



ION[®]
INSTITUTE OF NAVIGATION



IEEE

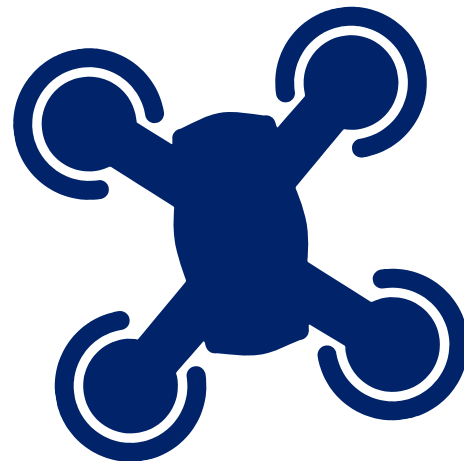


PLANS **2023**

IEEE/ION Position Location and Navigation Symposium

April 24-27, 2023

Hyatt Regency Monterey
Monterey, CA



ADVANCE PROGRAM

ion.org/plans



Program Chair
Dr. Zak Kassas
The Ohio State University



Tutorial Chair
Dr. Jason Gross
West Virginia University



Track A:
Dr. Michael Braasch
Ohio University



Track B:
Dr. Pau Closas
Northeastern University



Track C:
Dr. Christian Gentner
German Aerospace Center (DLR)



Track D:
Dr. Robert Leishman
Draper

CONFERENCE INFORMATION

Conference Special Events

The following meals and events are all included in all full-conference registrations. Single day registrations include events taking place on the day the attendee is registered.

Informal Luncheon

Tuesday, April 25, 12:15 p.m. - 1:15 p.m., Exhibit Hall

Evening Hour in Exhibit Hall

Tuesday, April 25, 5:30 p.m. - 6:30 p.m., Exhibit Hall

Informal Luncheon

Wednesday, April 26, 12:15 p.m. - 1:15 p.m., Exhibit Hall

Awards Luncheon

Thursday, April 27, 12:15 p.m. - 1:45 p.m.

(late arrivals cannot be served after 12:30 p.m.)

The IEEE will present the Kershner Award and Walter Fried Award. This event is included in full-conference or Thursday-only registrations. Guest tickets may be purchased onsite.

For Speakers and Session Chairs

A mandatory Speakers' Breakfast will be held at 7:30 a.m. Tuesday through Thursday. This event is for session chairs and the presenting author (for both 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 and Presentations

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.

Mobile Conference Site

Access the technical program, exhibitor listing, and other conference information from your mobile device at m.ion.org.

Photography Policy

Your presence at PLANS constitutes your agreement to be photographed, filmed, videotaped or otherwise recorded by conference management, or its agents, and your agreement that your image or voice may be distributed in print or electronic communications media without any compensation being paid to you. Video recording by participants is not allowed without written permission of ION during any portion of the conference. Photographs of copyrighted presentations are for personal use only and are not to be reproduced or distributed. Do not photograph any images labeled as proprietary. Flash photography, or any form of photography that disturbs those around you, is prohibited.

EXHIBIT HALL INFORMATION

Show Hours:

Tuesday, April 25

9:30 a.m. – 6:30 p.m.

Exhibit Hall Open

5:30 p.m. – 6:30 p.m.

Evening Hour in Exhibit Hall

Wednesday, April 26

9:30 a.m. – 4:00 p.m.

Exhibit Hall Open

View the exhibitor list and floor plan at ion.org/plans

For Exhibitors:

Exhibit space is still available - reserve your booth now at ion.org/plans

Questions? Contact ION:

Booth Reservations and Sponsorship Opportunities:

Megan Andrews

Phone: 703-366-2723

Email: mandrews@ion.org

PROGRAM OVERVIEW



Pre-Conference Tutorial Sessions (Add'l Registration and Fee Required)

Room: Spyglass

Monday, April 24

8:30 a.m. - 9:30 a.m. Introduction to Inertial Navigation Systems (INS) and Aiding, Dr. Michael Braasch
 9:30 a.m. - 11:00 a.m. Visual Aided Inertial Navigation, Dr. Michael Veth
 11:15 a.m. - 12:45 p.m. Magnetic Aided Inertial Navigation, Dr. Aaron Nielsen

12:45 p.m. - 2:15 p.m., Lunch on Your Own

2:15 p.m. - 3:45 p.m. Signals of Opportunity Based Navigation, Dr. José A. del Peral-Rosado and Dr. Christian Gentner
 4:00 p.m. - 5:30 p.m. Factor Graphs for Non-linear Estimation Problems, Dr. Clark Taylor

IEEE/ION PLANS Technical Sessions

Technical Sessions: Track A

Technical Sessions: Track B

Technical Sessions: Track C

Technical Sessions: Track D

Tuesday, April 25

Exhibit Hall Open, 9:30 a.m. - 6:30 p.m.

A1: High Performance Inertial Sensor Technologies
 8:30 a.m. - 10:05 a.m.
 Room: Spyglass

B1a: Precise GNSS Positioning
 8:30 a.m. - 10:05 a.m.
 Room: Windjammer

C1: Multisensor Integrated Systems and Sensor Fusion Technologies
 8:30 a.m. - 12:15 p.m.
 Room: Big Sur

D1: Robotic and Indoor Navigation
 8:30 a.m. - 12:15 p.m.
 Room: Cypress

B1b: Atmospheric Effects
 10:35 a.m. - 12:15 p.m.
 Room: Windjammer

12:15 p.m. - 1:15 p.m. Lunch in the Exhibit Hall

A2: Small Size or Low-Cost Inertial Sensor Technologies
 1:45 p.m. - 3:25 p.m.
 Room: Spyglass

B2: Frontiers of GNSS
 1:45 p.m. - 5:30 p.m.
 Room: Windjammer

C2a: Navigation Using Environmental Features
 1:45 p.m. - 5:30 p.m.
 Room: Cypress

C2b: Collaborative and Networked Navigation
 1:45 p.m. - 5:30 p.m.
 Room: Big Sur

D2: Marine Vehicle Navigation
 3:55 p.m. - 5:30 p.m.
 Room: Cypress

Evening Hour in Exhibit Hall 5:30 p.m. - 6:30 p.m.

Wednesday, April 26

Exhibit Hall Open, 9:30 a.m. - 4:00 p.m.

