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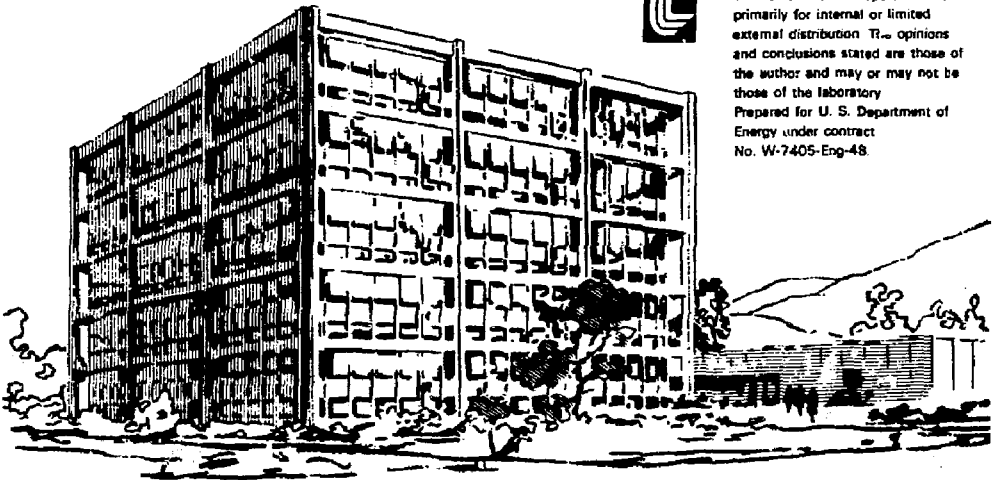
Lawrence Livermore Laboratory

ENGINEERING RESEARCH DIVISION REPORT ON REPORTS
CALENDAR YEAR 1978

E. K. Miller, Division Leader
M. E. Lorton, Editor

MASTER

November 2, 1979



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ACKNOWLEDGMENT

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M. E. Lorton, Editor
E. K. Miller, Division Leader

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ENGINEERING RESEARCH DIVISION
REPORT ON REPORTS - CALENDAR YEAR 1978

Introduction

Each year the Engineering Research Division of the Electronics Engineering Department has issued an internal report listing of all formal publications produced by the Division during the calendar year. The report for 1978 is being issued in two sections (the second section has been expanded from the former format due to a change in collection of information implemented during the calendar year 1978). The first section (covering January 1978 through June 1978) lists the titles, report numbers, authors, dates, an author index, and, when applicable, conferences or journals to which the paper was submitted. The second section (covering July 1978 through December 1978) provides, in addition to the above information, abstracts for each paper, and an appendix with keywords. Future publication reports will include abstracts and a keyword appendix for all reports. It is expected that the new format will make the publication report a more useful document.

Reports for January 1978 through June 1978

- | | | |
|------|--|---|
| 78-1 | OPTIMAL SECTIONING PROCEDURE FOR THE IMPLEMENTATION OF 2-D DIGITAL FILTERS
UCRL-79270, January 3, 1978 | R. E. Twogood
M. P. Ekstrom
S. K. Mitra |
| 78-2 | SCATTERING FROM OBJECTS OVER REAL EARTH
UCRL-80576, January 13, 1978
Presented at the 1978 International IEEE/AP-S Symposium, University of Maryland, College, MD, May 15-19, 1978. | H. S. Cabayan
J. N. Brittingham
F. J. Deadrick
J. T. Okada |
| 78-3 | EXPERIMENTALLY DETERMINED TRANSIENT RESPONSE AND NATURAL FREQUENCIES FOR CONDUCTING STRUCTURES
UCRL-80575, January 13, 1978
Presented at the 1978 International IEEE/AP-S Symposium, University of Maryland, College Park, MD, May 15-19, 1978 | F. J. Deadrick
A. J. Poggio |

- 78-4 INVERSION OF ONE-DIMENSIONAL SCATTERING DATA USING PRONY'S METHOD
UCRL-80574, January 13, 1978
Presented at the 1978 International IEEE/AP-S Symposium, University of Maryland, College Park, MD, May 15-19, 1978
D. L. Lager
R. J. Lytle
E. K. Miller
- 78-5 PRONY'S METHOD REVISITED
UCRL-80573, January 13, 1978
Presented at the 1978 International IEEE/AP-S Symposium, University of Maryland, College Park, MD, May 15-19, 1978
E. K. Miller
- 78-6 HORIZONTAL ANTENNA AND HORIZONTAL GROUND SCREEN NEAR A HALF-SPACE
UCRL-80560, January 16, 1978
Presented at the 1978 International IEEE/AP-S Symposium, University of Maryland, College Park, MD, May 15-19, 1978
J. N. Brittingham
J. T. Okada
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- 78-7 CURRENT INDUCED IN A THIN, INFINITELY LONG WIRE EMBEDDED IN A LOSSY INTERFACE BY A PLANE WAVE
UCRL-80579, January 16, 1978
Presented at the 1978 International IEEE/AP-S Symposium, University of Maryland, College Park, MD, May 15-19, 1978
J. N. Brittingham
F. V. Schultz
- 78-8 RADIATION FIELD ANALYSIS AND SYNTHESIS USING PRONY'S METHOD
UCRL-80532, January 16, 1978
Published in the Electronics Letters
E. K. Miller
D. L. Lager
- 78-9 DYNAMIC CONTROL OF FRACTURE EXPERIMENTS WITH COMPLEX SPECIMENS: DESIGN AND ANALYSIS OF TIGHT CONTROLLERS
UCRL-52387, January 20, 1978
G. C. Corynen
- 78-10 ESTIMATION OF THE NONSTOICHIOMETRY OF AISb
UCRL-80654, January 20, 1978
Published in the Journal of Electrochemical Society
J. W. Sherohman
- 78-11 MATERIAL CONTROL SYSTEM SIMULATOR PROGRAM REFERENCE MANUAL
UCID-17725, January 24, 1978
R. B. Hollstien
- 78-12 MATERIAL CONTROL SYSTEM SIMULATOR USER'S MANUAL
UCID-17727, January 24, 1978
R. B. Hollstien
- 78-13 ADVANCED-FUELED FUSION REACTORS SUITABLE FOR DIRECT ENERGY CONVERSION
UCRL-50039-77-3 and UCRL-50039-77-4
January 31, 1978
A. S. Blum

- 78-14 AN IMPEDANCE CAMERA: A SYSTEM FOR DETERMINING
THE SPATIAL VARIATION OF ELECTRICAL CONDUCTIVITY
UCRL-52413, January 31, 1978 R. J. Lytle
K. A. Dines
- 78-15 SYMMETRY CONSIDERATIONS IN SEM COMPUTATIONS
UCRL-80854, January, 1978 R. M. Bevensee
Presented at IEEE APS Symposium, Washington,
DC, 5/15-19/78
- 78-16 DESIGN AUTOMATION SYSTEM AT LAWRENCE
LIVERMORE LABORATORY R. J. Smith, II
W. G. Magnuson, Jr.
UCID-17708, January, 1978
- 78-17 INSTRUMENTATION FOR THE EVALUATION OF IN-SITU
RECOVERY PROJECTS D. T. Davis
R. J. Lytle
P. Kasameyer
UCRL-80757, February 8, 1978
Presented at the American Association of Petroleum
Geologists, Oklahoma City, OK, April 12-15, 1978
- 78-18 CURRENT ON INFINITELY LONG THIN WIRE IMBEDDED IN AN
INTERFACE FROM PLANE WAVE EXCITATION J. N. Brittingham
F. V. Schultz
UCRL-80420, February 17, 1978
Published in Radio Science
- 78-19 SOMINT: AN IMPROVED MODEL FOR STUDYING CONDUCTING
OBJECTS NEAR LOSSY HALF-SPACES J. N. Brittingham
E. K. Miller
J. T. Okada
UCRL-52423, February 24, 1978
- 78-20 SOME DIFFICULTIES WITH THE DOUBLE BILINEAR
TRANSFORMATION IN 2-D RECURSIVE FILTER DESIGN D. M. Goodman
UCRL-80777, March 1, 1978
Published in Proceedings of the IEEE
- 78-21 SURFACE FIELD MEASUREMENTS ON SCALE MODELS IN
THE TIME DOMAIN F. J. Deadrick
A. J. Poggio
UCRL-80835, March 2, 1978
Presented at the 1978 Nuclear EMP Meeting, IEEE,
Albuquerque, NM, University of New Mexico, 6/6-8/78
- 78-22 THE INTERACTION OF A RELATIVISTIC E-BEAM WITH AN
APPERTURED SOLID DIELECTRIC ANODE (LUCE GEOMETRY) D. Zucker
J. Wyatt
H. Sahlin
John S. Luce
B. Freeman
UCRL-80871, March 8, 1978
Presented at the 3rd International Conference on
Collective Methods of Acceleration, Laguna Beach,
CA, UC Irvine, 5/22-25/78
- 78-23 AN ANALYSIS OF OFF-GUIDEWAY ENERGY STORAGE/PROPULSION
SYSTEMS FOR DUAL MODE TRANSIT SYSTEMS I. J. Sacks
UCRL-80874, March 9, 1978
Presented at the Advanced Transit Association
International Conference, Hyatt Regency,
Indianapolis, IN, 4/25-28/78

- 78-24 120-keV HELIUM-3 NEUTRAL BEAM INJECTOR
DESIGN CONSIDERATION
UCRL-80904, March 15, 1978
Prepared for submittal to the Electric
Power Research Institute Annual Report
A. S. Blum
W. L. Baar
T. H. Batzer
W. L. Dexter
J. H. Fink
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- 78-25 STRUCTURED-ACTION APPROACH TO CONTINUOUS-TIME
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UCRL-80919, March 17, 1978
Presented at the 1978 Conference on Information
Sciences & Systems, Johns Hopkins University,
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S. J. Hegner
- 78-26 THE EFFECT OF PLASMA SHIELDING ON THE FIDELITY OF
MAGNETIC PROBE IN A PLASMA FOCUS ENVIRONMENT
UCRL-80933, March 22, 1978
Presented at the 1978 IEEE Conference on
Plasma Science, Monterey, CA, IEEE, 5/15-17/78
O. S. Zucker
- 78-27 AN EXPERIMENTAL STUDY OF THE USE OF BETHE HOLE
THEORY FOR WIRES BEHIND APERTURES
UCRL-52443, March 23, 1978
J. N. Brittingham
F. J. Dadrack
D. Lager
- 78-28 ALGEBRAIC SIMPLIFICATION OF INTERCONNECTED SYSTEMS
UCID-17760, March 31, 1978
S. J. Hegner
- 78-29 SYSTEM RELIABILITY OF THE LLL EXTERNAL
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UCRL-80828, March, 1978
Presented at Nuclear & Space Radiation Effects,
IEEE, Albuquerque, NM, 7/18-21/78
R. M. Bevensee
H. S. Cabayan
L. C. Martin
E. K. Miller
- 78-30 OVERVIEW OF A DATA BASE FOR ENGINEERING PREDICTIONS
OF EMP EXTERNAL COUPLING
UCRL-80809, March, 1978
Presented at the 1978 NEM Meeting, Albuquerque,
NM, 6/6-8/78
R. M. Bevensee
L. C. Martin
- 78-31 THE LLL DATA BASE FOR EXTERNAL COUPLING OF EMP
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UCRL-80829, March, 1978
Presented at Nuclear & Space Radiation Effects,
IEEE, Albuquerque, NM, 7/18-21/78
R. M. Bevensee
J. T. Okada
- 78-32 AN EXPERIMENTAL STUDY FOR THE USE OF THE BETHE
HOLE THEORY FOR WIRES BEHIND APERTURES
UCRL-80808, March, 1978
Presented at the 1978 NEM Meeting, Albuquerque,
NM, 6/6-8/78
J. N. Brittingham
F. J. Dadrack
D. L. Lager

