-31 USER'S MANUAL FOR SMACS A FAMILY OF CODES
FOR PROBABILISTIC STRUCTURAL ANALYSIS
UCIO-19137, March 1982

S. Bumpus
S. N. Shukla
W. J. O'Connell
M. A. Gerhard

Probabilistic Structural Dynamics Code
Users Manual

Abstract

SMACS is a code for probabilistic structural dynamics. It links the seismic input, soil-structure interaction and structural response calculations to obtain response vectors, which in turn are used as input for risk analysis. Uncertainties are included explicitly by varying key inputs. Preprocessors set up structural and wave scattering matrices. SMACS does repeated time history analyses with varied inputs. Post-processors summarize statistics of the results. The report includes input manuals and a solved example.

82-32 ANALYSIS OF PRE-BURST TEMPERATURE
DISTRIBUTION IN EXPLODING BRIDGEWIRE FOILS
UCRL-86630, March 1982
Submitted to Firing Systems Conference,
Los Alamos National Laboratory,
Los Alamos, New Mexico,
November 17-18, 1981

N. K. Madsen

Bridgewire Modeling
Detonator
Temperature Analysis
Time-Domain Modeling

Abstract

The purpose of this paper is to describe and discuss the transient temperature distributions in detonator bridgewire foils of varying geometric designs when they are electrically exploded. It has been noted experimentally that these bridgewire foils heat nonuniformly with marked hot spots developing at the corners with the "bridge" and "land" areas of the foil meet. It has been speculated that this hot spot formation may be responsible, at least in part, for the erratic behavior of some detonators.

82-33 ANALYSIS OF IMPACT OF NONCOMPLIANCE WITH
PHYSICAL SECURITY REQUIREMENTS AT NUCLEAR
FACILITIES

J. N. Green

UCRL-86205, March 1982
TMS/DRSA Detroit Joint National
Meeting April 18-21, 1982

Nuclear Safeguards
Physical Protection

Abstract

Inspectors are required to analyze the impact of instances of non-compliance with physical security requirements at licensed nuclear facilities. A scoring procedure for components and a method for evaluating the effectiveness of the subsystems involved are proposed to reinforce an inspector's judgment about the remaining level of safeguards.

82-34 DECONVOLUTION OF NOISY TRANSIENT SIGNALS:
A KALMAN FILTERING APPLICATION

J. V. Candy
J. E. Zicker

UCRL-87432, Draft, March 1982
and August 31, 1982,
21st IEEE Conference on Decision
and Control, Orlando, Florida,
December 8-10, 1982

Kalman Filters

Abstract

The deconvolution of transient signals from noisy measurements is a common problem occurring in various tests at Lawrence Livermore National Laboratory. The transient deconvolution problem places atypical constraints on algorithms presently available. The Schmidt-Kalman filter, a time-varying, tunable predictor, is designed using a piecewise constant model of the

transient input signal. A simulation was developed to test the algorithm for various input signal bandwidth and different signal-to-noise ratios for the input and output sequences. The algorithm performance is reasonable.

82-35 A DYNAMIC MODEL FOR THE LLNL SHOCK-HARDENED
DATA RECORDER
UCID-19196, March 1982

G. A. Clark
W. J. King

Recorder
Shock-Hardened
Signal Processing

Abstract

This report describes the analysis, simulation, and validation of a dynamic model for the LLNL shock-hardened recorder designed to record accelerations experienced by a warhead during collision with various targets, projectiles and media. We discuss the importance of modeling and signal processing to the recording and smart fuzing problems, models for the various recorder components, and the computer code used to simulate the models. Our model validation work is discussed and the results presented, showing that the model closely predicts the recorder's behavior. We also briefly describe some proposed work involving modeling accelerometers, a warhead, and a shock test fixture.

82-36 REAL AXIS INTEGRATION OF SOMMERFELD INTEGRALS:
SOURCE AND OBSERVATION POINTS IN AIR
UCRL-87466, March 1982
Submitted to Radio Science

W. A. Johnson
D. G. Dudley

Interface Problem
Numerical Integration
Sommerfeld Integrals

Abstract

Change of variables and subtraction of asymptotic terms are used to aid in the integration of Sommerfeld integrands along the real axis. Interest is restricted to practical earth parameters above 2 megahertz. Comparison with a complex contour technique shows the present method to be particularly well suited for the analysis of a vertical, thin-wire antenna in the presence of a lossy earth.

82-37 MODELING OF SIMPLE ANTENNAS NEAR TO AND
PENETRATING AN INTERFACE
UCRL-87496, March 1982
Submitted to IEEE Electronics Letters

G. J. Burke
W. A. Johnson
E. K. Miller

Antennas
Electromagnetic Modeling
Interface Problem
NEC Applications

Abstract

Some results are presented for horizontal and vertical electric dipole antennas as they are brought close to, or penetrate, the interface between two half-spaces. The model used is an electric field integral equation together with the Sommerfeld solution for the fields caused by the interface.

82-38   SOUND AND COMPUTER INFORMATION PRESENTATION   S. A. Bly
          UCRL-53282, Ph.D. Thesis

Computer Graphics
Computer Sound
Information Presentation

Abstract

This thesis examines the use of sound to present data. Computer graphics currently offers a vast array of techniques for communicating data to analysts. Graphics is limited, however, by the number of dimensions that can be perceived at one time, by the types of data that lend themselves to visual representation, and by the necessary eye focus on the output. Sound offers an enhancement and an alternative to graphic tools.

82-39   A DIRECTIONAL BOREHOLE PROBE FOR   H. M. Buettner
          GROUND PROBING RADAR   C. G. Dease
          UCRL-87215-Rev. 1, March 10, 1982
          To be presented at IEEE Geoscience
          and Remote Sensing Symposium,
          Munich, Germany, June 2-4, 1982

Antennas
Directional Borehole Probe
Electromagnetic Measurement
Radar

Abstract

A miniature, directional borehole probe has been designed for radar investigation of salt domes. In free space this probe exhibits optimal directivity at 276 MHz with a front-to-back ratio of 13.5 dB and half-power beam width of 140°. This performance is in excellent agreement with predictions made by our computer model for the probe. In Cypress Creek Salt the probe is expected to exhibit optimal directivity at 275 MHz with a front-to-back ratio of 4.1 dB and half-power beam width of 210°. The probe is approximately one-fourth the size of an "equivalent" free-space antenna array and represents a significant improvement over conventional, omnidirectional designs.

Determination of the radio-frequency dielectric constant of Cypress Creek Salt along with some estimates regarding our directional probing system enable us to predict a radar probing range of 100 to 200 meters in the salt.

82-40 EVALUATION OF ELECTROMAGNETIC TECHNIQUES
IN METAL DETECTION FOR OSI OPERATIONS
UCID-19329, March 11, 1982

C. G. Dease
E. M. Didwall

Electromagnetic Induction
Electromagnetic Modeling
Interface Problem
Verification Program

Abstract

There is considerable interest in developing reliable methods for detecting objects with high electrical conductivity buried in the earth. A particularly important problem is the remote detection of vertical metal cables or casings that were used in emplacement and instrumentation of an underground nuclear explosion. Electromagnetic induction techniques were considered for detection of both ferrous and nonferrous metals. Because geophysical research has been oriented to a different set of problems, it was necessary to develop a generalized electromagnetic (GEM) code to evaluate the feasibility of detecting a buried vertical cylinder.

The code considers primary sources which are electric or magnetic, vertical or horizontal, located on or above an interface separating a dielectric (air) from a dissipative half-space (earth). For these possibilities it calculates the electromagnetic field scattered by a vertical cylinder which is electrically thin. To date, the code has been employed to quantitatively investigate source and receiver configurations. The central result of this investigation shows that the horizontal electric source is clearly superior. It couples to a vertical conductor buried in the earth. Further, it offers geometrical features which aid in the discrimination between the primary and the scattered fields.

82-41 MODELING OF EMP INDUCED BREAKDOWN PHENOMENA
IN SEMICONDUCTOR JUNCTION DEVICES
UCRL-87350, March 11, 1982
Submitted to 1982 IEEE Annual Conference
on Nuclear and Space Radiation Effects
Las Vegas, Nevada, July 20-22, 1982

W. J. Orvis
J. H. Yec

EMP
Semiconductor Breakdown

Abstract

Electromagnetic Pulses (EMP), coming from such diverse sources as lightning, Radar beams or nuclear explosions can induce transient electrical effects in metallic or semiconductor materials. Damage to sensitive components by strong EMP induced transients is a serious problem in both military and commercial electronic systems. While many circuits can be protected from EMP by placing them in metal boxes, others require connections to wires that must pass out of these boxes. These wires act like antennas, and channel the destructive pulses through the shield and into the electronics. Invariably, some of these penetrating wires connect directly to sensitive electronic components (i.e., the signal diode in a communications system that must connect to an antenna wire). If the system is to survive, this component must be able to withstand the EMP induced transient with a minimum of damage or degradation.

82-42 MODELING OF CURRENT AND THERMAL MODE SECOND
BREAKDOWN PHENOMENA
UCRL-87400, Abstract/Summary
March 12, 1982

J. H. Yee
W. J. Orvis
L. C. Martin
J. C. Peterson

Finite Element
Semiconductor Breakdown

Abstract

The physical processes of second breakdown in semiconductor devices are investigated by solving the continuity, the Poisson's, and the transport equations for the temperature using the finite element method. Both current and thermal mode second breakdown phenomena are investigated with computations of the temporal variations of the current, the electric field, and the temperature of the device. The threshold failure power for both of these phenomena of breakdown are studied as a function of pulse widths. Test results with shorter pulse widths are consistent and show clear evidence of decreased failure energy required for the current mode second breakdown in epitaxial transistors.

82-43 ENGINEERING RESEARCH DIVISION PUBLICATION
REPORT CALENDAR YEAR 1981
UCID-19080-81
March 15, 1982

E. K. Miller
Division Leader
P. L. Livingston,
Editor

Publications

Abstract

We have found it useful to issue an internal report listing all formal publications produced by the Engineering Research Division during the year. This is the publication report for calendar year 1981.

