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# PLANS2004

## Welcome! Celebrating our 29th Year!

IEEE, the world's largest professional engineering organization, through its Aerospace and Electronics Systems Society, invites you to attend and enjoy PLANS 2004. We sponsor the Position Location and Navigation Symposium every two years. The focus of this year's conference is on navigation technology that is currently operational, emerging or in the research stage. PLANS has an excellent reputation for providing a broad spectrum of high quality, technically significant papers and tutorials.

Our technical program and tutorial sessions offer the latest information on a wide variety of subjects. In addition to research and development topics, we have placed increased emphasis on applications and integration of navigation equipment and technologies. With our plans for 24 technical paper sessions, a poster session and a full day of tutorials, we will offer an intensive and interesting week of exciting information. An outstanding group of session chairs has selected over 100 papers for our technical program. This is a great opportunity to get to know your professional colleagues from around the world.

For updates to this technical program, or for further details on any subject matter, visit our website at: [www.plans-ieee.org](http://www.plans-ieee.org).

***Support PLANS 2004 by staying at our conference hotel—  
Hyatt Regency, Monterey, CA***

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- Track A:** Inertial Sensing Technology  
**Kenneth Marino,**  
Northrop Grumman
- Track B:** Inertial Navigation Applications  
**Mike Johnnie,**  
Northrop Grumman, NSD
- Track C:** Global Navigation Systems  
**Len Jacobsen,**  
GSAM Inc.
- Track D:** Future Navigation Systems and Applications  
**Steven P. Fleischut,**  
Penn State

## SUNDAY, APRIL 25

## LOCATION

4:00-7:00 **Registration** *Regency Ballroom Foyer*

## MONDAY, APRIL 26 (TUTORIAL PROGRAM BEGINS)

7:30-6:00 **Registration** *Regency Ballroom Foyer*

12:00-5:00 **Exhibit Setup** *Regency Ballroom*

## 8:30-12:00 TUTORIALS PART 1

**1. MEMS Inertial Technology: A Short Course** *Cypress 1-2*  
Instructor: Ralph Hopkins

**2. Navigation and Man** *Spyglass 1*  
Instructor: Marvin May

**3. Fundamental Issues Affecting GPS/INS Integrations** *Big Sur 1-2*  
Instructor: G. Jeffrey Geier

**4. Navigation System Test and Evaluation** *Spyglass 2*  
Instructor: Athanison Monroe

12:00-1:00 **Lunch Break** *Attendees' Choice*

## 1:30-5:00 TUTORIALS PART 2

**1. GPS Protection Toolbox: Picking the Right Technology for Interference Suppression** *Cypress 1-2*  
Instructors: Dr. Ira M. Weiss and Allen W. Morrison

**2. It's About Time** *Spyglass 2*  
Instructor: Dr. Demetrios Matsakis

**3. Low-Cost Inertial Finally! From MEMS to NAV Systems** *Big Sur 1-2*  
Instructor: James L. Farrell, Ph.D.

## TUESDAY, APRIL 27 (TECHNICAL PROGRAM BEGINS)

## LOCATION

7:00-8:15 **Speakers' Breakfast** *Windjammer 1-2*

7:30-4:00 **Registration** *Regency Ballroom Foyer*

8:30-11:45 **SESSION A1: MEMS Inertial Sensor Technology** *Spyglass 1-2*  
Chair: David Arch

**SESSION B1: Integration of Inertial Systems with Satellite Navigation Systems** *Regency 4-6*  
Chair: Phil Bruner  
Co-Chair: Marina Ruggieri

**SESSION C1: GPS Receiver Augmentations** *Cypress 1-3*  
Chair: Karen Van Dyke

**SESSION D1: Navigation Research in Acadamia** *Big Sur 1-3*  
Chair: Mr. Neil Weinman  
Co-Chair: Mr. Joseph Gentile

9:00-10:00 **Spouses' Reception** *Windjammer 1-2*

10:00-4:00 **Exhibits Open** *Regency Ballroom*

12:00-1:30 **Luncheon and Keynote Address** *Monterey Ballroom*  
Keynote Speaker: Michael G. May

1:45-5:00 **SESSION A2: MEMS Inertial Measurement Unit Technology** *Big Sur 1-3*  
Chair: Marvin Silver

**SESSION B2: Advanced Integrated Navigation Technology** *Spyglass 1-2*  
Chair: Don Anttila

**SESSION C2: GPS, GALILEO and GLONASS** *Regency 4-6*  
Chair: John Clark  
Co-Chair: Larry D. Vittorini

**SESSION D2: Mapping, Charting, Survey and Geophysical Navigation** *Cypress 1-3*  
Chair: Dr. Lee Ott  
Co-Chair: Sunil Bisnath

5:30-8:00 **Opening Reception** *Regency Ballroom/Exhibit Area*  
(Free Beer and Snacks)

| WEDNESDAY, APRIL 28 |  | LOCATION                             |
|---------------------|--|--------------------------------------|
| 7:00-8:15           | <b>Speakers' Breakfast</b>   | <i>Windjammer 1-2</i>                |
| 7:30-4:00           | <b>Registration</b>  | <i>Regency Ballroom Foyer</i>        |
| 8:30-11:45          | <b>SESSION A3: MEMS Manufacturing Technology (Workshop)</b><br>Chair: Brian Norling<br>Co-Chair: Brian Lovitt                                | <i>Regency 4-6</i>                   |
|                     | <b>SESSION B3: Inertial Navigation Applications for Space, Commercial and Military Systems</b><br>Chair: Bob Blizzard<br>Co-Chair: Brian Fly | <i>Spyglass 1-2</i>                  |
|                     | <b>SESSION C3: National Airspace</b><br>Chair: Dr. Sam Pullen<br>Co-Chair: Demoz Gebre-Egziabher   | <i>Big Sur 1-3</i>                   |
|                     | <b>SESSION D3: Homeland Security Applications</b><br>Chair: Dr. Ilir Progrid   | <i>Cypress 1-3</i>                   |
| 9:00-10:00          | <b>Spouses' Reception</b>  | <i>Windjammer 1-2</i>                |
| 10:00-4:00          | <b>Exhibits Open</b>   | <i>Regency Ballroom</i>              |
| 12:00-1:30          | <b>Lunch Break</b>   | <i>Attendees' Choice</i>             |
| 1:45-5:00           | <b>SESSION B4: Novel Applications Enabled by Emerging Sensor Technology</b><br>Chair: Dave Borgersen   | <i>Spyglass 1-2</i>                  |
|                     | <b>SESSION C4: Atmospheric Errors and Modeling</b><br>Chair: Dr. Mikel M. Miller<br>Co-Chair: Dr. Y.T. Jade Morton                           | <i>Big Sur 1-3</i>                   |
|                     | <b>SESSION D4: GPS Modernization (Panel Session)</b><br>Moderator: Lt. Bryan Titus<br>Co-Moderator: Ken Hudnut                               | <i>Regency 4-6</i>                   |
| 1:45-8:30           | <b>Posterboard Session</b><br>Chair: Dr. Nicholas Nicholas   | <i>Regency Ballroom/Exhibit Area</i> |
| 6:00-8:30           | <b>Reception</b><br>(Complimentary Buffet)   | <i>Regency Ballroom/Exhibit Area</i> |