A3: Alternative Sensors for Aiding INSs and Precision Timing
 8:30 a.m. - 12:15 p.m.
 Room: Spyglass

B3: GNSS Resilience to Interference, Jamming, and Spoofing 1
 8:30 a.m. - 12:15 p.m.
 Room: Windjammer

C3: Signals of Opportunity-Based Navigation Systems 1
 8:30 a.m. - 12:15 p.m.
 Room: Big Sur

D3: Space Navigation and Observation
 8:30 a.m. - 12:15 p.m.
 Room: Cypress

12:15 p.m. - 1:15 p.m. Lunch in the Exhibit Hall

B4: GNSS Resilience to Interference, Jamming, and Spoofing 2
 1:45 p.m. - 5:30 p.m.
 Room: Windjammer

C4: Signals of Opportunity-Based Navigation Systems 2
 1:45 p.m. - 5:30 p.m.
 Room: Big Sur

D4a: AI-Enhanced Navigation Systems
 1:45 p.m. - 5:30 p.m.
 Room: Spyglass

D4b: Ground Vehicle Navigation
 1:45 p.m. - 5:30 p.m.
 Room: Cypress

Thursday, April 27

A5a: Inertial Measurement Units
 8:30 a.m. - 10:05 a.m.
 Room: Spyglass

B5: Receiver Design, Signal Processing, and Antenna Technology 1
 8:30 a.m. - 12:15 p.m.
 Room: Windjammer

C5a: Frontiers of Radionavigation: Signals of Opportunity, 5G, LEO, and Beyond
 8:30 a.m. - 12:15 p.m.
 Room: Cypress

C5b: Vision-Based Navigation Systems
 8:30 a.m. - 12:15 p.m.
 Room: Big Sur

A5b: Integrated Inertial Navigation Systems
 10:35 a.m. - 12:15 p.m.
 Room: Spyglass

12:15 p.m. - 1:45 p.m. Awards Luncheon (late arrivals cannot be served after 12:30 p.m.)

A6: Alternative Sensors for Aiding INSs and Precision Timing
 1:45 p.m. - 3:20 p.m.
 Room: Spyglass

B6a: Receiver Design, Signal Processing, and Antenna Technology 2
 1:45 p.m. - 4:50 p.m.
 Room: Windjammer

B6b: GNSS Integrity and Augmentation Systems
 1:45 p.m. - 4:50 p.m.
 Room: Big Sur

D6: Aerial Vehicle Navigation
 1:45 p.m. - 4:50 p.m.
 Room: Cypress

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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

Introduction to Inertial Navigation Systems (INS) and Aiding

Date: Monday, April 24, 2023

Time: 8:30 a.m. - 9:30 a.m.

Room: Big Sur

Registration Fee:

\$450 if paid on or before March 24

\$530 if paid after March 24

For over 70 years inertial navigation systems have proven to be indispensable in the aerospace industry. They are immune to jamming and provide position, velocity and attitude with low noise, high data rates and low data latencies. Since the 1960s, the long-term drift inherent in any inertial system has typically been corrected through the integration of an external aiding source via an extended Kalman filter. In this lecture we will review the key operating principles of inertial navigation and will highlight the major error characteristics. The primary inertial-aiding design architectures will then be discussed along with performance considerations.



Dr. Michael Braasch is a Professor of EE at Ohio University and has taught inertial navigation short courses at Honeywell, Kearfott and Northrop Grumman.

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Image Aided Inertial Navigation – Design, Analysis, and Alternatives

Date: Monday, April 24, 2023

Time: 9:30 a.m. - 11:00 a.m.

Room: Big Sur

Registration Fee:

\$450 if paid on or before March 24

\$530 if paid after March 24

This course focuses on the rapidly growing area of image and video-based navigation techniques. The topics will include detailed descriptions of camera calibration and removal of image distortion, feature extraction techniques, methods for solving the correspondence problem and extracting navigation information. Strategies for incorporating image updates into navigation systems are presented including feature matching and tracking, optical flow, and methods for coupling with inertial sensors.

Examples of real-time implementations are presented along with references to open-source software packages. Applicable references are provided for further study.

This course will be presented at an engineering level with the goal of understanding the various components and algorithms required to construct a multi-sensor image-aided navigation system. The course is appropriate for engineers with experience in the navigation field with an interest in learning practical approaches for incorporating image observations into navigation systems.



Dr. Michael Veth 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.

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Magnetic Aided Inertial Navigation

Date: Monday, April 24, 2023

Time: 11:15 a.m. - 12:45 p.m.

Room: Big Sur

Registration Fee:

\$450 if paid on or before March 24

\$530 if paid after March 24

Magnetic-Aided Inertial Navigation (MagNav) uses the magnetic anomaly of the Earth's crust as a map to provide corrections to an inertial navigation system. This tutorial covers the essentials required for MagNav, including the required sensor technology, magnetic anomaly maps for navigation, as well as removal of the magnetic fields generated by vehicles and the techniques to incorporate magnetic measurements into an inertial navigator.



Dr. Aaron Nielsen is a research assistant professor at the Air Force Institute of Technology. He received a PhD in Physics from the University of Maryland focused on magnetic microscopy of superconductors and then worked in industry with a focus on airborne magnetics.

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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

Signals of Opportunity Based Navigation

Date: Monday, April 24, 2023

Time: 2:15 p.m. - 3:45 p.m.

Room: Big Sur

Registration Fee:

\$450 if paid on or before March 24

\$530 if paid after March 24

Signals of Opportunity (SoO) can be used to complement or back-up Global Navigation Satellite Systems (GNSS) and other dedicated positioning systems. This tutorial covers the fundamentals principles of SoO based navigation together with practical examples from indoor positioning, Simultaneous Localization and Mapping (SLAM) methods using SoO and 5G networks for positioning.



Dr. José A. del Peral-Rosado is working within the Future Navigation Programs Department at Airbus Defence and Space GmbH. He conducted theoretical and experimental research activities on hybrid GNSS, LTE, and 5G localization.



Dr. Christian Gentner is working at the Institute of Communications and Navigation of the German Aerospace Center (DLR). His current research focuses on multipath assisted and indoor positioning. In 2020, he founded the DLR-spin-off TrackIn which offers an accurate, simple, and affordable ultra-wideband based localization technology which is used in retail.

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 to registered tutorial attendees from the conference website one week prior to the course; tutorial registrants are encouraged to download notes in advance of courses. ION reserves the right to cancel a portion of the tutorial program based on availability of the instructor.

Factor Graphs for Non-linear Estimation Problems

Date: Monday, April 24, 2023

Time: 4:00 p.m. - 5:30 p.m.

Room: Big Sur

Registration Fee:

\$450 if paid on or before March 24

\$530 if paid after March 24

While the Kalman Filter (KF) family (linear KF, EKF, UKF, etc.) has been the workhorse of navigation systems for several decades, the factor graph is a generalization of the Kalman Filter that offers improved performance for non-linear systems and is more easily applied to complex systems. In this tutorial, factor graph method for estimating non-linear systems will be introduced to those who are already familiar with Kalman Filter estimators. A comparison of the factor graph vs the extended Kalman Filter will be presented.