82-44 A GRAPH-THEORETIC ALGORITHM FOR HIERARCHICAL
DECOMPOSITION OF DYNAMIC SYSTEMS
UCID-19354, March 24, 1982

V. Pichai
M. E. Sezer
D. D. Siljak

Estimation
Filters
Kalman Filter

Abstract

A graph-theoretic scheme is proposed for partitioning of dynamic systems into hierarchically ordered subsystems having independent inputs and outputs. The resulting subsystems are input-output reachable as well as structurally controllable and observable, so that a "piece-by-piece" design of estimators and controllers can be accomplished for systems with large dimensions without excessive computer requirements.

82-45 HFEM MONITORING OF COAL GASIFICATION
RAWLINS, WYOMING
UCID-19363, March 25, 1982

E. F. Laine
N. J. Chakakis
W. D. Daily
F. J. Deadrick
G. Holladay
K. I. Kishiyama

Borehole Measurements
Electromagnetic Probing

Abstract

This report covers the high frequency electromagnetic monitoring (HFEM) of an underground coal gasification (UCG) test conducted by Gulf Research and Development Company at the DOE/GR & DC test site located in the North Knobs area about eight miles west of Rawlins, Wyoming in Section 11 T21N, R89W. The site was leased from Rocky Mountain Energy Company, a subsidiary of Union Pacific Railroad. At the test site, the gasified coal seam is steeply dipping (63°) with a seam width of about 23 feet. The coal is subbituminous.

The purpose of the HFEM is to monitor the burn or cavity progress between the injection well and the production well. We will also attempt to monitor the reverse burn linkage.

82-46 IDENTIFICATION OF ELECTROMAGNETIC OBJECT
RESPONSE FROM NOISY TRANSIENT MEASUREMENTS
UCRL-86135, March 30, 1982
6th IFAC Symposium on Identification
System Parameter Estimation,
Washington, DC, June 7-11, 1982

J. V. Candy
J. E. Zicker

EMP
Electromagnetic Signal Processing
Estimation
Signal Processing

Abstract

The response of an object subjected to high energy, transient electromagnetic (EM) fields called an electromagnetic pulse (EMP) is an important issue in the survivability of electronic systems (e.g., aircraft), especially when the field has been generated by a high altitude nuclear burst. The characterization of transient response information is a matter of national concern. In this paper we apply identification techniques to: (i) improve signal processing at a test facility, and (ii) parameterize a particular object response.

First, we discuss the application of identification-based signal processing techniques to improve signal levels at the Lawrence Livermore National Laboratory (LLNL) Electromagnetic Test Facility. We identify models of test equipment and then use these models to deconvolve the input/output sequences from the noisy measurements for the object under test. A parametric model of the object is then identified from this data. The model is then used to extrapolate the response to the threat level EMP.

82-47 LOCATING VERTICAL IRON WELL CASING
WITH A MAGNETOMETER
UCID-19355, March 30, 1982

E. F. Laine
R. J. Lytle

Magnetometer Measurements

Abstract

Prior theoretical results to describe the magnetic field caused by a vertical steel well casing are confirmed by field tests. A proton magnetometer was used to survey a gridded area about a known well casing. The measured magnetic fields are plotted in isometric views to show the steel well casing with and without interfering magnetic fields.

82-48 THE APPLICATION OF LARGE-SCALE STATE
ESTIMATION TO VIBRATING STRUCTURES
UCRL-86138, March 30, 1982
6th IFAC Symposium on Identification
and System Parameter Estimation,
Washington, DC, June 7-11, 1982

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

Estimation
Kalman Filter
State-Space Modeling
Structure Dynamics

Abstract

We have applied state-space methods to the analysis and measurement of the dynamic response of mechanical structures.

Our basic approach has been to use finite element structural dynamics models and convert the geometric description of the structure to produce a set of 2nd order matrix differential equations. The equations are then transformed into state-space form for input to a large-scale discrete-time linear Kalman filter. The filter has been implemented on the CRAY-1 computer which has sufficient capacity for a system of 500 states.

The actual testing and analysis of a sample structure subjected to vibration tests is discussed. The state estimates are compared post-facto to a finite element model output to evaluate estimator performance. The state estimator consisted of 72 states predicting nodal displacements.

82-49   AUDIT PROGRAM FOR PHYSICAL SECURITY SYSTEMS   C. Minichino
          AT NUCLEAR POWER PLANTS
          UCIO-19132, March 31, 1982

Nuclear Safeguards
Physical Protection

Abstract

This report was prepared as guidance to the Nuclear Regulatory Commission and licensees in developing, operating, and maintaining a comprehensive audit program for physical security systems at nuclear power plants.

82-50   THE "IMG" IMAGE PROCESSING SYSTEM   R. J. Sherwood
          PRELIMINARY USERS MANUAL   M. R. Portnoff
          M-134, April 1982   C. H. Journeay
                                                                  R. E. Twogood

Image Processing
Users Manual

Abstract

The IMG Image Processing System is a software and hardware system for processing images on the IPRG PDP-11/70. Images are represented as arrays of 32-bit floating point numbers, and are processed on the Floating Point Systems AP-120B array processor and on the DEC PDP-11/70 computer.

82-51   IDENTIFICATION OF CONTINUOUS TIME SYSTEMS--   D. T. Gavel
          AN APPLICATION OF LJUNG'S CORRECTED EXTENDED   S. G. Azevedo
          KALMAN FILTER
          UCRL-86138, April 1, 1982
          6th IFAC Symposium on Identification
          and System Parameter Estimation,
          Washington, DC, June 7-11, 1982

Estimation
Filters
Kalman Filter

Abstract

The extended Kalman filter (EKF) has often been used as a parameter identifier for linear systems. Ljung has proposed a correction to the EKF that would allow the algorithm to asymptotically converge to unbiased parameter estimates. In this paper a continuous-discrete version of the algorithm is presented and found to have similar convergence properties. Discussion of the advantages of using continuous time models follows. Also included is a discussion of the computer methods used to propagate the differential equations found in the algorithm.

82-52 GEOTOMOGRAPHY IN OIL SHALE
UCRL-85748, Rev. 1
Submitted to Journal of Geophysical
Research, April 7, 1982

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

Borehole Probing
Electromagnetic Probing
Geotomography

Abstract

Geophysical tomographs were made of oil shale at the Occidental Oil Shale, Inc., mine near DeBeque, Colorado. These tomographs mapped the in-situ radio-frequency electromagnetic attenuation of oil shale between 1 and 40 MHz in a plane 27 by 12 m. Measured attenuation rates (inverse skin depth) ranged from 0.1 to 0.5 m^{-1} with the attenuation rate approximately proportional to the square root of frequency. At 20 MHz, the measured relative permittivity of oil shale is about 9.

Geotomographs were made in another plane 16.8 by 12 m, before and again after the shale in this region was explosively rubbled. Measured electromagnetic attenuation rates at 20 MHz were generally larger in the rubble than in the undisturbed shale, suggesting that geotomography may be useful in mapping a characteristic of the rubbled zone such as void content or void size distribution. Model calculations of the rubble using a theory of dielectric mixtures predict a smaller attenuation rate in the rubble, implying that the measurements result from phenomena such as scattering or oil shale anisotropy, which are not accounted for in the model.

82-53 HIGH FREQUENCY ELECTROMAGNETIC PROBING
AT LLNL'S LARGE BLOCK COAL GASIFICATION
UCID 19356, April 15, 1982

K. I. Kishiyama

Borehole Probing

Abstract

The burn-cavity of LLNL's large block coal gasification experiment near Centralia, Washington was probed by using the High Frequency Electromagnetic (HFEM) technique. Since the burn area was small and the boreholes closely spaced, there was less signal attenuation than previous experiments. Thus, higher frequencies were used for better resolution. Also, sufficient data was taken to use image reconstruction algorithms to produce a tomograph of the burn-cavity. Since the large block will be excavated, this experiment provides an excellent opportunity to compare the results of HFEM probing to the actual burn-cavity.

82-54   EVALUATING ALTERNATIVE RESPONSES TO SAFEGUARDS
         ALARMS

UCRL-86220, April 15, 1982
Submitted to the ESARDA SPECIALIST
MEETING 1982, Petten, The Netherlands
April 27-29, 1982

R. A. Al-Ayat
B. R. Judd
R. K. McCord

Nuclear Safeguards

Abstract

This paper describes a quantitative approach to help evaluate and respond to safeguards alarms. These alarms may be generated internally by a facility's safeguards systems or externally by individuals claiming to have stolen special nuclear material (SNM). This approach can be used to identify the most likely cause of an alarm--theft, hoax, or error--and to evaluate alternative responses to alarms. Possible responses include conducting investigations, initiating measures to recover stolen SNM, and replying to external threats. Based on the results of each alarm investigation step, the evaluation revises the likelihoods of possible causes of an alarm, and uses this information to determine the optimal sequence of further responses. The choice of an optimal sequence of responses takes into consideration the costs and benefits of successful thefts or hoaxes. These results provide an analytical basis for setting priorities and developing contingency plans for responding to safeguards alarms.

82-55   POSTCLOSURE RISKS OF ALTERNATIVE SRP NUCLEAR
         WASTE FORMS IN GEOLOGIC REPOSITORIES
         UCRL-53269, May 1982

H. Cheung
L. L. Edwards
T. F. Harvey
M. A. Revelli

Nuclear Waste
System Assessment

Abstract

The postclosure risks of REFERENCE and ALTERNATIVE waste forms for the defense high-level waste at the Savannah River Plant (SRP) were compared by analyses with a computer code, MISER, written to study the effects of repository features in a probabilistic framework. MISER traces radionuclide flows through a network of stream tubes from the repository to risk-sensitive points. Uncertainties in waste form, package properties, and geotechnical data are accounted for with Monte Carlo techniques. Our results show: 1) for generic layered-salt and basalt repositories, the difference in performance between the two waste forms is insignificant; 2) where the doses are sensitive to uncertainties in leaching rates, the doses are orders of magnitude below background; 3) disruptive events contribute only slightly to the risk of a layered-salt repository; 4) simple design alterations have strong effects on near field doses; 5) great care should be exercised in selecting the location at which repository risks are to be measured, calculated, or regulated.

82-56 RESPONSIBILITIES, OPPORTUNITIES AND
CHALLENGES IN GEOPHYSICAL EXPLORATION
UCRL-87593, May 5, 1982
Submitted to 23rd US Symposium on
Rock Mechanics, Berkeley, California
August 25-27, 1982

R. J. Lytle

Geophysical Exploration

Abstract

Geophysical exploration for engineering purposes is conducted to decrease the risk in encountering site uncertainties. Such studies are needed in construction of underground facilities. Current responsibilities, opportunities and challenges for those with geophysical expertise are defined. These include: replacing the squiggly line format, developing verification sites for method evaluations, applying knowledge engineering and assuming responsibility for crucial national problems involving rock mechanics expertise.