- 78-33 NEC - NUMERICAL ELECTROMAGNETICS CODE FOR FREQUENCY DOMAIN ANALYSIS
UCRL-80942, March, 1978
Presented at 1978 International Symposium on Antennas & Propagation, the Institute of Electronics & Communication Engineers of Japan, Sendai, Japan, 8/29-31/78
G. J. Burke
A. J. Poggio
- 78-34 APPLICATION OF DECISION THEORY TO EMP SYSTEM HARDENING
UCRL-80830, March, 1978
Presented at Nuclear & Space Radiation Effects, IEEE, Albuquerque, NM, 7/18-21/78
H. S. Cabayan
G. C. Corynen
J. W. Lathrop
- 78-35 A COST-EFFECTIVE TECHNIQUE FOR EVALUATING SHIELDING EFFECTIVENESS OF ENCLOSURES
UCRL-80907, March, 1978
Presented at the 1978 NEM Meeting, Albuquerque, NM, 6/6-8/78
H. S. Cabayan
F. J. Deadrick
- 78-36 RESPONSE OF SCATTERERS IN COMPLEX ENVIRONMENTS
UCRL-80810, March, 1978
Presented at the 1978 NEM Meeting, Albuquerque, NM, 6/6-8/78
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E. K. Miller
J. T. Okada
- 78-37 THE TRANSIENT MEASUREMENT FACILITY FOR BROADBAND ELECTROMAGNETICS
UCRL-80941, March, 1978
Presented at 1978 International Symposium on Antennas & Propagation, the Institute of Electronics & Communication Engineers of Japan, Sendai, Japan, 8/29-31/78
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- 78-38 DESIGN CONSIDERATIONS IN ULTRA-FAST ELECTRON-OPTICAL IMAGING TUBES
UCRL-80923, March, 1978
Presented at 1978 International Symposium on Antennas & Propagation, the Institute of Electronics & Communication Engineers of Japan, Sendai, Japan, 8/29-31/78
R. Kalibjian
- 78-39 SPACE-CHARGE TEMPORAL BROADENING EFFECTS IN STREAK CAMERA TUBES
UCRL-80922, March, 1978
Presented at the 13th International Congress on High Speed Photography and Photonics, Tokyo, Japan, 8/20-25/78
R. Kalibjian
- 78-40 FRAMING CAMERA TUBE DEVELOPMENT FOR THE SUB-100 ps RANGE
UCRL-80924, March, 1978
Presented at the 13th International Congress on High Speed Photography and Photonics, Tokyo, Japan, 8/20-25/78
R. Kalibjian
Lamar Coleman

- 78-41 TECHNIQUES IN EMP HARDENING PRACTICE EVALUATION
UCRL-80831, March, 1978
Presented at Nuclear & Space Radiation Effects,
IEEE, Albuquerque, NM, 7/18-21/78
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F. J. Deadrick
- 78-42 A QUANTITATIVE REVIEW OF HUMAN SUSCEPTIBILITY TO
MAGNETIC FIELDS
UCID-17773, March, 1978
Albert Schiff
- 78-43 SPECKLE IMAGING UNDER NON-ISOPLANATIC CONDITIONS AND
WITH TELESCOPIC ABERRATIONS
UCRL-80894, March, 1978
Presented at SPIE's 22nd International Symposium,
Town and Country Hotel, San Diego, CA, 8/28-31/78
J. W. Sherman
- 78-44 SPECKLE IMAGING USING THE PRINCIPLE VALUE
DECOMPOSITION METHOD
UCRL-80893, March, 1978
Presented at SPIE's 22nd International Symposium,
Town and Country Hotel, San Diego, CA, 8/28-31/78
J. W. Sherman
- 78-45 EXPLICIT MODELING OF ANTENNAS WITH SPARSE
GROUND SCREENS
UCRL-81026, April 4, 1978
Prepared for submittal to Electronics Letters
E. K. Miller
J. N. Brittingham
J. T. Okada
- 78-46 TRADE OFF BETWEEN THRESHOLD VOLTAGE
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MOS TRANSISTORS
UCRL-79419, April 5, 1978
Published in IEEE Trans. on Electron Devices
M. D. Pocha
J. D. Plummer
J. D. Meindl
- 78-47 USE OF HIGH-FREQUENCY ELECTROMAGNETIC WAVES FOR
MAPPING AN IN SITU COAL GASIFICATION BURN FRONT
UCRL-81016, April 7, 1978
Prepared for submittal to In Situ
D. T. Davis
R. J. Lytle
E. F. Laine
- 78-48 A NEW SERIES REPRESENTATION FOR THE TWO-DIMENSIONAL
SOMMERFELD INTEGRALS
UCRL-80062, April 11, 1978
Preparation for submittal to the Journal of
Mathematical Physics
J. N. Brittingham
- 78-49 EXTERNAL COUPLING OF EMP TO GENERIC SYSTEM
STRUCTURES
M-090, April 14, 1978
R. M. Bevenssee
H. S. Cabayan
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R. W. Egbert
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J. T. Okada
A. J. Poggio
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- 78-50 ANALYSIS OF CCD INPUT STRUCTURE FOR Q-DOT,
EG&G, AND LASL M. Pocha
UCID-17790
- 78-51 TRANSIENT ELECTROMAGNETIC MEASUREMENTS OF A BRASS
SHIP MODEL F. J. Deadrick
UCRL-52454, April 19, 1978
- 78-52 HIGH FREQUENCY ELECTROMAGNETIC WAVE PROBING OF AN
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UCRL 81126, May 12, 1978 R. J. Lytle
Presented at the Society of Exploration E. F. Laine
Geophysicists, 48th Annual International
Meeting, San Francisco, October 29-November 2
- 78-53 EVALUATION OF SOCIAL RISK J. Lathrop
UCRL-81059, May 15, 1978
Presented at Analysis of Risks to Life and
Limb, ORSA, Los Angeles, 11/13-15/78
- 78-54 THE USE OF HIGH FREQUENCY ELECTROMAGNETIC WAVES
TO MAP THE UCG BURN FRONT D. T. Davis
UCRL-81161, May 19, 1978 R. J. Lytle
Presented at the 4th Underground Coal Conversion F. F. Laine
Symposium, Steamboat Springs, CO, 7/17-20/78
- 78-55 SPACE-CHARGE TEMPORAL BROADENING EFFECTS IN
STREAK-CAMERA TUBES R. Kalibjian
UCRL-80922, May 23, 1978
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- 78-56 FRAMING-CAMERA TUBE DEVELOPMENT FOR THE SUB-100-ps
RANGE R. Kalibjian
UCRL-80924, May 24, 1978 Lamar W. Coleman
Presented at the 13th International Congress on
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- 78-57 SYSTEM RELIABILITY OF THE LLL EXTERNAL COUPLING DATA R. M. Bevensee
UCRL-81174, May 25, 1978 H. S. Cabayan
Presented at the IEEE Nuclear and Space Radiation L. C. Martin
Effects Conference, Albuquerque, NM, 7/18-21/78 E. K. Miller
- 78-58 OBSERVATION OF ELECTRICAL CONDUCTIVITY OF
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UCRL-81172, May 25, 1978 T. J. Burgess
Submitted to Physical Review Letters D. E. Duerre
J. G. Huebel
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- 78-59 MATERIAL CONTROL SYSTEM DESIGN: TEST BED NITRATE STORAGE AREA (TBNSA), JANUARY, 1977-APRIL, 1977
UCID-17525-77-3, May, 1978
Published May, 1978
G. A. Clark
R. A. DaRoza
D. R. Dunn
I. J. Sacks
W. Harrison
J. G. Heubel
W. N. Ross
J. D. Salisbury
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- 78-60 PERFORMANCE ANALYSIS OF AN INFRARED INTERIOR INTRUSION DETECTOR
UCID-17888, May, 1978
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- 78-61 PHOTOVOLTAIC PROPERTIES OF REACTIVELY SPUTTERED Cu_xS FILMS AND REACTIVELY SPUTTERED Cu_xS -CdS HETEROJUNCTIONS
UCRL-81199, June 2, 1978
Presented at the 13th IEEE Photovoltaic Specialists Conference, Washington, DC, 6/5-8/78
G. A. Armantrout
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- 78-62 ELECTROMAGNETIC CROSS-BOREHOLE SURVEY OF A SITE PROPOSED FOR AN URBAN TRANSIT STATION
UCRL-52484, June 5, 1978
R. J. Lytle
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- 78-63 A MATERIAL CONTROL SYSTEM SIMULATOR
UCRL-80815, June 9, 1978
Presented at the Institute of Nuclear Materials Management's 19th Annual Meeting, Cincinnati, Ohio, 6/27-29/78
R. B. Hollstien
- 78-64 PROCEDURE FOR THE ASSESSMENT OF MATERIAL CONTROL AND ACCOUNTING SYSTEMS
UCRL-80814, June 9, 1978
Presented at the Institute of Nuclear Materials Management's 19th Annual Meeting, Cincinnati, Ohio, 6/27-29/78
A. Maimoni
I. Sacks
L. L. Cleland
- 78-65 THE HUMAN AS A COMPONENT OF A NUCLEAR MATERIAL SAFEGUARD SYSTEM
UCRL-80818, June 9, 1978
Presented at the Institute of Nuclear Materials Management's 19th Annual Meeting, Cincinnati, Ohio, 6/27-29/78
D. E. Morgan
R. S. Schechter
- 78-66 DDT (Dynamic Debugging Techniques) and TDT (Tracing Debugging Techniques) for PDP-11 Systems
UCID-17886, June 14, 1978
D. E. Bering

- 78-67 DESIGN CONSIDERATIONS IN ULTRA-FAST ELECTRON-
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UCRL-80923, June 14, 1978
13th International Congress on High Speed
Photography and Photonics, Tokyo, Japan
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- 78-68 CCD WORKSHOP PROCEEDINGS E. K. Miller
UCID-17834, June 26, 1978 R. Kalibjian
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- 78-69 THE APPLICATION OF RANDOM-POINT PROCESSES
TO THE DETECTION OF RADIATION SOURCES J. W. Woods
UCRL-52490, June 28, 1978
- 78-70 FILE MANAGEMENT SYSTEM Herschel H. Loomis
UCID-17841, June 29, 1978

Reports for July 1978 through December 1978

78-71 TRANSIENT DIAGNOSTICS INSTRUMENTATION NEWSLETTER
FOR THE DOE COMMUNITY
July 1, 1978

R. Kalibjian

Abstract

The recent charge-coupled devices (CCD) workshop held at Livermore on January 24 and 25, 1978, has motivated the Electron Device Group of Lawrence Livermore Laboratory's Electronics Engineering Department to issue a Newsletter twice a year. The Newsletter will announce news items of advanced electron-device developments and prototype instruments that will impact transient diagnostic instrumentation throughout the Department of Energy (DOE) community. The news sources will be obtained from a broad spectrum both from within and outside the DOE laboratories. It will describe primarily what prototype developments are taking place to fulfill DOE diagnostic needs in the absence of commercially available instruments, as well as to include new products and components of possible interest. Since most advanced instrumentation is dependent upon new solid-state device and electron tube developments, the newsletter will emphasize this viewpoint and will show how and where these devices and tubes are being developed and packaged into user systems. Your cooperation will be important.

