REGISTRATION FORM
IEEE 2001 Radar Conference

Registration Fees
Conference registration fee includes technical sessions, two daily lunches, one conference Proceedings on CD-ROM, and coffee breaks.

Advance Registration (Received by April 1, 2001):

IEEE Member*	$420	$_______________
Non-Member*	$495	$_______________
IEEE Student	$180	$_______________
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On-Site Registration (Received after April 1, 2001):

IEEE Member*	$495	$_______________
Non-Member*	$570	$_______________
IEEE Student	$200	$_______________
IEEE Retired	$200	$_______________
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* includes banquet

Conference Proceedings

_______ Member	$ 30	$_______________
_______ Non-Member	$ 40	$_______________

Extra Banquet Tickets

Qty _______	$ 50	$_______________

Your Conference Cost **$_______________**

IEEE MEMBERSHIP NO. __________________________

CONFERENCE TUTORIAL COURSES

Monday, April 30, 2001
Evening Session
Time: 6:30 PM to 9:30 PM

_____ Course 1 ***Basic Radar Concepts***
Dr. Bill Holm & Mr. Jim Scheer

Thursday, May 3, 2001
Morning Session (choose one)
Time: 8:00 AM to 12:00 Noon

_____ Course 2 ***Introduction to SAR: A Signal Processing Viewpoint***
Dr. Dave Munson, Jr.

_____ Course 3 ***Multitarget Tracking and Multisensor Fusion*** **
Dr. Yaakov Bar-Shalom

_____ Course 4 ***Radar Cross Section***
Dr. John Shaeffer

_____ Course 5 ***Adaptive Array Processing and STAP Theory, Applications, and Advanced Techniques***
Dr. Joe Guerci

** **Book Required for Course 3**
Multitarget-Multisensor Tracking: Principles & Techniques
Y. Bar-Shalom and X.R. Li

Afternoon Session (choose one)
Time: 1:00 PM to 5:00 PM

_____ Course 6 ***Pulse Compression in Radar Systems***
Dr. Marvin Cohen

_____ Course 7 ***Automatic Target Recognition Using SAR***
Dr. Les Novak

_____ Course 8 ***Understanding the Fundamentals, Merits, Complexities, and Applications of Bistatic Radar***
Mr. Bob Ogrodnik

_____ Course 9 ***Space-Based Radar: Application of SAR for GMTI***
Dr. Chuck Livingstone

Conference Tutorial Course Registration Fees
Registration for only the tutorial courses is permitted, but conference registrants have priority. Registration received by April 1, 2001 will qualify as advanced registrations.

Member Status	Before 4/1/01	After 4/1/01
IEEE Member	$125	$140
Non-Member	$145	$160
IEEE Student	$ 40	$ 50
IEEE Retired	$ 40	$ 50
IEEE Unemployed	$ 40	$ 50

Calculating Cost
No. of Courses _______ x Fee $__________ = $______________ (1)

Book Fee (Course 3 Only) $ 75 $______________ (2)
Multitarget-Multisensor Tracking: Principles & Techniques
Y. Bar-Shalom and X.R. Li

Total Course Costs (sum of lines 1 & 2) $________________

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"2001: Radar's Odyssey Into Space"

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2001 IEEE Radar Conference

Atlanta, Georgia, May 1-3, 2001

December 12, 2000

Conference Tutorials

We want to welcome you to the 2001 IEEE Radar Conference tutorial session. We have put together a total of 9 tutorials from which to choose. We are doing something a little different this year in that we are offering a three-hour tutorial on the evening prior to the conference (April 30, 2001). This tutorial will provide a review of basic radar concepts. The other eight tutorials will be held on May 3. The tutorial session is divided into a morning session and an afternoon session. You may choose one tutorial from each session in addition to the pre-conference tutorial. Abstracts describing each of the tutorials are included with this package. Please note that the tutorial on Multitarget Tracking and Multisensor Fusion requires a textbook at an additional cost of $75. The book charge is indicated on a separate line on the registration form. We look forward to seeing you at the conference and serving your tutorial needs.