82-57 HEALTH PHYSICS INSTRUMENTS: WHAT ARE THE
CURRENT NEEDS?
UCRL-86222/Summary, May 14, 1982
1982 Nuclear Science Symposium,
Shoreham Hotel, Washington, DC,
October 20-22, 1982

G. A. Armantrout

Health-Physics Instrument

Abstract

Health physics instruments are used with appropriate conversion factors to indicate the health risk factors for individuals exposed to given radiation fields. Significant changes in the values of these conversion factors are under consideration by cognizant bodies as a result of increasing understanding of radiobiological effects and the desire to accurately quantitate these effects. This, coupled with the present shortcomings of current instruments in terms of energy response and use in mixed radiation fields, provides incentive for the development of the next generation of smart instruments.

82-58 ALTERNATE METHODS FOR DETERMINING THE
ELECTRICAL CONDUCTIVITY OF CORE SAMPLES-II
UCRL-87656, May 20, 1982

R. J. Lytle

Electrical Conductivity
Electrode Configurations

Abstract

Electrode configurations are described that can be used in measuring the electrical conductivity of a core sample. The use of these configurations is warranted for laboratory measurements simulating the pressure and fluid flow conditions encountered at depth within the earth. Three particular electrode configurations are illustrated with numerical results depicting their relative merits.

82-59 THEORETICAL MODELING OF EMP EFFECTS IN
SEMICONDUCTOR JUNCTION DEVICES
UCRL-87672, May 27, 1982
To be published by Air Force
Weapons Laboratory

J. H. Yee
W. J. Orvis
L. C. Martin

EMP
Semiconductor Breakdown

Abstract

In this report, we discuss various damage mechanisms and their effects on the performance of semiconductor devices. We also discuss some of the important theoretical models which are used to describe second breakdown phenomena. We show that the dominant mechanism responsible for the occurrence of second breakdown is probably the thermal excitation of electrons from a device's valence band (thermal mode second breakdown). Conclusions from theoretical calculations based on three different approximations seem to support this model. We discuss current mode breakdown, another form of second breakdown, in terms of the role it plays in determining the shape of the threshold failure power curve.

- 82-60 DETECTING HIGH-CONTRAST SEISMIC ANOMALIES USING CROSS-BOREHOLE PROBING R. J. Lytle
UCRL-87694, May 28, 1982 M. R. Portnoff
Submitted to IEEE Geoscience
and Remote Sensing

Borehole Probing
Seismic Probing

Abstract

Seismic probing between boreholes is useful for locating high-contrast geophysical anomalies such as an abandoned tunnel. Theoretical studies of continuous-wave components of a swept-frequency or pulse seismic wave interaction with a tunnel show that both the signal minima and the phase structure of the received signal can be used for locating the anomaly. The theoretical studies show that as the source and receiver are lowered in separate boreholes straddling the anomaly, the signal minima and the phase structure can be easily interpreted to yield both the lateral and vertical positions of the anomaly. Plane waves of compressional, horizontally polarized shear, and vertically polarized shear wave types incident on a cylindrical horizontal anomaly have been considered. The total seismic field has been calculated using an exact formulation. The variation of the response is studied as a function of the ratio of anomaly diameter to wavelength. The resulting fields in the receiver borehole are an effective diagnostic when a wavelength in the surrounding medium is less than or equal to the diameter of the anomaly. These results are analogous to the corresponding electromagnetic case which has been studied previously.

- 82-61 DESIGN OF NEUTRON STREAK CAMERA C. L. Wang
FOR FUSION DIAGNOSTICS R. Kalibjian
UCRL-86162 Rev. 1, June 1982 M. S. Singh
Submitted to the 15th International
Congress on High Speed Photography
and Photonics, San Diego, California,
August 22-27, 1982

Neutron Detection
Streak Camera
Transient Measurements

Abstract

The D-T burn time for advanced laser-fusion targets is calculated to be very short, < 50 ps. We describe the design of a neutron streak camera of 16 ps resolving time that can be used to study the temporal history of fusion burn. The cathode of the neutron streak camera is sensitive to neutrons and is curved such that the difference in the neutron path lengths from a point source to various parts of the cathode is compensated by

electron transit times within the streak tube. Thus the cathode can be made large for high sensitivity, without sacrificing time resolution. The cathode is coated with $1\text{ }\mu\text{m}$ UO_2 . Each fission fragment leaving the cathode generates 400 secondary electrons that are all $< 20\text{ eV}$. These electrons are focused to a point with an extractor and an anode, and are then purified with an electrostatic deflector. The electron beam is streaked and detected with the standard streak camera techniques. Careful shielding is needed for x-rays from the fusion target and general background. It appears that the neutron streak camera can be a viable and unique tool for studying temporal history of fusion burns in D-T plasmas of a few keV ion temperature.

- 82-62 RECENT DEVELOPMENTS IN THE DISSECTOR/RESTORER
FRAMING CAMERA TUBE
UCRL-86930, June 1982
Submitted to the 15th International
Congress on High Speed Photography
and Photonics, San Diego, California,
August 22-27, 1982

R. Kalibjian
S. W. Thomas
J. P. Henz
R. L. Peterson

Framing Camera
Picosecond Imaging
Transient Measurements

Abstract

The dissector/restorer framing camera tube (DRFCT) has been characterized with a Nd:YAG mode-locked laser. The 3-frame format tube has a $0.5 \times 0.5\text{ cm}$ field-of-view (referenced to the photocathode) and 0.3 ns duration frames with better than 5 lp/mm spatial resolution (at cathode) using a microwave triode tube driver.

- 82-63 SPACE-CHARGE PERTURBATION EFFECTS IN
PHOTONIC TUBES UNDER HIGH IRRADIATION
UCRL-86929, June 1982
Submitted to the 15th International
Congress on High Speed Photography and
Photonics, San Diego, California,
August 22-27, 1982

R. Kalibjian
G. G. Peterson

Photonic Tubes
Space-Charge Effects

Abstract

Potential perturbation effects at the cathode region of a photonic tube can occur at high intensity due to space-charge. Using appropriate photoelectron energy distribution functions, the electric field at the cathode is calculated and its effect upon the spatial/temporal resolution is examined.

82-64 RISK ANALYSIS OF NUCLEAR SAFEGUARDS
REGULATIONS
UCRL-87721, June 1982
Workshop on Low-Probability/High
-Consequence Risk Analysis,
Society for Risk Analysis,
June 15-16, 1982

R. A. Al-Ayat
W. D. Altman
B. R. Judd

Aggregated Systems Model
Detection Analysis
Nuclear Safeguards
Probabilistic Analysis

Abstract

This paper describes an application of the Aggregated Systems Model (ASM), a probabilistic risk analysis tool for nuclear safeguards, developed for NRC and DOE. We applied the ASM to determine benefits and costs of proposed amendments to NRC regulations governing nuclear material control and accounting systems. The objective of the amendments was to improve the ability to detect insiders attempting to steal large quantities of special nuclear material (SNM).

Insider threats range from likely events with minor consequences to unlikely events with catastrophic consequences. Moreover, establishing safeguards regulations is complicated by uncertainties in threats, safeguards performance, and consequences, and by the subjective judgments and difficult trade-offs between risks and safeguards costs. The ASM systematically incorporates these factors in a comprehensive, analytical framework.

We used the ASM to evaluate the effectiveness of current safeguards and to quantify the risk of SNM theft. We then analyzed how various modifications designed to meet the objectives of the proposed amendments reduced that risk. We judged safeguards effectiveness in terms of the probability of detecting and preventing theft, the expected time to detection, and the expected quantity of SNM diverted in a year. The latter measure quantifies the risk from theft attempts.

Data were gathered in tours and interviews at NRC-licensed facilities. We began the assessment at each facility by carefully selecting scenarios representing the range of potential insider threats. A team of analysts and facility managers assigned probabilities for detection and prevention events in each scenario.

Using the ASM we computed the measures of system effectiveness and identified cost-effective safeguards modifications that met the objectives of the proposed amendments. We also determined the costs of different levels of effectiveness proposed by NRC and highlighted critical value judgments for selecting the appropriate level.

82-65 IMAGE ENHANCEMENT APPLICATIONS AT THE
LAWRENCE LIVERMORE NATIONAL LABORATORY
UCRL-87784, June 1982
15th International Congress on
High Speed Photography and Photonics
San Diego, California, August 21-27,
1982

R. E. Twogood
R. J. Sherwood
M. R. Partnoff

Image Enhancement
Radiography
Waveform Digitization

A diverse set of digital image processing applications exists at the Lawrence Livermore National Laboratory. While many of these include some sort of image analysis or restoration, virtually all of them require image enhancement procedures. In this paper we describe the principal image processing facility at the Laboratory, followed by a discussion of several of the major image processing application areas.

82-66 COMPUTER AIDED ENGINEERING IN LLNL'S
EE DEPARTMENT
UCRL-87684/Abstract, June 2 1982
Submitted to the 5th Biennial
Cube Symposium, Sandia Laboratories
Albuquerque, New Mexico, October 27-29,
1982

L. Hatfield

Computer-Aided Engineering

Abstract

A long range plan for implementing Computer Aided Engineering (CAE) within the Electronics Engineering Department at LLNL is being developed. This plan recognizes the gains that have been achieved with computer aided drafting and design and seeks to bring the same increased productivity to a broader range of engineering activities.

In addition to traditional turnkey systems in such areas as schematic drafting, PC layout, and IC design, the plan calls for work stations available to, and, in many cases, in the offices of engineers. These workstations, based on today's rapidly evolving computer technology, will have significant computational capability, large main memory, and graphics.

Workstations will be networked together and will have access to larger computers, such as 32 bit super-minis and mainframes. Other systems, such as the turnkey systems and those operated by the print room, will also be accessible via networking.

Essentially all aspects of an engineer's job are potential candidates for inclusion in the CAE plan. Currently, the tasks of electronics design, modeling, simulation, software development, project planning and management project communication, and documentation has been identified. Typically, applications software will be acquired and integrated into the system, though conversion or development of some software will probably be necessary.