Please send us your latest information about developments that may be included in our next newsletter. We anticipate the next issue will contain more news items from other DOE Laboratories, and will not be items primarily from LLL as it is in this first issue. Send your news items to the following address:

Ralph Kalibjian, L-156
Electron Device Group
EE Department
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, CA 94550

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.

The contents of the evaluation contained in this document are necessitated by program requirements intrinsic to the work of this laboratory.

- 78-72 A DEMONSTRATION OF THE CAPABILITIES OF THE LIVERMORE ENERGY POLICY MODEL S. S. Sussman
UCRL-52508, July 1, 1978 W. F. Rousseau

Abstract

We have demonstrated the capabilities of the recently developed Livermore Energy Policy Model by examining a reference scenario and conducting two sensitivity analyses. This computer tool is unique in that it can analyze, within the framework of a general equilibrium model, the potential economic effects of government policies that alter free-market equilibrium in the energy sector.

Since this report focuses on the aspects of the model that are of interest to analysts, the specification of input data and output formats is presented in detail; the use of a new language for defining the energy network and data is also described. However, the reader interested in a detailed description of the economic algorithms, the code listing, and the language is referred to other reports.

It should be emphasized that the results presented here are demonstrations of the model's capabilities and do not necessarily reflect our best judgment.

- 78-73 A NEW LANGUAGE FOR ECONOMIC GENERAL EQUILIBRIUM MODELS S. S. Sussman
UCRL-52507, July 1, 1978 W. F. Rousseau

Abstract

We have developed and implemented a new language for building network models of the economic general equilibrium type. The language provides a flexible system for symbolic definition of the flow network and the associated data entries. The detail of the model can be readily expanded or contracted as the problem dictates.

We have used the language to build a model of the energy sector of the U.S. economy. This model is a detailed regional description of energy flows from the primary resource level through end-use consumption. It can analyze the effects of nonequilibrium conditions, including government policies and regulations. The examples presented in this report are taken from the energy model, and the reader interested in descriptions of the model and its use is referred to other reports.

78-74 DEFINITION OF SUBSURFACE GEOPHYSICAL
PROPERTIES BY HIGH FREQUENCY TRANSMISSIONS
UCRL-81307, July 3, 1978
Presented at the AGARD Meeting, Lisbon,
Portugal, May 24 - June 1, 1979

R. J. Lytle

Abstract

Over the past few years, the Lawrence Livermore Laboratory has developed and demonstrated instrumentation and techniques using high frequency electromagnetic waves to determine subsurface geophysical structure. We have successfully employed these techniques in a variety of applications including: detecting and accurately defining the location of tunnels whose presence or location is unknown, monitoring the movement of an in-situ coal gasification burnfront, detecting suspect areas in concrete foundations, and providing a detailed high resolution picture of the subsurface structure. A common element to all of the application is that the measurements rely on cross-borehole electromagnetic probing. Separate interpretation techniques are, however, used for the different applications.

In our cross-borehole probing procedure, a transmitting antenna, which is made to radiate in the frequency range of 0.1-100 MHz, is lowered down one borehole while a receiving antenna is lowered down another. The region between the boreholes is investigated by recording the amplitude and phase of the wave at the receiver for a large number of various transmitter and receiver depths. If there is an anomaly present which has a large contrast in its electromagnetic constitutive parameters relative to those of the host medium, then a modified shadowgraph approach can be used to locate the anomalous region. To a limited extent, even the shape of the anomalous region can be determined. If the host medium has its constitutive properties change relatively slowly from point-to-point, then modifications of standard tomographic interpretations (such as are used in interpreting x-ray probing of the human head and torso) can be successfully employed to provide detailed pictures of the subsurface. When the host medium properties are moderately changing from point-to-point, then ray-bending can complicate the interpretation and decrease the attainable resolution. By performing an iterative least squares procedure, it is possible to achieve good resolution for cross-borehole probing even when there is significant ray-bending occurring when probing the geologic structure. This presentation will concentrate upon demonstrating the present state of the art of this technology. An accompanying written description will be provided presenting the mathematical equations governing the various physical interactions and methods of inversion.

- 78-75 THE LAWRENCE LIVERMORE LABORATORY DATA BASE FOR EMP EXTERNAL COUPLING-SYSTEM RELATABILITY UCRL-81344, July 14, 1978
Presented at the 1978 IEEE Conference on Nuclear & Space Radiation Effects, Albuquerque, NM 7/18-21/78
- R. M. Bevenssee
H. S. Cabayan

Abstract

This paper describes the external coupling data base prepared by Lawrence Livermore Laboratory for EMP assessment. The data may be used either by electromagnetic specialists or by engineers who may have only limited knowledge of the subject. Data generation by computer code and Transient Electromagnetics Range is described. The modular (generic system) form of the base is outlined, with examples. The worst-case philosophy adapted is explained. Validation data for the Range are given. Illustrative simulation test data on a real system are compared to canonical and representative model data. The close agreement validates the links between the real system/canonical model and real system/representative model. Validation from other test data establishes the wide scope of the base for EMP prediction/estimation.

- 78-76 MEASURING SOCIAL RISK AND DETERMINING ITS ACCEPTABILITY UCRL-81060, July 14, 1978
Presented at the IIAASA Workshop, Vienna, Austria, May 2-4, 1978
- J. W. Lathrop

Abstract

The implementation of a nuclear waste management technology raises several issues concerning the regulation of social risk. This paper will present a decision analytic approach to resolving some of those issues. A methodology for developing a radiological risk measure is presented, and several approaches to defining acceptable levels of that risk measure are considered. The methodology presented is oriented toward the development of radiological performance objectives for use as guidance in the drafting of regulations.

- 78-77 COMPUTER CODE DOCUMENTATION FOR THE LIVERMORE ECONOMIC MODELING SYSTEM UCRL-52519, July 18, 1978
- W. F. Rousseau
J. T. Rambo
R. N. Castleton
S. S. Sussman

Abstract

The Livermore Economic Modeling System (EMS) is a package of computer codes for constructing, solving, and presenting results from general equilibrium economic models. Macromodels are defined in a symbolic language as a network of interconnected microeconomic models with appropriate parameters. Individual microeconomic models may represent a free market or certain government-imposed conditions such as price or quantity controls. Included with the package is a model of the U.S. energy supply sector, Energy Policy Model (EPM).

EPM, which contains about 3100 submodels and 80,000 variables, requires about 220,000 words of memory. Solution is by iteration with relaxation. Approximately 100 eight-second iterations will solve the equations to an average error of the order of one cent. Use of a trial solution from a similar previous run reduces the number of iterations required to about 20. All input/output is to disk files. Modification of system calls and the plot code will be required for use at other installations.

This report presents the economic models and equation solution methods built into the LLL Economic Modeling Systems (EMS). Covered are networks, microeconomic models, solutions by iteration, and simulations of government-imposed constraints. Microeconomic models are described in great detail and are tied directly to the parameters a user must provide in the data set. References to other EMS reports are included.

78-78 A STUDY OF TARGET IDENTIFICATION USING POLES
UCRL-81375, July 19, 1978
Presented at the National Radio Science
Meeting, University of CO, Boulder, CO,
November 5-10, 1978

E. K. Miller

Abstract

The identification of a target from its radar return has been a long-sought goal. One approach to this problem is to somehow derive information about the target's scattering characteristics over a wide bandwidth which includes the resonance region. Such information could be obtained for example, by illuminating the target with an impulsive field or a set of discrete frequencies. The idea is that, however it is obtained, it should be feasible to estimate from this information a set of features or parameters which provide as nearly as possible a unique "signature" for each target. Of course, the problem becomes more manageable the fewer the targets there are in the set of interest. Note too, that while imaging could represent one way to identify a target, other characterizations could be equally valid and useful. Besides, imaging would generally require a much higher frequency range than suggested above. The approach we consider here is the use of pole sets. Recent work has demonstrated that the poles of electromagnetically excited objects can be extracted from either frequency-domain or time-domain observables using Prony's method. These poles have particular potential for target identification because they are independent of the excitation (angle of incidence, polarization, etc.) It is therefore of interest to evaluate ways in which pole sets might be used for target identification.

For purposes of this study, sets of poles were specified to generate transient waveforms to which varying levels of noise were added. Various schemes were then applied to the waveforms for estimating to which pole set each one belonged. These included a correlation technique; a linear predictor; computation of the residues; and

direct extraction of the poles. Monte Carlo computer experiments were conducted to develop expected false-alarm rates and correlation matrices. The results obtained from this study are summarized, and lead to the tentative conclusion that greater computation effort is generally rewarded with increased probability of correct identification.

- 78-79 IMAGING OF LINEAR SOURCE DISTRIBUTIONS E. K. Miller
UCRL-81376, July 19, 1978 D. L. Lager
Presented at the National Radio Science
Meeting, University of CO, Boulder, CO
November 5-10, 1978

Abstract

One version of the inverse problem is that of determining the source distribution which produces a given field. When the sources lie on a perfectly conducting object, and the fields can be obtained arbitrarily close to it, then the inversion is trivial. Of more practical interest is the situation where the fields are observable only at a large distance from the object. In this case, it might be expected that only those sources that produce far field radiation will be directly derivable. Using the far fields to locate the radiating sources is an exercise that may be regarded as imaging, and is the subject of this discussion.

Previous work by the authors has demonstrated that Prony's method can be used to image a linear array of discrete sources from its far field, and to synthesize discrete source distributions which produce the fields of continuous ones. Here we examine the possibility of using the same procedure to image the source distribution of a straight-wire from its far field. The effects of varying the wire's length, radius and excitation are discussed. As previously found, a resolution limit of \sim two sources per wave length seems to hold. Sources are consistently obtained which seem to be due to radiation from the wire's ends and excitation point when operated as an antenna. Other sources are also found which may be interpreted as originating from traveling wave radiation. The implications of these findings with respect to imaging simple objects are discussed.

- 78-80 A PERSPECTIVE ON NUMERICAL METHODS FOR ANTENNAS A. J. Poggio
UCRL-81398, July 24, 1978 E. K. Miller
Presented at Antenna Applications Symposium,
Allerton, IL, 9/20-22/78

Abstract

The method of moment techniques used for antenna analysis is considered from the viewpoint of the user. The method is briefly described. Several problems are discussed to highlight the fact that even though antenna problem solving can be very computer oriented, the ingenuity, care, and understanding of the antenna engineer are still required.

- 78-81 THE FORMATION OF THIN Cu_2S (Chalcocite) FILMS
USING REACTIVE SPUTTERING TECHNIQUES
UCRL-81404, July 25, 1978
Presented at the 25th National Vac. Symposium
and Vac. Show of American Vac. Society,
San Francisco, November 28-December 1, 1978

G. A. Armantrout
D. E. Miller
K. E. Vindelov
T. G. Brown

Abstract

The formation of thin semiconductor layers of Cu_2S (chalcocite) is of interest in the formation of the Cu_2S -CdS heterojunction solar cell. The copper-sulfur system is polymorphic, with numerous possible phases characterized by small energy gap differences for different copper-to-sulfur ratios. Normal reactive sputtering in an atmosphere of excess H_2S will produce the sulfur rich phases of copper sulphide, none of which are suitable for photovoltaic applications. The chalcocite phase, which is the most copper rich phase, is formed in an approximately 7% H_2S /argon environment. An extensive study of the parameters which affect chalcocite formation has been performed. Parameter variables which have been studied include the partial pressure of H_2S (ppH_2S) in the sputtering atmosphere, substrate temperature, substrate sputtering bias, and various substrate materials.