| THURSDAY, APRIL 29 |  | LOCATION                      |
|--------------------|--|-------------------------------|
| 7:00-8:15          | <b>Speaker's Breakfast</b>   | <i>Windjammer 1-2</i>         |
| 7:30 -4:00         | <b>Registration</b>  | <i>Regency Ballroom Foyer</i> |
| 8:00-5:00          | <b>AESS Board of Governors</b>   | <i>Oak Tree 1-3</i>           |
| 8:00-5:00          | <b>Gyro and Accelerometer Panel</b>  | <i>Windjammer 3-4</i>         |
| 8:30-11:45         | <b>SESSION A5: Inertial Sensor Test and Evaluation</b><br>Moderator: Dean Wiberg   | <i>Spyglass 1-2</i>           |
|                    | <b>SESSION B5: Integrated Navigation for Precision and Non-Precision Landing Approaches</b><br>Chair: Glen Colby             | <i>Big Sur 1-3</i>            |
|                    | <b>SESSION C5: Receiver and Antenna Technology</b><br>Chair: Anthony Abbott<br>Co-Chair: Allen Morrison                      | <i>Regency 4-6</i>            |
|                    | <b>SESSION D5: Indoor Navigation</b><br>Chair: Jean-Pierre Barboux   | <i>Cypress 1-3</i>            |
| 9:00-10:00         | <b>Spouses' Reception</b>  | <i>Windjammer 1-2</i>         |
| 10:00-1:00         | <b>Exhibits Open</b>   | <i>Regency Ballroom</i>       |
| 12:00-1:30         | <b>Awards Luncheon</b>   | <i>Monterey Ballroom</i>      |
| 1:45 - 5:00        | <b>SESSION A6: Advanced Inertial Sensing Technology</b><br>Chair: J.C. Ha  | <i>Big Sur 1-3</i>            |
|                    | <b>SESSION B6: Inertial Navigation in the Unmanned Vehicle Marketplace</b><br>Chair: Tom Black                               | <i>Spyglass 1-2</i>           |
|                    | <b>SESSION C6: The Future of Aerospace: Progress, Safety and Efficiency</b><br>Chair: Dennis Akos<br>Co-Chair: Knute Berstis | <i>Regency 4-6</i>            |
|                    | <b>SESSION D6: Advanced GPS Technology</b><br>Chair: Clyde Edgar<br>Co-Chair: Don Latterman                                  | <i>Cypress 1-3</i>            |

FRIDAY, APRIL 30

LOCATION

8:00-5:00 Gyro and Accelerometer Panel

Windjammer 3-4

*D.S.S. regulations suggest that attendees representing Department of Defense activities be advised that Foreign Nationals will be attending this meeting.*

## Exhibits of the Latest Equipment and Services

For additional information contact:

Larry Cortland

Phone: 909-693-0877

31456 Corte Sonora

Fax: 801-881-1174

Temecula, CA 92592

E-mail: lcortland@juno.com

The following organizations have already reserved exhibit space:

- Acutronics
- BAE Systems
- CAST Navigation
- Colibrys SA
- Conventor
- Crossbow
- GPS Test Center of Expertise (COE)
  - AF 746th Test Squadron (CIGTF)
  - SPAWAR Systems Center San Diego
  - Army Electronics Proving Ground
  - Naval Air Weapons Center
  - Naval Research Laboratory
  - Army CECOM
  - Army Yuma Proving Grounds
- GPS World
- Honeywell
- Ideal Aeromsmith Inc.
- IXSEA OCEANO
- KVH Industries
- L-3 Interstate Electronics
- Northrop Grumman Navigation Systems
- NovAtel
- Rockwell Collins
- Silicon Sensing Systems
- SPAWAR Systems Center, San Diego
- Spirent Federal Systems Inc.

# PLANS2004

TECHNICAL PROGRAM: SCHEDULE AT-A-GLANCE

|   | <b>TUESDAY<br/>APRIL 27</b> | <b>WEDNESDAY<br/>APRIL 28</b> | <b>THURSDAY<br/>APRIL 29</b> |
|---|-----------------------------|-------------------------------|------------------------------|
| <b>Speakers' Breakfast*</b>                   | 7:00-8:15                   | 7:00-8:15                     | 7:00-8:15                    |
| <b>Registration</b>                           | 7:30-4:00                   | 7:30-4:00                     | 7:30-4:00                    |
| <b>Morning Technical Sessions</b>             | 8:30-11:45                  | 8:30-11:45                    | 8:30-11:45                   |
| <b>Technical Exhibits</b>                     | 10:00-4:00                  | 10:00-4:00                    | 10:00-1:00                   |
| <b>Luncheon</b>                               | 12:00-1:30                  | —                             | 12:00-1:30                   |
| <b>Afternoon Technical Sessions</b>           | 1:45-5:00                   | 1:45-5:00                     | 1:45-5:00                    |
| <b>Receptions</b> (in Exhibits Area)          | 5:30-8:00                   | 6:00-8:30                     | —                            |
| <b>Posterboard Session</b> (in Exhibits Area) | —                           | 1:45-8:30                     | —                            |

\* The Speakers' Breakfast is by invitation only. All other events are included with your registration.

There are parallel sessions throughout the conference. You are welcome to move between rooms to hear your choice of papers. Presenters are nominally given 30 minutes each, including time for questions.

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IEEE Liaison—Dr. James Huddle

## MEMS Inertial Sensor Technology

Chair: David Arch, Honeywell AES

**LOCATION: Spyglass 1-2**

**8:30-11:45**

1. **High G MEMS Accelerometer for Compact Kinetic Energy Missile**, Robert Stewart, Northrop Grumman Corporation, Dave Tarrant and Paul Couch, US Army Aviation and Missile Command
2. **MEMS Gyroscopes and Accelerometers—A Review of Current Designs and Fabrication Approaches**, Marc Weinberg and Tony Kourepenis, Draper Labs
3. **Progress in Integrated Gyroscopes**, John Geen, Analog Devices Inc.
4. **Performance of a Silicon-On-Insulator MEMS Gyroscope with Digital Force Feedback**, Tracy Hudson, Sherrie Burgett, Paul Ruffin and Paul Ashley, U.S. Army RDECOM, Michael Kranz and Jim McKee, Morgan Research Corporation, Milan Buncick, Aegis Technologies Group
5. **High Angular Rate and High G Effects in the MEMS Gyro**, Mark Weber and Mark Bellrichard, Honeywell, Chris Kennedy, Coventor Inc.
6. **Modeling Dynamic Behavior of MEMS Parallel Plate Capacitors**, Professor Emmanuel Saucedo-Flores

## Integration of Inertial Systems with Satellite Navigation Systems

Chair: Phil Bruner, Northrop Grumman NSD

Co-Chair: Marina Ruggieri, University of Roma

**LOCATION: Regency 4-6**

**8:30-11:45**

1. **Measurement Bias Rejection in Multisensor Systems and its Application to SDINS**, Jaewon Seo, Jange Gye Lee and Chan Gook Park, Seoul National University
2. **An Experiment of 2-D and 3-D GPS/INS Configurations for Land Vehicle Applications**, Bishnu Phuyal, Navigation Technologies Corp.
3. **Sensitivity of an Ultra Tightly Coupled GPS-Inertial System to Variations in IMU and Oscillator Quality**, Lawrence Vallot and Christopher Lund, Honeywell Aerospace Electronic Systems Laboratories
4. **HMS SCOTT Ring Laser Gyro Navigator Integration**, Martin Leblang and Steven Dunham, SPAWAR Systems Center, San Diego, Frederick Pappalardi, Technical Documentation Inc.
5. **The Development and Test of Two Ultra-Tightly Coupled GPS/INS Integrations**, Harold Klotz, The Boeing Company, Lawrence Vallot, Honeywell Aerospace Electronic Systems Laboratories, Conrad Mueller, Honeywell International, John Weger, Rockwell Collins, B. Treadway, Eglin Air Force Base
6. **GPS/INS Integration Module with Gyro Free**, Huan Lin, Department of AE, National Huwei Institute of Technology

### PUBLISH ONLY:

**An Improved GPS/INS Integrated Navigation System**, Bin Wang and Jian Wang, UK China Joint ITS Center, Beijing Jiaotong University, Baigen Cai, School of Electronics and Information Engineering, Beijing Jiaotong University, Jianping Wu, Transportation Research Group, University of Southampton

**An Embedded GPS/INS Navigation System for Vehicles**, Jian Wang and Bin Wang, UK China Joint ITS Center, Beijing Jiaotong University, Baigen Cai, School of Electronics and Information Engineering, Beijing Jiaotong University, Jianping Wu, Transportation Research Group, University of Southampton

## GPS Receiver Augmentations

Chair: Karen Van Dyke, Department of Transportation (DOT)

**LOCATION:** Cypress 1-3

**8:30-11:45**

1. **Real Time Dual Frequency Software Receiver**, Suman Ganguly, Center for Remote Sensing Inc.
2. **A Navigation System Fusing Visual Information and a Digital Terrain Map**, Hector Rotstein, Dept. of Aerospace, Engineering and Mechanics, University of Minnesota, Minneapolis, Ehud Rivlin and Ronen Lerner, Dept. of Computer Science, Technion.
3. **GPS Augmentation Using Quasi-Zenith Satellite System in Japan**, Falin Wu, Nobuaki Kubo and Akio Yasuda, Tokyo University of Marine Science and Technology
4. **A High Resolution Model for the Aeronautical Multipath Navigation Channel**, Fernando Perez Fontan and Maria Jesus Martin, University of Vigo, Alexander Steingass and Andreas Lehner, German Aerospace Center DLR, Erwin Kubista, Joanneum Research
5. **Military Civilian Mixed-Mode GPS Receiver**, Andrzej Peczkalski and Steven Sampson, Air Force Research Laboratory, Space Vehicles Directorate, Jeff Kriz, Honeywell, Stephen Carlson, Rockwell Collins Inc.