Basic Radar Concepts

Dr. Bill Holm and Mr. Jim Scheer

Basic Radar Concepts is a course in the basic fundamental principles of modern radar technology. This course is intended to impart to the student a basic, high-level, understanding of today's modern radar technology in simple, easy-to-understand terms. The two instructors, Bill Holm and Jim Scheer, have a vast level of experience in presentation of radar-related short course material, and have, over the years, developed an understanding of how to best present special topics (e.g. propagation phenomena, Nyquist sampling issues, use of decibel (dB) nomenclature, probability density functions, etc.) using easy-to-interpret every-day situations as examples. Topics include: Introduction to Radar - definitions, classes of radars, radar range equation, radar cross section, detection process, and design considerations, and Basic Elements of the Radar System - transmitters, receivers, antennas (including phased arrays) and signal processing and processors.

Professional Biographies

Mr. Scheer, a Principal Research Engineer, has been involved in radar systems engineering at GTRI since 1975. He was formerly at General Electric, Utica, New York, involved in the F-111 airborne radar development beginning in 1966. In addition to his 34 years of radar systems engineering experience, he has taught in numerous radar-related short courses, including “Principles of Modern Radar”, which has been presented at GTRI for over 25 years. He is coeditor of the Artech House book entitled *Coherent Radar Performance Estimation*, the subject of another GTRI course. Mr. Scheer holds an M.S. in Electrical Engineering from Syracuse University.

Dr. Holm, a Principal Research Scientist, has been employed at GTRI since 1977. He is currently conducting research in the area of advanced signal processing techniques to effect stationary target/clutter discrimination and target identification. He has conducted research in radar technology, and related topics, resulting in scores of research papers, technical papers, and book chapters. He lectures in numerous radar short courses, and is course administrator for “Principles of Modern Radar” and “Radar Target Identification”, two popular courses at GTRI. Dr. Holm holds a Ph.D. from Georgia Tech.

Introduction to SAR: A Signal Processing Viewpoint

Dr. David Munson, Jr.

Synthetic aperture radar (SAR) is a microwave system capable of synthesizing imagery having extraordinary resolution by processing radar data collected from a single sensor moved to different spatial locations. This tutorial focuses on developing the fundamental mathematical ideas underlying both strip-map and spotlight-mode SAR. The signal processing aspects of SAR are stressed and an understanding of the image formation process is gained, beginning with the original scene reflectivity and ending with the final image. For strip-map SAR, three image reconstruction methods are described: correlation based, chirp scaling, and omega-k,. For spotlight-mode SAR, we concentrate on the polar-format approach. Using theorems from 3-D computer tomography, the relationship of a 2-D SAR image to the true 3-D scene is explained. Also, SAR interferometry is developed for topographic mapping, and the phase unwrapping problem is discussed. When imaging 3-D objects having irregular shapes, interferometric SAR suffers from layover, where various parts of the 3-D object are collapsed into 2-D. A new method of radar imaging of complex 3-D objects is described, where the imaging problem is converted into a high-resolution spectral estimation problem. Reconstructions of military targets are shown using simulated radar data generated by XPATCH.

Professional Biography

David C. Munson, Jr. received his BS degree from the University of Delaware in 1975, and his MS and PhD degrees from Princeton University in 1977 and 1979, respectively. Since 1979 he has been with the University of Illinois at Urbana-Champaign where he is a professor in the Department of Electrical and Computer Engineering. Prof. Munson's research interests are in signal and image processing, with curent work focused on passive microwave imaging of aircraft, hybrid optical/digital imaging, and lidar imaging of ocean mines. Professor Munson is a Fellow of the IEEE, a Past President of the IEEE Signal Processing Society, and Founding Editor-in-Chief of the IEEE Transactions on Image Processing. (109)