We have shown that chalcocite can be formed reproducibly by controlling the ppH_2S value. The use of single crystal CdS substrates can result in the formation of epitaxial Cu_2S layers. The effect of a positive bias on the substrate is to shift the ppH_2S at which chalcocite is formed to a lower value. The effect of increasing the substrate temperature from 20°C to 150°C is to broaden the ppH_2S range for chalcocite formation without the inclusion of significant quantities of the djurelite ($Cu_{1.96}S$) phase. Sputtering at ppH_2S values less than necessary for chalcocite formation at a given substrate temperature results in a two phase system of Cu_2S and copper where the precipitate phase appears as copper cones on the surface of the film.

- 78-82 THEOREMS ABOUT MAXIMUM RADIATION AND ZERO
SCATTERING OF THE LINEAR LOSSY ANTENNA
UCRL-81437, July 25, 1978
Presented at the International Conference,
IEEE, November 28-30, 1978, London, ENGLAND

R. M. Bevensee

Abstract

Theorems are presented for the linear lossy antenna, to the effect that the gain or radiated power in a given direction is maximized with a reactive load at a control port and a theoretical zero-scattering antenna would be a good scatterer of matched load.

78-83 TRANSMISSION LINE PARAMETERS FOR A THIN,
INFINITELY-LONG WIRE EMBEDDED IN AN INTERFACE

J. N. Brittingham

UCRL-81441, July 25, 1978

Presented at the National Radio Science
Meeting, Boulder, CO, URSI 11/5-10/78

Abstract

In the past J. Wait ("Theory of Wave Propagation Along a Thin Wire Parallel to an Interface," Radio Science, Volume 7, Number 6, pp. 675-679, June 1972) developed a procedure to find the transmission line parameters for a thin, infinitely-long wire over a lossy half-space. He presented integral equations for the propagation constant down the thin wire along with integral representations for the series impedance and parallel admittance. Wait did not present any numerical results. In the present paper Wait's procedure will be applied to a wire embedded in the interface. The difficulty with using this procedure to obtain numerical results is that there are two Sommerfeld's integrals which must be evaluated numerically.

To prevent the necessity of numerically integrating these Sommerfeld's integrals a procedure, developed previously (J. N. Brittingham, "A New Series Solution for the Electric Fields from a Long, Thin Wire on an Interface," A.P.S. International Symposium, Stanford, California, June 20-22, 1977, pp. 162-165), will be used to evaluate the integrals. It consists of finding a series representation for the integrals. These series are developed by expanding the integrand in a Taylor's series and then interchanging the integration and summation. The new series is expressible in Hankel functions and is absolutely convergent. Because of the special nature of the series only the first two terms of the series are needed to accurately represent the integrals for thin wires. The new series representation is then substituted into the equation for the propagation constant.

A parameter study of the propagation constant for a thin wire on the interface was performed by using the new series approximation. These numerical results appear to have the correct physical behavior, which further demonstrate the accuracy of using the new series approximation for the Sommerfeld's integrals.

78-84 PROBABILISTIC POTENTIAL THEORY (PPT) SOLUTION
OF THE VECTOR WAVE EQUATION

R. M. Bevensee

UCRL-81440, July 26, 1978

Presented at the National Radio Science
Meeting, Boulder, CO, URSI 11/5-10/78

Abstract

The fields of Maxwell's equations can be obtained within a closed region with known sinusoidal-frequency surface excitation from vector magnetic potential \vec{A} and scalar potential ϕ . In the Lorentz gauge, both \vec{A} and ϕ derived from it satisfy the homogeneous wave

equation within the volume. In cartesian coordinates each spacial component of A satisfies the wave equation and is decoupled from the other components. The analogy between the discretized wave equation for $A_i(r)$ and the equation for random walk of a particle to the surface of known potentials can be exploited to solve non-analytically for the A_i and hence ϕ at any point of interest. The random walk can be performed by Monte Carlo runs or so-called number diffusion (R. M. Bevenssee, *Proc. IEEE*, 61, 423-437, 1973), whichever is most efficient, depending on tolerable error and number of cells in the volume. However the largest dimension of the volume must be \leq half wavelength for numerical convergence. The boundary conditions of $A_{\tan} = \partial A_{\text{normal}}/\partial n = 0$ are imposed on perfectly conducting metal walls, and $A_{\tan} \neq 0$, $\partial A_{\text{normal}}/\partial n \neq 0$ may be related to known surface electric current on exciting aperture(s). The PPT method is not as rapid as finite difference techniques but it is easy to program for a computer and apparently does not require unreasonably fine spacial discretization for reasonable numerical accuracy.

78-85 AN EFFICIENT PROCEDURE FOR MODELING ANTENNAS
OVER LOSSY HALF-SPACE
UCRL-81439, July 26, 1978
Presented at the National Radio Science
Meeting, Boulder, CO, URSI 11/5-10/78

J. N. Brittingham
E. K. Miller
J. T. Okada
G. J. Burke

Abstract

In the study of practical antennas over lossy air-earth interfaces one needs to evaluate the Sommerfeld's integrals numerous times. In the past the time required to evaluate the Sommerfeld's integrals has been the limiting factor in the study of large antennas. This paper presents a numerical moment-method code that models thin wire antennas over lossy half-spaces which contain an improved method for evaluating the Sommerfeld's integrals. The key to this improved method is the realization that all the interaction between all points on any antenna over an interface can be modeled as a two-dimensional space. These two-dimensional representations are called the solution spaces.

When the separation between the field-point-source-point in the solution space is greater than 1.0λ we use asymptotic series to evaluate the Sommerfeld's integrals. When the field-source-point distances are less than 1.0λ and greater than $.01 \lambda$ we use a previously presented bivariate interpolation procedure (J. N. Brittingham, E. K. Miller, and J. T. Okada, "Bivariate Interpolation Approach for Efficiently and Accurately Modeling Antenna Near a Half-Space," *Electronics Letters*, Volume 13, pp. 690-691, 1977). This procedure uses a linear bivariate interpolation to find values of the Sommerfeld's integrals on a sparsely-spaced, prestored two-dimensional grid. The bivariate interpolation procedure is 1000 times faster than the numerical integration of the integrals. For field-source-point distances less than 0.1λ we use a new series solution for the Sommerfeld's integrals (J. N. Brittingham and J. T.

Okada, "A New Series Solution for Sommerfeld Integrals in a Two Media Problem," USNC/URSI Meeting 9-13 January 1978, p. 151). This new series solution is 10 times faster than numerically integrating the integrals.

- 78-86 GEOPHYSICAL CHARACTERIZATION USING ADVANCED DATA PROCESSING R. J. Lytle
UCRL-81294, July 28, 1978
Presented at the Proceedings of the Science Foundation Conference on Site Exploration, June 5-7, Northwestern University, Evanston, IL

Abstract

Such geophysical means as electromagnetic and seismic probing can be used to investigate the geologic structure of underground construction sites. However, these techniques can generate much data and so create problems with processing and displaying this data in an intelligible form. Algorithmic techniques for imaging x rays passed through the body can be applied to this problem, resulting in color-coded pictures of the geophysical structure which can imply the geologic structure. High-frequency electromagnetic probing has proved successful in several experiments. Low-frequency probing has also proved feasible. The effect of ray bending can be accounted for in interpreting received-signal data.

- 78-87 ON THE USE OF STATISTICAL DESIGN AND ANALYSIS IN ASSESSING THE PROPERTIES OF A RECEIVER IN A COMPLEX ENVIRONMENT R. Mensing J. T. Okada
UCRL-81495, July 31, 1978
Presented at the National Radio Science Meeting, Boulder, CO, URSI 11/5-10/78

Abstract

In recent years there has been an increasing recognition of random CW and systematic variation that exists in basic measurements (current, energy, etc.). Awareness of such variation is important, for example, in realistically assessing the survivability of a system due to various electromagnetic environment. Thus, many experiments are being planned for the purpose of evaluating the random distribution of measurements in many situations. This paper discusses the use of statistical design and analysis in such experiments.

The principles of statistical design (e.g., replication, randomization) as well as the important question of the number of replications necessary for a valid statistical analysis are discussed. Some statistical methods (e.g., tests of goodness of fit, distribution function estimation) are outlined and a method of describing the random variation is suggested.

An experiment planned to assess the effect of scatterers on properties of a receiver in a complex environment is critiqued. The use of statistical design and analysis is illustrated to the extent possible for this experiment.

- 78-88 EFFICIENT DESIGN OF TWO-DIMENSIONAL RECURSIVE DIGITAL FILTERS
UCRL-13900, July, 1978
- M. P. Ekstrom
S. K. Mitra
R. E. Twogood

Abstract

The digital processing of two-dimensional (2-D) data has found increasing application during the last ten years in a number of different areas such as processing of geological and seismological data (detection of oil and natural gas reserves), satellite-borne remote photography in the visible and infrared ranges (monitoring surface features, earth resources, environmental effects and urban land use), and x-ray and gamma-ray photographs (medical and industrial diagnostics and physics). The need to filter two-dimensional data exists in each of the above application areas. Our investigations over the last two-year period have been concerned with the problem of developing efficient methods for the design and implementation of stable 2-D digital filters. This report outlines the progress of our activities during the second year (11/76-11/77) of the grant period.

- 78-89 ENERGY MODELING AND THE LAWRENCE LIVERMORE LABORATORY
UCRL-81357, July, 1978
Presented at the Workshop on Validation of Mathematical Methods
- Mary D. Schrot

Abstract

This short paper presents an overview of the LLL Economic Modeling Systems (EMS). Briefly described are how the EMS works, how the structure and parameters are defined in data sets, and what the results look like. References to more detailed information are given.

- 78-90 SAFETY ANALYSIS OF SAFING, ARMING AND FUSING SYSTEM OF GBU 17/B FOR FLIGHT TESTS
UCRL-17894, August 1, 1978
- R. A. Emmert
J. D. Salisbury
H. L. Lambert

Abstract

This report documents results of a safety analysis for the GBU 17/B, a hard structure munition (HSM) with conventional high explosive charges. The analysis was for use by the Air Force prior to their flight test program for this missile.

The results of our analysis were that the probability of warhead detonation during transportation, storage, and use up until HSM launch was 2.3×10^{-7} .

The probability of warhead detonation after launch prior to safe separation was 1.9×10^{-9} .

78-91 ECONOMIC MODELS AND ALGORITHMS USED IN THE
LIVERMORE ECONOMIC MODELING SYSTEM
UCRL-52527, August 10, 1978

W. F. Rousseau
S. S. Sussman
R. N. Castleton
J. T. Rambo

Abstract

This report presents the economic models and equation solution methods built into the Livermore Economic Modeling System (EMS). Networks, microeconomic models, solution by iteration, and simulation of government-imposed constraints are all discussed. Microeconomic models are described in great detail in nomenclature similar to that used in the data set. References to other EMS reports are included.

78-92 ADDITIONAL MEDIA STUDIES FOR SITE
SUITABILITY CRITERIA
UCID-17887, August 11, 1978

T. R. Donich
A. M. Kaufman
G. D. Sauter
T. L. Steinborn
D. F. Towse

Abstract

Site suitability studies at LLL to date have considered repositories in bedded salt and shale. The models have been varied to include a number of dimensions, parameter values, histories, and potential failure modes. These model studies have enabled us to provide preliminary site suitability criteria based on parameter sensitivity calculations and to begin uncertainty analyses.

