MEETING ORGANIZERS

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Mr. Wayne Soehren
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Track A: Inertial Sensing and Technology
Mr. Randall Curey
Northrop Grumman

Track B: Global Navigation Satellite Systems (GNSS)
Dr. Okuary Osechas
German Aerospace Center (DLR), Germany

Track C: Connected, Integrated, Alternative Sensing
Dr. Di Qiu
Polaris Wireless

Track D: Applications to Automated, Semi-Autonomous, and Fully-Autonomous Systems
Dr. Zak Kassas
University of California, Riverside

EXHIBIT HALL INFORMATION

Show Hours:
Tuesday, April 24
10:00 a.m. – 4:00 p.m. Exhibit Hall Open
6:00 p.m. – 8:00 p.m. Exhibitor Hosted Reception

Wednesday, April 25
10:00 a.m. – 4:00 p.m. Exhibit Hall Open

Exhibitor List:
• Acutronic (Booth 11)
• CAST Navigation (Booth 18)
• Ideal Aerosmith (Booth 19)
• IFEN Inc. (Booth 14)
• The Institute of Navigation (ION) (Booth 4)
• Northrop Grumman (Booth 12)
• NovAtel, Inc. (Booth 8)
• OFS (Booth 1)
• Physical Logic Ltd. (Booth 13)
• Septentrio (Booth 16)
• Silicon Sensing Systems Ltd. (Booth 10)
• Spirent Federal Systems (Booth 2)
• Systron Donner Inertial (Booth 6)
• UTC Aerospace Systems (Booth 9)

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Conference Special Events
The following events are included in a full-conference registration. Single day registrations include events taking place on the day the attendee is registered. Student and retired registrations include meals in the exhibit hall; a ticket is required for the Awards Luncheon.

Informal Luncheon
Tuesday, April 24, 12:15 p.m. - 1:15 p.m.
Exhibit Hall

Exhibitor Hosted Reception
Tuesday, April 24, 6:00 p.m. - 8:00 p.m.
Exhibit Hall

Informal Luncheon
Wednesday, April 25, 12:15 p.m. – 1:15 p.m.
Exhibit Hall

Awards Luncheon
Thursday, April 26, 12:15 p.m. - 1:45 p.m.
Regency Ballroom
(late arrivals will not be served after 12:30 p.m.)

The IEEE will present the Kershner Award and Walter Fried Award. This event is included in the price of a Full-conference or Thursday-only registration. Guest tickets may be purchased onsite for $70 each.

For Speakers and Session Chairs
A mandatory Speakers' Breakfast will be held at 7:30 a.m. daily in the Regency Grand Ballroom. This event is for session chairs and the presenting author (primary and alternate presentations), who are presenting that day only. Names will be checked at the door. Please attend the Speakers' Breakfast the morning of your presentation only.

Online Access to Technical Papers
Qualified attendees may download copies of conference papers online for FREE by logging in to the ION website at www.ion.org/plans. Only papers provided to the ION by the presenting author will be available. If a desired document is not available, we recommend you contact the author directly. Official conference proceedings will be distributed electronically in May to all eligible conference participants.

Complimentary Internet
Free wireless internet is available to attendees in all session rooms and public areas:
- Network ID: Hyatt-Meeting
- Password: ion2018

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Pre-conference tutorials have been organized to provide in-depth learning prior to the start of the technical program. All courses will be taught in a classroom setting. Electronic notes will be made available for download by registered attendees from the meeting website; registered attendees are encouraged to download notes in advance of courses. Power will NOT be available to course attendees for individual laptop computers; please come prepared with adequate battery power if required. Tutorial registration is required for each individual course. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

### Time

<table>
<thead>
<tr>
<th>Time</th>
<th>Concurrent Morning Courses</th>
<th>Presenter</th>
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<tr>
<td>9:00 a.m. - 12:30 p.m.</td>
<td>Contemporary and Emerging Inertial Sensor Technologies</td>
<td>Ralph E. Hopkins</td>
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<td>Alternative Navigation Methods Exploiting Integration with Inertial Measurements</td>
<td>Dr. Maarten Uijt de Haag</td>
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<td>Fundamentals of Inertial Navigation Systems and Aiding</td>
<td>Dr. Michael Braasch</td>
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<td></td>
<td>Fundamentals of Nonlinear Recursive Estimation</td>
<td>Dr. Michael J. Veth</td>
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### Tutorial Descriptions and Instructor Biographies: Morning Courses

#### Contemporary and Emerging Inertial Sensor Technologies

This course will present an overview of current state-of-the art inertial instrument technology and how emerging developments in nano and micro-scale fabrication, solid-state optics and cold atom technologies are influencing gyroscope and accelerometer design. The course will initially focus on the recent developments in MEMS-based inertial instruments and how MEMS technology is revolutionizing the inertial guidance navigation and control (GN&SC) industry. 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. New developments in inertial instrument design will follow with discussion of how advanced nano and microfabrication methods, new solid-state optical component developments and cold atom interferometry are being exploited in the next generation of precision gyro and accelerometer designs.

Suitable for experienced inertial instrument practitioners, it will also be of interest to novice developers, as it will cover an overview of basic inertial sensing principles, and detailed discussion of gyroscope and accelerometer designs. This course will appeal to R&D, systems and manufacturing engineers, managers and executives, and will conclude with a discussion on the future direction of advanced inertial technologies.

**Course Outline:**
- Overview of Inertial Sensing
- MEMS Accelerometers and Gyroscopes
- Emerging Inertial Sensors
- Emerging INS Applications and Integration
- Future Direction of Inertial Technology

**Ralph E. Hopkins** is a Distinguished Member of the Technical Staff and Group Leader in the Guidance Hardware Division at Draper Laboratory where he is responsible for the design and development of inertial instruments and sensors. He is an invited speaker for short course tutorials on inertial instruments and inertial technology and has presented internationally for the NATO Science Technology Organization sponsored lecture series and symposia on navigation technology.

#### Alternative Navigation Methods Exploiting Integration with Inertial Measurements

This tutorial introduces the latest technology trends for navigating in difficult urban and indoor environments where the performance of typical Global Navigation Satellite System (GNSS) receivers is deteriorated or absent. This introduction will shortly discuss three broad categories of alternative navigation (Alt-Nav) techniques including image/Ladar/Doppler/dead-reckoning aiding of inertial sensors, beacon-based navigation (including pseudolites), and navigation using signalsof-opportunity such as Wi-Fi signals. Then the course will focus on the latest alternative navigation technologies based on electro-optical techniques specifically. The Alt-Nav technologies presented include laser- and image-aided INS and Simultaneous Localization and Mapping (SLAM) methods using laser and imaging sensors. In the former methods, tight integration with an INS should lead to navigation performance similar to that achieved in today’s GPS/INS integrations. The discussion includes the basic principles of integration with an IMU; EO/IMU integration mechanisms; the use of correlation techniques, feature-based techniques or optical-flow-based techniques; the use of a priori information such as terrain and feature databases; and SLAM approaches.

**Course Outline:**
- Introduction to alternative navigation,
- Alternative navigation categories,
- Basic principles of integration with an IMU,
- EO/IMU integration mechanisms,
- Correlation techniques, feature-based techniques or optical-flow-based techniques,
- Use of passive and active electro-optical sensors to aid the inertial,
- Passive EO sensors: image-based navigation using features,
- Active EO sensors: Ladar-based navigation using correlation and feature based techniques,
- Simultaneous Localization and Mapping approaches;
- Integration of image-based and Ladar-based sensors.

**Dr. Maarten Uijt de Haag** is the Edmund K. Cheng Professor of Electrical Engineering and Computer Science and a Principal Investigator (PI) with the Avionics Engineering Center at Ohio University since 1999. He has authored or co-authored over 140 navigation-related publications and seven book chapters, he is a senior member of the IEEE, an associate Fellow of the AIAA, is currently an associate editor for NAVIGATION: The Journal of the Institute of Navigation. Dr. Uijt de Haag was awarded the ION’s 2008 Thurlow Award for his contributions to laser-based navigation and integrity monitors for synthetic vision systems.
**Fundamentals of Inertial Navigation Systems and Aiding**

This tutorial will start by highlighting the basic principles of operation of an inertial navigation system. The course will focus initially on the concepts underlying the algorithms used to determine position, velocity, and attitude from inertial sensor measurements. Key error characteristics will be described as well such as Schuler oscillation and vertical channel instability. We will also consider the impact of various sensor errors on system performance. The tutorial will continue by covering the basics of Kalman filtering and aided-inertial systems. The daunting matrix mathematics involved in the full algorithm can be extremely intimidating to the newcomer. The basic concepts of estimation theory will be briefly reviewed, and the Kalman Filter will be described first in terms of simple one-dimensional problems for which the full algorithm reduces to an approachable set of scalar equations. We will look at the performance of the filter in some simple case studies and by the end will have an intuitive feel for how the full filter operates. We will apply the Kalman filter to the aiding of inertial systems. We will see how external sources of position and velocity (such as GPS) can be used first to measure inertial system error and then, with the aid of the Kalman filter, to estimate and correct inertial sensor error as well as system error.