Dr. Clark Taylor is the ANT Center director and an assistant professor at the Air Force Institute of Technology. He received his PhD from University of California, San Diego, and previously worked as a senior research engineer with the Air Force Research Laboratory and an assistant professor in electrical engineering at Brigham Young University.

A1: High Performance Inertial Sensor Technologies

Date: Tuesday, April 25, 2023

Time: 8:30 a.m. - 10:05 a.m.

Room: Spyglass

Session Chairs:



Dr. Arnon Arbel

Cielo Inertial Solutions



Zenon Melnyk

Collins Aerospace

8:35. A New High-Performance, Closed-Loop Digital MEMS Accelerometers and Gyros Platform for Dynamic Applications, Pierre Gazull, Vincent Gaff, Olivier Gigan, Antoine Filipe, Tronics Microsystems

8:57. Fused Multi-IMU Direct Sensor-to-Vehicle Extrinsic Calibration, Gregory M. Mifflin, David M. Bevely, Auburn University

9:20. Hull Deformation Angle Measurement Algorithm Based on Improved Particle Swarm Optimization Inertia Matching, Xiaofeng Wei, Shiwei Fan, Ya Zhang, Longkang Chang, Zixuan Ning, Wen Xing, Feng Shen, Harbin Institute of Technology

9:43. Miniature Silicon Photonics Optical Gyro, Mike Horton, ANELLO Photonics

10:05-10:35, Break. Refreshments in Exhibit Hall

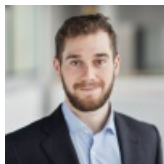
B1a: Precise GNSS Positioning

Date: Tuesday, April 25, 2023

Time: 8:30 a.m. - 10:05 a.m.

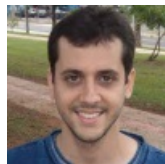
Room: Windjammer

Session Chairs:



Dr. Daniel Medina

German Aerospace Center (DLR)



Dr. Fabricio Prol

Finnish Geospatial Research Institute

8:35. Triple-frequency PPP-AR model comparison from the user perspective: combined and uncombined models, Liu Yichen, Robert Bosch GmbH & Technical University of Munich; Mikhaylov Nikolay, Robert Bosch GmbH; Hugentobler Urs, Duan Bingbing, Technical University of Munich

8:57. Multipath Detection and Mitigation from GNSS Observations Using Antenna Arrays, Mohanad Ahmed, Tarig Ahmed, Xing Liu, Tareq Al-Naffouri, King Abdullah University of Science and Technology

9:20. On the Feasibility of Instantaneous Multi-GNSS Multi-Frequency PPP-RTK, Andreas Brack, Benjamin Männel, GFZ Potsdam; Harald Schuh, GFZ Potsdam and Technische Universität Berlin

9:43. Massive Differencing of GNSS Pseudorange Measurements, Helena Calatrava, Electrical and Computer Engineering Dept., Northeastern University; Daniel Medina, Institute of Communications and Navigation, German Aerospace Center (DLR); Pau Closas, Electrical and Computer Engineering Dept., Northeastern University

10:05-10:35, Break. Refreshments in Exhibit Hall

12:15 p.m. – 1:15 p.m. Lunch in the Exhibit Hall

B1b: Atmospheric Effects

Date: Tuesday, April 25, 2023

Time: 10:35 a.m. - 12:15 p.m.

Room: Windjammer

Session Chair:



Dr. Fabio Dovis

Politecnico di Torino

10:40. Optimal Reconstruction of Atmospheric Gravity Waves from Traveling Ionospheric Disturbances, Sebastijan Mrak, University of Colorado Boulder; Joe Huba, Syntek Technologies; Erich Becker, Sharon Vadas, North West Research Associates

11:03. Performance Evaluation of the Ionospheric Threat Mitigation Strategies in Dual-Frequency Multi-Constellation GBAS, Maria Caamano, Daniel Gerbeth, Hiroatsu Sato, German Aerospace Center (DLR); Mihaela-Simona Cirtiu, ESA/ESTEC; Michael Felux, Zurich University of Applied Sciences (ZHAW)

11:26. GNSS Pseudorange Measurement Noise Identification by Measurement Difference Method, Oliver Kost, University of West Bohemia; Jindrich Dunik, Honeywell International, Advanced Technology Europe and University of West Bohemia; Ondrej Straka, University of West Bohemia; Ondrej Daniel, Huld

11:48. On the Use of Machine Learning Algorithms to Improve GNSS Products, Andrea Nardin, Fabio Dovis, Diego Valsesia, Enrico Magli, Politecnico di Torino - DET; Chiara Leuzzi, Rosario Messineo, ALTEC; Hugo Sobreira, Richard Swinden, European Space Agency - ESTEC

12:15 p.m. – 1:15 p.m. Lunch in the Exhibit Hall

C1: Multisensor Integrated Systems and Sensor Fusion Technologies

Date: Tuesday, April 25, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Big Sur

Session Chairs:



Dr. Charles Toth

The Ohio State University



Dr. Vibhor Bageshwar

Honeywell

8:35. A Context-Based Framework for Enhancing GNSS Performance and Security, Sara Baldoni, Roma Tre University; Federica Battisti, University of Padova; Marco Carli, Roma Tre University; Alessandro Neri, Roma Tre University and Radiolabs

8:57. Multi-ride Fusion for Rail Digital Map Construction, Michele Brizzi, Roma Tre University; Alessandro Neri, Roma Tre University & Radiolabs

9:20. A Strong Lane Tracking Algorithm for Mobile Terminals, Hong kai Wang, Pan Jiang, Wei Yan, Yi long Yuan, Chang Liu, Tencent Technology (Beijing) Co., Ltd.