To reduce implementation and maintenance costs, "standard" hardware and software will be used to the greatest extent possible. Still, a number of areas will probably require additional effort on LLNL's part. At the present, these include development of suitably friendly and useful human/computer interface techniques, distributed processing procedures, and resolution of data base access and compatibility problems.

82-67 A METHODOLOGY FOR ASSESSING THE
SECURITY RISKS ASSOCIATED WITH
COMPUTER SITES AND NETWORKS
UCRL-53292 Pt. 1, June 23, 1982

G. C. Corynen

Computer Security
Security-Risk Methodology

Abstract

A new methodology has been developed for the assessment of security risks associated with the operation of computer complexes. It is designed to assist computer security managers and their risk assessment teams in obtaining an overall risk figure for their computer site or network.

82-68 GEOLOGICAL FRACTURE MAPPING USING
ELECTROMAGNETIC GEOTOMOGRAPHY
UCRL-87785, June 29, 1982
Submitted to Review of Progress in
Quantitative NDE, University of
California, San Diego, August 1-6,
1982

A. L. Ramirez
F. J. Deadrick
R. J. Lytle

Borehole Probing
Electromagnetic Geotomography

Abstract

This article describes the evaluation of a new geophysical technique used to map fractures between boreholes: electromagnetic geotomography used in conjunction with salt water tracers. An experiment has been performed in a granitic rock mass. Geotomographic images have been generated and

compared with borehole geophysical data: neutron logs, acoustic velocity logs, caliper logs and acoustic televiewer records. Comparisons between the images and the geophysical logs indicate that clusters of fractures were detected but single fractures were not.

82-69 THE FASCINATING FIELD OF COMPUTER GRAPHICS
UCRL-87925, July 1982
Submitted to IEEE Potentials

L. Hatfield

Computer Graphics

Abstract

Computer graphics, that is, producing a "picture" or "drawing" of some sort with a computer, is hardly a new field. Computers have controlled pen plotters and produced drawings since the 1950's; this type of "passive graphics" remains important to this day. Even "interactive graphics," which involves a person and the computer to generate the drawing interactively, has its origins in the early 1960's. Yet, the excitement in the field of graphics today makes it seem as if the area were totally new. Developments in many facets of graphics are more rapid than ever before, and the number of practitioners and developers is greatly expanding.

The field of graphics does, indeed, have many aspects. Among these are the design and development of hardware, the development of graphics system software, the development of graphics application software, research and development of fundamental algorithms, and development of techniques--at many levels. In fact, computer graphics is in many ways just a microcosm of the entire computer field.

82-70 MODELING OF SIMPLE ANTENNAS NEAR TO
AND PENETRATING AN INTERFACE
UCRL-87495 Rev. 1, July 1982
Proceedings of the IEEE

G. J. Burke
W. A. Johnson
E. K. Miller

Antennas
Interface Problem
NEC Applications

Abstract

Some results are presented for horizontal and vertical electric dipole antennas as they are brought close to, or penetrate, the interface between two half-spaces. The model used is an electric field integral equation together with the Sommerfeld solution for the fields caused by the interface.

- 82-71 FOCUS WAVE MODES IN HOMOGENEOUS
MAXWELL'S EQUATIONS - TE-MODE
UCRL-86512 Rev. 3, July 1982
Submitted to The Journal of
Applied Physics

J. N. Brittingham

Electromagnetic Pulses
Focus Wave Modes

Abstract

This paper presents mathematical formulations for new, three-dimensional, packet-like solutions to the free-space homogeneous Maxwell's equations. These solutions are real, nonsingular, continuous functions which propagate in a straight line at light-velocity. They remain focused for all time. The asymptotic behavior of the fields away from the moving pulse center has a magnitude which decreases as the inverse of the distance from the pulse centers.

- 82-72 RESULTS OF INSTRUMENT RELIABILITY STUDY
FOR WASTE REPOSITORIES
UCRL-87808, Rev. 1/Abstract, July 8, 1982
IEEE Nuclear Science Symposium,
Shoreham Hotel, Washington, DC,
October 20-22, 1982

F. Rogue
E. F. Binnall

Geotechnical Instrumentation

Abstract

Reliable instrumentation will be needed to monitor the performance of future high-level waste repository sites. A study has been made to assess instrument reliability at DOE waste repository related experiments and to identify failure modes, rates, and mechanisms. Though the study covers a wide variety of instrumentation, this paper concentrates on experiments with geotechnical instrumentation in hostile repository environments. Related information from other sources is included to augment the reliability of instruments for repositories. Manufacturers have made some changes to improve the reliability of instruments for repositories. In this paper, we will review the failure modes, rates and mechanisms along with recommendations for needed improvements in instrument performance.

- 82-73 DESIGN OF RESISTIVE MULTIPLE-VALUED
DIGITAL-TO-ANALOG CONVERSION LADDERS
UCID-19445, July 29, 1982

S. K. Mitra

Digital-to-Analog Conversion
Ladder Networks

Abstract

A general procedure for designing resistive ladders for converting data in arbitrary m-valued representation to its analog equivalent is outlined.

82-74 A MOMENT-METHOD SOLUTION FOR SCATTERING
FROM AN ELASTIC SHELL
UCRL-87992, Abstract, July 30, 1982
Workshop on Research Techniques in
Wave Propagation and Scattering

E. K. Miller

Acoustic Scattering
Elastic Shell

Abstract

As in electromagnetic (EM) scattering, it is possible to formulate the acoustic problem as an integral equation for the sources induced on a scattering surface. Solution for these sources then provides the means for obtaining the scattered field from an integral over that surface. For those cases where the acoustic problem is closely analogous to the EM one, the formulation and numerical treatment are correspondingly similar. Examples are provided by rigid and free-surface acoustic scatterers whose treatments are essentially identical to EM scattering from perfect magnetic and perfect electric conductors, respectively. Early work in numerical acoustics [1,2,3] illustrates this fact.

But, the more general EM and acoustics problem is that wherein the scatterer is penetrable, in which case the incident field can induce not only surface sources but interior fields as well. It is in this situation that the acoustics problem can become generally more complicated than its EM counterpart. Whereas the EM problem involves only two polarizations of basically the same kind of field for most media of interest, the acoustic problem frequently involves an elastic scatterer (and sometimes also an elastic medium). The elasticity leads to both shear-wave and compressional-wave interior fields, whose mutual presence can give rise to a very complex scattering behavior, and significantly complicates the formulation and subsequent solution.

A relatively straightforward approach to objects having penetrable interiors is to use a Green's function for an infinite medium having the same properties as the object's interior, if one is available. Expressions can be written for the interior and exterior fields in terms of their respective Green's functions and surface integrals over the object. It is then possible to derive integral equations for the induced surface sources by letting the observation points approach the surface from either side while imposing the required boundary conditions at the object-medium interface. However, this approach is not always suitable even if a Green's function is available. An inhomogeneous object, for example, requires a volumetric-integral treatment, in which case an approach based on a differential equation is usually preferable.

Various approximations may be used to reduce the complexity of the solution for the penetrable scatterer. In electromagnetics, it is common to use the concept of a surface impedance, whereby the tangential electric field is expressed in terms of the tangential magnetic field multiplied by an impedance which is determined by the interior medium and possibly the radius of curvature. A further approximation results from expressing both fields as the sum of incident and reflected components, where again the reflection coefficient is determined by the object parameters.

Corresponding approximations can be appropriate in acoustic problems. One problem of interest is that of scattering from an elastic shell located in a fluid medium. [For scattering from thin shells in the linear-response regime ^[4], it is possible to greatly simplify the problem by using the "thin-shell" approximation in which the normal stresses and bending moments can be neglected. In this case, the interior problem simplifies to a differential equation of motion for the shell. When this is combined with an integral equation for the exterior scattered field, a coupled integro-differential equation is obtained.

In this paper, the analytical development of a solution to the problem of scattering from fluid-immersed, thin, elastic, spherical shells is given. The numerical treatment is described and representative results which validate the treatment and illustrate physical behavior are presented. Consideration is given to extending the treatment to non-spherical shells (axi-symmetric, for example).

82-75 FOCUS WAVE MODES MIGHT PRESENT NEW
REPRESENTATION FOR SINGLE PHOTON
UCRL-88098, August 1982
International Union of Radio Science
Winter Symposium, University of
Colorado, Boulder, Colorado,
January 5-7, 1983

J. N. Brittingham

Electromagnetic Pulses
Focus Wave Modes

Abstract

The TE modes solutions presented at a recent meeting are the first mathematical formulations of three-dimensional, source-free, nondispersive electromagnetic pulses [Focus Wave Modes in Homogeneous Maxwell's Equations - TE Modes, J. N. Brittingham, 1982 International Symposium Digest Antennas and Propagation, Vol. 2, pp. 656-659, Albuquerque, New Mexico]. These pulses propagate in a straight line at light velocity. They are not only nondispersive but the pulses' functional

shapes remain fixed for all time as they propagate through free space. It is the focused nature of these functions which explains the terminology Focus Wave Modes [abbreviated FWM]. This paper will discuss the strong similarities between the FWM solutions and a single photon.

- 82-76 FOCUS WAVE MODES IN HOMOGENEOUS MAXWELL'S J. N. Brittingham
EQUATIONS - TM MODE
UCRL-86675 Rev. 1, August 1982
International Union of Radio Science
Winter Symposium, University of Colorado,
Boulder, Colorado, January 5-7, 1983
Submitted to The Journal of Applied Physics
December 1982

Electromagnetic Pulses
Focus Wave Modes

Abstract

Last year new and unique mathematical formulations were presented [Focus Wave Modes in Homogeneous Maxwell's Equations - TE Modes, J. N. Brittingham, 1982 International Symposium Digest Antennas and Propagation, Vol. 2, pp. 656-659, Albuquerque, New Mexico] of some pulse functions. These mathematical solutions: satisfy homogeneous Maxwell's equations, are three-dimensional pulses, are continuous and nonsingular, propagate in a straight line at light velocity, remain focused as they propagate, have a far-field identical to that of a stationary dipole in free space.

The terminology Focus Wave Modes [abbreviated FWM] comes from the characteristic that these pulses remain focused for all time. It is obvious that these mathematical solutions represent three-dimensional, source-free, nondispersive electromagnetic pulses which propagates at light-velocity in a straight line.