**Dr. Michael Braasch** is the Thomas Professor of Electrical Engineering and is also a Principal Investigator with the Ohio University Avionics Engineering Center. Mike has over 30 years of experience in navigation research and has also taught graduate-level courses in inertial navigation, Kalman filtering, and integrated navigation for the past 20 years. Mike has also taught short courses on these subjects at all of the major inertial navigation system manufacturers in the United States. Mike is a Fellow of the Institute of Navigation, a Senior Member of the IEEE and is an instrument-rated commercial pilot.

**Fundamentals of Nonlinear Recursive Estimation**

This course presents an overview of estimation techniques suitable for systems with nonlinearities that are not well suited to traditional linear or extended Kalman filter algorithms. The course begins with an overview of the generalized recursive estimation problem and associated notation and conventions. Next, the limitations of applying linear theory to nonlinear problems are addressed, along with techniques for compensating for these adverse effects, including a brief overview of the traditional extended Kalman filter and Gaussian sum techniques. In addition, the mathematical effects of system nonlinearities on random processes are presented and discussed along with computational techniques for efficiently capturing this information, which serves as the foundation for the development of many nonlinear estimators. Next, the unscented Kalman filter (UKF) and particle filters (PF) are presented and analyzed using multiple examples. Common limitations of nonlinear estimators are addressed and hybrid solutions are discussed including Rao-Blackwell marginalization approaches. The course concludes with a discussion and qualitative comparison of the strengths and weaknesses of various recursive estimation techniques from linear Kalman filtering to particle filtering, and their applicability to various problem spaces. Numerous Matlab examples are presented to illustrate sample nonlinear estimation algorithms and performance.

This course will be presented at an engineering level with the goal of understanding the fundamental concepts behind current nonlinear estimation algorithms and how they compare to traditional approaches. The course is appropriate for engineers and scientists with linear and extended Kalman filter experience with an interest in the potential benefits of nonlinear estimation algorithms for difficult problems. The “Fundamentals of Kalman Filtering” sequence by Dr. Gewal is a recommended prerequisite for students wishing to enhance their background prior to this course.

**Dr. Michael J. Veth, Ph.D.** is the president and CEO of Veth Research Associates. He leads a team of engineers dedicated to pursuing novel solutions in autonomous navigation, control, and tracking applications for GNSS-denied and degraded environments. He received his BSEE from Purdue University and a Ph.D. in Electrical Engineering from the Air Force Institute of Technology. He is a member of the ION, a Senior Member of the IEEE, and a graduate of the US Air Force Test Pilot School.
TUESDAY MORNING TECHNICAL SESSIONS • 8:30 a.m. - 12:15 p.m.

Session A1: High Performance Inertial Sensor Technologies
Room: Big Sur

8:35
A New IMU with a Digitally Controlled PZT CVG:
A. Dorian Challoner, Jeremy D. Popp, Peter W. Bond, InertialWave, Inc.; Jose Beitia, Innalabs, LLC; Rongsheng (Ken) Li, The Boeing Company

8:57
An Operation and Mechanization of the Hemispherical Resonator Gyroscope:
Anthony Matthews, Retired

9:20
Design and Fabrication of High-Q Birdbath Shell Resonators for MEMS Gyroscopes:
Sajal Singh, Tal Nagourney, Jae Yoong Cho, Ali Darvishian, Behrouz Shiari, Khalil Najafi, University of Michigan Ann Arbor

9:43
milli-HRG Inertial Instrument Assembly:
A. D. Meyer, A. A. Trusov, D.K Sakaida, D. M. Rozelle (Retired), Northrop Grumman Systems Corporation

10:05-10:35, Refreshment Break in Exhibit Hall

10:40
Nuclear Magnetic Resonance Gyroscope:
Michael Larsen, Northrop Grumman

11:03
The NG DIVA: A Navigation Grade Differential Inertial Vibrating Beam Accelerometer:
Olivier Le Traon, Jean Guérard, Raphael Levy, Pierre Lavenus, Amandine Andrieux Ledier, DPhIEE, ONERA, Université Paris Saclay, France

11:26
Parameter Optimization of the Resonator of Resonant Photonic Crystal Fiber Optic Gyroscope Under Dynamic Conditions:
Zhao Wang, Guochen Wang and Wei Gao, Harbin Institute of Technology, China

11:48
A Hybrid Atom Interferometer Accelerometer-Gyroscope:
Jennifer T. Choy, David M. S. Johnson, Christine Y. Wang, Alexander T. Gill, Steven J. Byrnes, Richard E. Stoner, Krish Kotru, Sungyung Lim, Zachary Smigelski, William Trinkle, Buddy Clemmer, Louis Kratchman, Stefanie Golman, Matthew Sinclair, Adam Kelsey, Tom Thorvaldsen, Matthew Bolkol, Draper; Grant Biedermann, Akash Rakholia, Sandia National Laboratories; Michael Berarducci, Air Force Research Laboratory

Alternates

1. Design and Evaluation of High-order Non-commutativity Error Compensation Algorithm in Dynamics:
Maosong Wang, National University of Defense Technology, China & University of Calgary, Canada; Wenqi Wu, Xiaofeng He, National University of Defense Technology, China

2. Rate Table Improvements in Rate Stability using Look-up Tables: Faster Commissioning through Automated Processes:
André S. P. Niederberger, Remo Kälin, Sascha Smajlovic, Acutronic Switzerland Ltd., Switzerland; Dino Revel, Acuronic Switzerland Ltd., Switzerland

3. Time Series Modeling of the Accelerometer’s bias Considering the Temperature Delay Effect:
Wenfeng Tan, Wei Wu, Dongkai Dai, Xingshu Wang and Shiqiao Qin, National University of Defense Technology, China

Session B1: Receiver Signal Processing
Room: Cypress

8:35
Combining Secondary Code Correlations for Fast GNSS Signal Acquisition:
Jérôme Leclère, René Jr Landry, LASSEN, École de Technologie Supérieure (ETS), Canada

8:57
Quantifying Phase Lock Loop Robustness Through Interference using the Phase Discriminator Output:
Wengxiang Zhao, Stefan Stevanovic, Boris Pervan, Illinois Institute of Technology

9:20
Preliminary Assessment on the Vulnerability of NMA-based GNSS Signals for a Special Class of Record & Replay Spoofing Attacks:
Daniel Maier, Kathrin Frankl, Ronny Blum, Thomas Pany, Bernd Eissfeller, Universität der Bundeswehr München, Germany

9:43
Dual-frequency Signal Processing Architecture for Robust and Precise Positioning Applications:
Padma Bolla, Samara National Research University, Samara, Russia; Elena Simona Lohan, Tampere University of Technology, Finland

10:05-10:35, Refreshment Break in Exhibit Hall

10:40
A Joint TOA and DOA Approach for Positioning with LTE Signals:
Kimia Shamaei and Zak (Zaher) M. Kassas, University of California, Riverside

11:03
A Collaborative Technique for Spatial Interference Reduction in Multi-Node Antenna Arrays with Antenna Diversity:
Kenneth L. Collier Jr. and Laurie Joiner, University of Alabama in Huntsville

11:26
Doppler Considerations and Phase Manifold Effects for Anti-jam Electronics:
Adam Simmons, Greg Reynolds, Russell Powell, Caleb Perry, Laura Mcrain, Brian Baeder and Timothy Pitt, US Army AMRDEC

11:48
Improved Stochastic Modelling of Low-Cost GNSS Receivers Positioning Errors:
Ahmed Radi, Sameh Nassar, Maan Khedr, University of Calgary, Canada; Roberto Molinari, Stéphane Guerrier, Pennsylvania State University; Naser El-Sheimy, University of Calgary, Canada

12:15 p.m. - 1:15 p.m. • Attendee Luncheon in the Exhibit Hall • Regency Grand Ballroom

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**TUESDAY MORNING TECHNICAL SESSIONS • 8:30 a.m. - 12:15 p.m.**