**PUBLISH ONLY:**

**GPSOne: A New Solution to Vehicle Navigation**, Kedong Wang, Lei Yan and Hui Wen, Peking University

## Navigation Research in Academia

Chair: Mr. Neil Weinman, NRDC, Warminster, PA

Co-Chair: Mr. Joesph Gentile, U.S. Navy

**LOCATION:** Big Sur 1-3

**8:30-11:45**

1. **Aided Integer Ambiguity Resolution Algorithm and its Implementation**, Jingrong Cheng, Professor Jay Farrell, Yu Lu
2. **An Algorithm to Compute the Generalized Normal Radius of Curvature on an Ellipsoid**, David Hsu, Northrop Grumman NSD
3. **Measurement for Mental Workload of Bridge Team at Leaving/Entering Port**, Koji Murai and Yuji Hayashi, Kobe University, Tadatsugi Okazaki, National Maritime Research Institute
4. **A Superconducting Gravity Gradiometer for Inertial Navigation**, Martin Moody and Ho Jung Paik, University of Maryland
5. **Positioning Performance Effects of AM Broadcast Signal Propagation Irregularity**, Timothy Hall, MIT Lincoln Laboratory
6. **GPS Attitude Determination for a JPALS Testbed: Integer Initialization and Testing**, David De Lorenzo, Dennis Akos, Santiago Alban and Per Enge, Stanford University

**PUBLISH ONLY:**

**Data Map Characteristic Used in Aided Inertial Navigation**, Hao Feng, Beijing University of Posts and Telecommunications, Lei Yan, Peking University

## MEMS Inertial Measurement Unit Technology

Chair: Marvin Silver, BAE Systems

LOCATION: Big Sur 1-3

1:45–5:00

1. **A Miniature, Gun-Hard MEMS IMU for Guided Projectiles, Rockets and Missiles**, Stuart Cooper, Ian Scaysbrook and Eric Whitley, BAE Systems
2. **Forward Inertial Sensor Package (ISP) for the Compact Kinetic Energy Missile (CKEM)**, Dave Tarrant and Paul Couch, US Army Aviation and Missile Command
3. **Honeywell MEMS Inertial Technology & Product Status**, Joel Hanse, Honeywell
4. **Honeywell Gun-Hard Inertial Measurement Unit (IMU) Development**, Drew Karnick, Gary Ballas, Mike Secord, Lisa Koland, Todd Braman and Eric Abbott, Honeywell, Tony Kourepenis, Draper Labs
5. **A MEMS-Integrated IMU**, Donato Cardarelli, MilliSensor Systems and Actuators Inc., Michelle White, Air Force Research Laboratory, Munitions Directorate
6. **Development of Packaging for MEMS Inertial Sensors**, Ryszard Pryputniewicz and Cosme Furlong, Worcester Polytechnic Institute, Thomas Marinis and Joseph Soucy, Draper Laboratory

## Advanced Integrated Navigation Technology

Chair: Don Anttila, Sikorsky

LOCATION: Spyglass 1-2

1:45-5:00

1. **A New Kinematic Theorem for Rotational Motion**, Kevin Blankinship, Boeing
2. **INS/GPS Data Fusion Technique Utilizing Radial Basis Functions Neural Networks**, Aboelmagd Nouredin and Rashad Sharaf, Royal Military College of Canada, Ahmed Osman and Naser El-Sheimy, The University of Calgary
3. **An Unscented Kalman Filter for In-Motion Alignment of Low Cost IMUs**, Eun-Hwan Shin and Naser El-Sheimy, The University of Calgary
4. **Mixed H2/H Infinite Filtering for GPS/INS Navigation**, Dah-Jing Jwo and Rong-Jyh Chen, National Taiwan Ocean University

### PUBLISH ONLY:

**Error Analysis of Strapdown Inertial Navigation Using Dual Quaternion Algebra**, Yuanxin Wu, Meiping Wu, Prof. Xiaoping Hu and Dr. Dewen Hu, National University of Defense Technology

**Geo-Information Entropy for Navigation and Positioning System**, Ming Yan, Lei Yan and Kedong Wang, Peking University

**A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit**, Anthony Kim and Farid Golnaraghi, University of Waterloo

## GPS, GALILEO, and GLONASS

Chair: John Clark, The Aerospace Corporation

Co-Chair: Larry D. Vittorini, Genesis Systems Engineering

**LOCATION: Regency 4-6**

**1:45–5:00**

- 1. Flexible Navigation Payload for Future GPS III**, Kristine Maine, Phil Dafesh, Grace Wang and Victor Lin, The Aerospace Corporation
- 2. Vehicular Remote Tolling Services Using EGNOS**, Mirko Antonini and Marina Ruggieri, University of Rome, Ramjee Prasad, Aalborg University, Umberto Guida, Alenia Spazio and Gian Franco Corini, Next S.P.A.
- 3. Lessons Learned Through the Implementation of Space-Time Adaptive Processing Algorithms for GPS Reception in Jammed Environments**, Keith McDonald, Ram Raghavan and Ron Fante, The MITRE Corporation
- 4. GPS III System Operations Concepts**, Jeff Crum, Infinity Systems, Ollie Luba, Larry Boyd and Art Gower, Lockheed Martin
- 5. Validation of Novel Navigation Signal Structures for Future GNSS Systems**, Mike Quilan and Graeme Burden, Thales Research and Technology (UK) Ltd., Stephane Rollet, Thales Navigation SA, Riccardo De Gaudenzi, ESA, Steve Harding, QinetiQ
- 6. A GPS Bistatic Sonobuoy Localization System**, Harper Whitehouse, Linear Measurement Inc.

## Mapping, Charting, Survey and Geophysical Navigation

Chair: Dr. Lee Ott, Omnistar Inc.

Co-Chair: Sunil Bisnath, The University of Southern Mississippi

**LOCATION: Cypress 1-3**

**1:45–5:00**

- 1. Terrain Navigation with the Correlation Method**, Ingemar Nygren, FOI, Magnus Jansson, Royal Institute of Technology (KTH)
- 2. Geophysical Navigation Technology Capabilities and Future Applications**, Hugh Rice and Steve Kelmenson, Lockheed Martin Corporation
- 3. Initial Results From a Long Baseline, Kinematic, Differential GPS Carrier Phase Experiment in a Marine Environment**, Sunil Bisnath and David Wells, The University of Southern Mississippi, Marcelo Santos and Karen Cove, University of New Brunswick
- 4. Environmental Engineering Grade A Shock Tests**, Juanito Del Rosario, SPAWAR Systems Center, San Diego
- 5. Planning the Future of the WGS**, Scott True, National Imagery and Mapping Agency

### PUBLISH ONLY:

**Determination of the Disturbing Potential from GPS Measurements**, Mikhail Shugaev, Land Surveyor

## MEMS Manufacturing Technology (Workshop)

Chair: Brian Norling, MEMS Precision Technology

Co-Chair: Brian Lovitt, Raytheon

**LOCATION:** Regency 4-6

**8:30-11:45**

This workshop provides a hands-on opportunity for MEMS designers to interface with MEMS merchant foundry suppliers, MEMS equipment suppliers, MEMS packaging suppliers and MEMS design support services. The first half of the session will be a short general briefing from suppliers of MEMS technology and services. The second half of the session will involve multiple, simultaneous "round table" technology training/interface sessions. These round table sessions are designed to provide hands-on MEMS design information, process planning information, process capability information, facilities installation information, health & safety information, etc. The participants of the MEMS technology workshop will gain valuable knowledge for entering the MEMS technology arena or advancing the state-of-the-art of their emerging MEMS technology.