Inasmuch as in situ tests are either underway or planned for the near future in other geologic environments in the United States, and since these environments may be recommended as waste repositories, work should begin immediately to produce results for these environments that are similar to those we have for the bedded media. Once the necessary data are available and the models developed, advanced analyses can be conducted in parallel with those on shale and bedded salt.

In this report we consider domed salt, basalt, and crystalline rock, comparing these three media with each other and with bedded salt and shale. Comparisons are made on the following basis:

1. The estimated level of effort required to develop models for these media that are similar in quality to those now available for bedded salt and shale. The models must therefore consider regional and local migration of wastes, recharge of the repository, dissolution, and other special effects.
2. Our present state of knowledge about the important physical and chemical properties of these media and the estimated level of effort necessary to develop data bases for each that are comparable to the data base we currently have for bedded salt and shale.
3. An evaluation of each medium as a suitable repository environment. The evaluation is based on construction costs, colocation of other resources, availability of potential repository sites, retrievability of stored wastes, and suitability of physical and chemical properties.

We have reached two principal conclusions on the basis of this study.

1. The funding necessary to bring our understanding of domed salt, basalt, and crystalline rock to a level comparable to our current understanding of bedded salt is estimated to be \$1457K, \$813K, and \$1742K, respectively, for the three media. In each case, roughly 75% of the effort would be devoted to model development and analysis, 25% to data base development.
2. Basalt and crystalline rock are about equally suitable as waste repositories in terms of all criteria except the availability of potential repository sites, where crystalline rock has a clear advantage. Domed salt should yield substantially lower construction costs than basalt or crystalline rock, but it is inferior in the categories of collocated resources and waste retrievability, and probably suitability of chemical and physical properties.

The funding estimates reflect not only the effort and time required for each medium study, but also the probable DOE schedule for experimental pilot plant work and for potential repository development. The studies should begin simultaneously, allowing them to be completed in the order: basalt, domed salt, crystalline rock. Hydrology studies and systems model development will be an extension of work either already completed or in progress at LLL. If studies of other environments and media become necessary, they can be made in the same way.

Abstract

Computerized tomography is used as an aid in geophysical exploration. With this method detailed pictures of electromagnetic properties in the regions between pairs of boreholes can be reconstructed. The spatial distribution of attenuation or propagation velocity is calculated from line integrals along rays in the plane between boreholes and displayed as a digital picture. In principle, the transmission of seismic data can also be analyzed by this method as long as it obeys the line integral model. Iterative solution techniques similar to those used in medical x-ray tomography are applied to solve the large sets of linear equations relating the line integral data and the remote observables. A straight-line ray optics model was used for energy propagation between boreholes. The performance of the reconstruction algorithm is demonstrated using computer-generated data and it is then applied to experimental data collected by continuous wave electromagnetic transmission probing. Experimental attenuation reconstructions are presented of a proposed underground urban mass transit site and the interior of a concrete bridge pier. Both lateral and vertical variations are displayed using these methods.

78-94 COMPUTERIZED GEOPHYSICAL TOMOGRAPHY
UCRL-81508, August 14, 1978
Published in Proceedings of the IEEE

K. A. Dines
R. J. Lytle

Abstract

Computerized tomography is used as an aid in geophysical exploration. With this method detailed pictures of electromagnetic properties in the regions between pairs of boreholes can be reconstructed. The spatial distribution of attenuation or propagation velocity is calculated from line integrals along rays in the plane between boreholes and displayed as a digital picture. In principle, the transmission of seismic data can also be analyzed by this method as long as it obeys the line integral model. Iterative solution techniques similar to those used in medical x-ray tomography are applied to solve the large sets of linear equations relating the line integral data and the remote observables. A straight-line ray optics model was used for energy propagation between boreholes. The performance of the reconstruction algorithm is demonstrated using computer-generated data and it is then applied to experimental data collected by continuous wave electromagnetic transmission probing. Experimental attenuation reconstructions are presented of a proposed underground urban mass transit site. Both lateral and vertical variations are displayed using these methods.

- 78-95 HIGH-FREQUENCY ELECTROMAGNETIC PROBING TO CHARACTERIZE SEALS IN COFFERDAMS
UCRL-82042, August 21, 1979
Published in Proceedings of the American Society of Civil Engineers, Journal of the Geotechnical Engineering Division
- E. F. Laine
K. A. Dines
J. T. Okada
R. J. Lytle

Abstract

Electromagnetic probing has the potential for assessing the integrity of concrete cofferdam seals. Data are taken using a high-frequency transmitter antenna and a receiver antenna in separate boreholes drilled in the concrete seal, and the geophysical profile (spatial variation of conductivity) is calculated using geotomographic techniques adapted from the medical tomographic method. The results show the variation within the plane between the boreholes. Experimental results on an actual cofferdam seal show anomalous regions in the concrete. One core sample confirmed this result for one of the profiles, but a core sample in a different region did not correlate with the profile of that region. The change in conductivity with time might have caused this one disagreement. Studies on the conductivities of various concrete mixes would aid the interpretation of such results.

- 78-96 SPECKLE IMAGING USING THE PRINCIPLE VALUE DECOMPOSITION METHOD
UCRL-80893, August 25, 1978
Presented at the SPIE Tech. Symposium
Town & Country Hotel, San Diego, CA
August 23-31, 1978
- J. W. Sherman

Abstract

Obtaining diffraction limited images in the presence of atmospheric turbulence is a topic of current interest. Two types of approaches have evolved: real-time correction and speckle imaging. Using an "optimal" filtering approach, we have developed a speckle imaging reconstruction method. This method is based on a non-linear integral equation which is solved using principle value decomposition.

The method has been implemented on a CDC 7600 for study. The restoration algorithm is discussed and it's performance is illustrated.

- 78-98 WHY FILTER RECURSIVELY IN TWO-DIMENSIONS? M. P. Ekstrom
UCRL-81637, September 5, 1978 R. E. Twogood
Presented at the 1979 IEEE Int'l Conf. on
Acoustics, Speech and Signal Processing,
Washington, D.C., April 2-4, 1979

Abstract

Recursive methods of two-dimensional (2-D) digital signal processing have enjoyed much less success than their 1-D predecessors. This has principally to do with the remarkably increased complexity in design and analysis for the 2-D case, and the lack of important applications requiring true real-time operation. Despite these difficulties there appear to be potentially significant advantages in choosing recursive over nonrecursive processors. In this paper we examine the issues associated with their quantitative comparison. The basis of this comparison is achievable design performance (using the best available recursive and nonrecursive design algorithms) and efficiency of implementation (arithmetic and data manipulation requirements).

- 78-99 USING PARET (PARAMETER ESTIMATION TECHNIQUE) D. L. Lager
FOR THE DETERMINATION OF MODE SHAPES
UCID-17898, September 8, 1978

Abstract

In this report we apply the Parameter Estimation Technique (PARET) to the measured responses of a T-shaped aluminum plate. We obtain the frequency and damping for the natural resonances and display animated mode shapes for the plate. The measurements consist of the response of an accelerometer mounted on a corner of the plate to hammer blows at 38 separate locations on the plate. We use PARET to compute the natural resonances by determining the parameters of an exponential model that fits the responses. We tabulate the frequencies and damping for seven modes occurring over a frequency range 500-1650 Hz and also plot the shape for each mode.

- 78-100 THE LAWRENCE LIVERMORE LABORATORY DATA BASE R. M. Bevensee
FOR EMP EXTERNAL COUPLING-SYSTEM RELATABILITY H. S. Cabayan
UCRL-81344, September 14, 1978
Presented at the IEEE Trans. on Nuclear Science,
December, 1978

Abstract

This paper describes the external coupling data base prepared by Lawrence Livermore Laboratory for EMP assessment. The data may be used either by electromagnetic specialists or by engineers who may have only limited knowledge of the subject. Data generation by computer code and Transient Electromagnetics Range is described. The modular (generic system) form of the base is outlined, with examples, from a worst-case viewpoint. Validation data for the

Range are given. Illustrative simulation test data on a real system are compared to canonical and representative model data. The close agreement validates the links between the real system/canonical model and real system/representative model. Validation from other test data establishes the wide scope of the base for EMP prediction/estimation.

78-102 PERFORMANCE MODEL FOR A CCTV-MTI
UCID-17935, September 20, 1978

D. R. Dunn
D. L. Dunbar

Abstract

CCTV-MTI (closed circuit television - moving target indicator) monitors represent typical components of access control systems, as for example in a material control and accounting (MC&A) safeguards system. This report describes a performance model for a CCTV-MTI monitor. The performance of a human in an MTI role is a separate problem and is not addressed here. This work was done in conjunction with the NRC sponsored LLL assessment procedure for MC&A systems which is presently under development.

We develop a noise model for a generic camera system and a model for the detection mechanism for a postulated MTI design. These models are then translated into an overall performance model. Measures of performance are probabilities of detection and false alarm as a function of intruder-induced grey level changes in the protected area. Sensor responsivity, lens F-number, source illumination and spectral response were treated as design parameters.

Some specific results are illustrated for a postulated design employing a camera with a Si-target vidicon. Reflectance or light level changes in excess of 10% due to an intruder will be detected with a very high probability for the portion of the visible spectrum with wavelengths above 500 nm. The resulting false alarm rate was less than one per year.

We did not address sources of nuisance alarms due to adverse environments, reliability, resistance to tampering, nor did we examine the effects of the spatial frequency response of the optics. All of these are important and will influence overall system detection performance.

78-103 PROPERTIES OF THE GROUND INFERRED FROM
ELECTROMAGNETIC MEASUREMENTS
UCRL-80851, September 20, 1978 (Rev. 1)
Published in IEEE Trans. on
Antenna and Propagation

R. J. Lytle

Abstract

This is a mini-review prepared for persons who are unfamiliar with a topic and need a current overview of the art. This particular paper reviews the topic of determining the dielectric constant and resistivity of the ground. By using laboratory data on the

variation of dielectric constant and resistivity with other physical parameters (e.g., temperature, pore size, pore fluid salinity), it is sometimes also possible to provide an "interpretation" of other physical properties in the subsurface environment (e.g., fluid permeability, fluid type, geologic dimensions).

- 78-104 PARAMETRIC CHARACTERIZATION OF THE EGG FOR SURGERY MONITORING
UCRL-81697, September 21, 1978
Presented at the 1979 Biomedical Symposium, San Diego, CA
- W. D. Smith
D. L. Lager

Abstract

A parametric characterization of the electroencephalogram suitable for real time processing is applied to human surgery EEGs. Five or fewer parameters, versus the 50-100 in a typical spectral density, adequately describe the patient's EEG state.

- 78-105 ALTERNATIVE METHODS FOR DETERMINING THE ELECTRICAL CONDUCTIVITY OF CORE SAMPLES
UCRL-81695, September 25, 1978
Published in the Review of Scientific Instruments
- R. J. Lytle
A. G. Duba
J. L. Willows

Abstract

Electrode configurations are described that can be used in measuring the electrical conductivity of a core sample and that do not require access to the core end faces. The use of these configurations eliminates the need for machining the core ends for placement of end electrodes. This is because the conductivity in the cases described is relatively insensitive to the length of the sample. We validated the measurement technique by comparing mathematical models with actual measurements that were made perpendicular and parallel to the core axis of granite samples.