### Session C1: Sensor Aiding and Augmenting

**Room: Windjammer**

- **8:35** Wearable-based Pedestrian Inertial Navigation with Constraints based on Biomechanical Models: Dina Bousdar Ahmed, Institute of Communications and Navigation, German Aerospace Center (DLR), Germany; Kai Metzger, Technical University of Munich, Germany
- **8:57** Utilizing The ACC-FMCW-Radar for Land Vehicles Navigation: Ashraf Abosekeen, Queen's University, Canada; Aboelmagd Noureldin, Royal Military College of Canada/Queen's University, Canada; Michael J. Korenberg, Queen's University, Canada
- **9:20** Multiple Ultrasonic Aiding System for Car Navigation in GNSS Denied Environment: M. Moussa, A. Moussa, N. El-Sheimy, University of Calgary, Canada
- **9:43** A New Method to Calculate Relative Distance of Closest Terrain Point Using Interferometric Radar Altimeter Output in Real Flight Environment: Juhyun Oh, Chang-Ky Sung, Jung-Shin Lee, Myeong-Jong Yu, Agency for Defense Development, Republic of Korea
- **10:05-10:35, Refreshment Break in Exhibit Hall**
- **10:40** Chained Wireless Synchronization Algorithm for UWB-TDOA Positioning: Vaclav Navratil, Josef Kraka, Frantisek Vejrazka, Czech Technical University in Prague, Czech Republic; Vaclav Korecek, RCD Radiokomunikace, Czech Republic
- **11:03** Exclusion of GNSS NLOS Receptions Caused by Dynamic Objects in Heavy Traffic Urban Scenarios Using Real-Time 3D Point Cloud: An Approach without 3D Maps: Weisong Wen, Guohao Zhang and Li-Ta Hsu, The Hong Kong Polytechnic University, Hong Kong
- **11:26** Three-Axis Magnetometer Calibration based on Optimal Ellipsoidal Fitting under Constraint Condition for Pedestrian Positioning System Using Foot-mounted Inertial Sensor/Magnetometer: Xufei Cui, Yibing Li, Qiuying Wang, Minghui Zhang, Harbin Engineering University, China; Jia Li, Oakland University

### Session D1: Robotic and Indoor Navigation

**Room: Spyglass**

- **8:35** SLAM-based Pseudo-GNSS/INS Localization System for Indoor LiDAR Mobile Mapping Systems: Tamer Shamseldin, Ankit Manerikar, Magdy Elbahnasawy, and Ayman Habib, Purdue University
- **8:57** Improvements in Pedestrian Movement Prediction by Considering Multiple Intentions in a Multi-Hypotheses Filter: Florian Particke, Markus Hiller, Jörn Thielecke, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany; Christian Feist, AUDI AG, Germany
- **9:20** A Smart Phone based Multi-Floor Indoor Positioning System for Occupancy Detection: Md Shadab Mashuk, James Pinchin, Peer-Olaf Siebers, Terry Moore, University of Nottingham, UK
- **9:43** Utilization of Weak Received Signal Strength for Accurate Indoor Position Estimation: Toshiaki Yokoi, Tokyo City University, Japan; Kazuki Oikawa, Digital Arts Inc., Japan
- **10:05-10:35, Refreshment Break in Exhibit Hall**
- **10:40** Graphical Kalman Filter: Thomas Burgess and Boxian Dong, indoo.rs GmbH, Austria; Hans-Bernd Neuner, TU Wien, Austria
- **11:03** Indoor Navigation Using Wi-Fi Fingerprinting Combined with Pedestrian Dead Reckoning: Shan-Jung Yu, Shau-Shiun Jan, National Cheng Kung University, Taiwan; David S. De Lorenzo, Athentek Inc.
- **11:26** Laser-Camera Based 3D Reconstruction of Indoor Environments: Jamal Atman, Institute of Systems Optimization (ITE), Karlsruhe Institute of Technology (KIT), Germany; Gert F. Trommer, ITE, KIT, Germany and ITMO University, Russia

**Alternates**

- **1.** A Comparison of Particle Propagation and Weight Update Methods for Indoor Positioning Systems: Tanner Ray, Dan Pierce, and David Bevly, Auburn University
- **2.** Near Ground UWB Channel Modeling for Relative Localization: Shihong Duan, Iacan Si, Junluo Yin, Jie He, University of Science and Technology, China
- **3.** Research of Kinect/IMU Integrated Navigation Based on Indoor Robot: Hang Guo, Xi Wen, Min Wan, Huixia Li, Nanchang University, China; Min Yu, Jiangxi Normal University, China

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**12:15 p.m. - 1:15 p.m. • Attendee Luncheon in the Exhibit Hall • Regency Grand Ballroom**

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Session A2: Small Size or Low Cost Inertial Sensor Technologies  
**Room: Big Sur**

1:50 Wafer-Level-Packaged HARPSS+ MEMS Platform: Integration of Robust Timing and Inertial Measurement Units (TIMU) on a Single Chip: Haoran Wen, Anosh Daruwalla, Yae suk Jeong, Pranav Gupta, Jae hoo Choi, Chang-Shun Liu, Farrokh Ayazi, Georgia Institute of Technology

2:12 Heading and Attitude Determination System with Low-cost IMU Embedded Inside One of Multiple Antennas: Nikolay Vasilyuk, Mikhail Vorobiev, and Dmitriy Tokarev, Topcon Positioning Systems, LLC, Russia

2:35 Loosely Coupled GPS/INS Integration with Snap to Road for Low-Cost Land Vehicle Navigation: Mohamed LAJMI Cherif, Jérôme Leclere and René Jr. Landry, University of Québec, École de Technologie Supérieure, Canada

2:58 A Piezo-Capacitive BAW Accelerometer with Extended Dynamic Range using a Gap-Changing Moving Electrode: Anosh Daruwalla, Haoran Wen, Chang-shun Liu, Hoon Jeong, Farrokh Ayazi, Georgia Institute of Technology

3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 MEMS Gyro bias Drift Mitigation by Simultaneous Operation of the n = 2 and n = 3 Modes: Howard Ge and Robert M'Clokey, University of California Los Angeles


4:46 Using a Mobile Range-Camera Motion Capture System to Evaluate the Performance of Integration of Multiple Low-Cost Wearable Sensors and Gait Kinematics for Pedestrian Navigation in Realistic Environments: Chandra Tjhai, Jeremy Steward, Derek Lichti, and Kyle O'Keefe, University of Calgary, Canada

5:08 Temperature Compensation of MEMS Inertial Sensors based on Neural Network: Golrokh Araghi, René Jr Landry, École de Technologie Supérieure, Canada

5:12 Alternates

1. Performance Assessment of An MPU-6000 IMU for Low-Cost Ground Vehicle Navigation: Rodrigo Gonzalez, GridTICS, National University of Technology, Argentina; Paolo Dabove, Politecnico di Torino, Italy

2. Bi-orthonormal based De-Noiseing for Improving Wellbore Continuous MWD Surveying Utilizing MEMS Inertial Sensors: Umar Iqbal, Mississippi State University, USA; Lu Wang, Beijing University of Aeronautics and Astronautics (BUAA), China; Abdalla M. Osman, Royal Military College of Canada; Aboelmagd Noureldin, Queen's University and Royal Military College of Canada, Chunxi Zhang, BUAA, China

Session B2: GNSS Integrity and Augmentation  
**Room: Cypress**

1:50 A Formula for Solution Separation without Subset Solutions for Advanced RAIM: Juan Blanch, Todd Walter, Per Enge, Stanford University

2:12 Preliminary Integrity Assessment for GPS/GLONASS RAIM with Multiple Faults: Eugene Bang, Carl Milner and Christophe Macabiau, École Nationale de l'Aviation Civile (ENAC), France; Philippe Estival, DSNA, France

2:35 Multi-Constellation Time-Differenced Carrier Phase Solution with Protection from Multiple Failures: Zhen Zhu, East Carolina University and Eric Vinande, AFRL

2:58 GPS Receiver Failure Detection Method in High Dynamic Environment: Junyi Li, Yandong Wang, Beihang University, China

3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 Comparison of Different Bounding Methods for Providing GPS Integrity Information: Hani Dbouk and Steffen Schön, Leibniz Universität Hannover, Germany

4:23 Vertical Integrity Monitoring with Direct Positioning: Arthur Hsi-Ping Chu and Grace Xingxin Gao, University of Illinois at Urbana-Champaign

4:46 GNSS-based Location Determination System Architecture for Railway Performance Assessment in Presence of Local Effects: Cosimo Stallo, Pietro Salvatori, Andrea Coluccia, Alessandro Neri, Radiolabs, Italy; Roberto Capua, Giorgia Olivieri, Luca Gattuso Sogei, Lukasz Bonenberg, Terry Moore, University of Nottingham, UK, Francesco Rispoli, Ansaldo STS, Italy

5:08 Location Corrections through Differential Networks (LOCDIN): Evan Dill, Russell Gilabert, NASA Langley Research Center; Maarten Uijt de Haag, Ohio University

Alternates

1. DOA Classification and CCPM-PC based GNSS Spoofing Detection and Mitigation Technique: Guanghui Xu, Harbin Engineering University, China & Villanova University, USA; Feng Shen, Harbin Institute of Technology, China; Moeness G. Amin, Villanova University, USA; Chun Wang, Villanova University, USA & Xi'an University of Architecture and Technology, China