9:43. Factor Graph Dimensionality Reduction using Lateral Motion Constraints for Aided Dead Reckoning Navigation, Adam J Rutkowski, Air Force Research Laboratory; Yetong Zhang, Frank Dellaert, Georgia Institute of Technology

10:05-10:35, Break. Refreshments in Exhibit Hall

10:40. Improved Initial Integer Ambiguity Resolution When the Sky Visibility is Considerably Masked, Nobuaki Kubo, Kaito Kobayashi, Tomohiro Ozeki, Tokyo University of Marine Science and Technology; Tomohiro Narumi, Norihiro Yamaguchi, Shimizu Corporation

11:03. Predicting GPS Fidelity in Heavily Forested Areas, Andrew Moore, Nicholas Rymer, J. Sloan Glover, Derin Ozturk, NASA Langley Research Center

11:26. GPS Alignment from Multiple Sources to Extract Aircraft Bearing in Aerial Surveys, Joshua Power, University of New Brunswick; Derek Jacoby, University of Victoria; Marc-Antoine Drouin, Guillaume Durand, National Research Council Canada; Yvonne Coady, University of Victoria; Julian Meng, University of New Brunswick

11:48. Optimizing GNSS Time-Differenced Carrier Phase Measurements for High-integrity INS + GNSS Sensor Fusion Without Ambiguity Resolution, Tim Barford, Exail Defense Systems; Jean-Baptiste Lacambre, Exail, Inc.; Robert Greer, ExailDefense Systems

Alternate Presentations:

1. **Vision and UWB-Based Collaborative Positioning Between Ground and UAV Platforms**, Andrea Masiero, University of Florence; Charles Toth, Xiankun Wang, The Ohio State University; Fabio Remondino, Bruno Kessler Foundation
2. **Position Location Determination**, Eric S. Hodson, Naval Postgraduate School

12:15 p.m. – 1:15 p.m. Lunch in the Exhibit Hall

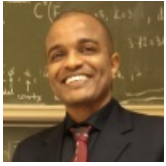
D1: Robotic and Indoor Navigation

Date: Tuesday, April 25, 2023

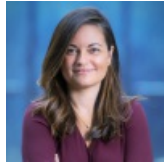
Time: 8:30 a.m. - 12:15 p.m.

Room: Cypress

Session Chairs:



Dr. Mohammed Khider
Google



Dr. Camila Francolin
Draper

8:35. Attitude Estimation Method for Smart Watch Using External Disturbance Model, Jae Hong Lee, Dept. of Aerospace Engineering, Seoul National University; Chan Gook Park, Dept. of Aerospace Engineering / Automation and Systems Research Institute, Seoul National University

8:57. Vibration-Based Dead-Reckoning for Vehicle Localization, Masakatsu Kourogi, Ryoshuke Ichikari, Takahiro Miura, Satoki Ogiso, Takashi Okuma, National Institute of Advanced Industrial Science and Technology

9:20. Integration of BLE-Based Proximity Detection with Particle Filter for Day-Long Stability in Workplaces, Satoki Ogiso, Ikue Mori, Takahiro Miura, Satoshi Nakae, Takashi Okuma, National Institute of Advanced Industrial Science and Technology (AIST); Yasunori Haga, Shintaro Hatakeyama, Kengo Kimura, Atsushi Kimura, DENSO CORPORATION; Takeshi Kurata, National Institute of Advanced Industrial Science and Technology (AIST)

9:43. Indoor Location Estimation of Electromagnetically Shielded Chassis Utilizing RSSI Fingerprint Pattern Matching, Toshiaki Yokoi, Department of Information Systems, Tokyo City University

10:05-10:35, Break. Refreshments in Exhibit Hall

10:40. Hips-SC: Hierarchical Primitive and Semantics Aided Scan Context for Place Recognition Using LiDAR and Monocular Image, Mengchi Ai, Ilyar asl sabbaghian hokmabadi, Chrysostomos Minaretzis, Naser El-Sheimy, University of Calgary

11:03. Implementation of Real-Time RTK/DGNSS on Smartphones and Positioning Improvement for Millions of Users in Southeast Asia, Xiao Hu, Xiaochuan Gong, Xiaolong Ji, Chao Wei, Hann Lam Woo, Firdaus Kiagos, Yanjin Li, Chunda Ding, Minbo Qiu, Bo Hu, Grab Holdings Inc.

11:26. Indoor 5G Positioning Using Multipath Measurements, Martin Andersson, Andreas Lidström, Linköping University; Gustav Lindmark, Ericsson AB

11:48. Integrity with Incorrect Extraction Faults in LiDAR-Based Urban Navigation for Driverless Vehicles, Kana Nagai, Yihe Chen, Matthew Spenko, Ron Henderson, Boris Pervan, Illinois Institute of Technology

Alternate Presentations:

- 1. Edge Focused Precise Positioning and Tracking with UWB Technology**, Muhammad Hafeez Chaudhary, and Bart Scheers, Royal Military Academy

12:15 p.m. – 1:15 p.m. Lunch in the Exhibit Hall

A2: Small Size or Low-Cost Inertial Sensor Technologies

Date: Tuesday, April 25, 2023

Time: 1:45 p.m. - 3:25 p.m.

Room: Spyglass

Session Chairs:



Ryan Knight

Army Research Lab



Dr. Alex Trusov

Northrop Grumman

1:50. Resource efficient and accurate altitude conversion to Mean Sea Level, Brian Julian and Michael Angermann, Google Inc.

2:12. Challenges in Developing a Family of MEMS Accelerometers for High-G Navigation Applications, John Cole, Andy Cunningham, Jerry Sweet, Pete Hulbert, Silicon Designs, Inc.

2:35. Universal Resonator Controller ASIC for Low SWaP-C INS, A. Dorian Challoner, Roy (Sy-Min) Chueng, Vladimir Vesely, Peter W. Bond, Eric Wittinger, Anjelica Pazmino, InertialWave, Inc.; David Hayner, Coherent Sensors, LLC

2:58. Design for Manufacturability Toward Achieving High-Performance MEMS Inertial Sensor in a Wafer-Level Vacuum-Sealed Platform, Tyler Harrison, Dean Spicer, Teledyne MEMS Inc.; Hasnet Ahmed, Sahereh Sahandabadi, Kevin Li, Huaishen Yan, Ankang Wang, and Mohammed Jalal Ahamed, Mechanical, Automotive and Materials Engineering, University of Windsor

3:25 - 3:55, Break. Refreshments in Exhibit Hall

Evening Hours in Exhibit Hall 5:30 p.m. – 6:30 p.m.

B2: Frontiers of GNSS

Date: Tuesday, April 25, 2023

Time: 1:45 p.m. - 5:30 p.m.