## Inertial Navigation Applications for Space, Commercial and Military Systems

Chair: Bob Blizzard, CAST Navigation LLC

Co-Chair: Brian Fly, Honeywell DSES-CD

**LOCATION:** Spyglass 1-2

**8:30-11:45**

- 1. GPS Align in Motion of Civilian Strapdown INS**, Doug Weed, Tom Ryno, Jim Broderick and Jeff Love, Honeywell
- 2. The NAV 100™ a New Paradigm in Small, High Accuracy, Inertial Navigation Systems**, Dwain Bostick and James Miletich, Honeywell International Inc.
- 3. Adaptive Filter for a Miniature MEMS-Based Attitude and Heading Reference System**, Mei Wang, Shanghai Jiaotong University, Yunchun Yang, NavCom Technology Inc., Mr. Ronald Hatch, Professor Yanhua Zhang
- 4. An Adaptive Kalman Filter for Integrated SINS/GPS System**, Qiuping Wu, Tsinghua University
- 5. Anti-Backlash Gear Substitution Device**, Henry Reinhardt and Zak Pishnov, Northrop Grumman
- 6. Tactical HIGH-Solution Separation Methods Applied to the War Fighter Environment**, Brian Fly and Jim Waid, Honeywell
- 7. Mathematical Model Of Missile Defence System**, Varadan S.V., Kalpana R., SASTRA

### PUBLISH ONLY:

**A Linearized Model for the Line of Sight Guidance Law**,  
Fethi Balkhouche, Tulane University

## National Airspace

Chair: Dr. Sam Pullen, Stanford University

Co-Chair: Demoz Gebre-Egziabher, University of Minnesota

**LOCATION: Big Sur 1-3**

**8:30-11:45**

1. **Orbit Ephemeris Monitors for Category I LAAS**, Livio Gratton and Boris Pervan, Illinois Institute of Technology, Sam Pullen, Stanford University
2. **Detect and Avoid Technology Demonstration**, John McCalmont, Air Force Research Laboratory, James Utt and Michael Deschenes, Defense Research Associates Inc.
3. **Paired Overbounding and Application to GPS Augmentation**, Jason Rife, Sam Pullen and Per Enge, Stanford University, Boris Pervan, Illinois Institute of Technology

*Other invited papers are in process.*

## Homeland Security Applications

Chair: Dr. Ilir Progri, California State Polytechnic University, Pomona

**LOCATION: Cypress 1-3**

**8:30-11:45**

1. **Ground Based 2D/3D Position Location System**, Ion Tomescu, Innovant Inc.
2. **Real-time Monitoring and Emergency Handling System for Dangerous Goods on the Rail Infrastructure**, Giovanni Esposito, IT TELECOM SpA, Enrico Benvenuto, TSF SpA
3. **Maximum Likelihood Time of Arrival Estimation for Real-Time Physical Location Tracking of 802.11a/g Mobile Stations in Indoor Environments**, Peter Voltz, California State Polytechnic University, David Hernandez, Symbol Technologies Inc.
4. **LOCO GPSI: Preserve the GPS Advantage for Defense and Security**, Kenneth Simonsen, SPAWAR Systems Center, San Diego, Mark Suycott, SAIC, Robert Crumplar, Whitney, Bradley & Brown Inc., John Wohlfiel, FALON Inc.

*Other invited papers are in process.*

### PUBLISH ONLY:

**In-Building Intruder Detection for WLAN Access**, Ahmad Hatami, Worcester Polytechnic Institute

**ISAR Technique With Complementary Phase Code Modulated Signals**, Andon Lazarov, Bourgas University, Chavdar Minchev, Military University

## Novel Applications Enabled by Emerging Sensor Technology

Chair: Dave Borgersen, Boeing

LOCATION: Spyglass 1-2

1:45-5:00

- 1. Accurate Synchronization Using a Full Duplex DSSS Channel**, Dr. Ilir Progri, California State Polytechnic University, William Michalson and Arkadiy Deych, Worcester Polytechnic Institute
- 2. The Development of a SAR Dedicated Navigation System: From Scratch to the First Flight**, José Lorga, Technical University of Delft/TNO-FEL
- 3. Adaptive Kalman Filtering Algorithms for Integrating GPS and Low Cost INS**, Christopher Hide, Terry Moore and Martin Smith, IESSG, University of Nottingham
- 4. A Vector-Based Gyro-Free Inertial Navigation System by Integrating Existing Accelerometer Network in an Automobile**, Ken Peng and Farid Golnaraghi, University of Waterloo
- 5. Low Cost Sensors Data for Parameters and Trajectory Determination**, Bishnu Phuyal, Navigation Technologies Corp.
- 6. A Novel Adaptive Federal Kalman Filter and Its Application to Navigation**, Professor Yanhua Zhang

## Atmospheric Errors and Modeling

Chair: Dr. Mikel M. Miller, Wright-Patterson AFB, USAF

Co-Chair: Dr. Y.T. Jade Morton, Miami University, Ohio

LOCATION: Big Sur 1-3

1:45-5:00

- 1. Ionospheric Data Assimilation Methods for Geodetic Applications of the Global Positioning System (GPS)**, Douglas Robertson and Gerald Mader, NGS/NOS/NOAA, Paul Spencer, CIRES, University of Colorado
- 2. Ionospheric Corrections from Operational Assimilation and Forecast System**, Boris Khattatov, Michael Murphy, Brian Cruikshank and Jason Boisvert, Fusion Numerics Inc.
- 3. Ionosphere Modeling Using the NGS CORS Network**, Dru Smith, Federal Government
- 4. Application of a Neutral Network Model to the GPS Ionosphere Error Correction**, Christopher Mantz, Qihou Zhou and Yu Morton, Miami University, Ohio
- 5. Assimilative Modeling of Low-Latitude Ionosphere**, Xiaqing Pi, George Hajj, Brian Wilson and Anthony Mannucci, Jet Propulsion Laboratory, Chunming Wang and Gary Rosen, University of Southern California

## GPS Modernization (Panel Session)

Moderator: Lt. Bryan Titus, NAVSTAR GPS JPO

Co-Moderator: Ken Hudnut, USGS

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**LOCATION: Regency 4-6**

**1:45-5:00**

The GPS JPO is hosting a panel discussion to update the navigation community on GPS Modernization, GPS III and the possibility of an additional L1 civil signal. Discussion topics will center around GNSS compatibility and interoperability in the Galileo and GPS III timeframe.