2. Analysis of the Baseline Data based GPS Spoofing Detection Algorithm: Changhui Jiang, Shuai Chen, Yuwei Chen, Yuming Bo, Boya Zhang, Nanjing University of Science and Technology, China

3. An Improved Algorithm for Receiver Implementation of ARAIM: Paul Massatt and Andrew Binder, The Aerospace Corporation
Session C2: Vision/Integrated Navigation Systems
Room: Windjammer

1:50 Stereo Vision-Based Simultaneous Localization and Mapping with Ranging Aid: Young-Hee Lee, Chen Zhu, Technical University Munich, Germany; Gabriele Giorgi, German Aerospace Center (DLR), Germany; Christoph Guenther, Technical University Munich and DLR, Germany

2:12 Integrating Low-Resolution Surveillance Camera and Smartphone Inertial Sensors for Indoor Positioning: Jiu Xin Zhang and Pingqiang Zhou, Shanghaitech University, China

2:35 Image-Assisted GNSS/INS Navigation for UAV-based Mobile Mapping Systems During GNSS Outages: Magdy Elbahnasawy, Tamer Shamseldin, and Ayman Habib, Purdue University

2:58 Photogrammetric Visual Odometry with Unmanned Ground Vehicle using Low Cost Sensors: Paolo Dabove, Andrea Maria Lingua, Marco Piras, Politecnico di Torino, Italy

3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 VO-Sim: A Generic Framework for Tuning and Evaluating Visual Odometry Systems: Islam Alaa and Amr Wsasal, Cairo University, Egypt

4:23 Enhancing Accuracy in Visual SLAM by Tightly Coupling Sparse Ranging Measurements Between Two Rovers: Chen Zhu, Technische Universität München (TUM), Germany; Gabriele Giorgi, German Aerospace Center (DLR), Germany; Young-Hee Lee, TUM, Germany; Christoph Günther, TUM and DLR, Germany

4:46 Low Cost, Standards based EO/IR Payload Simulation for Visual Aided Navigation Applications: Ben Thompson, Humphreys, University of Texas at Austin; Lucas Thompson, Humphreys, University of Texas at Austin

5:08 Low-cost Precise Vehicular Positioning in Urban Environments: Todd Humphreys, Matthew Murrian, and Lakshay Narula, University of Texas at Austin

Alternates
1. Updating Globally-Referenced Sub-Decimeter-Accurate Visual 3D Reconstructions: Tucker C. Haydon and Todd E. Humphreys, University of Texas at Austin

2. Indoor and Outdoor evaluation of Visual-Inertial Localization Algorithms: Alvika Gautam, IIT Delhi, India; Subodh Mishra and Srikant Saripalli, Texas A&M University, USA

3. Research on Optical Flow Assisted MEMS Navigation Method based on ROF Denoising in UAVs: Ling Zhang, Zhi Xiong, Jianye Liu, Pin Lv, Jianxin Xu, NUAA University, China

4. Visual-Inertial SLAM by fusing Stereo and Inertial Measurement Units based on ORB-SLAM: Yi-Chieh Sun, Shau-Shiun Jan, National Cheng Kung University, Taiwan

Session D2: Marine Vehicle Navigation
Room: Spyglass

1:50 Advances on a Null-space-based Approach to Range-only Underwater Steering and Positioning: Daniela De Palma, Giovanni Indiveri, University of Salento - ISME Node, Italy; António M. Pascoal, University of Lisbon, Portugal

2:12 Optimal Measurement Location Planning for Localizing Underwater Transponders: Jesse Garcia, Jay A. Farrell, Zak (Zaher) M. Kassas, University of California, Riverside

2:35 Range-based Underwater Target Localization using an Autonomous Surface Vehicle: Observability Analysis: N. Crasta, University of Lisbon, Portugal; D. Moreno-Salinas, National Distance Education University, Spain; B. Bayat, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland; A. M. Pascoal, University of Lisbon, Portugal; J. Aranda, National Distance Education University, Spain


3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 Fast and High Precision Alignment Algorithm Based on Multi-Vector: Dingjie Xu, Pan Jiang, Ya Zhang, Shiwei Fan, Guochen Wang, Harbin Institute of Technology, China

4:23 Performance Analysis of Cooperative Localization System: Fei Yu, Shiwei Fan, Qian Li, Pan Jiang, and Zicheng Wang, Harbin Institute of Technology, China

4:46 Use of Situation and Risk Modeling in Guidance Solutions: Edwin A. Williams IV and Yan Jin, University of Southern California

5:08 AUV Navigation Aiding using Multiple Surface Vehicles: Dula Na, Ivan Lonar, Nikola Miškovi, UNIZG-FER, Croatia

Alternates
1. Calibration and Compensation of Inner Lever Arm for Accelerometer: Pan Jiang, Wei Gao, Guochen Wang, Qian Li, Ya Zhang, Harbin Institute of Technology, China

WednesDay Morning Technical Sessions • 8:30 a.m. - 12:15 p.m.

Session A3: Inertial Measurement Units
Room: Big Sur

8:57  A Two-Step Computationally Efficient Procedure for IMU Classification and Calibration: Gaetan Bakalli, University of Geneva, Switzerland; Ahmed Rady, University of Calgary, Canada; Stéphane Guerrier, Yuming Zhang, Roberto Molinari, Pennsylvania State University; Sameh Nassar, University of Calgary, Canada
9:20  Fast Self-Calibration of Fiber-Optic Strapdown Inertial Navigation System: Dingjie Xu, Pan Jiang, Ya Zhang, Shiwei Fan, Guochen Wang, Harbin Institute of Technology, China
9:43  Accelerated Aging Test for MEMS Inertial Measurement Units using Temperature Cycling: Anil Sami Onen, Yesim Gunhan, Roketsan A.S., Turkey

10:05-10:35, Refreshment Break in Exhibit Hall
10:40  Determining Efficient Temperature Test Points for IMU Calibration: Altiön Ö Bagis, Unsal Derya, Roketsan A.S., Turkey
11:03  Research on Dual-MIMU Trajectory Tracking Based on Support Vector Machine Constraint: Wang Quying, Cheng Ming, Cui Xuefei, Guo Zhong, Harbin Engineering University, China
11:26  Research on Pedestrian Location Based on Dual MIMU/Magnetometer/Ultrasonic Module: Wang Guoping, Guo Zheng, Zhang Minghui, Cui Xuefei, Harbin Engineering University, China; Wu Hui, Dalian Shipbuilding Industry Offshore Co., Ltd, China; Jia Li, Oakland University, USA

Alternates
1. IMU-12 – More Performance in Small Size: Evgeny Zaitsev, Itzik Engel, Amon Arbel, Al Cielo Inertial Solutions Ltd., Israel
2. A Quaternion-based Attitude Estimation Algorithm for Low Cost MEMS IMU: Mundla Narasimhappa and Arun D. Mahindrakar, Indian Institute of Technology, India; Marco H. Terra-University of Sao Paulo (USP), Brazil; Samrat L. Sabat, University of Hyderabad, India

Session B3: Precise GNSS Positioning Applications
Room: Cypress

8:35  Spatial Gradient Monitor for GBAS Using Multiple Baseline Antennas: Jaymin Patel, Samer Khanafeh, and Boris Pervan, Illinois Institute of Technology
8:57  ECEF Position Accuracy and Reliability for Connected and Autonomous Vehicle Requirements: F. Rahman, E. Aghapour, J.A. Farrell, University of California, Riverside
9:20  Evaluation of Precise Point Positioning Convergence with an Incremental Graph Optimizer: Ryan M. Watson and Jason N. Gross, West Virginia University
9:43  On the Kalman Filtering Formulation for RTK Joint Positioning and Attitude Quaternion Determination: Daniel Medina, Anja Heßelbarth, Rauno Büscher, Ralf Ziebold, German Aerospace Center (DLR), Germany; Jesús García, Charles III University of Madrid, Spain

10:05-10:35, Refreshment Break in Exhibit Hall
10:40  Robust Multipath Detection by Intra- and Inter-Domain Fusion with Real-Time Capability: Artem Gostischchev, Friederike Fohlmeister, Andriy Konovaltsev, German Aerospace Center (DLR), Germany
11:03  Preliminary Analysis of URA Characterization for GPS Real-time Precise Orbit and Clock Products: Chun Chen, Yuxin Zhao, Liang Li, Jianhua Cheng, Xianyu Sun, Harbin Engineering University, China
11:26  An Empirical Study of the Relative Phase Center Variation of a Ceramic Patch Antenna Mounted on a Vehicle in Multiple Locations: Ran Liu and Daniel N. Aloj, Oakland University

Alternates
1. An Assessment of the Precise Products on Static Precise Point Positioning using Multi-Constellation GNSS: Jareer Mohammed, University of Wasit, Iraq; Terry Moore, Chris Hill, Richard M. Bingley, University of Nottingham, UK
2. A Performance Assessment of Low-Cost RTK GNSS Receivers: John M. C. Jackson, Brian Davis, Demoz Gebre-Egziabher, University of Minnesota, Twin Cities
WEDNESDAY MORNING TECHNICAL SESSIONS • 8:30 a.m. - 12:15 p.m.