Multitarget Tracking and Multisensor Fusion

Dr. Yaakov Bar-Shalom

Part 1 of the tutorial reviews the basic techniques for tracking including Kalman, Alpha-Beta (-Gamma) and Extended Kalman filters. Part 2 reviews the Interacting Multiple Model (IMM) estimation algorithm (a self-adjusting, variable-bandwidth tracking filter). Part 3 introduces the agile-beam radar allocation problem. Part 4 addresses the problem of tracking in clutter using a Probabilistic Data Association filter. Part 5 reviews a benchmark problem for high-g targets in the presence of RGPO and jamming. Part 6 addresses radar management and tracking issues when applying a combined IMMPDAF. Part 7 presents an example of multisensor track formation and maintenance using an ATC tracking problem. Part 8 contains a comparison of IMM vs. KF on real data (800 targets, from 5 FAA/JSS radars). Part 9 addresses large-scale tracking of ground targets. The Variable Structure IMM is applied with topographic information for precision tracking of ground targets using airborne GMTI radars. Part 9 also considers the acquisition of low observable (LO) targets, including track formation for low SNR targets, the Cramer-Rao lower bound in the presence of false measurements, and the acquisition of a 4 dB SNR Theatre Ballistic Missile target with an ESA radar. The course is based on the book *Multitarget-Multisensor Tracking: Principles & Techniques* by Y. Bar-Shalom and X.R. Li. The book is an integral part of the course and is a required purchase at an additional charge of $75.

Professional Biography

Yaakov Bar-Shalom received the B.S. and M.S. degrees from the Technion, Israel Institute of Technology, in 1963 and 1967, and the Ph.D. degree from Princeton University in 1970, all in electrical engineering. Currently he is School of Engineering Distinguished Professor in Electrical and Computer Engineering at the University of Connecticut. His current research interests are in estimation theory and target tracking and has published 6 books and over 250 papers and book chapters in these areas and in stochastic adaptive control. He has been elected Fellow of IEEE for contributions to the theory of stochastic systems and of multitarget tracking. He has been consulting to numerous companies and government agencies, and originated the series of Multitarget-Multisensor Tracking short courses.

Radar Cross Section

Dr. John Shaeffer

This tutorial will cover the following RCS topics: An Overview of Stealth; RCS Scattering Mechanisms; RCS Prediction Methods; and RCS Scattering Center Visualization.

An Overview of Stealth includes a top-level description of the basic approaches to stealth design and considerations starting with the notion of threat sectors. The four basic approaches to RCS reduction will be reviewed with emphasis on shaping.

RCS Scattering Mechanisms will highlight the physical processes by which incident electromagnetic energy is re-radiated. Included will be a consideration of scattering centers using a visual approach. Scattering mechanisms to be discussed include: specular, multiple bounce, end region returns (which are responsible for pattern side lobes), edge diffraction, surface traveling/edge/creeping waves, and surface imperfection scattering.

RCS Prediction Methods will overview some of the basic approaches used to compute mono and bi-static scattering. Topics for consideration include Physical Optics and Physical Theory of Diffraction for large targets and MOM codes for moderate sized targets.

RCS Scattering Center Visualization includes image animations of scattering centers from measured and computed data. The bi-static k-space imaging approach for analytical computations without a frequency sweep will be reviewed.

Professional Biography

John Shaeffer earned his BS, MS, and Ph.D. degrees in Physics. He is a Principal Scientist and one of the founders of Marietta Scientific, Inc. He is a co-author of *Radar Cross Section* and has developed a three-day “Design Oriented Radar Cross Section” short course. For several years, he was an Engineering Program Manager for Low Observables at the Lockheed-Georgia Possum Works. He has specialized in visualization and method of moment codes for scattering applications.

Adaptive Array Processing and STAP:
Theory, Applications, and Advanced Techniques

Dr. Joe Guerci

This tutorial is designed to provide a firm grounding in both the underlying theory of optimum and adaptive array processing, as well as an understanding of the key practical challenges facing real-world implementations. After introducing the motivation and theory of 1D, 2D (i.e., space-time adaptive processing--STAP), and 3D STAP, the course focuses on practical implementation issues. Particular emphasis is placed on those real-world factors that can have a significantly deleterious effect on performance, such as interference heterogeneity/nonstationarity, and subspace leakage (i.e., internal clutter motion, nonlinear array geometries, transmitter/receiver instabilities, etc.). The latest techniques drawn from up to the minute research for combating these effects are surveyed and contrasted.

Professional Biography

From 1984 to 1997, Dr. Guerci was with the Northrop-Grumman Corporation (formerly Grumman Corp.), Bethpage, NY, where he headed up the Signal Processing Group of the corporate R&D center. From 1997 to 1999, he was with Science Applications International Corp. (SAIC), where he served as Chief Scientist for the Adaptive Signal Exploitation (ASE) Branch. Currently, Dr. Guerci is a Program Manager with DARPA's Special Projects Office (SPO).