## Posterboard Session

Chair: Dr. Nicholas Nicholas, Penn State

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**LOCATION: Regency Ballroom/Exhibit Area**

**1:45-8:30**

- 1. Modeling of Tilting System of Vehicle System in Railway**, Yong Song, Korea Railroad Research Institute
- 2. Method for Mapping of the Free Air Anomaly by Neural Interpolation: Theory (a)**, Rouxel Didier and Marie-Francoise Lalancette, SHOM, Olivier Sarzeau, ECTIA, David Wolyniec, ADREG
- 3. Method for Mapping of the Free Air Anomaly by Neural Interpolation: Application (b)**, Marie-Francoise Lalancette and Rouxel Didier, SHOM, Olivier Sarzeau, ECTIA, David Wolyniec, ADREG
- 4. Information Fusion in a Multi-Frequency GPS Receiver**, Jamila Kacemi, Serge Reboul and Mohammed Benjelloun, Laboratoire d'Analyse des systèmes du Littoral

## Inertial Sensor Test and Evaluation

Chair: Dean Wiberg, JPL, California Institute of Technology

LOCATION: Spyglass 1-2

8:30-11:45

1. **Proposed IEEE Inertial System Terminology Standard and Existing Inertial Sensor Standards**, Randall K. Curey, Northrop Grumman Navigation Systems Division, Michael E. Ash, Draper Laboratory, Leroy Thielman, Honeywell International Inc. Cleon H. Barker, 746 Test Squadron, Holloman Air Force Base
2. **Analysis of Inertial Navigation System Errors from Van Testing Using an Optimal Kalman Filter/Smoother**, Te-chang Li, Northrop Grumman
3. **Application of Wavelet Packet Analysis in the De-Noising of MEMS Vibrating Gyro**, Wang Chang-Hong and Huang Xu, Harbin Institute of Technology
4. **Development of a Gyro Test System at Samsung Advanced Institute of Technology**, Vladimir Skvortzov, Youn Chul Cho, Byeung-Leul Lee and Cimoo Song, Samsung Advanced Institute of Technology (SAIT)
5. **Characterization of Vibrating Beam Sensors During Shock and Vibration**, Lisa McMahan and Bruce Castleman, Honeywell Space Systems
6. **Modeling and Measurements of MEMS Gyroscopes**, Ryszard Pryputniewicz, Worcester Polytechnic Institute, Xiangguang Tan and Andrzej Przekwas, CFD Research Corporation

### PUBLISH ONLY:

**Experiment Research on Counter-Balanced Dither Mechanism for Ring Laser Gyroscope**, Kedong Wang and Lei Yan, Peking University, Oitai Gu, Tsinghua University

**Initial Calibration of an Inertial Measurement Unit Using an Optical Position Tracking System**, Anthony Kim and Farid Golnaraghi, University of Waterloo

## Integrated Navigation for Precision and Non-Precision Landing Approaches

Chair: Glen Colby, U.S. Navy, Naval Air Systems Command

LOCATION: Big Sur 1-3

8:30-11:45

1. **Hybrid Integrity for Precision Guidance and Landing**, Kenneth Gold, NAVSYS Corporation
2. **Robust Airborne Navigation Algorithms for SRGPS**, Moon-Beom Heo and Boris Pervan, Illinois Institute of Technology, Sam Pullen, Jennifer Gautier and Per Enge, Stanford University, Demoz Gebre-Egziabher, University of Minnesota, Twin Cities
3. **Shipboard GPS Antenna Motion Test Results For JPALS**, Ray Breslau and John Clark, Titan Systems

*Other invited papers are in process.*

## Receiver and Antenna Technology

Chair: Anthony Abbott, Aerospace Corporation  
Co-Chair: Allen Morrison, SAIC

**LOCATION:** Regency 4-6

**8:30-11:45**

- 1. Consecutive Mean Excision (CME) Algorithms in Narrowband or Short Time Interference Mitigation**, Harri Saarnisaar, Centre for Wireless Communications
- 2. FaSTAPTM: A Scalable Anti-Jam Architecture for GPS**, Chris Reed, Ivan Johnston and Bob Van Wechel, L-3 Communications/Interstate Electronics Corporation
- 3. Unaided Acquisition of Weak GPS Signals Using Circular Correlation or Double Block Zero Padding**, Nesereen Ziedan and James Garrison, Purdue University
- 4. A Testbed for Frequency Domain GPS Acquisition and Receiver Simulation**, Brian Schipper, Honeywell
- 5. Precise Phase Calibration of a Controlled Reception Pattern GPS Antenna for JPALS**, Ung Suok Kim, Dennis Akos, Per Enge, Jennifer Gautier and David De Lorenzo, Stanford University, John Orr, Worcester Polytechnic Institute
- 6. Multipath Mitigation in the Frequency Domain**, Yujie Zhang and Chris Bartone, Ohio University

**PUBLISH ONLY:**

**Fast Matched Filter in Time Domain**, David Akopian and Sos Aghaian, University of Texas at San Antonio

## Indoor Navigation

Chair: Jean-Pierre Barbou, THALES Navigation

**LOCATION:** Cypress 1-3

**8:30-11:45**

- 1. Automated Geo-Location Network for Use in GPS-Degraded Environments**, Danny Carter, US Army RDE Command, Mr. Aaron Brown
- 2. An Investigation of an OFDM/CDMA/FDMA Indoor Geolocation System**, Dr. Ilir Progni, California State Polytechnic University, William Michalson, Worcester Polytechnic Institute
- 3. A Multipath-Mitigating Indoor Carrier-Phase Position Tracking System**, Enrico Haemmerle, The University of Auckland, Paul Winton, Paric Limited
- 4. A High Resolution Model for the Satellite-to-Indoor Channel**, Fernando Perez Fontan and Belen Sanmartin, University of Vigo, Alexander Steingass and Andreas Lehner, German Aerospace Center (DLR), Erwin Kubista, Joanneum Research
- 5. Project BlueStar—Privacy Centric Location Awareness**, Aaron Quigley, Smart Internet Technology CRC, Australia
- 6. Indoor Personnel Tracking Using Infrared Beam Scanning**, Dr. Udaya Madawala

**PUBLISH ONLY:**

**Cooperative Location Model Under the Nearest-Neighbor Criterion**, Yi Xiao, He You and Guan Xin, Naval Aeronautical Engineering Institute

## Advanced Inertial Sensing Technology

Chair: J.C. Ha, Wright Patterson AFB, USAF

**LOCATION:** Big Sur 1-3

**1:45-5:00**

- 1. Isolated Post Resonator Mesogyroscope**, Anthony Challoner, Boeing
- 2. H-Inf Controller Design for MEMS Gyroscope and Its Performance Test**, Woon-Tahk Sung and Jang Gye Lee, Seoul National University, Taesam Kang, Konkuk University
- 3. A High-Performance, Magnetically-Suspended, MEMS-Spinning Wheel Gyro**, Charles Dauwalter, Milli Sensor Systems and Actuators Inc., Joung Ha, Air Force Research Laboratory
- 4. Market Opportunities for Advanced MEMS Accelerometers and Overview of Actual Capabilities vs. Required Specifications**, Jean-Michel Stauffer, Colibrys SA

*Other invited papers are in process.*

## Inertial Navigation in the Unmanned Vehicle Marketplace

Chair: Tom Black, Wright-Patterson AFB, USAF

**LOCATION:** Spyglass 1-2

**1:45-5:00**

- 1. Some Design Aspects of Military Mobile Local Positioning Systems**, Harri Saamisaari, Centre for Wireless Communications
- 2. Global Hawk-A Performance Comparison Between a SCAT-1 DGPS System and the Omnistar DGPS System**, Greg Loegering, Northrop Grumman
- 3. The Experimental Study of GPS/INS/DVL for AUV**, Lin Zhao, Harbin Engineering University, Mr. Wei Gao
- 4. Countermeasures Against Enemy C2 Capabilities in a Low Altitude Battlespace**, Paul Wang, ITT Industries
- 5. A MEMS Guidance, Navigation and Control System for the Organic Air Vehicle**, Wayne Soehren and Jason O'Keane, Honeywell
- 6. Aspects of Pure and Satellite-Aided Inertial Navigation for Gun-Launched Munitions**, Thomas Kuhn, Diehl Munitionssysteme GmbH

### PUBLISH ONLY:

**Filter Algorithm for Visual Tracking of Maneuvering Target**, Feili Hou, Graduate School of the Chinese Academy of Sciences, Feng Zhu, Robotics Lab, Shenyang Institute of Automation, Chinese Academy of Sciences

## The Future of Aerospace: Progress, Safety and Efficiency

Chair: Dennis Akos, Stanford University

Co-Chair: Knute Berstis, NOAA

LOCATION: Regency 4-6

1:45-5:00

1. **A Software Approach to Access Ultra-Wide Band Interference on GPS Receivers**, Yu Morton, Qihou Zhou and Marcus French, Miami University, James Tsui, David Lin and Mikel Miller, AFRL
2. **Intersystem and Intrasystem Interference with Signal Imperfections**, John Betz, MITRE, Bryan Titus, US Air Force, GPS Joint Program Office
3. **Noise Floor Measurements in the GPS Band**, Juyong Do, Dennis Akos and Per Enge, Stanford University
4. **Assessing Worldwide Radio Frequency Interference from Ground Nav aids to GPS L5**, Taehwan Kim, MITRE
5. **Unfinished Business: Glaring Absences from the List of Improvements**, James Farrell, VIGIL Inc.
6. **GNSS Implementation and Benefits: Focus on WAAS and Spectrum Issues**, Sally Frodge, FAA AND-703