In the last paper, the FWM electric and magnetic fields were presented as TE modes of propagation; the present paper presents the electric and magnetic fields for TM modes of propagation.

- 82-77 FOCUS WAVE MODES IN HOMOGENEOUS MAXWELL'S J. N. Brittingham
EQUATIONS - TE AND TM MODES
UCRL-88097, August 1982
1983 URSI International Symposium
on Electromagnetic Theory, Santiago De
Compostela, Spain, August 23-26, 1982

Electromagnetic Pulses
Focus Wave Modes

Abstract

A recent paper [Focus Wave Modes in Homogeneous Maxwell's Equations - TE Modes, J. N. Brittingham, 1982 International Symposium Digest Antennas and Propagation, Vol. 2, pp. 656-659, Albuquerque, New Mexico] presented new, unique mathematical formulations which are wave-packet like solutions to the homogeneous Maxwell's equations in free space. These solutions have the following properties: they propagate at light-velocity in a straight line, they are continuous and nonsingular, their amplitudes decrease as the inverse of the distance from the moving pulse center, they propagate without alteration in pulse shape.

The most unique feature of these formulations is that the conditions three-dimensional, nondispersive, continuous, and nonsingular all appear simultaneously in a single solution to the homogeneous Maxwell's equations.

82-78 AVALANCHE TRANSISTOR
UCRL-53303, August 12, 1982

J. C. Koo
M. D. Pocha

Avalanche Transistor
Semiconductor Breakdown

Abstract

By using a simple, one-dimensional model, we argue that the phenomenon of second breakdown in an avalanche transistor arises due to the collapsing of the internal electric field. This, we propose, is a result of an expanding plasma wave.

82-79 THE APPLICATION OF A LARGE-SCALE KALMAN
FILTER TO THE VIBRATIONS OF A MECHANICAL
STRUCTURE
UCRL-88039, Abstract, August 17, 1982

D. L. Lager
S. G. Azevedo

Estimation
Kalman Filter
State-Space Modeling
Structure Dynamics

Abstract

We have applied state-space methods to the analysis and measurement of the dynamic response of mechanical structures. Our basic approach has been to use finite element structural dynamics models and convert the geometric description of the structure to produce a set of 2nd order matrix differential equations. The equations are then transformed into state-space form for input to a large-scale discrete-time linear Kalman filter. The filter has been implemented on the CRAY-1 computer which has sufficient capacity for a system of 500 states.

The actual testing and analysis of a sample structure subjected to vibration tests is discussed. The state estimates are compared post-facto to a finite element model output to evaluate estimator performance. The state estimator consisted of 72 states predicting nodal displacements.

- 82-80 EFFECTS OF UNEQUAL INPUT/OUTPUT SAMPLING RATES ON THE IDENTIFICATION OF ELECTROMAGNETIC TRANSIENT SYSTEMS E. J. Bogdan
G. A. Clark
UCID-19488, August 18, 1982

Electromagnetic Measurements
Identification
Signal Processing
Transient Measurements

Abstract

This report discusses some limitations on the identification of electromagnetic systems based on input and output records of different record lengths and sampling rates. This problem has come to our attention when trying to process internal data for the A-7E scale model in the Large Scale Model Measurement Program. The problems arise due to limitations of the measurement equipment and computer algorithms used to process the data. Because the input and output records must have the same sampling rates to be processed, considerable data preprocessing must be done to ensure that this condition exists. We present three such preprocessing methods for comparison, demonstrate them with examples, and conclude that the second one is to be preferred for general use.

Included are examples of the identification of a system model for each of the above three cases, along with a brief discussion of each. Identification, however, is not the main topic of this report, and it will be discussed in detail in a subsequent report.

Brief mention is made of the importance of proper windowing of truncated data sequences in order to obtain correct Fourier transforms using the DFT (discrete Fourier transform). Examples demonstrate the importance of windowing properly.

- 82-81 OPPORTUNITIES FOR UTILIZING COMPUTER-BASED TELECOMMUNICATION TOOLS IN CONTINUING EDUCATION E. K. Miller
W. D. Decker
UCRL-87478, September 1982
1982 ASEE Annual Conference Proceedings

Computer-Based Telecommunications
Continuing Education
Telecommunications Utilization

Abstract

"Information Explosion" has been used in recent years to describe the tremendous growth in the publication of scientific and technical results. It appears that output in this area is increasing at an exponential rate, due to at least two factors. One must be the large number of people engaged in scientific endeavors, compared with times past. The other is that the tools available, foremost of which must be the digital computer, have greatly increased the productivity and output of those involved in such work.

In a broader sense, however, we might equally well speak of an "information management" explosion. The computer, a major cause of the increased information being generated, can just as well provide the means for controlling and managing it. The information-management aspect of the computer will have a profound and incalculable impact on all areas of our lives, not the least of which will be education in general, and continuing education in particular.

This paper describes some near-term and longer-term possibilities for utilizing computer-based telecommunications technology in education that are not limited just to continuing education. As will be seen, our view is that computers are bound to play an increasingly important role in this area and must be taken into account even if the specific concern is, as we began with, telecommunications utilization. This theme will be developed after first describing briefly our experience of many years at Livermore in using television to enhance our educational offerings, the use of which has only scratched the surface so far.

82-82 ON THE ADVISABILITY OF AN AUTOMATIC
SEISMIC SCRAM
UCRL-53037, September 1982

W. J. O'Connell
J. W. Wells

Seismic Scram System

Abstract

We examine the advisability of requiring commercial nuclear power plants to have a seismic scram system set at a high trip level--e.g., 0.6 SSE. A high trip level avoids loss of electric generation after a low level earthquake. A seismic trip will give a lead time before other trip initiators. A few seconds is a significant time--3 s required to scram, and 5 to 10 s for 50% reduction of stored heat in the fuel rods. Then transient pressure and loads will be reduced. Using a decision tree, we compare the risks involved in both employing and not employing a seismic scram system.

82-83 COMPUTER MODELING OF SUBSURFACE PROBING USING
ELECTROMAGNETIC FIELDS

UCRL-88607, September 1982
Submitted to National Radio Science
Meeting, URSI, Boulder, Colorado
January 13-15, 1983

E. K. Miller
G. J. Burke
C. G. Dease
E. M. Didwall
W. A. Johnson

Electromagnetic Modeling
Geophysical Exploration
Interface Problem
NER Applications

Abstract

The radiating and scattering behavior of conducting objects buried in the ground are of interest in such diverse areas as hardened communication systems, EMP simulation, geophysical exploration, and underground construction. Our attention in this paper is directed to the latter two applications, wherein electromagnetic fields provide a means for probing into a half space such as the ground. The approach is to use an integral equation for wire objects located on either side of, or penetrating, the interface between two electrically dissimilar media. Solution of the integral equation is achieved via the moment method, and the Sommerfeld integrals are evaluated using an interpolation procedure.

Results are shown from representative computations for two different scenarios, passive probing and active probing. In passive probing, the sensing field is due to a background source, for example, the field of a broadcast station or the earth's natural electromagnetic field. Detection is then based on the local variation in the background field which is caused by scattering from a buried object. In active probing, the sensing field is produced by the probing system itself and an object's presence detected via a change in self or mutual impedance. Because the environment is a noisy one, both approaches can benefit from signal processing to improve the effective signal-to-noise ratio and reliability of detection, a subject which is also discussed.

82-84 ELECTRONICS ENGINEERING DEPARTMENT
COMPUTER PROGRAM NEWSLETTER Number 7
UCID-19563, September 1982

W. G. Magnuson, Jr.

Computer Newsletter
Network Analysis

Abstract

This issue of the Computer Program Newsletter updates an earlier newsletter (Number 2, September 1979) and focuses on electrical network analysis computer programs. In particular, five network analysis programs (SCEPTRE, SPICE2, NET2, CALAHAN, and EMP) will be described. The objective of this newsletter will be to provide a very brief description of the input syntax and semantics for each program, highlight their strong and weak points, illustrate how the programs are run at Lawrence

Livermore National Laboratory using the Octopus computer network, and present examples of input for each of the programs to illustrate some of the features of each program. In a sense, this newsletter can be used as a quick reference guide to the programs.

82-85 THE GEOMETRICAL OPTICS FIELD IN A
MAGNETO-ACTIVE RELATIVISTIC ANISOTROPIC
PLASMA

R. W. Ziolkowski

UCRL-88115, September 1982
The Physics of Fluids

Geometrical Optics
Plasma Interaction
Ray Tracing

Abstract

The electromagnetic field in a general inhomogeneous, non-stationary, temporally and spatially dispersive medium is obtained with a geometrical optics approach. The analysis accounts for a magnetic as well as an electric conductivity tensor. Convolution forms of those non-local conductivity tensors are used. Terms appear in the amplitude transport equation that are not obtained when central averaged forms are used to describe the non-local physics. They account for a spreading of the rays in (k, ω) -space. This is in addition to the usual factor that accounts for the spreading of rays in (x, t) -space. The geometrical optics results are applied to a general magneto-active, relativistic, anisotropic plasma.

82-86 PARTITIONING OF ATMOSPHERIC PARTICLE-IN-CELL
MODELS TO MULTIPROCESSORS
UCRL-63374, September 1982

B. S. Lawver

Multiprocessors
Particle-in-Cell
Software Partitioning

Abstract

This thesis formulates a design methodology for developing a multiprocessor computer system to solve atmospheric Particle-in-Cell models. The atmospheric Particle-in-Cell model is a subset of the class of fluid dynamics problems called Particle-in-Cell (PIC). The PIC class of problems requires very large data arrays to track the flow of mass through a two- or three-dimensional mesh and is computationally quite intensive.

The two atmospheric pollution problems examined by this thesis are relatively simple three dimensional PIC problems, yet are very expensive to compute. The data storage requirements of these models are met by the very large memory that is common to multiprocessor systems. A multiprocessor system was developed for these two models and speedup and performance were measured. The hardware components of the multiprocessor system are microcomputers with memory mapping. Five processors are configured as a Master/Slave multiprocessor. The five processor system showed a throughput increase of 4.5 over a single processor system. For the atmospheric PIC problems studied, the concurrency of the Eulerian step provided most of the improved performance. By distributing the particles equally to each of the slave processors, the work is balanced and maximal throughput is achieved.