- 78-106 THE FORMATION OF THIN Cu_2S (CHALCOCITE) FILMS USING REACTIVE SPUTTERING TECHS.
UCRL-81404, October 3, 1978
Published in the Journal of the American Vacuum Society
- G. A. Armantrout
D. E. Miller
K. E. Vindelov
T. G. Brown

Abstract

Thin Cu_2S (chalcocite) films, which are of interest for solar cell fabrication, have been prepared using reactive sputtering techniques. The copper-sulfur system, which is polymorphic and is difficult to form in the chalcocite phase, requires careful control of substrate temperature and the partial pressure of H_2S in the sputtering atmosphere. Sulfur rich atmospheres produce the sulfur rich Cu_xS phases which are unsuitable for solar cell fabrication whereas the sulfur lean atmospheres result in precipitated copper cones on the surface. Epitaxial chalcocite films can be formed on single crystal CdS.

78-107 NUMERICAL ELECTROMAGNETICS CODE -
A PROGRAM FOR ANTENNA SYSTEM ANALYSIS

UCRL-81739, October 3, 1978

Presented at the 3rd Symposium and Technical
Exhibition on Electromagnetic Compatibility,
Rotterdam, Netherlands, May 1-3, 1979

G. J. Burke
A. J. Poggio
J. C. Logan
J. W. Rockway

Abstract

The numerical Electromagnetics Code (NEC) is a user oriented computer program for the analysis of interactions of the electromagnetic waves with conducting structures. It is based on the numerical solution of integral equations for the currents induced on the structure by the exciting field.

The program combines an integral equation for smooth surfaces with one for wires to provide convenient and accurate modeling of a wide range of structures. A model may include nonradiating networks and transmission lines, perfect and imperfect conductors, lumped element loading, and ground planes which may be either perfectly or imperfectly conducting.

The excitation in NEC may be either voltage sources, plane waves of linear or elliptic polarization, or fields due to a Hertzian source. The output may include induced current and charge densities, near or far zone electric or magnetic fields, and impedance or admittance. In addition, many of the commonly used quantities such as gain directivity and power budget are also available. Hence the program is suited to either antenna analysis or scattering and Electromagnetic Pulse (EMP) studies.

This paper will deal only briefly with the theoretical foundation for NEC as it is documented in the literature and in the extensive documentation for the computer program which is composed of a theory portion, a program description, and a user's guide.

This paper will focus primarily on the wide range of applicability of NEC in typical EM analyses. We will show the calculated input impedances of several shipboard HF antennas and will compare these with experimental results. These antennas include twin whips, discone-cages, trussed whips, and bottom-fed fans. Also, the computed near fields of a whip antenna at 2 MHz will be compared to measured near fields and the results will be seen to be in very good agreement.

NEC provides a capability for two approaches to modeling solid bodies, viz., wire grid modeling and surface patch modeling. In the former approach, antennas and surfaces are modeled with thin wires by using grids. In surface patch modeling, a two dimensional field equation with appropriate boundary conditions is solved for the surface current density. We will show that both approaches can

be used to provide data for engineering decisions with relatively small differences in computing time. We will also show the accuracies which are available by comparison with experiment.

The analysis of antennas over an imperfectly conducting half-space is a topic of great interest. NEC has the capability for modeling this additional complexity by using an approximation based upon Fresnel reflection coefficients or the rigorous Sommerfeld theory. Results using both these approaches will be presented.

Concisely then, the computer program NEC will be briefly described and its broad applicability in EMC analyses will be illustrated with engineering examples. Overall, potential users will be given an overview of its capabilities.

- 78-108 MATERIAL RESOURCE AND RESERVE CONSTRAINTS IN PHOTOVOLTAIC ELECTRIC POWER GENERATION E. Fischer-Colbrie
UCRL-81769, October 10, 1978
Presented at the 1979 Photovoltaic Solar Energy Conference, Berlin

Abstract

Limited availability of materials is an all-overriding element for planning and designing large area photovoltaic installations. In order to assess and weigh such potentially critical situations we have investigated actual resource and reserve constraints for a series of materials which, as constituents in photovoltaic cells, show promising performance and/or cell cost in the laboratory.

As a reference, a photovoltaic power plant of 75 Gigawatts has been chosen against which identified material constraints have been related and measured. We arrived at this design goal by analysing present day U.S. energy consumption and distribution. Taking this data, we found that of the total 7 Quads electricity consumed in the United States 2.2 Quads per year, or 6.6×10^{11} kWh are being produced by consuming about 6 Quads of fuels of potential shortage, i.e. petroleum and natural gas. The design goal of a 75 Gigawatts photovoltaic power station, central or distributed, appears to be capable to eliminate the consumption of fuels potentially short in supply. Installations of this size will deliver energy continuously and the power values are not peak power related.

- 78-109 SIMULTANEOUS LIGHT AND HEAT TREATMENT OF $\text{Cu}_x\text{S-CdS}$ PHOTOVOLTAIC CELLS E. Fischer-Colbrie
UCRL-81768, October 10, 1978
Presented at the 1979 Photovoltaic Solar Energy Conference, Berlin

Abstract

It has been observed that V_{OC} , FF and I_{SC} on various Cu_xS -CdS photovoltaic cells can be improved by an exposure of 3-5 sec to a 3000°K tungsten light of 2.5-3.5 Watts/cm² intensity and the transient heat associated with this exposure.

Whereas, V_{OC} and FF increases are seen immediately after the exposure, I_{SC} appears reduced down to 20% of its pre-treatment values at this time. Over a period of up to 12 hours, however, I_{SC} recovers slowly mostly to values larger than the pre-treatment values, with V_{OC} and FF holding their improved values. The cells then show normal stability.

It has been found that there exists an optimum for the amount of power deposited on the cells during the exposure and overexposure damages the cell.

The objective of the paper is to identify the mechanism which leads to the desirable performance improvement and to determine the parameters leading to the optimization.

In order to separate the effects of light from those produced by heat, sources with corresponding spectra but same intensity will be used. Variation of intensity are also contemplated. If time permits, experiments with laser sources will be carried out and reported.

The following types of cells are under investigation:

- Cells produced by the dip process;
- Cells produced by the evaporation of CdS and reactively sputtered Cu_xS ; and
- All-sputtered CdS/ Cu_xS cells

The following parameters are presently or will be under investigation, possibly being affected by the light-heat treatment:

- Copper diffusion in Cu_xS ;
- Copper diffusion in CdS and its grain boundaries;
- Effects on Cu_2O surface films; and
- Chemical and electronic changes in the CdS- Cu_xS interface

The analysis has been or will be based on:

- Resistivity data
- I-V characteristics
- Spectral response data;
- Quantum efficiency vs wavelength data;
- Diffusion length measurements (EBIC);
- SEM topological and topographical data;
- X-ray analysis; and
- X-ray elemental analyses.

- 78-110 DESIGN AND ANALYSIS OF ISENTROPIC COMPRESSION EXPERIMENTS R. S. Hawke

UCRL-81797, October 13, 1978
Presented at the 2nd Int'l Conf. on
Megaguass Magnetic Field Generation and
Related Topics, May 29-June 1, 1979, Wash. D.C.

Abstract

This paper will describe the design of the flux compression device used to isentropically compress materials up to about 5 Mbars. Computer simulators will be compared with actual results. The data obtained on experiments with hydrogen neon, Al_2O_3 , and teflon will be discussed.

- 78-111 WASTE PIPE CALCULUS A. M. Kaufman
UCID-17953, October 13, 1978

Abstract

We present a rapid method of calculating transport in a network of one dimensional flow paths or "pipes". The method defines a Green's function for each flow path and prescribes a method of combining these Green's functions to produce an overall Green's function for the flow path network. A unique feature of the method is the use of the Laplace transform of these Green's functions to carry out most of the calculations.

- 78-112 CALCULATED RADIONUCLIDE MIGRATION FROM A GEOLOGIC HIGH LEVEL WASTE REPOSITORY A. M. Kaufman
UCRL-81148, October 17, 1978 D. J. Isherwood
Presented at the ASTM Conference B. Ross
7/10-14/78, Johnson, Vermont

Abstract

Transport by groundwater is the most likely means of escape for radioactive waste contained in a geologic repository. The rock formations through which the groundwater flows are characterized by inhomogeneities on all distance scales. Large scale inhomogeneities cause pulses of dissolved pollutants to spread both in the direction of motion and transverse to it. This phenomenon is known as macroscopic dispersion. Similarly, inhomogeneities in the chemical properties of the rock will cause this spreading to be greater for species whose movement through the rock is retarded by waste rock chemical interactions.

Previous risk analyses of nuclear waste disposal which have ignored macroscopic dispersion found that predicted radiation dose to individuals are very sensitive to the waste dissolution time. When macroscopic dispersion is incorporated into the analysis, however, the sensitivity of risk to dissolution time is greatly reduced.

78-113 PRONY'S METHOD REVISITED
UCRL-52590, October 18, 1978

E. K. Miller

Abstract

Prony's Method belongs to a class of techniques in systems theory called "parameter estimators" which estimate constants appearing in mathematical models of physical phenomena. This method interests us because, with only modest computation, one can derive the exponents, or poles, of data described by an exponential series. In this report, we continue our evaluation of the moving-window approach for reducing the deleterious effects of noise to which Prony processing is particularly sensitive. We have conducted a series of systematic computer experiments on analytically specified transient waveforms and, in particular, have examined transmission of errors through the process by determining the accuracy of the input data, the characteristic-equation coefficients and roots, and the poles. We have also derived statistical distributions of these quantities for combinations of input data parameters. With respect to the pole accuracy available from a given number of window iterations, we find that averaging the coefficients generally appears as acceptable as averaging the poles.

78-114 INTERFACE RECOMBINATION OF CHARGE CARRIERS
IN BICRYSTALS
UCRL-81819, October 19, 1978
Presented in the Applied Physics Letters

J. Y. Leong
J. H. Lee

Abstract

A standard photoconductance measurement is suggested for determining the intergrain recombination velocity of excess charge carriers in a bicrystal. Analysis of the bicrystal photoconductance shows two important effects: First, if the grain size is much larger than the diffusion length, the excess-carrier lifetime in a polycrystalline material will be indistinguishable from that in a single crystal with the same bulk and surface properties. Second, as the intergrain recombination velocity increases, its effect tends to saturate.

- 78-116 CROSS-BOREHOLE ELECTROMAGNETIC PROBING TO LOCATE HIGH-CONTRAST ANOMALIES
UCRL-79272, October 25, 1978
Published in Geophysics
- R. J. Lytle
E. F. Laine
D. L. Lager
D. T. Davis

Abstract

Electromagnetic probing between boreholes is useful for locating high-contrast geophysical anomalies such as a tunnel. Theoretical and experimental studies of electromagnetic interaction with a tunnel show that minima in the received signal can be used for the locating. The theoretical studies show that, as a transmitter and receiver are lowered in separate boreholes, the minima can be easily interpreted to yield both the lateral and vertical positions of the tunnel. The main mechanism of electromagnetic interaction with the tunnel appears to be diffraction, and the spatial variation of the field strength is affected by the tunnel shape. Frequencies from 10 to 70 MHz were studied to assess the usable frequencies. The field in the receiver borehole was an effective diagnostic when a half wavelength in the surrounding medium was less than or equal to the diameter of the tunnel. Electromagnetic probing at two test sites gave the locations of tunnels within 1 ft of the surveyed locations.

- 78-117 MULTIDIMENSIONAL SPECTRAL FACTORIZATION
UCRL-81345, October 27, 1978
Presented at the 17th IEEE Conf. on Decision & Control, Islandia Hyatt House, San Diego, CA
January 10-12, 1978
- D. M. Goodman
M. P. Ekstrom

Abstract

In this paper, we present a procedure for the spectral factorization of multidimensional spectral density functions. Properties of the multidimensional cepstrum are developed and used as a basis for the procedure. In analogy with Wiener's one-dimensional factorization, the resulting factors are stable and realizable (i.e., recursive). A numerical algorithm for performing the factorization is described, along with its use in obtaining unilateral representations of multidimensional random fields.