## Advanced GPS Technology

Chair: Clyde Edgar, Aerospace Corporation

Co-Chair: Don Latterman, SAIC

LOCATION: Cypress 1-3

1:45-5:00

1. **Development of Centimeter-Level GPS Kinematic Relative Positioning Software**, Wang Min, Master Candidate
2. **An Algorithm for Instantaneous Position Estimation of GPS Satellites for GAGAN SBAS Program of India**, Rajneesh Gupta and A. Ganeshan, ISRO
3. **Fine Delay Estimation Technique Under Multipath**, Zhen Zhang, Erry Gunawan and Choi Look Law, Nanyang Technological University
4. **Success Rate Determination of GPS Ambiguity Resolution Using Syntactic Data**, Ramin Kiamehr, Ph.D. Student
5. **Requirements for Future Aerospace**, Robert Crow, AirNav Inc.
6. **Distributed Positioning, Navigation and Timing**, Brenda Gillcrist, Robert Castello and Jaime Radulovich, SPAWAR Systems Center San Diego, Carm Finocchiaro, Navmar

### PUBLISH ONLY:

**GDOP Results for GPS All-In-View Positioning and Four Optimum Satellites**, Yong Yang, Doctoral Student, Lian-juan Miao, Professor

# PLANS2004

TUTORIAL PROGRAM: SCHEDULE AT-A-GLANCE

## MONDAY, APRIL 26 8:30A-12:00P

- MEMS Inertial Technology:  
A Short Course
- Navigation and Man
- Fundamental Issues Affecting  
GPS/INS Integrations
- Navigation System Test  
and Evaluation

## MONDAY, APRIL 26 1:30P-5:00P

- GPS Protection Tool Box:  
Picking the Right Technology for  
Interference Suppression
- It's About Time
- Low Cost Inertial Finally!  
From MEMS to NAV Systems

## MEMS Inertial Technology: A Short Course

Instructor: Ralph Hopkins

**LOCATION:** Cypress 1-2

**8:30-12:00**

**Syllabus:** This course will present an overview of how the micro-electro-mechanical systems (MEMS) technology is revolutionizing the inertial guidance navigation and control (GN&C) industry. Suitable for those new to the MEMS and inertial disciplines, this course will also be of interest to more experienced practitioners as it will cover an overview of basic inertial sensing principles, detailed discussion of MEMS gyroscope and accelerometer designs, and MEMS fabrication and sensor packaging technologies. Current industry trends will be discussed along with examples of MEMS inertial technology in the commercial, military and space sectors, including advanced systems which integrate inertial MEMS with GPS. This course will be of interest to R&D, systems and manufacturing engineers, managers and executives, and will conclude with a discussion on the future direction of MEMS technology.

### Course Outline:

- Overview of Inertial Sensing
- Inertial MEMS Development
- MEMS Accelerometers– Theory and Design
- MEMS Accelerometers– Examples and Performance Data
- MEMS Gyroscopes– Theory and Design
- MEMS Gyroscopes– Examples and Performance Data
- MEMS Fabrication Processes and Packaging
- System Applications and Requirements
- Developments in MEMS INS/GPS
- Future Direction of MEMS Technology

**Biography:** Ralph Hopkins is a Principal Member of the Technical Staff at Draper Laboratory in Cambridge, MA where he is responsible for the design and development of inertial instruments and sensors. Currently Ralph is Technical Director of the Silicon Oscillating Accelerometer development program, a high performance silicon MEMS vibrating beam accelerometer targeted for strategic grade applications. Ralph has also been involved in the development of navigation and tactical grade MEMS gyroscopes and accelerometers, and high performance electro-mechanical inertial sensors such as floated instruments and Dynamically Tuned Gyros. He holds four patents and has authored several papers on inertial instruments and inertial technology. Ralph holds a BS and ME in Mechanical Engineering from Rensselaer Polytechnic Institute, an ME in Engineering Mechanics from Columbia University and an MS in Engineering Management from The Gordon Institute of Tufts University. He is a current member of the AIAA Guidance Navigation and Control technical committee.

## Navigation and Man

Instructor: Marvin May

**LOCATION:** Spyglass 1

**8:30-12:00**

**Syllabus:** This informative half day course emphasizes the historical development of navigation systems. It spans modern civilization from the earliest celestial navigation techniques to the latest global satellite navigation system events. The life and times of principal contributors to the development of navigation theory and hardware are discussed. The course addresses the impact of navigation in today's civil and military environment and projects them to future applications.

**Biography:** Marvin B. May is the Chief Navigation Technologist at ARL Penn State's Navigation Research and Development Center in Warminster, PA. He also manages their Navigation Education Program. He has a BSEE from City College of NY and a Masters Degree from New York University, doctoral courses at Polytechnic Institute and is a Professional Engineer. He is an adjunct professor at several universities and teaches Master's Degree navigation courses for the Penn State Great Valley Graduate Center. He is a recognized navigation specialist with expertise in GPS, inertial and geophysical navigation. During his Navy career he has worked at the Navy's Navigation Laboratory of the Naval Command, Control and Ocean Surveillance Center (NCCOSC), and his experience includes eight years as chief analyst for GPS responsible for satellite navigation systems analysis, laboratory testing and integration issues. May has served as Chairman of the Greater Philadelphia Chapter and is the national Marine Navigation representative and Historian of the Institute of Navigation.

## Fundamental Issues Affecting GPS/INS Integrations

Instructor: G. Jeffrey Geier

**LOCATION:** Big Sur 1-2

**8:30-12:00**

**Syllabus:** The integration of GPS with an Inertial Navigation System improves the quality and integrity of each navigation system: use of GPS permits calibration of inertial instrument biases, and the INS can be used to improve the tracking and reacquisition performance of the GPS receiver. This course will first review the basics of Kalman filtering, and categorize approaches applied to GPS/INS integration. Kalman filter modeling issues will be examined; GPS receiver assistance, in the form of both acquisition and tracking aid, will also be reviewed. Case studies of low cost aircraft and automotive integrations will be used to provide practical applications of the theoretical discussions.

### Course Outline:

#### Introduction to GPS/INS Integration

- Motivation: The Integration Synergy
- Review of Kalman Filter Basics
- Categorization of Approaches

#### Kalman Filter Design Issues

- INS Error Modeling
- GPS Error Modeling

#### GPS Receiver Assistance

- Acquisition
- Tracking

**Biography:** Mr. G. Jeffrey Geier is a Distinguished Member of the Technical Staff with Motorola's Personal Communications Sector Research Lab, involved in GPS receiver technology development for Motorola cellular phones. He has designed the integrity monitoring algorithms used in Motorola's timing and aviation GPS products, and has led efforts to integrate Motorola's core GPS receiver with automotive sensors for emergency messaging applications. He has also made improvements to algorithms for signal acquisition and tracking for a spaceborne GPS receiver. Previously at Trimble Navigation, Mr. Geier was an engineering manager working on integrating GPS with low cost dead reckoning sensors for vehicle tracking applications, and improving the accuracy and integrity of Trimble's real-time differential GPS positioning systems.

Prior to working at Trimble, Mr. Geier spent more than 20 years in GPS navigation and signal processing, inertial navigation systems, and aircraft and spacecraft control system design. He received his B.S. and M.S. degrees in Aeronautics and Astronautics at M.I.T., and is a member of IEEE and ION. Mr. Geier is a former instructor for NavTech Seminars, teaching "Integration of GPS with Inertial Navigation Systems" for 10 years. He is a co-author of the textbook "Understanding GPS: Principles and Applications", and holds twenty two navigation related patents.