Room: Windjammer

Session Chairs:



Ranwa Haddad

The Aerospace Corporation



Eric Chatre

European Commission

1:50. Applied Atomic Timekeeping in Space, James Camparo, The Aerospace Corporation

2:12. Optical Technologies for Future Global Navigation Satellite Systems, Tobias D. Schmidt, Grzegorz Michalak, Janis Surof, Juraj Poliak, Gabriele Giorgi, Michael Meurer, Christoph Günther, German Aerospace Center, Institute of Communications and Navigation Thilo Schuldt, Claus Braxmaier, German Aerospace Center, Institute of Quantum Technologies

2:35. CRPA and Array Receivers for Civil GNSS Applications, E. Pérez-Marcos, M. Cuntz, A. Konovaltsev, L. Kurz, S. Caizzone, M. Meurer; Institute of Communications and Navigation, German Aerospace Center (DLR)

2:58. LEO PNT for Augmenting Europe's Space-Based PNT Capabilities, Lionel Ries, Miguel Cordero Limon, Florin-Catalin Grec, Marco Anghileri, Roberto Prieto Cerdeira, Felix Abel, Javier Miguez, Jose Vicente Perello Gisbert, Salvatore d'Addio, Rigas Ioannidis, Alessandra Ostilio, Manuela Rapisarda, Rui Sarnadas, Paride Testani - European Space Agency (ESA)

3:25 - 3:55, Break. Refreshments in Exhibit Hall

4:00. Integrated Missions: New Demands, Trends and Evolutions, Michel Monnerat, Hanaa Al Bitar, Thales Alenia Space

4:23. QZSS R&D and Future, Satoshi Kogure, Akihiro Matsumoto, Kyohei Akiyama, Japan Aerospace Exploration Agency; Jun Matsumoto, National Space Policy Secretariat Cabinet Office, Japan/QZSS Strategy Office

4:46. Enhancing PNT with Quantum-Atomic Technologies, Brenton C. Young, AOSense, Inc.

5:08. Synergies and Limitations of Inertial Measurements for PNT, Dr. Brad Parkinson, Stanford University

5:30. Opportunistic Navigation with Multi-Constellation LEO Satellites, Zak (Zaher) M. Kassas, Mohammad Neinavaie, and Sharbel Kozhaya, The Ohio State University

Evening Hours in Exhibit Hall 5:30 p.m. – 6:30 p.m.

C2a: Navigation Using Environmental Features

Date: Tuesday, April 25, 2023

Time: 1:45 p.m. - 5:30 p.m.

Room: Cypress

Session Chairs:



Dr. Jiwon Seo

Yonsei University



Tucker C. Haydon

Sandia National Laboratories

1:50. Magnetic Maps and Models for Alternative Navigation, Rick Saltus, CIRES, University of Colorado CIRES/NOAA Geomagnetism Team, University of Colorado

2:12. Bayesian Cramer-Rao Lower Bound for Magnetic Field-based Train Localization, Benjamin Siebler, Stephan Sand, German Aerospace Center (DLR); Uwe D. Hanebeck, Karlsruhe Institute of Technology (KIT)

2:35. Magnetic Anomaly Map Creation for Navigation, Luke Bergeron and Aaron Nielsen, Air Force Institute of Technology

2:58. Hardware-in-the-Loop Simulation Testbed for Three-Axis Earth's Magnetic Field Generation Based on 2.4-Meter Square Helmholtz Coils, Jormpon Chaisakulsurin, Shariff Manuthasna, Tanawish Masri, National Astronomical Research Institute of Thailand (NARIT); Thanayuth Panyalert, King Mongkut Institute of Technology Ladkrabang(KMITL); Kritsada Palee, Pakawat Prasit, Peerapong Torteeka, NARIT

3:25 - 3:55, Break. Refreshments in Exhibit Hall

4:00. Flight Test Results of Terrain Referenced Aircraft Navigation with Laser Altimeter, Burak Turan and Halil Ozan Ünsal, Roketsan Inc.

4:23. Evaluation of the Human Body Mask Effects on GNSS Wearable Devices for Outdoor Pedestrian Navigation Using Fisheye Sky Views, Ni Zhu, Univ Gustave Eiffel, AME-GEOLOC; Athanase Bouronopoulos, École Centrale de Nantes, IRSTV; Thomas Leduc, Nantes Université, ENSA Nantes, Myriam Servières, Nantes Université, ENSA Nantes, École Centrale Nantes, CNRS, AAU-CRENAU, UMR; Valérie Renaudin, Univ Gustave Eiffel, AME-GEOLOC

4:46. Terrain-Relative Navigation with Neuro-Inspired Elevation Encoding, Kristen Michaelson, The University of Texas at Austin; Felix Wang, Sandia National Laboratories; Renato Zanetti, The University of Texas at Austin

5:08. Investigations on Pedestrian Long-Term Trajectory Prediction Based on AI and Environmental Maps, Susanna Kaiser, German Aerospace Center (DLR), Institute of Communications and Navigation; Pierre Baudet, Ecole Centrale Nantes; Ni Zhu, Valerie Renaudin, University Gustave Eiffel

Evening Hours in Exhibit Hall 5:30 p.m. – 6:30 p.m.

C2b: Collaborative and Networked Navigation

Date: Tuesday, April 25, 2023

Time: 1:45 p.m. - 5:30 p.m.

Room: Big Sur

Session Chairs:



Dr. Jason Rife

Tufts University



Dr. Clark Taylor

Air Force Institute of Technology

1:50. Jammer Classification with Federated Learning, Peng Wu, Helena Calatrava, Tales Imbiriba, Pau Closas, Electrical and Computer Engineering Dept., Northeastern University

2:12. Proximity-Based Positioning Scheme with Multi-Layer Privacy, Guillermo Hernandez, Gerald LaMountain, Pau Closas, Northeastern University

2:35. Evaluation of Infrastructure-Assisted Cooperative Tracking of Vehicles Using Various Motion Models, Saswat Priyadarshi Nayak, Guoyuan Wu, Matthew J. Barth, University of California, Riverside; Yongkang Liu, Emrah Akin Sisbot, Kentaro Oguchi, Toyota Motor North America R&D

2:58. A Collaborative RTK Approach to Precise Positioning for Vehicle Swarms in Urban Scenarios, Daniel Medina, German Aerospace Center (DLR); Helena Calatrava, Northeastern University; J. Manuel Castro-Arvizu, Trimble Terrassat; Pau Closas, Northeastern University; and Jordi Vilà-Valls, ISAE-SUPAERO

3:25 - 3:55, Break. Refreshments in Exhibit Hall

4:00. Gaussian Process Regression for Learning Environment Impacts on Localization Accuracy of a UAV with Respect to UGV for Search Planning, Matteo De Petrillo, Derek Ross, Jason Gross, West Virginia University

4:23. A Low-Cost Open-Source GNSS Network for Network Real-Time Kinematic Positioning: Which Future and Performances?, Paolo Dabove and Vincenzo Di Pietra, Politecnico di Torino

4:46. Cooperative Guidance and Navigation of UAS for Common Midpoint Radar Remote Sensing, Aabhash Bhandari, Tuan D. Luong, Jordan D. Larson, University of Alabama

5:08. Flight Test Evaluation of Cooperative Swarm Navigation in Challenging Environments using UWB, GNSS, and Inertial Fusion, Mats Martens, Marcel Bartsch, Georgy Kalandadze, Kevin Kotinkar, and Maarten Uijt de Haag, Technical University of Berlin, TU Berlin

Evening Hours in Exhibit Hall 5:30 p.m. – 6:30 p.m.