Session C3: Multisensor Integrated Systems and Sensor Fusion Technologies
Room: Windjammer

8:35 Attitude and Velocity Estimation of a Projectile using Low Cost Magnetometers and Accelerometers: Christophe Combettes, French-German Research Institute of Saint-Louis (ISL), France

8:57 Modular Tightly Coupled System with Clock Error Estimation for Multi-GNSS for Road Vehicle Applications in Urban Scenarios: Johanna Rieke, Martin Escher and Ulf Bestmann, Institute of Flight Guidance, Germany

9:20 A Two-Stage Multiplicative Kalman Filter for Attitude Estimation of the Human Wrist: Daniel S. Eliahu, Gabriel H. Elkaim and Renwick E. Curry, University of California, Santa Cruz


10:05-10:35, Refreshment Break in Exhibit Hall

10:40 CDGNSS-Enabled Online Sensor Calibration for Automated Vehicles: Nick Montalbano, Evan Smrka and Todd Humphreys, University of Texas at Austin


11:26 Pure-Inertial AHRS with Adaptive Elimination of Non-Gravitational Vehicle Acceleration: Pavol Malinak, Milos Sotak, Zdenek Kana, Honeywell International, Czech Republic; Jindrich Dunik, Honeywell International and University of West Bohemia, Czech Republic; Radek Baranek, Honeywell International, Czech Republic

11:48 A Designed AKF Algorithm Applied to Unconventional GPS and Multiple Low-cost IMUs Integration Strategy: Fei Yu, Minghong Zhu, Shu Xiao, Harbin Engineering University, Harbin, China; Jianguo Wang, York University, Canada

Alternates
1. A Model Based Approach for Sensor Fault Detection in Civil Aircraft Control Surface: Omur Sercekman, Middle East Technical University, Turkey

2. Multisensor Navigation in Urban Environment: Andrea Delia Monica, Politecnico di Torino, Italy; Laura Ruotsalainen, Finnish Geospatial Research Institute, Finland; Fabio Dovis, Politecnico di Torino, Italy

3. Tightly Coupled GNSS/INS Integration based on Robust M-Estimators: Omar Garcia Crespillo, Daniel Medina, German Aerospace Center (DLR), Germany; Jan Skaloud, Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland; Michael Meurer, DLR, Germany


Session D3: Aerial Vehicle Navigation
Room: Spyglass

8:35 Airborne Visual Detection of Small Unmanned Aircraft Systems with ADS-B: James D. Jacob, Jon Loffi, Taylor Mitchell, Matt Vance, Oklahoma State University; Ryan Wallace, Polk State College

8:57 Interactive Multiple Model Sensor Analysis for Unmanned Aircraft Systems (UAS) Detect and Avoid (DAA): Adrian Canolla, Michael B. Jamoorn and Boris Pervan, Illinois Institute of Technology

9:20 Decentralized Collaborative Localization with Deep GPS Coupling for UAVs: Siddharth Tanwar and Grace Xingxin Gao, University of Illinois at Urbana-Champaign

9:43 Multi-UAV Formation Geometries for Cooperative Navigation in GNSS-challenging Environments: Flavia Causa, Amedeo Rodi Vetrella, Giancarmine Fasano, Domenico Accardo, University of Naples Federico II, Italy

10:05-10:35, Refreshment Break in Exhibit Hall

10:40 Relative Visual-Inertial Odometry for Fixed-Wing Aircraft in GPS-Denied Environments: Gary J. Ellingson, Brigham Young University; Kevin Brink, Air Force Research Laboratory; Timothy W. McLain, Brigham Young University

11:03 Observability Driven Path Planing for Relative Navigation of Unmanned Aerial Systems: He Bai, Oklahoma State University; Clark N. Taylor, Sensors Directorate, Air Force Research Lab, Wright-Patterson

11:26 Wide Baseline Matching for Autonomous Approaches of MAVs: Karsten Mueller, Ruben Kleis, Institute of Systems Optimization (ITE), Karlsruhe Institute of Technology (KIT), Germany; Gert F. Trommer, ITE/KIT, Germany & ITMO University, Russia

11:48 Using Unmanned Aerial Vehicles (UAVs) in Locating Wandering Patients with Dementia: D. Hanna, A Ferworn, M. Lukaczy; A. Abhari, Lum, J. Ryerson University, Canada

Alternates
1. Autonomous Exploration and Mapping of Structured Spaces using a Small Unmanned Aircraft System (sUAS): Adam Schultz and Maarten Uijt de Haag, Ohio University

2. Small UAV’s Attitude Estimation with Tightly Coupled Low-cost GNSS/INS Integration using Multiple GNSS Receivers: Marton Farkas, Hungarian Academy of Sciences, Budapest University of Technology and Economics, Hungary; Balint Vanek, Hungarian Academy of Sciences, Hungary; Szabolcs Rozsa, Budapest University of Technology and Economics, Hungary
WEDNESDAY AFTERNOON TECHNICAL SESSIONS • 1:45 p.m. - 5:30 p.m.

Session A4: Integrated Inertial Navigation Systems
Room: Big Sur

1:50 Robust Bayesian Filtering for Positioning using GPS & INS in Multipath Environments: Shun Tauchi and Takayoshi Yoshimura, Toyota Central R&D Labs., Inc., Japan

2:12 Gravity Model Error Considerations for High-Integrity GNSS-aided INS Operations: Timothy G. Needham and Michael S. Braasch, Ohio University

2:35 An Adaptive Cascaded Kalman Filter for Two-antenna GPS/ MEMS-IMU Integration: Wei Wang, Zongkai Wu and Hao Zhang, Harbin Engineering University, China

2:58 GNSS/INS Based Estimation of Air Data and Wind Vector using Flight Maneuvers: Kerry Sun, Christopher D. Regan, Demoz Gebre Egziabher, University of Minnesota Twin Cities

3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 Integrated Navigation Method Using Marine Inertial Navigation System and Star Sensor Based on Model Predictive Filtering: Wang Qiuying, Zhang Minghui, Guo Zheng, Harbin Engineering University, China; Wu Hui, Dalian Shipbuilding Industry Offshore Co., Ltd., China


4:46 Fast Alignment Method for Strapdown Navigation System on Stationary Base: Xu Bo, Duan Tenghui, Wang Lianzhao, Harbin Engineering University, China

5:08 An Open Source Flight Dynamics Model and IMU Signal Simulator: James McAnanama and Greg Marsden, L-3 Wescam

Alternates
1. Real-time Estimation of Dynamic Lever Arm Effect of Transfer Alignment for Wing’s Elastic Deformation: Chenghao Geng, Falin Wu, Shan Xu, Xueyan Zhang, Fan Si, Yan Zhao, Beihang University, China

2. Research on Accuracy Analysis and Enhancement of Low-cost MEMS INS/GNSS Integration for Land Vehicle Navigation: Quan Zhang and Xiaoji Niu, Wuhan University, China

3. Vibration-based Vehicle Dead Reckoning (VDR) for Localization of Wheeled Vehicles: Masakatsu Kourogi and Takeshi Kurata, National Institute of Advanced Industrial Science and Technology (AIST), Japan

Session B4: GNSS Resilience
Room: Cypress

1:50 An Improved Adaptive Multi-Frequency GPS Carrier Tracking Algorithm for Navigation in Challenging Environments: Rong Yang, University of Colorado, Boulder; Dongyang Xu, Colorado State University; Yu Morton, University of Colorado, Boulder

2:12 Interference Awareness and Characterization for GNSS Maritime Applications: E. Pérez Marcos, S. Caizzone, A. Konovaltsev, M. Cuntz, W. Elmarissi, K. Yinusa, M. Meurer, German Aerospace Center (DLR), Germany

2:35 Evaluation of Mitigation Methods Against Commercial-off-the-shelf (COTS) Privacy Protection Devices (PPDs): J. Rossouw van der Merwe, Alexander Rügamer, Fabio Garzia, Fraunhofer IIS, Germany; Jan Wendel, Airbus Defence and Space GmbH, Germany; Wolfgang Felber, Fraunhofer IIS, Germany

2:58 A Reduced Complexity Cross-correlation Interference Mitigation Technique on a Real-Time Software-defined Radio GPS L1 Receiver: Erick Schmidt and, David Akopian, The University of Texas at San Antonio; Zach A. Ruble and, Daniel J. Pack, The University of Tennessee at Chattanooga