82-87 ELECTRONICS ENGINEERING RESEARCH
FINAL REPORT FOR FY1981
UC10-19023-81, September 1982

C. Minichino, Editor
P. L. Phelps, Editor

Engineering Research

Abstract

Under the general direction of H. C. McDonald, Associate Director for Engineering, Engineering Research funds are provided by the Nuclear Explosives Program (NEP) to the EE and ME Departments to develop advanced technology capabilities to meet NEP long-term needs. The EE portion of the program, called Electronics Engineering Research (EER), is administrated by the Engineering Research Division. This report is a description of EER activities for FY1981.

Administrative policies for EER have been designed to stimulate a high quality of research and to ensure that the objectives of the EE Department and the NEP are met. Efforts are focused on those needs that are not expected to be satisfied by outside sources in time to meet the Laboratory's requirements.

EER projects are directed toward enhancing the engineering technology base in designated thrust areas, as presented in Table 1. Selection of projects for the EER Program is based on consideration of the following: pertinence to the Weapons Program, value to other Laboratory projects, technical merit, potential technical leverage or payoff.

The EER Program for FY1981 consisted of support for approximately 10 FTE's, with a total budget of \$1M, distributed over the eight projects described in this report. The projects are summarized briefly in this section. Sections 1 through 8 of the main text are full reports on the projects in FY1981.

82-88 ALTERNATE APPROACHES TO THE PROBLEM
OF H-POLARIZED PLANE WAVE SCATTERING
FROM AN AXIALLY SLOTTED INFINITE CYLINDER

W. A. Johnson
R. W. Ziolkowski
K. F. Casey

UCRL-88188/Abstract

September 1982

Submitted to 1983 National Radio Science
Meeting URSI, Boulder, Colorado,
January 5-7, 1983

Aperture Coupling
Electromagnetics
Method-of-Moments

Abstract

The azimuthal current induced on an axially slotted cylinder by an H-polarized plane wave at an arbitrary angle of incidence may be computed by a variety of techniques. Morris (1982 IEEE AP Symposium Digest, Vol. 2, pp. 511-512) solved integral equations with highly singular kernels using the Hadamard finite part interpretation of the integral to obtain this current.

Two alternate approaches will be considered in this paper. The dual series technique, a technique originally developed to treat problems in potential theory, has recently been applied by Casey to the analysis of irises in waveguides. This technique is analytical in nature, and the behavior of the current near the edges may be extracted from the solution. Application of the dual series technique to the present problem will be discussed. A purely numerical solution employing the method of moments will also be presented. This solution, based on vector and scalar potentials, is analogous to that of Glisson and Wilton (IEEE Trans. Antennas and Propagat., Vol. AP-28, No. 5, Sept. 1980, pp. 593-603).

Comparison of results obtained using each of these techniques will be made to identify their strengths and weakness.

82-89 SOME SIGNAL PROCESSING ISSUES IN
RADAR TARGET IDENTIFICATION

E. K. Miller

UCRL-88105, September 1, 1982

Submitted to the Topical Meeting on
Signal Recovery and

Synthesis with Incomplete Information
and Partial Constraints, Incline Village,
Nevada, January 12-14, 1983

Radar Target Identification
Signal Processing

Abstract

Three issues in radar target identification are discussed: 1) Prony-processing for EM features; 2) several EM examples; and 3) some results for target identification using poles.

82-90 SATER/LLNL AN INTERACTIVE IDENTIFICATION
/ESTIMATION/CONTROL PACKAGE
UCID-19551, September 2, 1982

J. V. Candy
C. H. Journeay

Estimation
Identification
SATER/LLNL

Abstract

This issue of the computer program newsletter focuses on SATER/LLNL--an interactive code for identification, estimation, and classical control. A brief description of the SATER/LLNL operation is included as well as a sample session. Attached is the fundamental reference that details more of the package.

82-91 A POLE-ZERO MODELING APPROACH TO LINEAR
ARRAY SYNTHESIS PART 1: The UNCONSTRAINED
SOLUTION
UCRL-87145, Rev. 1, September 2, 1982
Prepared for submittal to Radio Science

E. K. Miller
D. M. Goodman

Antenna Synthesis
Electromagnetic Radiation
Prony's Method

Abstract

The problem of pattern synthesis may be broadly viewed as one facet of the inverse problem. In electromagnetics, the inverse problem involves finding a spatial source distribution which produces an observed far field in order to estimate the geometry of the object with which the sources are associated. The synthesis problem involves specifying a pattern and seeking a source distribution for it that is possibly constrained in some way (e.g., to be confined to a prescribed surface, or to lie along a given line). Because pattern synthesis is related to the inverse problem, it is not surprising that it can be solved by similar mathematical procedures.

82-92 SITE CHARACTERIZATION USING
KNOWLEDGE ENGINEERING--AN APPROACH FOR
IMPROVING FUTURE PERFORMANCE
UCID-19560, September 16, 1982

R. J. Lytle

Knowledge Engineering
Site Characterization

Abstract

Site characterization involves planning, executing, integrating and interpreting the results of an ordered sequence of observations and measurements pertinent to a geological site. Medical diagnosis involves planning, executing, integrating and interpreting the results of an ordered sequence of observations and measurements pertinent to a human being. These different problems have important similarities. Both the site characterization and medical diagnosis procedures involve using data obtained for the particular site or patient. In addition, both procedures incorporate data learned from prior situations. This previously learned data consists of laboratory data, theoretical relationships, and case history data from prior sites or patients. Decision-making analysis is being applied to medical diagnostics with success. Decision-making analysis may also be appropriate in meeting site characterization needs. Examples of how such procedures may be of use are presented.

82-93 APPLICATIONS OF RIEMANN-HILBERT PROBLEM
TECHNIQUES TO ELECTROMAGNETIC COUPLING
THROUGH APERTURES

R. W. Ziolkowski
W. A. Johnson
K. F. Casey

UCRL-88169, September 17, 1982
Submitted to 1983 URSI International
Symposium on Electromagnetic Theory,
Santiago de Compostela, Spain,
August 23-26, 1983

Aperture Coupling
Electromagnetics

Abstract

The electromagnetic coupling problem as it applies to an enclosed region, an external source and a coupling aperture is one of major importance, both theoretically and from a practical point of view. Analytic solutions have not been available until recently and purely numerical techniques encounter difficulties largely due to the edge at the aperture rim. The analytic solutions to one or more canonical problems would greatly enhance our understanding of the coupling process. Furthermore, extensive analysis of those solutions could lead to "general rules of thumb," enabling one to estimate for engineering analysis and design purposes the coupling into more generally shaped cavities via more generally shaped apertures, and to the development of improved numerical techniques for dealing with aperture coupling in general geometries.

Techniques borrowed from the analysis of the Riemann-Hilbert problem of complex variable theory make it possible to obtain analytical solutions to families of canonical problems descriptive of electromagnetic and acoustic coupling via apertures into enclosed regions. This approach is applicable to all separable geometries; it represents a generalization of the Wiener-Hopf method. Examples of the canonical problems amenable to solution by these techniques include a plane wave incident on a slitted cylinder, with or without an interior conductor or impedance surface, on a cylinder with an arbitrary number of slits and on a conducting spherical shell with circular aperture. The angle of incidence is arbitrary.

The Riemann-Hilbert technique as they are applied to problems of electromagnetic coupling through apertures will be described. This approach will be illustrated with the example of a plane wave incident on a slitted cylinder enclosing a concentric impedance surface. This problem encompasses the coupling to an empty cylinder as well as to a cylinder enclosing a conducting wire or cable. The results for various angles of incidence will be presented for several cases of aperture and cylinder size. Special consideration will be given to the case in which the direction of incidence coincides with an edge of the aperture and the center of the cylinder. Comparisons with moment method results will also be made.

82-94 ELECTRIC VEHICLE CROSS-CUT ANALYSIS: VOLUME I-III D. D. Davis
UCID-19734, September 1982 M. K. Kong
J. R. Nettling

Electric Vehicle Performance

Abstract

This report documents an analysis that was done to establish realistic goals of range, performance, and cost for future electric vehicles and to identify the R&D that must be successful to attain these goals. Findings are the result of trade-off analyses which examined the contributions to improved range, acceleration performance, and reduction in cost, that are made by utilizing improved drivetrain components, vehicle body designs, and battery systems which are projected to be developed by 1988 as a result of successful R&D programs.

Prior publications documenting similar efforts serve as the data base for this analysis. Since a review of such publications sometimes reveals a rather wide diversity in projected results, our first step was to determine the reason(s) for these differences and thus, help insure that the analytical methods used in the analysis are sound.

The report of this work consists of three volumes:

- Volume I - Analysis of Past Projects of Electric Vehicle Performance
- Volume II - Future Electric Vehicle Performance Based Upon Improvements in Technology
- Volume III - Cost Reduction in Electric Vehicle Propulsion Systems

This effort was conducted for the Department of Energy (DOE) Electric and Hybrid Vehicle (EHV) Program. Its purpose was to provide information to assist the program in establishing future electric vehicle performance goals and R&D objectives.

82-95	THE SLITTED CIRCULAR WAVEGUIDE AS A LEAKY-WAVE ANTENNA	K. F. Casey W. A. Johnson R. W. Ziolkowski
	UCRL-88170/Abstract	
	September 21, 1982	
	Submitted to 1983 National Radio Science Meeting URSI, Boulder, Colorado, January 5-7, 1983	

Antenna Theory
Waveguide

Abstract

Slitted cylindrical waveguides of separable cross-section shape comprise a class of structures which are representative of certain leaky-wave antennas and whose analysis reduces to the problem of solving a set of dual series equations. In this paper is discussed the slitted circular-cylindrical waveguide operating as a leaky-wave antenna. A variational approach to this problem was described by Harrington (J. Appl. Phys., pp. 1366-1371, November 1953) and Tamir (in Antenna Theory, Part II, pp. 286 ff., McGraw-Hill, 1969). We consider an approach based on the reduction of the dual series equations arising in the formulation of the problem to a set of linear equations in the modal amplitudes. This reduction is carried out using an extension of techniques for the solution of dual series equations arising in potential theory described by Sneddon (Mixed Boundary Value Problems in Potential Theory, North-Holland, 1966). The reduction is exact; approximations in obtaining the solution become those associated with the approximate solution to the linear equations.

We review the analytical procedure employed and present computed numerical results for the complex propagation constant of the dominant (TE_{11}) mode. We also present new approximate analytical expressions for this quantity based on truncation and solution-by-hand of the linear equations, and indicate how one might extend the results to other (non-separable) waveguide cross-sections.