- 78-118 REALIZABLE WIENER FILTERING IN TWO-DIMENSIONS
UCRL-81847, October 30, 1978
Presented at the 4th Int'l Symposium on the Mathematical Theory of Networks & Systems, Delft, Netherlands, July 3-6, 1979
- M. P. Ekstrom

Abstract

This paper deals with the extension of Wiener's classical mean-square filtering theory to the estimation of two-dimensional (2-D), discrete random fields. In analogy with the 1-D case, the optimal filter is derived by solution of a 2-D discrete Wiener-Hopf type equation using a spectral factorization procedure. Canonical

versions of the filter are described along with a computational algorithm for performing the required calculations. The principal advantage of the approach is that it results in 2-D filter forms which are suitable for recursive implementation.

- 78-119 DESIGNING 2-D RECURSIVE FILTERS USING COMBINED M. P. Ekstrom
AMPLITUDE AND PHASE CRITERIA R. E. Twogood
UCRL-81846, October 30, 1978
Presented at the 1979 IEEE Int'l Symposium on
Circuits & Systems, Tokyo, Japan, IEEE, July, 1979

Abstract

A procedure for the design of 2-D half-plane recursive digital filters was recently presented in (1). This design procedure incorporated a 2-D spectral factorization into a nonlinear optimization algorithm.

The purpose of this paper is to present a technique for generalizing the design method of (1), where no control over the phase function exists (except for zero-phase implementations), to the case where an arbitrary phase function is specified. This is accomplished by augmenting the spectral factorization design technique with a phase error term in the objective function. An example illustrating the potential applicability of this new design procedure will be presented.

- 78-120 INVARIANT SYSTEM DESCRIPTION OF THE J. V. Candy
STOCHASTIC REALIZATION T. E. Bullock
UCRL-81857, October 31, 1978 M. E. Warren
Published in the IFAC Journal-Automatica

Abstract

In this paper it is shown that the class of all realizations possessing the same power spectral density can be uniquely characterized by giving an invariant system description. A new transformation group is introduced and shown to leave the spectral density unchanged. The action of this group must be considered when attempting to specify a stochastic realization from spectral densities or equivalently covariance sequences.

- 78-121 GENERAL-PURPOSE ALUMINUM-AIR/FLYWHEEL J. F. Cooper
ELECTRIC VEHICLES E. Behrin
UCRL-82003, November 1, 1978
Presented at the Electrochemical Society,
Pittsburgh, PA, October, 1978

Abstract

Design parameters and optimum operating conditions were determined for aluminum-air/flywheel vehicles with performances equivalent to that of a five-passenger highway automobile. The performance of

such vehicles depends strongly on the voltage-current characteristics of aluminum-air cells and on the weights of the reactants. The weight of cell hardware constitutes about 5% of the vehicle weight. The weight of the power cell (including reactants and electrolyte) is about 15% of the vehicle gross weight. The total energy cost of propulsion for the aluminum-air vehicle is approximately equal to that of an internal-combustion-engine vehicle of equivalent performance if the primary energy resource in both cases is coal.

- 78-122 SPECTRAL TRANSFORMATIONS FOR NONSYMMETRIC HALF-PLANE FILTERS D. M. Goodman
UCRL-81870, November 3, 1978
Presented at the 12th Annual Conf. on Circuits, Systems & Computers, Asilomar, CA, November 6-8, 1978

Abstract

The spectral transformation approach for designing two-dimensional $I\Omega$ filters is extended from the quantor-plane case to the nonsymmetric half-plane case. It is shown that this technique is not as general in the nonsymmetric half-plane case. The behavior of both quantor-plane and nonsymmetric half-plane all-pass functions is examined, and a property of these functions which limits their usefulness in spectral transformations is noted.

- 78-123 PARAMETRIC CHARACTERIZATION OF THE EEG FOR SURGERY MONITORING W. D. Smith
D. L. Lager
UCRL-81880, November 3, 1978
Presented at the AAMI 14th Annual Meeting & Exhibit Program, Las Vegas, NV, AAMI, May 20-24, 1979

Abstract

On line monitoring of the patient's electroencephalogram (EEG) can yield valuable information during surgery. Parametric characterization of the EEG may allow an even more concise display than the traditional time sequence of power spectra. Several possible algorithms for on line parameter estimation were compared, using simulated and real EEG.

It was assumed that the short-term autocorrelation of the EEG can be expressed as a low order sum of complex exponentials (i.e., negative real exponentials and damped sinusoids). This is equivalent to the assumption that discrete samples of the EEG are generated by a linear system, represented by a finite order difference equation, driven by white noise. The algorithms estimated the Laplace plane poles and residues of either the autocorrelation or the linear system transfer function. A Laplace domain characterization is useful, as the real and imaginary parts of the poles are related, respectively, to spectral peak widths and center frequencies and the residues to the strengths of these peaks.

The method of Prony applied to the autocorrelation accurately characterized the EEG. An oversquare Prony analysis of the raw EEG, though less accurate, gave a more precise (less variable) characterization. A simplified version of this technique to reduce computation proved most suitable for on line implementation.

One of many possible display modes is shown in Figure 1, where the frequency components of the poles are plotted at 5 second updates for various epochs during human surgery. The epochs represent: a. pre-anesthesia, b. induction, and c. surgical level.

- 78-124 DERIVATION OF APPROXIMATED FORMULAT J. H. Yee
FOR MINORITY CARRIER MOBILITY IN POLY-
CRYSTALLINE THIN FILM
UCID-17966, November 3, 1978

Abstract

This report presents the derivation of an approximated formula for the minority carrier mobility and diffusion length in a polycrystalline thin film.

- 78-125 QUADRANTAL SYMMETRY CALCULATIONS FOR NONSYMMETRIC D. M. Goodman
HALF-PLANE FILTERS
UCID-18062, November 6, 1978

Abstract

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

- 78-126 AN ALGORITHM FOR ENHANCING LOW-CONTRAST DETAILS G. K. Myers
IN DIGITAL IMAGES R. E. Twogood
UCID-18015, November 10, 1978

Abstract

An algorithm for improving the contrast in digital images, called "contrast stretching," was implemented on the CDC 7600 computer. The applicability of this algorithm to radiographic image enhancement has been investigated. Excellent contrast improvements have been observed for several sample images.

- 78-127 METALLIC HYDROGEN RESEARCH T. J. Burgess
UCID-17977, November 14, 1978 R. S. Hawke

Abstract

Theoretical studies predict that molecular hydrogen can be converted to the metallic phase at very high density and pressure, and we have achieved these conditions by subjecting liquid hydrogen to isentropic compression in a magnetic-flux compression device. We determined that hydrogen becomes electrically conducting at a density of about 1.06 g/cm³ and a calculated pressure of about 2 Mbar. In our experimental device, a cylindrical liner, on implosion by high explosive, compresses a magnetic flux which in turn isentropically compresses a hydrogen sample; coaxial conical anvils prevent escape of the sample during compression. One anvil contains a coaxial cable that uses alumina ceramic as an insulator; this probe allows continuous measurement of the electrical conductivity of the hydrogen. A flash x-ray radiograph exposed during the experiment records the location of the sample-tube boundaries and permits calculation of the sample density. We briefly summarize the theoretical underpinnings of the metallic transition of hydrogen and describe our experimental apparatus and technique, analytical methods, and results.

78-128 CROSS-BOREHOLE GEOPHYSICAL PROBING FOR
SITE CHARACTERIZATION

R. J. Lytle

UCRL-81901, November 15, 1978
Presented at the Rapid Excavation Conference,
Atlanta, Georgia, June 18-21, 1979, sponsored
Mining Engineers.

Abstract

Prior to excavation in soil and rock, it is useful to know the subsurface structure. This is important information both for safety and for equipment scheduling reasons. It is useful to know whether parts of the subsurface might be potentially troublesome or of different character than is generally present. By using geophysical probing, it is possible to infer the location and size of these unusual regions.

The ground structure is commonly estimated from core samples taken from boreholes. These cores give a detailed knowledge of the structure in the borehole. However, knowledge of the structure exterior to the borehole can only be extrapolated from core data. By using seismic and electromagnetic cross-borehole geophysical probing, remote probing can be used to sense the region exterior to boreholes. A recent advance has significantly improved the state of the art for defining the ground structure between boreholes. This new procedure utilizes large amounts of data and provides a detailed picture of the subsurface. The data processing algorithms used are similar to those in medical imaging of the human body using x-rays, a science called x-ray geotomography. This imaging of the ground is called geotomography. Several examples of geotomography applied to imaging ground structure will be presented.

78-129 CdS SURFACE LAYER EFFECTS ON THE PERFORMANCE
OF Cu_xS -CdS HETEROJUNCTION SOLAR CELLS
UCRL-31983, December 1, 1978
Presented at the 1979 Photovoltaic Solar
Energy Conference, Berlin, April 23, 1979

G. A. Armantrout
L. D. Partain
J. H. Yee

Abstract

Purpose of the Work - The research which will be reported is part of our program to apply reactive sputtering techniques to the fabrication of thin-film heterojunction solar cells. We have developed the techniques for reproducibly depositing high quality Cu_2S semiconductor layers¹ and we have applied this technique to the fabrication of an evaporated CdS - reactively sputtered Cu_xS heterojunction cell which yielded an efficiency of 4%². We have subsequently been working on all-sputtered Cu_xS -CdS heterojunction cell. In our study of these cells, we have encountered a cell performance degradation phenomena which we believe is common to all planar junction Cu_xS -CdS cells which are formed without first etching the CdS surface to texture the CdS. We will be reporting on the results of our laboratory studies of this phenomena and on the prospects of producing efficient all-sputtered heterojunction solar cells.

Method of Approach - Cu_xS -CdS cells have been formed using both reactive sputtering and dry process ($CuCl$ reaction) techniques to form the Cu_xS layer on CdS thin film layers which have been formed by evaporation or sputtering with 0.1% In as a dopant and on In doped or excess Cd doped single crystal slices. The following data was taken on each cell: (1) I-V characteristics and efficiency with a solar simulator, (2) quantum efficiency versus optical wavelength, (3) capacitance versus voltage, and (4) electron beams response of the cell as a function of electron beam energy in an SEM. The latter measurement has been especially useful in determining the regions of carrier loss in the heterojunction structure and has been correlated with the other measurements in defining the charge loss mechanisms.

Significant Results - A surface layer which ranges in thickness from 200 to 500 nanometers has been identified electrically, optically, and topographically. This region appears to contain significant quantities of deep acceptor levels which contain sufficient trapped negative charge so as to pin the Fermi level near the middle of the CdS band gap. The electric field at the Cu_xS -CdS interface is thus significantly reduced, resulting in greater interface loss of the electrons injected from the Cu_xS . This surface region also represents a region of high recombination rate for any photo-generated electrons and acts as a "dead-layer" on the cell.

The deep acceptor levels in this layer are believed to be caused by point defects in the surface layer of the CdS. While Cu is also known to introduce deep acceptor levels, such levels can normally

be photo-neutralized and efficient cells realized, whereas such is not true for the deep acceptors which cause the dead layer in the cells we have studied. Such dead layer effects have not been previously reported for textured CdS-Cu_xS cells possibly due to the rapid surface removal of the CdS immediately prior to the junction formation.