D2: Marine Vehicle Navigation

Date: Tuesday, April 25, 2023

Time: 3:55 p.m. - 5:10 p.m.

Room: Spyglass

Session Chairs:



Bryan Hoffman
NIWC Pacific



Dr. Andrew Hansen
USDOT/OST-R/Volpe Center

1:50. Direct Position Estimation for VDES R-Mode, Markus Wirsing, Armin Dammann, Ronald Raulefs, German Aerospace Center (DLR)

2:12. A New Multiple State Estimation Cooperative Positioning Method Based on MEMS/Underwater Acoustic Ranging for Multiple UUVs, Qingxin Wang, Shiwei Fan, Ya Zhang, Guangmin Li, Chunzhi Liu, Yanyan Wang, Wei Gao, Harbin Institute of Technology

2:35. A System-Level Calibration and Integrated Navigation Technology of HRG-Based SINS/DVL System for Underwater Vehicles, Jianxiong Wei, Ya Zhang, Shiwei Fan, Longkang Chang, Fei Yu, Harbin Institute of Technology

Evening Hours in Exhibit Hall 5:30 p.m. – 6:30 p.m.

A3: Advances in MEMS-based Inertial Sensors and Inertial Measurement Units

Date: Wednesday, April 26, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Spyglass

Session Chairs:



Dr. Andrei Shkel

University of California, Irvine



Dr. Adam Schofield

Army Research Lab

8:35. Low-Cost Navigation-grade MEMS Fabrication Platform to Enable PNT Innovations, David Lin, Robert Macdonald, Emad Andarawis, Marco Aimi, Jeremy Popp, Matthew Alberda, GE Aerospace

8:57. Manufacturing Platform for High-Performance MEMS Inertial Sensors, Jeffrey DeNatale and Philip Stupar, Teledyne Scientific & Imaging; Stephane Martel and Jonathan Lachance, Teledyne DALSA Semiconductor, Inc.

9:20. Atomic Layer Deposition and Sputtering of Piezoelectric Thin Films for Improved IMU Performance, Nicholas A. Strnad, Ryan R. Knight, Ryan Q. Rudy, Robert R. Benoit, Wendy L. Sarney, Jeffrey S. Pulskamp, Sensors and Electron Devices Directorate, DEVCOM Army Research Laboratory

9:43. Fully Integrated High-Frequency MEMS and CMOS Inertial Measurement Systems: Taking a Journey from Silicon to Silicon Carbide, Farrokh Ayazi, Georgia Tech

10:05-10:35, Break. Refreshments in Exhibit Hall

10:40. SiAc(TM) ASIC Module: MEMS Based Accelerometer for Next Generation Inertial Measurement Units, Alexander Trusov, Phillip Clark, Daniel Rampacek, Farzin Dinyarian, Jorge Gutierrez, Victor Akel, Albert Choi, Douglas Meyer, Northrop Grumman

11:03. State-of-the-Art in MEMS Coriolis Vibratory Gyroscopes with Multi-Degree-of-Freedom Architectures Designed for Dynamic Range, Robustness, and Sensitivity, Andrei M. Shkel, Cenk Acar, Chris Painter, Alex Trusov, Adam Schofield, Sergei Zotov, Igor Prikhodko, Brent Simon, Doruk Senkal, Alexandra Efimovskaya, Danmeng Wang, Sina Askari, Mohammad Asadian, University of California, Irvine

11:26. Gytrix, a Bulk Quartz PiezoMEMS Gyroscope able to Whole Angle Mode of Operation, O. Le Traon, T. Perrier, R. Levy, J. Guérard, P. Lavenus, A. Andrieux-Ledier, ONERA, Université Paris Saclay

11:48. Navigation-Grade 3D Fused-Silica Birdbath Resonator Gyroscope (BRG), Khalil Najafi, Jae Yoong Cho, Sajal Singh, Center for Wireless Integrated MicroSensors and Systems (WIMS2) University of Michigan

12:15 p.m. - 1:15 p.m. Lunch in the Exhibit Hall

B3: GNSS Resilience to Interference, Jamming, and Spoofing 1

Date: Wednesday, April 26, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Windjammer

Session Chairs:



Ryan Mitch

Johns Hopkins/APL



Dr. Todd Humphreys

University of Texas at Austin

8:35. Dual-Satellite Geolocation of Terrestrial GNSS Jammers from Low Earth Orbit, Zachary Clements, University of Texas at Austin; Patrick Ellis, Spire Global; Todd Humphreys, University of Texas at Austin

8:57. Spoofing-Resilient LiDAR-GPS Factor Graph Localization with Chimera Signal Enhancement, Adam Dai, Ashwin Kanhere, Tara Mina, Grace Gao, Stanford University

9:20. Comparison of Interference Mitigation with Adaptive Notch Filter Architectures Against Privacy Protection Devices, Johannes Rossouw van der Merwe, Focal Point Positioning; Iñigo Cortés, Muhammad Saad, Fabio Garzia, Alexander Rügamer, Matthias Overbeck, and Wolfgang Felber, Fraunhofer Institute for Integrated Circuits IIS

9:43. Impact Analysis of Spoofing on Different-grade GNSS Receivers, Saiful Islam, M. Zahidul H. Bhuiyan, Into Pääkkönen, Mika Saajasto, Maija Mäkelä, Sanna Kaasalainen, Finnish Geospatial Research Institute

10:05-10:35, Break. Refreshments in Exhibit Hall

10:40. Spoofing Detection Using Decomposition of the Complex Cross Ambiguity Function with Measurement Correlation, Sahil Ahmed, Samer Khanafseh, Boris Pervan, Illinois Institute of Technology

11:03. Crowdsourced Jammer Localization Using APBMs: Performance Analysis Considering Observations Disruption, Andrea Nardin, Dept. of Electronics and Telecommunications, Politecnico di Torino; Tales Imbiriba, Pau Closas, Dept. of Electrical & Computer Engineering, Northeastern University

11:26. Calibrating RFI Detection Levels in a Low-Cost GNSS Monitor, Nicolas Roberto San Miguel, Yu-Hsuan Chen, Sherman Lo, Todd Walter, Dennis Akos, Stanford University

11:48. Using Mobile Phones for Participatory Detection and Localization of a GNSS Jammer, Glädje Karl Olsson, Sara Nilsson, Erik Axell, Swedish Defence Research Agency (FOI); Erik G. Larsson, Linköping University; Panos Papadimitratos, Royal Institute of Technology (KTH)

Alternate Presentations:

1. **Joint DOA and Doppler Frequency Shift Method for GNSS Spoofing Interference Detection**, Zhengkun Chen, Xinzhi Peng, Junzhi Li, Xuelin Yuan, Chengxin Ran, Xiangwei Zhu. The College of Electronics and Communication Engineering, Sun Yat-Sen University

12:15 p.m. – 1:15 p.m. Lunch in the Exhibit Hall

C3: Signals of Opportunity-Based Navigation Systems 1

Date: Wednesday, April 26, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Big Sur

Session Chairs:



Dr. John Lawton

Naval Surface Warfare Center



Dr. Mahdi Maaref

OneNav

8:35. LTE Transmitter States Estimation Using a Combined Code and Carrier Phase Observation Model, Muhammad Subhan Hameed, Markel Arizabaleta Diez, Mathias Philips-Blum, Thomas Pany, Universität der Bundeswehr München

8:57. Smartphone-based Jammer Localization with Model-Failure Detection and Exclusion, M. Niestroj, M. Brachvogel, RWTH Aachen University, Chair of Navigation; M. Meurer, RWTH Aachen University, Chair of Navigation & German Aerospace Center (DLR), Institute of Communications and Navigation

9:20. LDACS APNT Architecture Development & Evolution, Gary McGraw, Consultant; Gianluca Zampieri, Alexandra Filip-Dhaubadel; Okuary Osechas, Michael Meurer, German Aerospace Center (DLR)

9:43. 5G Positioning Reference Signal Configuration for Hybrid Terrestrial/Non-Terrestrial Network Scenario, Alejandro Gonzalez-Garrido, Jorge Querol, Symeon Chatzinotas, University of Luxembourg

10:05-10:35, Break. Refreshments in Exhibit Hall

10:40. Starlink Doppler and Doppler Rate Estimation via Coherent Combining of Multiple Tones for Opportunistic Positioning, Chun Yang and Andrey Soloviev, QuNav

11:03. A Parametric Study on Autonomous Integrity Monitoring Using Non-GNSS Signals, Fabian Rothmaier, Trimble Terrassat, and Jose A. del Peral-Rosado, Airbus Defence and Space

11:26. Low-Cost Angle of Arrival-Based Auxiliary Navigation System for UAV Using Signals of Opportunity, Adrian Winter, Norwegian University of Science and Technology, (NTNU); Nadezda Sokolova, Aiden Morrison, Sintef Digital; Oliver Hasler, Tor Arne Johansen, NTNU

11:48. Prediction of Ground Wave Propagation Delays in Terrestrial Radio Navigation Systems Based on Soil Texture Maps, Niklas Hehenkamp, Filippo Rizzi, Lars Grundhöfer, Stefan Gewies, German Aerospace Center (DLR)

Alternate Presentations:

- 1. A Multi-Stage Long Coherent Integration Approach to Detect LEO Debris Scattered GNSS Signal: Experimental Results**, Md Sohrab Mahmud, Edwin G. W. Peters, University of New South Wales; Craig R. Benson, Skykraft Pty Ltd.; Andrew Lambert, University of New South Wales
- 2. A Sub-Meter Accurate Positioning Using 5G Double-Difference Carrier Phase Measurements**, Chengming Jin, Wee Peng Tay, Kai Zhao, Keck Voon Ling, Jun Lu, Nanyang Technological University (NTU); Yue Wang, University of Massachusetts Lowell

12:15 p.m. – 1:15 p.m. Lunch in the Exhibit Hall

D3: Space Navigation and Observation

Date: Wednesday, April 26, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Cypress

Session Chairs:



Dr. David Curtis

Air Force Institute of Technology



Kristen Michaelson

University of Texas at Austin

8:35. Characterization of Inter Constellation Bias between IRNSS & GPS and Methods for Performance Improvement in Positioning, V.S. Vinoj, C. Radhakrishna Pillai, O.T. Anand Shankar, A. Mohammed Basim, V.S. Biju, Aneesh K. Thampi, S. Sasikumar, D. Sam Dayala Dev, ISRO Inertial Systems Unit

8:57. GNSS TEC Data Assimilation by Using NTCM and Kalman Filtering for the Next Generation Ionospheric Prediction Services, Matteo Sgammini and Francesco Menzione, European Commission, Joint Research Centre (JRC)

9:20. Pulsar-Leveraged Autonomous Navigation Testbed System (PLANTS): A Low-Cost Software-Hardware Hybrid Testbed for Pulsar-Based Autonomous Navigation (XNAV) Positioning, Navigation, and Timing (PNT) Solutions., Sarah Hasnain, Michael Berkson, Sharon Maguire, Evan Sun, Katie Zaback, The Johns Hopkins University Applied Physics Laboratory

9:43. LiDAR-Based Autonomous Landing on Asteroids: Algorithms, Prototyping and End-to-end Testing with a UAV-Based Satellite Emulator, Max Hofacker, Harvey Gómez Martínez, Martin Seidl, Universität der Bundeswehr München; Fran Domazetovic, Department of Geography, University of Zadar; Larissa Balestrero Machado, Roger Förstner, Thomas Pany, Universität der Bundeswehr München

10:05-10:35, Break. Refreshments in Exhibit Hall

10:40. Relative Navigation Methods for an On-Orbit, Multi-Agent Inspection Mission, Mark Mercier and David Curtis, Air Force Institute of Technology

11:03. Satellite Guidance with Multi-Agent Reinforce Learning for Triangulating a Moving Object in a Relative Orbit Frame, Nicholas Yielding, USAF, Air Force Institute of Technology; Joseph Curro, USAF, Defense Threat Reduction Agency

11:26. Consensus on Region-Based Pose Estimation for Satellites, Daniel Grange, Stony Brook University; Alexander A. Soderlund, Air Force Research Laboratory; Romeil Sandhu, Sigmatech Incorporated; Sean Phillips, Air Force Research Laboratory

11:48. Unscented Kalman Filter-Based Protection Level for the Integrity of Space Launch Vehicle, Sheikh Arif Raihan, University of New South Wales; Sanat K. Biswas, Indraprastha Institute of Information and Technology (IIIT); Andrew G. Dempster, Australian Centre for Space Engineering Research (ACSER) University of New South Wales

Alternate Presentations:

1. **Future GNSS SSV for the Moon and Beyond**, S. Corvo, F. Paggi, and E. E. Zini, Thales Alenia Space Italy

12:15 p.m. – 1:15 p.m. Lunch in the Exhibit Hall

B4: GNSS Resilience to Interference, Jamming, and Spoofing 2

Date: Wednesday, April 26, 2023

Time: 1:45 p.m. - 5:30 p.m.