82-96 RELIABILITY OF GEOTECHNICAL, ENVIRONMENTAL,
AND RADIOLOGICAL INSTRUMENTATION IN NUCLEAR
WASTE REPOSITORY STUDIES
UCID-19467, October 1982

F. Rogue

Instrumentation
Waste Repository

Abstract

The task reported herein examines the reliability of instrumentation which may be used at future waste repository sites. Using studies of instrument reliability and failure mechanisms and on-site observations of instruments under actual operating conditions, this report assesses the status of instrument reliability in specific areas of waste repository instrumentation and identifies needed instrument improvements. Site visits to Department of Energy (DOE) waste repository experimental sites have yielded first-hand observations of problems and progress made by DOE experimenters in solving some of these problems. This report can aid in the development of regulatory guidance for conditions of application or on acceptable limits of instrument operation.

82-97 NON-STIFF ADAPTIVE MOVING NODE TECHNIQUES
UCRL-88227, October 1982
Submitted to the 10th IMACS World
Congress on Systems Simulation and
Scientific Computation, Montreal,
Canada, August 8-13, 1982

N. K. Madsen

Adaptive Methods
Finite Difference
Numerical Methods

Abstract

Non-stiff adaptive moving node techniques for solving partial differential equations are considered. The techniques are easy to implement, computationally inexpensive, easy to understand, and widely applicable. Numerical results for several wave propagation problems are presented.

82-98 ANALYZE USER'S GUIDE
UCID-19580, October 1982

S. G. Azevedo

Analyze
Continuing Education

Abstract

This report is a reproduction of the visuals that were used in the "ANALYZE Users' Guide" lectures of the videotaped LLNL Continuing Education Course CE2018-H, State Space Lectures. The course was given in Spring 1982 through the EE Department Education Office.

Since ANALYZE is menu-driven, interactive, and has self-explanatory questions (sort of), these visuals and the two 50-minute videotapes are the only documentation which comes with the code. More information about the algorithms contained in ANALYZ can be obtained from the IEEE book on Programs for Digital Signal Processing (IEEE Press, Edited by the DSP Committee for IEEE-ASSP Society, John Wiley and Sons, New York, N. Y., 1979).

82-99 UNDERGROUND OIL SHALE RETORT MONITORING W. D. Daily
USING GEOTOMOGRAPHY
UCRL-88347, October 1982
Submitted to Science

Geotomography
Oil Shale Retort

Abstract

Geophysical geotomographs (geotomographs) were made of two underground oil shale retorts: (1) the Occidental Oil Shale Inc. mini-retort constructed for ignition tests at the demonstration mine at Logan Wash, Colorado, and (2) the Geokinetics Oil Shale Inc. Retort 25 near Vernal, Utah. These experiments demonstrate that geotomography may be a valuable diagnostic tool for underground oil shale retorting processes. At the Geokinetics in situ retort, the technique delineated the zones of high permeability in a cross section of the retort. At the Occidental modified in situ mini-retort, the technique imaged the high temperature zone of the retort with a spatial resolution of about two meters and showed its temporal development over a period of eleven days.

82-100 REPORT ON THE 2ND EUROPEAN CONFERENCE ON W. G. Magnuson, Jr.
COMPUTER-AIDED DESIGN (CAD) IN SMALL AND
MEDIUM SIZE INDUSTRIES (MICAD 82)
UCID-19587, October 1982

CAD Applications

Abstract

A summary is presented of the 2nd European Conference on Computer Aided Design (CAD) in small and medium size industries (MICAD82) held in Paris, France, September 21-23, 1982. The conference emphasized applications of CAD in industries with limited investment resources and which are forced to innovate in order to sustain competition.

82-101 ON THE INDUCTIVE IRIS IN A RECTANGULAR WAVEGUIDE K. F. Casey
UCRL-88308, October 1982
Submitted to IEEE Transaction on Microwave
Theory and Techniques

Microwave Components
Waveguide

Abstract

An exact expression for the susceptance of an inductive iris in a rectangular waveguide is obtained by solving the dual series equations arising in the formulation of the problem. The exact results are compared with those obtained by an approximate treatment of this problem

82-102 ASYMPTOTIC EVALUATION OF HIGH FREQUENCY
FIELDS NEAR A CAUSTIC--AN INTRODUCTION
TO MASLOV'S METHOD

R. W. Ziolkowski
G. A. Deschamps

UCRL-88304, October 1982
Submitted to IEEE Transactions on
Antennas and Propagation

Asymptotics
Electromagnetic Theory
Maslov's Method

Abstract

It is well known that the geometrical optics approximation, generally valid for high frequency fields, fails in the vicinity of a caustic. A systematic procedure due to V. P. Maslov which remedies this situation will be reviewed in this paper. Maslov's method makes use of a representation of the geometrical optics field in the phase space $M = X \times K$ where a point $m = (x, k)$ is a pair of a position vector $x \in X$ and a wavevector $k \in K$. A Lagrangian submanifold of M , Λ , that lies in the dispersion surface and is a union of the phase space trajectories selected by the initial conditions is constructed. It can be considered as a global representation of the phase. The phase space amplitudes (half-densities) satisfy transport equations defined along those trajectories in Λ . Since trajectories in M never form a caustic, a globally defined amplitude can be established on Λ . The field on X is related to the resultant field on Λ by the "canonical operator," an operator introduced by Maslov. It generates an integral form of the solution near a caustic that can be evaluated analytically, numerically, or with uniform asymptotic techniques. Away from the caustic it recovers the geometrical optics field.

82-103 ELECTRODE CONFIGURATION INFLUENCE ON
RESISTIVITY MEASUREMENTS ABOUT A
SPHERICAL ANOMALY
UCRL-85434, Rev. 1, October 1, 1982
Submitted to Geophysics

R. J. Lytle
J. M. Hanson

Resistivity Probing
Subsurface Probing

Abstract

The trade-offs involved with subsurface resistivity probing are studied for the case of a spherical anomaly. In particular, two-, three-, and four-electrode configurations are investigated. The three- and four-electrode configurations have similar results and have significantly better remote detection capabilities than does a two-electrode configuration. Cross-borehole probing is capable of detecting anomalous conditions at a greater range than is single-borehole probing.

82-104 CAPACITIVE IRIS IN RECTANGULAR WAVEGUIDE:
AN EXACT SOLUTION
UCRL-88377, November 1982
IEEE Transactions on Microwave Theory
and Techniques

K. F. Casey

Microwave Components
Waveguide

Abstract

A formally exact solution to the problem of determining the susceptance of a capacitive iris in a rectangular waveguide is obtained by directly solving the dual series equations arising in the formulation of this problem. Approximate formulas for the susceptance are derived from this exact solution. Numerical results are presented to illustrate the behavior of the exact and the approximate solutions to the problem.

82-105 THE MAXIMUM ENTROPY FORMULATION OF
INVERSE PROBLEMS OF NDE
UCRL-88320, November 1982
Review of Progress in Quantitative NDE
San Diego, California, August 1-6, 1982

R. M. Bevenssee

Inverse Scattering
Maximum Entropy
Nondestructive Evaluation
Ultrasonic Scattering

Abstract

This paper introduces the Maximum Entropy method of resolving underdetermined objects (flaws or inclusions) by a physicists' brand of nonlinear processing of the image data. We survey three areas of research: (1) synthetic aperture imaging to resolve three dimensional flaws, with the aid of selective back projection, (2) scattering from anomalies according to the inhomogeneous Fredholm integral equation of the second kind and (3) ultrasonic flaw characterization by the boundary integral equation method. A simple example is offered to illustrate the potential resolving power of the ME method for problems in area (2). We present some criteria for effective ME inversion.

- 82-106 A RELIABILITY-CONFIDENCE METHODOLOGY FOR R. M. Bevensee
COMPLEX SYSTEMS
UCRL-88319, November 1982
Review of Progress in Quantitative NDE
San Diego, California, August 1-6, 1982

Probability of Failure
System Failure

Abstract

An important problem of many complex systems is that of assessing the reliability in the minimum probability of survival from the reliabilities of the components. If system performance can be represented by a network flow diagram, the system probability of failure can be expressed in terms of path probabilities of failure each of which is a function of component failure probabilities.

- 82-107 A HIERARCHIAL ESTIMATOR FOR LARGE-SCALE SYSTEMS M. Hodzic
M-15511, November 2, 1982 D. D. Siljak

Estimation
Kalman Filter

Abstract

This report presents a "piece-by-piece" design of the Kalman estimator (filter) for a large system composed of hierarchially ordered subsystems. Stability and suboptimality of the estimator are established. The design is based upon graph-theoretic methods for hierarcnial decompositions of dynamic systems.

- 82-108 NUMERICAL MODELING TECHNIQUES FOR FREE SPACE E. K. Miller
UCRL-88410, Abstract
AGARD Lecture Series 131 (EPP)
November 22, 1982

Electromagnetic Modeling
Method-of-Moments

Abstract

The continuing advancement of computational resources has seen a corresponding advancement in the capability for numerically modeling electromagnetic problems. In the precomputer era, quantitative results were limited, for the most part, to those problems whose solutions could be expressed in terms of tabulated functions. Now all these past solutions are literally obtainable using a personal computer, while large mainframe computers provide access via various codes to the solutions of much more complicated problems.

A brief overview of EM numerical modeling techniques based on Method-of-Moments (MoM) solutions of integral-equation formulations will be given in this lecture. The emphasis will be on frequency-domain applications of the MoM with particular attention devoted to wire and hybrid wire-surface objects. Topics to be covered include formulation of the integral-equation; introduction of expansion and testing functions to reduce it to a linear system; various of the numerical tradeoffs involved; treatment of features such as sources, impedance loads, and junctions; and convergence and error tests to assess solution validity. Modeling guidelines will be given and illustrated by representative results to emphasize limitations and uncertainties of such models and characteristics of which the user should be aware. The relative advantages of some of the more commonly used numerical approaches will be compared. Mention will also be made of wire time-domain modeling. Some concluding remarks will be directed to the Geometrical Theory of Diffractions (GTD) and hybrid MoM-GTD procedures.