Conclusions and Assessment - Cu_xS-CdS cells which are formed by any technique other than texturing and wet-dipping for the Cu_xS layer formation will be subject to the CdS "dead" surface layer effect which we have identified. The primary result of this layer is to reduce the short circuit current and fill-factor of the cells. Work is continuing on methods of neutralizing the effect of this layer without resorting to the etching process normally used to texture the CdS surface.

References

1. G. A. Armantrout, et al, "The Formation of Thin Cu₂S (Chalocite) Films Using Reactive Sputtering Techniques," UCRL-81404, October 3, 1978, Lawrence Livermore Laboratory, Livermore, California. Presented at the 25th National AVS Symposium, San Francisco, CA, November 29, 1978.
2. G. A. Armantrout, et al, "Photovoltaic Properties of Reactively Sputtered Cu_xS Films and Reactively Sputtered Cu_xS-CdS Heterojunction," 13th IEEE Photovoltaics Specialists Conference, p. 383, 1978.

78-130 AlSb AS A POTENTIAL PHOTOVOLTAIC MATERIAL
UCRL-81982, December 1, 1978
Presented at the 1979 Photovoltaic Solar
Energy Conference, Berlin, April 23, 1979

G. A. Armantrout
J. H. Yee

Abstract

Purpose of Work - InP and GaAs have both been shown to make excellent photovoltaic cells with efficiencies in the range of 14% to 24%. However, the availability of In and Ga is limited and makes large-scale application of large-area thin film arrays of these cells highly unlikely. Of the remaining III-IV compounds, only AlSb has a band gap which matches the solar spectrum. The resource availability of both Al and Sb is more than ample for large scale photovoltaic applications, thus making this compound of definite interest.

Method of Approach - We have previously calculated the band structure and charge transport properties of AlSb¹. Subsequently, we grew ingots of large polycrystalline AlSb using Czochralski techniques. The resulting material was near-single crystal (grain size \cong 1 cm) and was P-type with carrier concentrations in the range of 10^{17} - $10^{18}/\text{cm}^3$. We formed gold Schottky barrier cells and heterojunction cells using ITO and

n+ CdS layers. We evaluated the barrier heights which were obtained using I-V and $1/C^2$ vs V techniques. We then used the measured and calculated AlSb parameters in our solar cell simulation code to predict the eventual performance of AlSb homojunction and heterojunction cells.

Significant Results - Carrier mobilities for AlSb of $\mu_n = 700$ $\text{cm}^2/\text{V-sec}$ and $\mu_p = 1000$ $\text{cm}^2/\text{V-sec}$ are predicted. Au was found to form virtually no barrier on AlSb with the result that it is an excellent ohmic contact. n+ CdS forms a 0.6 volt barrier height while ITO forms up to a 1.05 volt barrier height. Cell performance was not as good as desired ($V_{OC} = 60$ mV and $I_{SC} = 1$ ma/cm^2) primarily due to the very heavy doping and poor charge transport properties of the AlSb which was used. Since AlSb is highly susceptible to Sb vacancy doping at high temperatures, alternate low temperature growth techniques must be employed to grow solar cell quality AlSb.

Simulated cell performance indicates potential cell efficiencies >15%, but this depends on the formation of a high-quality homojunction device.

Conclusions and Assessment

AlSb is a promising photovoltaic candidate due to the low cost and relative abundance of its constituent materials. AlSb is a relatively unknown compound possibly due to its known instability in moist air.

We have stabilized the AlSb surface with sputtered protective coatings and we believe, based on our experimental observation, that it can be stabilized. The predicted performance levels are excellent indicating that much more emphasis should be placed on this material.

References

1. J. H. Yee, et al, "The Potential of AlSb as a High Energy Gamma-Ray Detector," UCRL-77748, January 27, 1976, Lawrence Livermore Laboratory, Livermore, California, 94550

78-131 A CRYOTRAPPING VACUUM PUMPING SYSTEM DESIGN
UCRL-82006, December 1, 1978
Prepared for submittal to Nuclear Technology

M. A. Hoffman
A. S. Blum

Abstract

The conceptual design of a vacuum pumping system to handle a large gas flow on the order of 17 std Torr-litre/s of helium gas in the pressure range from about 3×10^{-4} down to 3×10^{-6} Torr is described. The neutral helium gas originates partly as leakage from the plasma ion source and partly as additional gas required in the neutralizer duct of the neutral beam injector. The vacuum pumping design is based on the recently demonstrated process of

cryotrapping the helium in a frost layer of argon formed by spraying the argon onto a liquid-helium-cooled cryopanel surface. About 10.7 m² of cryopanel area in the ducts and chambers of the injector are required for an allowed frost thickness of 1 mm. The design is based on preliminary experimental results that indicated that about 30 atoms of argon were needed to pump and cryotrap each helium atom, and that the specific pumping speed of the fully baffled cryopanel would be about 3 std-litre/cm²-s. Preliminary estimates of costs indicate that this vacuum system may cost as much as 77% of the entire neutral beam injector and that the LHe cryo-refrigerator alone may cost 35% of the total direct cost. The design points up the problem areas of cryotrapping helium and the need for clever new design concepts and improved performance to reduce costs.

78-132 TWO NEW CCD ARCHITECTURES FOR HIGH
SPEED TRANSIENT RECORDING

UCRL-81791, December 1, 1978

Presented at the IEEE International Solid-
State Circuits, Philadelphia, Pennsylvania

M. D. Pocha
J. W. Balch
F. McConaghy

Abstract

Two New Charge Coupled devices, a parallel-serial and a serial-parallel-serial architecture, are described for high speed (>100 MHz) Transient Recording.

78-133 PROCESSING OF POLY-SI ELECTRODES FOR CHARGED-
COUPLED DEVICES

UCID-17995, December 6, 1978

F. D. Cook
J. W. Sherohman

Abstract

A technique has been developed to fabricate poly-Si electrodes for charge-coupled devices. By controlling the microstructure of a poly-Si film, an anisotropic etchant was selected to provide essentially uniform electrode width dimensions. The electrode widths have only a 6% variation for the majority of the devices over the area of a 2 inch silicon wafer.

78-134 ENERGY STORAGE SYSTEMS FOR AUTOMOTIVE
PROPULSION: 1978 Study
UCRL-52553, Vol. 1, December 15, 1978

E. Behrin
C. J. Anderson
H. Bomelburg
M. Farahat
H. C. Forsberg
C. L. Hudson
B. C. Kullman
L. G. O'Connell
G. Strickland
W. J. Walsh

Abstract

We have performed a technical and cost analysis of energy storage devices and energy storage power systems for automobiles as well as an analysis of the national energy impact with the introduction of such automobiles. Our goal has been to determine which devices and power systems are likely to provide credible alternatives to current and future internal combustion engine (ICE) propulsion systems between now and the year 2000. This two-volume report results not only from work conducted during FY 1978, but coordinates this with the results of the study team's work on this subject in prior years. The study was initiated in late FY 1976 under the sponsorship of the then U.S. Energy Research and Development Administration, Divisions of Energy Storage Systems and Transportation Energy Conservation. Study panels continued to examine electrochemical, mechanical, chemical, and thermal storage devices with the purpose of identifying and selecting the most promising. These devices were used in conceptual designs of various energy storage propulsion systems. Their resultant performances and costs were calculated and compared against each other and against a baseline ICE vehicle system conceptually designed to provide the same performance.

Using the results of the study reported at the end of FY 1977, the FY 1978 study concentrated on examining the following:

- The effect on all-battery electric systems of optimizing batteries for the specific peak power and specific energy relationship.
- The effect on the relative results of using highly optimistic (10% confidence level) component characteristics.
- The national energy impact of the future introduction of energy storage automobiles.
- The effect on prior results and conclusions of R & D achievements in the past year.

As a result of this multiyear effort, we draw the following general conclusions:

- Some energy storage systems have the potential at various times between now and the year 2000 to provide vehicles with both range and acceleration performance essentially equivalent to today's automobiles except for costs and safety considerations. These systems include: dual-fueled hybrids; power-leveling heat-engine hybrids; refuelable metal-air electrics; roadway power systems; and liquid hydrogen.
- Most energy storage vehicles will weigh and cost more than ICE vehicles of equal performance. This cost differential will decrease in later time periods.
- Many energy storage devices are projected to be suitable for specific-mission applications (intermediate-, limited-, and minimum-performance levels). Some specific-mission automobiles, particularly those of limited and minimum performance, can have costs comparable to present day ICE automobiles.
- All advanced energy storage vehicles are high-risk developments with difficult technical and economic problems.
- While specific-mission energy storage automobiles should find limited use in the future automotive market, the introduction of general-purpose energy storage vehicles will be required before these vehicles will make a significant impact in reducing the kilometers traveled by gasoline vehicles and before a significant reduction in petroleum consumption by the highway vehicle system can occur.

UCRL-52553, Vol. 2, December 15, 1978

Volume 2 details the results for FY 1978 of a national, multilaboratory study of energy-storage propulsion systems for automobiles. We present the findings and procedures of the five participating panels, including an evaluation of how changing the relationship between specific peak power and specific energy affects electric vehicle performance. Also included are an update of previous results based on new information obtained from ongoing research and development programs, as well as the results of a national energy impact and market penetration analysis of representative future energy storage vehicles.

78-135 WHY FILTER RECURSIVELY IN TWO DIMENSIONS?

UCRL-81637, December 20, 1978

Presented at the 1979 IEEE International Conference on Acoustics, Speech, and Signal Processing, Washington, D.C., April 2-4, 1979

R. E. Twogood

M. P. Ekstrom

Abstract

The relative advantages of 2-D recursive digital filters over their nonrecursive counterparts are discussed. A design example illustrates the ability of 2-D recursive filters to yield excellent

responses with far fewer coefficients than nonrecursive filters require. This difficulty is seen to be partially overcome by using nonrecursive filters with very efficient implementations.

- 78-136 NUMERICAL ELECTROMAGNETICS CODE - G. J. Burke
A PROGRAM FOR ANTENNA SYSTEM ANALYSIS A. J. Poggio
UCRL-82105, December 27, 1978 J. C. Logan
Presented at the EMC Symposium and J. W. Rockway
Exhibition, Rotterdam, Netherlands,
May 1-3, 1979

Abstract

A computer program entitled Numerical Electromagnetics Code (NEC) will be described and its various capabilities listed. An example of its applications to EMC analysis is presented. Also, its extensive documentation is described.

- 78-137 RAIL GUNS AND THEIR RELATIONSHIP TO MEGAGUSS FIELDS R. S. Hawke
UCRL-82104, December 29, 1978 J. K. Scudder
Presented at the 2nd International Conference
on Megaguss Magnetic Field Generation and Related
Topics, May 29-June 1, 1979, Washington, D.C.

Abstract

Recent research has revived interest in electromagnetic rail guns, which utilize the Lorentz force to accelerate a plasma, which in turn accelerates a dielectric projectile. Calculations have indicated that it is possible, with present technology, to accelerate a 10 g projectile to velocities in excess of 20 km/s. Applications will be discussed and data on preliminary experiments will be presented.

- 78-138 REPORT ON THE EUROPEAN ECONOMIC COMMUNITIES W. G. Magnuson, Jr.
SYMPOSIUM ON COMPUTER-AIDED DESIGN OF DIGITAL C. W. Gwyn
ELECTRONIC CIRCUITS AND SYSTEMS
UCID-18154, December, 1978

Abstract

A summary is presented of the European Economic Communities (EEC) Symposium held in Brussels, Belgium, November 27-29, 1978. The symposium outlined the history, goals, conclusions, and recommendations of a feasibility study on computer-aided design of digital circuits and systems sponsored by the Commission of European Communities.

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