3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 Simultaneous Localization of Multiple Jammers and Receivers Using Probability Hypothesis Density: Sriramya Bhamidipati and Grace Xingxin Gao, University of Illinois at Urbana-Champaign

4:23 Analysis of the Impact of a Non-Standard GPS C/A Code on Galileo Signals: Fabio Dovis, Politecnico di Torino, Italy; Davide Margaria, Beatrice Motella, Istituto Superiore Mario Boella, Italy

4:46 On the Achievable Equivalent Security of GNSS Ranging Code Encryption: Gianluca Caparra, University of Padova, Italy

5:08 SNAP: An Authentication Concept for the Galileo Open Service: Beatrice Motella, Davide Margaria, Istituto Superiore Mario Boella, Italy; Matteo Paonni, Joint Research Centre of the European Commission, Italy

Alternates
1. Antispoofing Measure by Optimizing and Switching Radiation Pattern through Phase Control on QHA Monofilars: Shifa Nadeem, Muhammad Amin, Abdul Rehman Maud, Institute of Space Technology, Pakistan

2. Interferer Synchronized Sub-sampling for Continuous Wave Tone Suppression in Direct Sequence Spread Spectrum Systems such as GPS: Sakib Abdullah and Izzet Kale, University of Westminster, Applied DSP and VLSI Research Group, UK
**Session C4: Alternative/Terrestrial-based Opportunistic PNT**

**Room:** Windjammer

1:50 Precise UAV Navigation with Cellular Carrier Phase Measurements: Joe Khalife and Zak (Zaher) M. Kassas, University of California, Riverside

2:12 Algorithm for Geodetic Positioning Based on the Angle of Arrival of Aircraft Automatic Dependent Surveillance Broadcasts: Richard Gross, Nicholas Baine, Grand Valley State University


2:58 A Self-learning Fingerprinting Matching Algorithm for Indoor Wi-Fi Positioning: Guenther Retscher and Anton Stangl, Vienna University of Technology, Austria

3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 Exchanging Transmitter Maps in Multipath Assisted Positioning: Markus Ulmschneider, German Aerospace Center (DLR), Germany; David Calvo Luz, Universidad Politecnica de Madrid (UPM), Spain; Christian Gentner, DLR, Germany

4:23 Multi-radio Integrated Navigation System M&S Software Design for GNSS Back-up: Junhak Lee, Hyeonme Kim, Dong-Hwan Hwang, Chongnam National University, South Korea; Hyoungmin So, Agency for Defense Development, South Korea; Sang Heon Oh, Navigous, Co., Ltd., Republic of Korea

4:46 Preliminary Study of Multichain-Based Loran Positioning Accuracy for Dynamic Users in South Korea: Pyo-Woong Son and Jiwon Seo, Yonsei University, Republic of Korea

5:08 High Accuracy SFOL DME/N Pulse and Its Recommended Implementation in South Korea for Alternative Aircraft Navigation: Euiho Kim and Hwankee Cho, Hongik University, Republic of Korea

**Alternates**

1. A Simple Transmitter and Control Configuration for Indigenous Localization: Ya-Tzu Hung and Jyh-Ching Juang, National Cheng Kung University, Taiwan

2. Sensors Fusion using RSS based Particle Filter in Precise Indoor Localization: Ruojun Li, Liyuan Xu, Julang Ying, Kaveh Pahlavan, Worcester Polytechnic Institute

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**Session D4: Ground Vehicle Navigation**

**Room:** Spyglass

1:50 A Combined Approach to Single-Camera-Based Lane Detection in Driverless Navigation: Xin Zhang, Xingqun Zhan, Shanghai Jiao Tong University, China

2:12 Combination of Computer Vision Detection and Segmentation for Autonomous Driving: Yu-Ho Tseng, Shau-Shiun Jan, National Cheng Kung University, Taiwan


2:58 Integrity and Continuity of GPS-based Collision Warning Systems using Vehicle-to-vehicle Communication: Gustavo Lee, Mathieu Joerger, University of Arizona

3:25 - 3:55, Refreshment Break in Exhibit Hall

4:00 Behavioral Cloning for Driverless Cars using Transfer Learning: Xin Zhang, Xingqun Zhan, Shanghai Jiao Tong University, China

4:23 Quantitative Analysis of GNSS Performance under Railway Obstruction Environment: Debiao Lu, Shuxian Jiang, Baigen Cai, Wei Shangguan, Beijing Jiaotong University, China

4:46 Impact of Positioning Uncertainty on Eco-Approach and Departure of Connected and Automated Vehicles: Nigel Williams, Guoyuan Wu, University of California - Riverside; Pau Closas, Northeastern University

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**Cognizant Autonomous Systems for Safety Critical Applications (CASSCA) Workshop**

January 28-29, 2019

Hyatt Regency • Reston, Virginia

www.ion.org
Session A5: Alternative Sensors for Aiding INSs and Precision Timing  
Room: Big Sur

8:35  Tightly Coupled Navigation System of a Differential Magnetometer System with a MEMS-IMU for Enceladus: Sabine Macht, Martin Escher, Markus Bobbe, Barbara Kohn, Ulf Bestmann, Institute of Flight Guidance, Germany


10:05-10:35, Refreshment Break - Session Room Lobby

10:40  The Heights for the Time Measurement and the Time for the Heights Measurement: Alberto Cina, Politecnico di Torino, Italy; Davide Calonico, Istituto Nazionale di Ricerca Metrologica (INRIM), Italy; Paolo Dabove, Politecnico di Torino, Italy


11:26  LRF Assisted SLAM for Airborne Platforms: Kerem Eyice, Onur Çulha, Defense Industries Research and Development Institute (DIARDI), Turkey


Alternates

1. STL Performance for Positioning of Vessels and Ground Vehicles in GNSS Denied Environments: Oleg Garisilev, Brent Abbott, Andrey Tyagunov, Ryan Johnson, Orolia Spectracom

2. Magnetic Attitude Update (MAU) for Frame Misalignment Correction in Pedestrian Dead Reckoning (PDR): Maan Khedr, University of Calgary, Canada & Arab Academy for Science and Technology, Egypt; Ahmed Radi, Naser El-Sheimy, University of Calgary, Canada

Session B5: Atmospheric Effects  
Room: Cypress

8:35  Simulation and Tracking Algorithm Evaluation for Scintillation Signals on LEO Satellites Traveling Inside the Ionosphere: Dongyang Xu, Colorado State University; Yu Morton, University of Colorado Boulder; Yu Jiao, Intel Corporation; Charles Rino, University of Colorado Boulder

8:57  Dual Kalman Filtering Based GNSS Phase Tracking for Scintillation Mitigation: Friederike Fohlmeister, German Aerospace Center (DLR), Germany; Felix Antreich, Federal University of Ceara (UFC), Brazil; JoseF A. Nossek, Federal University of Ceara (UFC), Brazil/Technical University Munich (TUM), Germany


9:43  On-line Model Learning for Adaptive GNSS Ionospheric Scintillation Estimation and Mitigation: Jordi Vilà-Valls, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA), Spain; James T. Curran, ESA, The Netherlands; Pau Closas, Northeastern University, USA; Carles Fernández-Prades, Javier Arribas, CTTC/CERCA, Spain

10:05-10:35, Refreshment Break - Session Room Lobby

10:40  Study of the Effect of Ionosphere Scintillation-Induced Deep Fades on Multi-Frequency GNSS Carrier Phase: Brian Breitsch and Jade Morton, University of Colorado, Boulder

11:03  An End-to-end Approach for Near Real Time Ionosphere Monitoring Over Mid-latitudes from GPS Data using Kriging Interpolation and IGS Products: Elhadi Takka, Polytechnic Military School, Algeria; Aichouch Belhadj Aissa, USTHB University, Algeria; Hocine Kimouche, Polytechnic Military School, Algeria

11:26  Development of a European Ionospheric Threat Model in support of GBAS Deployment: Emilien Robert, Petr Jonas, EUROCONTROL, Belgium; Jonathan Vuillaume, Daniel Salos, Egis Avis; Philippe Yaya, Louis Hecker, CLS

11:48  Real-time Estimation of Atmospheric Disturbance for Unmanned Helicopter Based on Multi-source Navigation Data: Ke-cheng Sun, Qing-hua Zeng, Jian-ye Liu, Ya-jing Zhou, Yu-tong Dai, NRC, Nanjing University of Aeronautics and Astronautics, China

Alternates

1. Effects of the Ionosphere Dispersion on Wideband GNSS Signals: Zhao Danning, Lei Yu, National Time Service Center, Chinese Academy of Science, China

2. Performance Evaluation of Ionospheric Spatial Gradient Monitoring using Radio-over-Fiber Devices and a Single Clock Receiver for Extended Baselines: Takayuki Yoshihara, Susumu Saito, Shinji Saitoh, Electronic Navigation Research Institute (ENRI), National Institute of Maritime, Port and Aviation Technology (MPAT), Japan

3. Vector Tracking Algorithms Performances during Strong Equatorial Scintillation on Dynamic Platforms: Dongyang Xu, Colorado State University; Yu Morton, University of Colorado Boulder; Yu Jiao, Intel Corporation; Charles Rino, Rong Yang, University of Colorado Boulder
THURSDAY MORNING TECHNICAL SESSIONS • 8:30 a.m. - 12:15 p.m.