82-109 NUMERICAL MODELING TECHNIQUES FOR HALF-SPACE
(GROUND) PROBLEMS
UCRL-88409, Abstract
AGARD Lecture Series 131 (EPP)
November 22, 1982

E. K. Miller
R. J. King

Electromagnetic Modeling
Interface Problem

Abstract

In the frequency range below a few hundred MHz, the earth-air interface can significantly affect the EM characteristics of a nearby object. The characteristics most likely to be affected are: 1) the object's current distribution and input impedance (if an antenna); and 2) the near and far fields that it produces. This lecture will address the problem of modeling both the object-ground near-field interaction and the ground screens used to reduce or control this interaction.

The basic model employed for the object-ground interaction uses a thin wire approximation to the electric-field integral equation in which the kernel includes the interface effect via the usual Sommerfeld integrals. Both the reflected and transmitted fields are accounted for so that objects on both sides of the interface, or even penetrating the interface, can be modeled. An interpolation approach is used to improve the efficiency of the Sommerfeld integral evaluation so that results for a given problem typically require only two to four times as much computer time as would modeling the same object in free space. Use of this model will be demonstrated for single objects located on either side of the interface and for objects interacting across it. Application of the model to problems involving sparse-ground screens, wherein the current on each screen wire is evaluated, will be illustrated by representative results which show such effects as changing the geometry of the ground-screen (length and number of wires, and the angle between them) or of burying it.

Another approach to modeling a ground system uses the surface impedance Z_s to represent the boundary conditions at the interface. To permit application to a generic set of problems, $Z_s(\rho)$ is permitted to vary arbitrarily in the radial direction. A one-dimensional integral equation is first used to solve for the tangential magnetic field on the interface. This field is then used in a two-dimensional integral to find the radiation pattern. This approach works well in problems where the radially varying surface impedance can be accurately described, as in dense radial-wire ground systems using the theory of wire grids, or in land-sloping beach problems. Other applications will also be discussed.

82-110 PHYSICAL MODELING OF EM PROPAGATION OVER
NONHOMOGENEOUS TERRAIN

R. J. King

UCRL-88408, Abstract
AGARD Lecture Series 131 (EPP)
November 22, 1982

Electromagnetic Measurements
Electromagnetic Modeling

Abstract

To obtain experimental data for comparison with the theoretical results obtained from mathematical groundwave propagation models, it is often expedient to conduct experiments on laboratory models using microwaves. Besides the obvious convenience and reduced cost, practical difficulties encountered in full-scale experiments are avoided (e.g., weather and other uncontrolled parameters such as path nonhomogeneities, earth curvature, buildings, right-of-ways, etc.). There is no need to use exact similitude scaling; the media and geometries are generally chosen to test the limits of the theory's validity.

The design of several such models in the frequency range of 4-5 GHz will be discussed, and the experimental results will be compared with the corresponding theory. Specific examples are propagation over planar and curved surfaces (including stratified media, e.g., layered earth, sea ice, etc.), mixed paths (including media having abrupt discontinuities such as land-sea boundaries, gradual nonuniformities such as sloping beaches, off-path discontinuities such as islands, lakes and peninsulas), uniaxially anisotropic media, and media having an index of refraction near unity such as heavy vegetation.

When using such models, instrumentation systems and field probing techniques are key factors in their success. These will also be discussed.

82-111 A UNIFIED APPROACH TO TIME AND FREQUENCY DOMAIN
REALIZATION OF FIR ADAPTIVE DIGITAL FILTER G. A. Clark
S. R. Parker
UCRL-86761, Revision 1 November 22, 1982 S. K. Mitra
Submitted to IEEE Transactions on
Acoustics, Speech, and Signal Processing

Adaptive Filter
Block-Adaptive Filter
Digital Filter

Abstract

Specific implementations of the FIR block adaptive filter in the frequency domain are presented and some of their important properties are discussed. The time domain block adaptive filter implemented in the frequency domain is shown to be equivalent to the frequency domain adaptive filter (derived in the frequency domain), provided data sectioning is done properly. All of the known time and frequency domain adaptive filters [1-12, 16-18] are contained in the set of possible block adaptive filter structures. Thus, the block adaptive filter is generic and its formulation unifies the current theory of time and frequency domain FIR adaptive filter structures. A detailed analysis of overlap-save and overlap-add implementations shows that the former is to be preferred for adaptive applications because it requires less computation, a fact that is not true for fixed coefficient filters.

82-112 THE MATHEMATICAL AND PHYSICAL SCALING R. W. Ziolkowski
OF TRIGGERED LIGHTNING J. B. Grant
UCID-19655, December 1982

EMP
Lightning
Triggered Lightning

Abstract

As the aircraft industry incorporates current technology in airborne systems, electromagnetic compatibility can decrease. Composite fuselages can be more transparent to EMP, whether nuclear or lightning generated, than metal ones. Solid-state circuitry is sensitive to intense EM fluctuations whereas mechanical controls generally are not.

With this increased vulnerability comes increased concern for these dangers. Recently the anxiety over lightning has risen. Answers are sought to such questions as: how do the lightning EM effects couple into the aircraft's interior? Do aircraft trigger lightning, and if so, can the triggering be minimized?

An understanding, at least to some extent, of lightning would provide a needed foundation to examine the interaction of aircraft with lightning. A review of the literature on lightning and lightning-aircraft investigations, including triggered lightning, was conducted and is briefly summarized in this paper. In addition to this brief literature review, scaling the lightning event to laboratory size is also discussed. The ability to scale would allow accurate investigation of lightning effects, as well as the triggering phenomena, in scaled experiments.

82-113 LJUNG'S ALGORITHM FOR STATE SPACE SYSTEM
IDENTIFICATION--A USER'S GUIDE FOR THE
COMPUTER PROGRAM
UCID-19617, December 2, 1982

D. T. Gavel

Digital Filter
Identification
Kalman Filter
State Space Systems

Abstract

In this manual, we explain how to use the LKFID computer program on the CDC7600 and VAX computers at LLNL. LKFID is a dynamic system model identifier which, given a basic shell for the system model (basically a set of coupled differential equations with unknown coefficients), and experimental input/output data from the system under test, produces estimates of the unknown coefficients.

82-114 ELECTROMAGNETIC TEST FACILITY CHARACTERIZATION:
AN IDENTIFICATION APPROACH
UCID-19620, December 2, 1982

J. E. Zicker
J. V. Candy

Electromagnetic Measurement
EMP
Identification

Abstract

The response of an object subjected to high energy, transient electromagnetic (EM) fields sometimes called electromagnetic pulses (EMP), is an important issue in the survivability of electronic systems (e.g., aircraft), especially when the field has been generated by a high altitude nuclear burst. The characterization of transient response information is a matter of national concern. In this report, we discuss techniques to: (i) improve signal processing at a test facility, and (ii) parameterize a particular object response.

First, we discuss the application of identification-based signal processing techniques to improve signal levels at the Lawrence Livermore National Laboratory (LLNL) EM Transient Test Facility. We identify models of test equipment and then use these models to deconvolve the input/output sequences for the object under test. A parametric model of the object is identified from this data. The model can be used to extrapolate the response to these threat level EMP. Also discussed is the development of a facility simulator (EMSIM) useful for experimental design and calibration and a deconvolution algorithm (DECONV) useful for removing probe effects from the measured data.

82-115 MODEL BASED ESTIMATION: AN APPLIED APPROACH J. V. Candy
UCID-19641, December 15, 1982

Estimation
Kalman Filter
Signal Processing

82-116 HIGH POWER MICROWAVE PULSE SUSCEPTIBILITY OF C. F. McCunaghy
DISCRETE SEMICONDUCTOR DEVICES L. C. Martin
UCRL-88493, Abstract, December 15, 1982 J. H. Yee
Submitted to the 2nd National
Conference on High Power Microwave
Technology, Harry Diamond Laboratory,
Adelphi, Maryland, March 1-3, 1983

Microwave Susceptibility
Semiconductor Breakdown

Abstract

This paper describes work in process in the investigation of the susceptibility of semiconductor devices to short pulses of microwave energy. This investigation includes a combination of testing, circuit modeling, and basic physics modeling in order to provide susceptibility information. The testing includes

both unipolar (video) and microwave (GHz range) pulses in the nanosecond time regime. The circuit modeling includes a consideration of parasitic effects for the device in a particular package. The basic physics modeling is oriented toward the explanation of second-breakdown phenomena and the development of a breakdown level prediction model. Testing is being limited to a relatively few types of devices, such as bipolar transistors, mixer and PIN diodes. Preliminary results have been obtained for the 2N918 transistor.

82-117 TECHNOLOGY BASE DEVELOPMENT FOR MICROWAVE
SIMULATION AND LETHALITY
LLL-PROP-182 Volumes 1 and 2
Submitted to Defense Nuclear Agency
December 16, 1982

R. A. Alvarez
S. C. Burkhart
H. S. Cabayan
K. F. Casey
L. F. Jelsma
R. J. King
R. D. Scarpetti
A. J. Spero
G. E. Vogtlin
J. H. Yee

Microwave Technology

Abstract

In this manuscript, work performed at the Lawrence Livermore National Laboratory during the last half of fiscal year 1982 in microwave technology base is summarized. In addition, areas to be investigated during this fiscal year are discussed.

82-118 REFLECTIONS ON LAUNCHING FOCUS WAVE MODES
FROM CLASSICAL ANTENNAS
UCRL-88507, December 20, 1982
1983 Joint International IEEE/APS
Symposium, National Radio Science Meeting
Houston, Texas, May 23-26, 1983

J. N. Brittingham

Electromagnetic Pulses Focus Wave Modes

Abstract

At a recent meeting, a paper [Focus Wave Modes in Homogeneous Maxwell's Equations - TE Modes, J. N. Brittingham, 1982 International Symposium Digest Antennas and Propagation, Vol. 2, pp. 656-659, Albuquerque, New Mexico] containing new, unique mathematical solutions to Maxwell's equations was presented. These solutions represent three-dimensional, non-dispersive, source-free electromagnetic pulses which propagate in free space. The pulses propagate in a straight line at light-velocity. The pulses' amplitudes decrease in front of,

behind, and transverse to the axis of propagation. Besides the pulses being nondispersive, they retain the identical pulses' shapes for all time as they propagate through space. It is this focusing of the pulses which gives them the name Focus Wave Modes [abbreviated FWM]. The far-field amplitude away from the moving pulse-centers. It is natural to question how might such electromagnetic pulses be launched. This paper presents some ideas on this topic.

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