## Navigation System Test and Evaluation

Instructor: Athanison Monroe

**LOCATION:** Spyglass 2

**8:30-12:00**

**Syllabus:** The validation of performance requirements for the acquisition and integration of navigation systems and user equipment has been successfully assured over the years through test and evaluation. As acquisition philosophy has changed, so has test and evaluation philosophy. Test and evaluation philosophy has progressed over the years in that it now promotes a closer link between the artificial and the live test environments. This course will address the importance of test and evaluation as it relates to navigation systems and user equipment, and will take a glimpse into the future of test and evaluation. Adhering to sound test and evaluation principals will help ensure successful integration of navigation systems and user equipment now and into the future. The concentration in this course will provide a good baseline for addressing test and evaluation concerns.

### Course Outline:

#### Introduction to Test and Evaluation

- Definition
- Philosophy
- Principals

#### Facets of Test and Evaluation

- Artificial Environment  
–*Modeling & Simulation and Laboratory*
- Live Environment  
–*Blue Water, Field, Flight and Van*
- Collaborative Environment  
–*Combination of Resources*

#### Importance of Test and Evaluation

- Risk Mitigation Tool
- Honest Broker
- Anomaly Investigation
- Lessons Learned

#### Future of Test and Evaluation

- Test Tool Development
- Test Methodologies
- Effective Measurements

**Biography:** Athanison Monroe is the head of the Navigation Systems Evaluation and Testing Branch for SPAWAR Systems Center, San Diego, where he manages the GPS Central Engineering Activity Laboratory. He has worked in navigation for over 14 years from fleet introduction, integration and user equipment acquisition, to user equipment test and evaluation. He has concentrated his last eight years in laboratory test and evaluation of GPS user equipment for the GPS JPO as well as the integration of GPS user equipment on board US Navy platforms.

## GPS Protection Toolbox: Picking the Right Technology for Interference Suppression

Instructors: Dr. Ira M. Weiss/Mr. Allen W. Morrison

**LOCATION: Cypress 1-2**

**1:30-5:00**

**Syllabus:** This tutorial reviews the various technologies that are both currently implemented and proposed to mitigate the effects of intentional and unintentional interference on GPS signal reception and navigation. The performance benefits and limitations of each technology will be presented. The building blocks of interference mitigation techniques are discussed, including receiver spread spectrum processing, adaptive antenna arrays and associated control electronics, adaptive digital filters, and signal processing algorithms, including space-time adaptive processing. Techniques and metrics used to characterize each major component of interference suppression systems and overall GPS system anti-jam performance are described.

### Course Outline:

- GPS interference and jamming effects in the presence of GPS legacy and modernized signals
- Antenna array basics
- Adaptive antenna algorithms and processing issues
- Antenna controller design considerations
- Signal processing interference suppression filters
- Space-time/space-frequency adaptive processing benefits and implementation trade-offs
- Antenna array and controller characterization testing
- Test metrics and configurations for system level interference suppression characterization

### Biographies:

Dr. Ira M. Weiss is a Senior Engineering Specialist for the Aerospace Corporation in El Segundo California in the Communication Systems Engineering Subdivision. He has worked in GPS related areas for over 20 years, lectured and taught seminars on GPS, and written many papers in the areas of GPS systems aspects, anti-jam and waveform utilization. As part of the NAVWAR modeling effort, he directed simulation tasks, investigating advanced GPS receiver antenna performance, and has participated in the acquisition and testing of GPS anti-jam adaptive antenna systems.

Mr. Allen W. Morrison is an Assistant Vice President for Technology for Science Applications International Corp. Over the past 35 years, Mr. Morrison has worked extensively in the application of digital signal processing techniques for interference mitigation in communication systems and GPS-based navigation systems. For the past 12 years, he has been involved in the requirements definition, simulation, evaluation, fabrication, and testing of many variants of adaptive spatial, temporal, and spectral filters for enhancing GPS receiver performance in the presence of intentional and unintentional interference.

## It's About Time

Instructor: Demetrios Matsakis

**LOCATION: Spyglass 2**

**1:30-5:00**

**Syllabus:** Time is fundamental to GPS and all modern navigation systems, but it is only appreciated when it runs out. Before our time runs out, we will cover the nature of time, how ancient clocks worked, and how modern clocks work now. Without equations, we will show how clock performance is measured, and how the timescales are generated, including GPS Time and UTC (Coordinated Universal Time). We will discuss how clocks are steered using modern control theory. As important as generating the time is the transferring of it to the users, and we will describe different ways people do this, with particular emphasis on GPS as a time source or as a means of time transfer. Finally, we will predict what the timing state-of-the-art will be in ten years from now. Time permitting, we will discuss the theory of relativity and some of the details of timescale generation and clock steering.

### Course Outline:

#### What is Time?

- Definitions and concepts

#### Description and Performance of Physical Clock

- Pictorial Representation of Timekeeping Math
- Characterizing Clocks
- Noise types
- Stability Measures, such as Allan Variance

#### Generation of Timescales, Including UTC

- Steering Clocks
- Theory and Examples
- Steering GPS to UTC (USNO)

**Biography:** Although acting in his private capacity, Dr. Demetrios Matsakis's day job is Director of the Time Service Department at the U.S. Naval Observatory, whose Master Clock is the timing reference for GPS and many other systems. Prior to his work at the U.S. Naval Observatory, he was a molecular radio astronomer, maser builder, geodesist, water-vapor-radiometer builder, VLBI-er, atmospheric modeler, pulsar and quasar observer, timescale generator and clock-maker.

#### Time Transfer

- Low-precision modes
- GPS
- Two Way Satellite Time Transfer

#### Parade of Clocks

- Ancient Times
- Medieval Times
- Modern Times
- Timing in the Future
- Equationless discussion of Theory of Relativity and Theories of Time
- Interesting details of timescale generation, clock steering, statistics and time transfer

## Low Cost Inertial Finally! From MEMS to NAV Systems

Instructor: James L. Farrell, Ph.D

**LOCATION: Big Sur 1-2**

**1:30-5:00**

**Syllabus:** This seminar complements the INERTIAL MEMS and INTEGRATION courses, with focus as follows: Given raw MEMS outputs while in motion, what tools (digitization, sampling, synchronization, algorithms) make the conversion to familiar NAV system outputs (attitude/velocity/position)? The processes can differ in some important ways from corresponding steps common to current INS approaches. That is fortunate, since the differences considerably enhance comprehension; while current methods are not universally understood, procedures given herein will be transparently clear to all. Results with test data from Ohio University included.

### Course Outline:

- Short-term nature of MEMS inertial instrument processing (*Forget nmi/hr*)
- Short-term implications allow more straightforward algorithms (*Forget Schuler*)
- From raw MEMS gyro outputs to INS attitude
- From attitude plus raw MEMS accelerometer outputs to INS velocity
- Preprocessing: A/D, sampling, sync, coning and sculling
- Example: Simplified yet more general derivation of sculling
- Additional error sources needing more attention in strapdown mechanizations
- Example: Oscillatory instrument error rectified by attitude oscillation
- Example: Cross-axis errors from mounting imperfections take effect immediately
- Raw data usage: THE KEY to huge cost savings plus unprecedented flexibility
- Verification: Successful results using algorithms with GPS-updated Motion Pak

**Biography:** James L. Farrell (MS, UCLA, 1961; Ph.D., U. of MD, 1967) is a member of ION, a senior member of IEEE, a former local board member of AIAA, a registered professional engineer in Maryland, a member of TRIANGLE as well as various scholastic honorary fraternities. Technical experience includes temporary teaching appointments at Marquette and UCLA, two years each at Minneapolis Honeywell and Bendix-Pacific, and 31 years at Westinghouse in design, simulation, and validation/test for modern estimation algorithms in navigation and tracking applications and digital communications system design (synchronization, carrier tracking, decode). He is author of the book, *Integrated Aircraft Navigation* (Academic Press, 1976; now available in paperback after five printings), a former columnist for *Washington*

## Low Cost Inertial Finally! From MEMS to NAV Systems

Instructor: James L. Farrell, Ph.D

### Biography (cont.):

*Technology*, and has written over 70 journal and conference manuscripts. Teaching activity over the past two decades includes seminars run by Navtech, plus self-sponsored courses at ION-GPS and at IEEE PLANS. Active in RTCA (Washington D.C.) for several years, he served as co-chair of Working Group #5 (Fault Detection and Isolation) within Special Committee SC-159 for GPS Integrity. As president and technical director of VIGIL Inc. in Severna Park, MD, he has continued his teaching (on University campus as well as in both industry and conference seminars), and consulted for private industry, DOD and University research.