Session C5: Navigation Using Environmental Features
Room: Windjammer

8:35  Cooperative Simultaneous Localization and Mapping for Pedestrians using Low-Cost Ultra-Wideband System and Gyroscope: Christian Gentner, Markus Ulmschneider and Thomas Jost, German Aerospace Center (DLR), Germany
8:57  Enhanced Acceleration Phase Tracking for Moving Platform Detection in 3D Indoor Navigation: Susanna Kaiser, German Aerospace Center (DLR), Germany
9:20  First-Person Indoor Navigation via Vision-Inertial Data Fusion: Amirreza Farnoosh, Mohsen Naban, Pau Closas, Sarah Ostadabbas, Northeastern University
9:43  A Machine Learning Approach for Localization in Cellular Environments: Ali A. Abdallah, Samer S. Saab, Lebanese American University; Zak (Zaher) M. Kassas, University of California, Riverside
10:05-10:35, Refreshment Break - Session Room Lobby
10:40  Relative Train Localization with Magnetic Field Measurements: Benjamin Siebler, Oliver Heirich, Stephan Sand, German Aerospace Center (DLR), Institute of Communications and Navigation, Germany
11:03  Geolocalization via Tracking of Wideband Radio Astronomical Sources in the Presence of Radio Frequency Interference: Muhammet Emin Yanik, and Murat Torlak, University of Texas at Dallas
11:26  A Methodology for Estimation of Ground Phenomena Propagation: Sharon Rabinovich, Renwick E. Curry, Gabriel Hugh Elkaim, UCSC

Alternates
1. An Environment Recognition Method for MAVs using a Smartphone: Yaning Wang, Li Fu, Lingling Wang, Yandong Wang, Beihang University, China
2. Performance Evaluation of the 3D MAP Based Precise Positioning and its Applications: Nobuaki Kubo and Rei Furukawa, Tokyo University of Maritime Science and Technology, Japan
3. Importance Sampling Kalman Filter for Urban Canyon Navigation: Yeongkwon Choe, Seoul National University, Republic of Korea; Jin Woo Song, Sejong University, Republic of Korea; Chan Gook Park, Seoul National University, Republic of Korea
4. Study on the use of Q-R Codes as Landmarks for Indoor Positioning: Preliminary Results: Zheqi Li, Jidong Huang, California State University, Fullerton

Session D5: Space Navigation and Observation
Room: Spyglass

8:35  Navigating to Small-Bodies using Small-Satellites: Stephen Schwartz, Ravi Teja Nallapu, Vishnu Reddy, Erik Asphaug and Jekan Thangavelautham, University of Arizona
8:57  Simulation Toolset for Localization and Control of Swarming Vehicles using Random Finite Set Theory: Vaughn A. Weirens, Chuck S. Hisamoto, Sunee I. Sheikh, ASTER Labs Inc.
9:20  Smart Camera System On-board a CubeSat for Space-based Object Reentry and Tracking: Ravi Teja Nallapu, Aaditya Ravindran, Himangshu Kalita, Vishnu Reddy, Roberto Furfaro, Erik Asphaug and Jekan Thangavelautham, University of Arizona
9:43  Planning and Navigation of Climbing Robots in Low-Gravity Environments: Steven Morad, Himangshu Kalita and Jekan Thangavelautham, University of Arizona
10:05-10:35, Refreshment Break - Session Room Lobby
10:40  Path Planning and Navigation Inside Off-World Lava Tubes and Caves: Himangshu Kalita, Steven Morad, Aaditya Ravindran, Jekan Thangavelautham, University of Arizona
11:03  Detection of Surface Lake Ice with GNSS Reflectometry: Roohollah Parvizi, James Henry, Norikazu Honda, Boris S. Pervan, and Seeban Datta-Barua, Illinois Institute of Technology

Alternates
2. A Neural Network Approach to Localized Atmospheric Density Estimation for Orbit Determination: Kyri E. Barton, University of Kansas; Humberto C. Godinez, Los Alamos National Laboratory; Craig A. McLaughlin, University of Kansas

12:15 p.m. - 1:45 p.m. • Award Luncheon in the Regency Grand Ballroom • Late arrivals will not be served after 12:30 p.m.

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Session A6: Adaptive KF Techniques, Data Integrity, and Error Modeling

Room: Big Sur

1:50 Towards an Online Sensor Model Validation and Estimation Framework: Juan D. Jurado and John F. Raquet, Air Force Institute of Technology

2:12 State and Measurement Noise in Positioning and Tracking: Covariance Matrices Estimation and Gauussianity Assessment: Jindrich Dunik, Honeywell International, Advanced Technology Europe, Czech Republic; Oliver Kost, Ondrej Straka, University of West Bohemia, Czech Republic; Erik Blasch, US Air Force Research Laboratory

2:35 Construction of Dynamically-Dependent Stochastic Error Models: Philipp Clausen, Swiss Federal Institute of Technology – Lausanne (EPFL), Switzerland; Samuel Orso, University of Geneva, Switzerland; Jan Skaloud, EPFL, Switzerland; Stéphane Guerrier, Pennsylvania State University, USA

2:58 An Optimal Virtual Inertial Sensor Framework using Wavelet Cross Covariance: Yuming Zhang, Pennsylvania State University, USA; Haotian Xu, University of Geneva, Switzerland; Ahmed Ridi, University of Calgary, Canada; Roberto Molinari, Stephane Guerrier, Pennsylvania State University, USA; Naser El-Sheimy, University of Calgary, Canada

3:20 Deriving Confidence from Artificial Neural Networks for Navigation: Joseph Curro, Air Force Institute of Technology

3:42 Driver Behavior Assessment Based on Loosely Coupled GPS/INS Integration in Harsh Environment: Oussama Derbel, Mohamed Lajmi Cherif and René Jr. Landry, LASSENA/ETS, France


4:26 A Method of Inertial Integrated Navigation Based on Low Cost MEMS Sensors: Zheng-chun Wang, Zhi Xiong, Pin LV, Jian-xin Xu, Xin Huang, Li-min Xu, Nanjing University of Aeronautics & Astronautics, China

Alternates


2. Multi-Faults Detection and Isolation for Redundant Strapdown Inertial Navigation System: Jianhua Cheng, Xiangyu Sun, Daidai Chen, Chun Cheng, Hongjie Mou, Ping Liu, Harbin Engineering University, China

3. Results from Van Testing of Inertial Unit with Innovative Bias Drift Compensation by Kalman Filtering: Rita Fontanella, Rosario Schiano Lo Morriello, Domenico Accardo, Leopoldo Angrisani University of Naples "Federico II", Italy; Domenico De Simone, Generale Meccatronica Applicata S.p.A., Italy

4. Combining Locally Weighted Scatterplot Smooth and Least Squares Predication to Reduce TOA Ranging Error: Shihong Duan, Yanzhong Liu, Jie He, University of Science and Technology, China

Session B6: Frontiers of GNSS

Room: Cypress

1:50 Use of SBAS Corrections with Local-Area Monitoring for Railway Guidance and Control Applications: Pietro Salvatori and Cosimo Stallaro; RadioLabs, Italy; Sam Pullen, Sherman Lo, and Per Enge; Stanford University, USA

2:12 Multi-Frequency Precise Point Positioning using GPS and Galileo Data with Smoothed Ionospheric Corrections: Francesco Basile, Terry Moore, Chris Hill, Nottingham Geospatial Institute, University of Nottingham, UK; Gary McGraw and Andrew Johnson, Rockwell Collins

2:35 New Solutions to Reduce the Time-To-CED and to Improve the CED Robustness of the Galileo I/NAV Message: Lorenzo Ortega Esplugà, TESA, France; Charly Pouilliat, Marie-Laure Boucheret, ENSEEIHT, France; Marion Aubault, CNES, France; Hanaa Al bitar, Thales Alenia Space, France

2:58 Galileo Open Service Time Performance: Amale Kanj, Jérôme Delporte, Norbert Suard, Bernard Bonhoure, CNES, France; Pascale Defraigne, Royal Observatory of Belgium

3:20 BeiDou Signal Acquisition based on a New Double Block Zero-padding Method: Shan Xu, Falin Wu, Chenghao Geng, Beihang University, China

3:42 Pre- and Post-Correlation Methods for Acquisition of New GNSS Signals with Secondary Code: Jiri Svaton, Frantisek Vejrazka, Czech Technical University in Prague, Czech Republic