Dr. Guerci has held adjunct professorships in engineering and applied mathematics at Cooper Union, the City University of New York, Polytechnic University, and Virginia Tech. In 1996, he was a Visiting Senior Research Scientist at Polytechnic University conducting research into robust space-time adaptive processing for radar.

Dr. Guerci received the BS (Highest Honors) in Engineering Science from the City University of New York, and the MSEE and PhDEE (System Engineering) from Polytechnic University. He has eight US patents, over 35 peer-reviewed technical publications, is a Member of the IEEE Radar Systems Panel and a Senior Member of the IEEE, and in 1996, he won the DARPA/Rome Labs CREST Challenge space-time adaptive processing radar design contest.

Pulse Compression in Radar Systems

Dr. Marvin Cohen

The principles, motivations, and terminology related to radar pulse compression are presented with an emphasis on obtaining a fundamental understanding of the concepts and techniques involved. The lecture contains an in-depth discusssion of specific pulse compression techniques based on frequency, phase, and hybrid modulation schemes. Frequency modulation techniques include linear and non-linear frequency modulation, Stretch, and stepped-frequency waveforms. Particular phase modulation techniques reviewed in the course include Barker, MPS, pseudorandom, Golay, Welti, Frank, and P4 codes, and the 'concatenation' of these codes for the construction of long codes-filter designs. The course closes with a discussion of innovative mismatch filtering techniques and the analysis and evaluation of pulse compression schemes based on application of the radar ambiguity function. Dr. Cohen seeks to both inform and entertain his students in an atmosphere conducive to learning. Extensive references and a PDF file of the entire tutorial are provided to ensure that the student is well-equipped to translate attendance at the tutorial into an ability to apply the material on the job.

Professional Biography

Dr. Cohen, a Fellow of both The IEEE and The Georgia Tech Research Institute, holds a Ph. D. in mathematics and has been active in the development and teaching of radar pulse compression for two decades. He is a Principal Research Scientist at GTRI, Head of its Target Identification Program Office, and GIT Adjunct EE Faculty. He also is CEO of his firm, IRTA/MCA, which supplies expert consulting services to government, industry, and academia in the areas of target identification, identification fusion, pulse compression, advanced radar concepts and developments, and the conduct of large, complex technical programs. Dr. Cohen is the author of well over one hundred professional publications, is co-author, with Nathanson and Riley, of the text, *Radar Design Principles, 2nd Edition*, published by McGraw-Hill in 1991 and re-released, with minor modification, by SciTech in 1998. He has also published five chapters in four graduate-level / reference texts, and teaches in five GIT short courses.

Automatic Target Recognition using SAR

Dr. Les Novak

This tutorial on Automatic Target Recognition (ATR) using Synthetic Aperture Radar (SAR) imagery focuses on two main areas of research: (1) SAR ATR using fully polarimetric data and (2) SAR ATR using superresolution image processing. In part 1 of the tutorial we describe a fully polarimetric Ka-Band SAR sensor and we develop various techniques, including the polarimetric whitening filter (PWF) and the polarimetric matched filter (PMF), for optimum processing of the fully polarimetric data. A complete end-to-end target recognition system is developed, and performance results versus resolution and polarization are summarized. In part 2 of the tutorial, various superresolution processing algorithms applied to SAR data are described, and for each algorithm the improvement in ATR performance is quantified. Recognition performance results are presented for a 20-target classifier, and lessons learned from extensive SAR ATR evaluations conducted at MIT Lincoln Laboratory are summarized.

Additional ATR topics to be presented include: target recognition performance comparisons using 1-D high range resolution (HRR) profile classifiers versus 2-D SAR classifiers; model-based classifier performance; combined polarimetric/superresolution processing; low frequency foliage penetration (FOPEN) SAR target detection and discrimination.