Monterey Bay, California is beautiful and vibrant in the spring. Come and visit its mountains and ocean splendor. Join us for a Continental Breakfast in the Windjammer Room on Tuesday, Wednesday and Thursday at 9:00 AM. During your stay, visit the following "must see" attractions:

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- Open-deck kayaking in the Bay to see seals and sea otters is quite memorable
- The scenic, coastal Seventeen-Mile Drive which includes Pebble Beach, the Lone Cypress, and exits to Carmel By-the-Sea—a beautiful walking town for shopping and wonderful restaurants
- The Carmel Mission—beautifully restored and fronted by a pretty garden—is where a chain of Missions was founded
- Migrating gray whales surface and vie offshore at Point Lobos State Reserve

Tour information will be available at the PLANS 2004 registration area at the hotel. For further details you may contact:

Cheryl Dunkin  
 dunkincd@aol.com  
 (301) 926-3041

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- |   |   |
|---|---|
| <p><b>MONDAY, APRIL 26 8:30A-12:00P</b></p> <p><input type="checkbox"/> MEMS Inertial Technology:<br/>A Short Course</p> <p><input type="checkbox"/> Navigation and Man</p> <p><input type="checkbox"/> Fundamental Issues Affecting<br/>GPS/INS Integrations</p> <p><input type="checkbox"/> Navigation System Test<br/>and Evaluation</p> | <p><b>MONDAY, APRIL 26 1:30P-5:00P</b></p> <p><input type="checkbox"/> GPS Protection Tool Box:<br/>Picking the Right Technology for<br/>Interference Suppression</p> <p><input type="checkbox"/> It's About Time</p> <p><input type="checkbox"/> Low Cost Inertial Finally!<br/>From MEMS to NAV Systems</p> |
|---|---|

*Note: PLANS 2004 reserves the right to cancel a tutorial if there are insufficient attendees by April 20, 2004.*

|                | <b>ADVANCED REGISTRATION<br/>TUTORIAL FEES (USA \$)</b><br><i>(Rec'd by April 9, 2004)</i> | <b>AT CONFERENCE<br/>TUTORIAL FEES (USA \$)</b> |
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| Single Session | \$230 + PLANS REGISTRATION   | \$280 + PLANS REGISTRATION                      |
| Two Sessions   | \$380 + PLANS REGISTRATION   | \$430 + PLANS REGISTRATION                      |

| OFFICE USE ONLY                      |  |
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| Confirm & Check if IEEE Member       | <input type="checkbox"/>                         |
| Symposium Registration Fee Received: | \$ _____ \$ _____                                |
| Tutorial Registration Fee Received   | \$ _____ \$ _____                                |
| Total Fees Received                  | \$ _____ \$ _____                                |
| Tutorial Selected (check)            | 1. ___ 2. ___ 3. ___ 4. ___ 5. ___ 6. ___ 7. ___ |
| Person Receiving Fees                | _____  |

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**Hotel Room Availability is Limited**

The PLANS 2004 room block is reserved until 5pm PST March 25, 2004. After that date, available rooms will be booked at prevailing rates. **BE SURE TO MAKE YOUR RESERVATION EARLY!**

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The following major airlines have scheduled flights to Monterey: American, United and Southwest

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**Ground Transportation**

The Monterey airport is approximately five minutes from the hotel. Taxicabs or rental cars are readily available.



We are pleased to welcome  
**POSITION, LOCATION, AND NAVIGATION SYSTEMS (PLANS)**  
**April 25-30, 2004**

**Hyatt's Central Reservations Phone Number:** (800) 233-1234 *(Request for the PLANS Rate)*  
**Hyatt Regency Monterey Direct Reservation Dept. Fax:** (831) 372-4277 *(Complete the sections below)*  
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- 575 luxurious rooms in the heart of the magnificent Monterey Peninsula, located on the historic Del Monte Golf Course
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 Knuckles Sports Bar with 12 TV monitors, and more

| LAST NAME                                    | FIRST NAME |
|--|------------|
|  |            |
| NAME(S) OF ADDITIONAL PERSON(S) SHARING ROOM |            |
|  |            |
|  |            |
|  |            |

ARRIVAL DATE \_\_\_\_\_  
 TIME OF ARRIVAL \_\_\_\_\_  
 DEPARTURE DATE: \_\_\_\_\_

- SLEEPING ROOM RATES PER NIGHT:**
- |  |   |
|--|---|
| <b>INDUSTRY</b>                              | <b>GOV'T (IF QUALIFIED)</b>                 |
| <input type="checkbox"/> Single/Double \$149 | <input type="checkbox"/> Single/Double \$94 |
| <input type="checkbox"/> Triple \$174        | <input type="checkbox"/> Triple \$119       |
| <input type="checkbox"/> Quad \$199          | <input type="checkbox"/> Quad \$144         |

- View Room +\$25.00 *(Please call for availability)*  
 Suites \$300-\$675.00 *(Please call for availability)*  
 Number of Beds Requested \_\_\_\_\_

*Rates subject to city hotel tax, currently at 10%, and nightly Resort Services Program of \$10.00 per night, plus tax. We can't guarantee reservations if deposit is not received by Wednesday, March 25, 2004 by 5:00 pm. RESERVATIONS ACCEPTED AFTER THIS DATE ARE BASED UPON AVAILABILITY AND MAY BE CONFIRMED AT AVAILABLE PUBLISHED RACK RATES.*

*(Check-in time is after 3:00PM & Check-out time is 12 Noon)*

**PLEASE ENCLOSE ONE NIGHT'S ROOM DEPOSIT OR COMPLETE CREDIT CARD INFORMATION.**  
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 (Deposit refundable if cancellation notice received 48 hours prior to arrival date. Early departure fee - \$60.00)

**CREDIT CARD AUTHORIZATION:**  
 Please accept the following credit card to guarantee my reservation. I understand that one night's room & tax will be posted to this card only if I fail to cancel within 48 hours prior to arrival or if I fail to arrive to the Hotel on the date noted above.

Card Type: \_\_\_\_\_

| CARD NUMBER | NAME ON CARD | EXP. DATE |
|-------------|--------------|-----------|
|             |              |           |

Authorized Signature on card: \_\_\_\_\_



**From San Francisco International Airport or San Jose Airport to Hyatt Regency Monterey**  
 Take Highway 101 South until you arrive at the 156 West turn off, which is labeled "Monterey Peninsula". Veer right onto 156 West which turns into 1 South. Exit Highway 1 at the Del Monte/Pacific Grove exit and follow until the 3rd signal labeled "Sloat" and turn left. Go 1/2 mile until Sloat ends at the driveway of the Hyatt. Continue through the signal labeled "Mark Thomas" and veer right at the top of the hill.

**From the Greater Los Angeles Area to Hyatt Regency Monterey**  
 Take 405 North until it meets 5 North and stay on 5 North for approx. 2.5 hours. Exit on 46 West toward Paso Robles. Exit 46 West at the 101 North. From 101 North, take Highway 68 West (Salinas exit) and continue to Main St., turn left (you are now on Highway 68). Continue through Salinas to Monterey Airport (Olmsted Rd.) and turn right. Take the next left (Garden Road) and continue to Mark Thomas Drive.; take another left. At the next light make a left turn and follow the road up the hill to the Hyatt.

- From Monterey Airport to Hyatt Regency Monterey**
- Exit airport onto Olmstead Road
  - Turn right onto Garden Road
  - At the end of Garden Road, turn left onto Mark Thomas Drive
  - At the next stop light turn left onto Old Golf Course Road