4:04 Multiplex Modulation Techniques for a Navigation Constellation Simulator: Philipp Neumaier, Markus Bochenko, Andreas Blumenschein, Nikolas Hansen, Josef Lex, Philipp Clausen, Markus Bochenko, Andreas Blumenschein, Nikolas Hansen, Josef Lex

4:26 An Optimized and Payload Achievable Multiplexing Design Technique for GNSS Signals: Jiayi Zhang, Zheng Yao, Junjie Ma and Mingquan Lu, Tsinghua University, China

Alternate

1. Estimating Temporally and Spatially Dependent GNSS Errors Across Roadway Networks using Crowdsourced Data: Nigel Williams, Chao Wang, and Matthew Barth, University of California, Riverside
Session C6: Collaborative and Networked Navigation
Room: Windjammer

1:50 Information Fusion Strategies for Collaborative Radio SLAM: Joshua Morales and Zak (Zaher) M. Kassas, University of California, Riverside
2:12 Evaluating an EKF Simulation tool for Collaborative Navigation Systems: Nicolas Garcia Fernandez and Steffen Schönn, Institut für Erdmessung, Leibniz Universität Hannover, Germany
2:35 A Novel GNSS based V2V Cooperative Localization using Consistency Checks to Exclude Multipath Effect: Guohao Zhang, Weisong Wen and Li-Ta Hsu, The Hong Kong Polytechnic University, Hong Kong
2:58 GPS-Limited Cooperative Positioning Using Scalable Approximate Decentralized Data Fusion: Steven Dourmaskin, University of Colorado Boulder; William Whitacre, Draper; Dennis Akos, Nisar Ahmed, University of Colorado Boulder
3:20 GPS Time Authentication against Spoofing for Power Systems via a Network of Receivers: Tara Yasmin Mina, Sriramya Bhamdipati, and Grace Xingxin Gao, University of Illinois at Urbana-Champaign
3:42 A Theoretical Framework for Collaborative Estimation of Distances Among GNSS Users: Alex Minetto and Fabio Dovis, Politecnico di Torino, Italy
4:04 Scalable Ad-hoc UWB Network Adjustment: Zoltan Koppanyi, Charles K. Toth, and Dorota Grejner-Brzezinska, The Ohio State University
4:26 UWB Body Motion Assisted Indoor Geolocation with a Single Reference Point: Liyuan Xu, Jie He, Julang Ying, Peng Wang, Kaveh Pahlavan, Qin Wang, University of Science and Technology Beijing, China

Alternates
1. Research on Optimal Inter-vehicle Fusion Method for Low-cost-sensor-based Cooperative Navigation: Rong Wang, Zhi Xiong, Jianye Liu and Yuxuan Cao, Nanjing University of Aeronautics and Astronautics, China
2. Range-Free Localization with Multidimensional Scaling for Dense NB-IoT Networks in 5G: Emanuel Staudinger, Michael Walter, Armin Damman, German Aerospace Center (DLR), Germany
3. Intel GNSS Assistance Server Solution: Murugan Natesan, Geraint Ffoulkes-Jones, Siddhant Sadanah, Intel, India
4. Utilize Aerostat to Realize Emergency Service of Integrated Network for Navigation and Communication: Weiyi Chen Haitao Wu Pingke Deng Xiaoguang Zhang YiQu, Chinese Academy of Science, China
5. Collaborative Navigation in Fusion of Inertial Sensors and IoT Applications: Julang Ying, Ruojun Li, Liyuan Xu, Kaveh Pahlavan, Worcester Polytechnic Institute

Session D6: Algorithms and Methods
Room: Spyglass

1:50 Exploiting Side-Information for Resilient GNSS Positioning in Mobile Phones: Silvia Ceccato, Francesco Formaggio, Gianluca Caparra, Stefano Tomasin, Nicola Laurenti, University of Padova, Italy
2:12 TOA Positioning for a TDMA Localization System: Sihao Zhao, Xiaowei Cui, Shuang Xu, Mingquan Lu, Tsinghua University, China
2:35 Doppler-aided Position Estimation for HS-GNSS: Francois Vincent and Eric Chaumette, University of Toulouse, ISAE-Supaero, France
2:58 A Novel DE-KFL for BOC Signal Tracking Assisted by FRFT in a Highly Dynamic Environment: Yiran Luo, University of Technology, China, and University of Calgary, Canada; Naser El-Sheimy, University of Calgary, Canada
3:20 Hardware Validation of an Adaptive Optimization Algorithm for Tap Delay Wavefront: Gregory Reynolds, US Army, AMRDEC; Laurie Joiner, University of Alabama in Huntsville
3:42 Aero-Flexure Estimation and Autonomous Navigation Performance Improvement: Transfer Alignment Algorithm Implementation: Daniele Grifi, Roberto Senatore, Andrea Pizzarulli, Civilanavi Systems, Italy
4:04 A Statistical Approach for Optimal Order Adjustment of A Moving Average Filter: Rodrigo Gonzalez, GridTICs, National University of Technology, Argentina; Carlos A. Catania, ITICS, National University of Cuyo, Argentina
4:26 A Noise Estimation Algorithm based on Modified System Model and Its Application on Backtracking: Xuan Xiao, Xiang Guo, Meiling Wang, Tong Liu, Songtian Shang, Beijing Institute of Technology, China
April 8-11, 2019
Hilton Waikiki Beach
Honolulu, Hawaii

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<tr>
<th>Date</th>
<th>Room: Big Sur</th>
<th>Room: Cypress</th>
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<tbody>
<tr>
<td>Monday, April 23</td>
<td>Contemporary and Emerging Inertial Sensor Technologies 9:00 a.m. - 12:30 p.m.</td>
<td>Alternative Navigation Methods Exploiting Integration with Inertial Measurements 9:00 a.m. - 12:30 p.m.</td>
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<td>12:30 p.m. - 1:30 p.m., Lunch on Your Own</td>
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<td></td>
<td>Fundamentals of Inertial Navigation Systems and Aiding 1:30 p.m. - 5:00 p.m.</td>
<td>Fundamentals of Nonlinear Recursive Estimation 1:30 p.m. - 5:00 p.m.</td>
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<tr>
<td>Technical Sessions: Track A</td>
<td>Room: Big Sur</td>
<td>Technical Sessions: Track B</td>
</tr>
<tr>
<td>Tuesday, April 24</td>
<td>A1: High Performance Inertial Sensor Technologies 8:30 a.m. - 12:15 p.m.</td>
<td>B1: Receiver Signal Processing 8:30 a.m. - 12:15 p.m.</td>
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<tr>
<td></td>
<td>A2: Small Size or Low Cost Inertial Sensor Technologies 1:45 p.m. - 5:30 p.m.</td>
<td>B2: GNSS Integrity and Augmentation 1:45 p.m. - 5:30 p.m.</td>
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<td>12:15 p.m. - 1:15 p.m. Lunch in the Exhibit Hall, Regency Ballroom</td>
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<td>Exhibitor Hosted Reception in Exhibit Hall 6:00 p.m. - 8:00 p.m., Regency Ballroom</td>
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<tr>
<td>Wednesday, April 25</td>
<td>A3: Inertial Measurement Units 8:30 a.m. - 12:15 p.m.</td>
<td>B3: Precise GNSS Positioning Applications 8:30 a.m. - 12:15 p.m.</td>
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<tr>
<td></td>
<td>A4: Integrated Inertial Navigation Systems 1:45 p.m. - 5:30 p.m.</td>
<td>B4: GNSS Resilience 1:45 p.m. - 5:30 p.m.</td>
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<td></td>
<td>A5: Alternative Sensors for Aiding INSs and Precision Timing 8:30 a.m. - 12:15 p.m.</td>
<td>B5: Atmospheric Effects 8:30 a.m. - 12:15 p.m.</td>
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<td></td>
<td>12:15 p.m. - 1:15 p.m. Lunch in Exhibit Hall, Regency Ballroom</td>
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<tr>
<td>Thursday, April 26</td>
<td>A6: Adaptive KF Techniques, Data Integrity, and Error Modeling 1:45 p.m. - 5:00 p.m.</td>
<td>B6: Frontiers of GNSS 1:45 p.m. - 5:00 p.m.</td>
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<td></td>
<td>12:15 p.m. - 1:45 p.m. Awards Luncheon, Regency Ballroom (late arrivals will not be served after 12:30 p.m.)</td>
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</tbody>
</table>

**HOTEL FLOOR PLANS**

- **Conference Center, First Floor**
  - Tutorials
  - Technical Sessions

- **Conference Center, Second Floor**
  - Exhibit Hall
  - Speakers’ Breakfast
  - Registration

- **REGENCY GRAND BALLROOM**
- **EXHIBITS**

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