Professional Biography

Leslie Novak received his PhD from UCLA; he has been at MIT Lincoln Laboratory since 1977. He currently holds the position of Senior Staff in Division 4 and is assigned to the Sensor Exploitation Group, where he is involved in the development of target detection, acquisition, and classification algorithms for SAR (synthetic aperture radar) systems. Recently, he has been performing studies on polarimetric radar signal processing algorithms and superresolution signal processing algorithms for synthetic aperture radar systems. He has published numerous papers on optimum processing of polarimetric radar data (including the polarimetric whitening filter and the polarimetric matched filter) and on SAR superresolution processing applied to the radar automatic target recognition problem.

Understanding the Fundamentals, Merits, Complexities, and Application of Bistatic Radar

Mr. Bob Ogrodnik

This tutorial provides the student with a comprehensive overview of bistatic radar founded on the knowledge and experience gained by the instructor in applying bistatic radar principles to both airborne and spaceborne reconnaissance and surveillance assets. The course reviews radar principles from a moving-lookdown application viewpoint. The goal is to develop an integration of all-signal-awareness and full air-situation-awareness in a manner not found in basic radar textbooks nor in the classic radar literature. In this regard, it sets the foundation for Intelligence, Surveillance, and Reconnaissance (ISR) modeling and analysis. The integrated features of ISR bear the new emphasis of full battlefield and force strategy awareness addressed in new sensor technologies and current DoD trends. The combination of passive ISR that bistatic radar features, combined with moving-lookdown applications which this tutorial will address as examples, will provide the student with a deeper insight to bistatic radar, its merits, and sensor application power not readily appreciated in classical radar theory.

Professional Biography

Mr. Robert Ogrodnik received his BS in Physics and EE from Clarkson University in 1961, and his MS in Physics and EE from Syracuse University in 1966. He has post graduate studies leading to a Ph.D. in EE from Syracuse University, 1967-78. Currently he is a Principal Engineer at the Air Force Research Laboratory, Sensors Directorate, Radar Research Branch, Rome NY. Mr. Ogrodnik has been a key figure in defining a low risk technology strategy for AF planning in transitioning its key airborne surveillance, reconnaissance and imaging assets such as, respectively, AWACS, Rivet Joint and JSTARS, into space. In that capacity, he has conducted both fundamental research and applied developments in bistatic radar technology in both airborne and spaceborne radar sensor applications. One of the more notable achievements Mr. Ogrodnik has accomplished is the unique integration of passive signals awareness, known as SIGINT technology, with bistatic radar techniques in support of the deployment of stand-alone passive radar. He initiated, technically contributed to, and completed mission requirements and standards for the transition of passive radar into the USAF Rivet Joint 495th reconnaissance wing.

Space-Based Imaging Radar
(with Application to GMTI)
Dr. Chuck Livingstone

The Space-Based Imaging Radar course is intended to provide the student with an overview of the issues associated with space-based radar. Topics include theory, applications, and orbital considerations. Emphasizing radar sensor issues, the course will also include top-level satellite system engineering topics. Examples will be taken from current systems with a focus on Canada's RADARSAT 2 earth observation satellite. The course will also include a special section on the characteristics of a strip-mapping, two-aperture SAR that can be employed to detect moving targets and to measure their speeds. This material is based on work in progress to modify and use RADARSAT 2 for ground moving target (GMTI) experiments. Examples will be drawn from airborne experiments and from simulation studies.

Topics to be discussed include:

<u>Space-Based Radar</u>

- Orbital Considerations
- System Requirements / Constraints
- Radar Modes

<u>Special Topic: The Application of SAR for GMTI</u>

- GMTI constraints imposed by strip-mapping SAR architectures.
- The roles of aperture time, bandwidth, and phase center displacement time in target motion measurements.
- The properties of temporal interferometer and DPCA phase spaces.
- Strategies for adapting SAR matched filters to moving targets.
- Dealing with ambiguities.

Professional Biography

From 1976 to 1997 Dr. Chuck Livingstone developed airborne earth observation SAR technology and explored the use of radar systems for quantitative terrain measurements for the Canada Centre for Remote Sensing. Since joining the Defense Research Establishment Ottawa he developed a program to install an experimental GMTI mode of the RADARSAT 2 (R2) satellite (launch 2003) for the Canadian Department of National Defence (DND). He is currently chief scientist and project manager for the DND RADARSAT 2 GMTI demonstration project.