Room: Windjammer

Session Chairs:



Dr. Andrew Dempster
University of New South Wales



Dr. Joshua Morales
StartNav

1:50. Performance Evaluation of an Indistinguishability Based Attack Against Spreading Code Secured GNSS Signals, Laura Crosara, Francesco Ardizzon, Stefano Tomasin, and Nicola Laurenti, University of Padova

2:12. GNSS L5/E5 Maximum Likelihood Synchronization Performance Degradation under DME Interferences, Lorenzo Ortega, IPSA/TESA; Corentin Lubeigt, TESA/ISAE-Supaero; Jordi Vilà-Valls, Eric Chaumette, ISAE-Supaero

2:35. Assisted NMA Proof of Concept on Android Smartphones, Cillian O'Driscoll, Independent Consultant; Jon Winkel, Rhea Group; Ignacio Fernandez Hernandez, European Commission

2:58. Validation of a Combined GNSS Correction and NMA L-Band Service Against Spoofing, Alexander Rügamer, Fraunhofer IIS; Tor Egil Melgård, Fugro; Wim De Wilde, Septentrio; Heiko Gerstung, Meinberg; Isa Wegmann, Meinberg; Dries Schellekens, Septentrio

3:25 - 3:55, Break. Refreshments in Exhibit Hall

4:00. Probabilistic Detection of GNSS Spoofing using Opportunistic Information, Wenjie Liu and Panos Papadimitratos, KTH Royal Institute of Technology

4:23. Deep Temporal Semi-Supervised One-Class Classification for GNSS Radio Frequency Interference Detection, Viktor Ivanov, University of York; Maurizio Scaramuzza, Skyguide - Swiss Air Navigation Services Ltd; Richard C. Wilson, University of York

4:46. Experimental Validation of Optimal INS Monitor against GNSS Spoofer Tracking Error Detection, Birendra Kujur, Samer Khanafseh, and Boris Pervan, Illinois Institute of Technology

5:08. Contributions to RF Interference Detection, Identification, Monitoring and Mitigation for GNSS by the Navigation Innovation and Support Program (NAVISP) and European Industry, Stefano Binda, Elizabeth Laier English, European Space Agency

Alternate Presentations:

- 1. Multi-Layer Protection by Time/Frequency and Spatial Technologies Against RF Threats for Robust and Accurate GNSS Positioning**, N. Pastori, A. Emmanuele, L. Danelli, M. Puccitelli, L. Marradi, Thales Alenia Space Italia

C4: Signals of Opportunity-Based Navigation Systems 2

Date: Wednesday, April 26, 2023

Time: 1:45 p.m. - 5:30 p.m.

Room: Big Sur

Session Chairs:



Dr. José del Peral Rosado
Airbus Defence and Space



Dr. Ramsey Faragher
Focal Point Positioning

1:50. The First Multi-Constellation Blind Beacon Estimation, Doppler Tracking, and Opportunistic Positioning with OneWeb, Starlink, Iridium NEXT, and Orbcomm LEO Satellites, Sharbel Kozhaya, Haitham Kanj, and Zak (Zaher) M. Kassas, The Ohio State University

2:12. LEO PNT Mega-Constellations: A New Design Driver for the Next Generation MEO GNSS Space Service Volume, Francesco Menzione and Matteo Paonni, European Commission, Joint Research Centre (JRC)

2:35. Low Cost SDR Receiver for Medium Frequency R-Mode, Lars Grundhöfer, Filippo Rizz, Niklas Hehenkamp, Stefan Gewies, German Aerospace Center (DLR)

2:58. Random Finite Set Approach to Signal Strength Based Passive Localization and Tracking, Ossi Kaltiokallio, Tampere University; Huseyin Yigitler, Aalto University; Jukka Talvitie, Mikko Valkama, Tampere University

3:25 - 3:55, Break. Refreshments in Exhibit Hall

4:00. Recent Advances for UWB Ranging from Android Smartphone, Vincenzo Di Pietra and Paolo Dabove, Politecnico di Torino

4:23. Optimum Access-Point Constellation for Indoor Time Difference of Arrival Positioning, Ali Eltohamy, Universität der Bundeswehr München, Institute for Microelectronics and Integrated Circuits; Rudolf Zetik, NXP Semiconductors Austria GmbH; Reiner S. Thomä, Technische Universität Ilmenau, Electronic Measurements and Signal Processing Group; Matthias Korb, Universität der Bundeswehr München, Institute for Microelectronics and Integrated Circuits

4:46. UAV-Aided Indoor Localization of Emergency Response Personnel, Harish K. Dureppagari, Don-Roberts Emenonye, Harpreet S. Dhillon, R. Michael Buehrer, Virginia Tech

5:08. Dual-use Radar and Communications for Automotive Applications, Ian Weiner, Houssam Abouzahra, Mitch LeRoy, MIT Lincoln Laboratory

D4a: AI-Enhanced Navigation Systems

Date: Wednesday, April 26, 2023

Time: 1:45 p.m. - 5:30 p.m.

Room: Spyglass

Session Chairs:



Dr. Erik Blasch

Air Force Office of Scientist Research



Dr. Jindrich Dunik

University of West Bohemia

1:50. Solution Separation-Based Integrity Monitor for Integrated GNSS/IMU/Camera Navigation: Constraining the Hypothesis Space With Deep Learning, Vasileios Bosdelekidis, Tor A. Johansen, Department of Engineering Cybernetics, Norwegian University of Science and Technology; Nadezda Sokolova, SINTEF & Department of Engineering Cybernetics, Norwegian University of Science and Technology; Torleiv H. Bryne, Department of Engineering Cybernetics, Norwegian University of Science and Technology

2:12. Improving Predictive Navigation Through the Optimization of Counterfactual Track Evaluation, Alexander Stringer, Geoffrey Dolinger, Timothy Sharp, Debra Hogue, Joseph Karch, Lesya Borowska, USAF/76 SWEG; Justin Metcalf, University of Oklahoma

2:35. A Novel Satellite Selection Algorithm Using LSTM Neural Networks for Single-Epoch Localization, Ibrahim Sbeity, CEA-Leti, Université Grenoble Alpes, ETIS UMR, CY Cergy Paris Université, ENSEA, CNRS; Christophe Villien, CEA-Leti, Université Grenoble Alpes; Christophe Combettes, Benoît Denis, CEA-Leti, Université Grenoble Alpes; and E. Veronica Belmega, Univ. Gustave Eiffel, CNRS, LIGM, ETIS UMR CY Cergy Paris Université, ENSEA, CNRS; Marwa Chafii, Abu Dhabi, Engineering Division, New York University

2:58. Machine-Learning-Based Classification of GPS Signal Reception Conditions Using a Dual-Polarized Antenna in Urban Areas, Sanghyun Kim and Jiwon Seo, Yonsei University

3:25 - 3:55, Break. Refreshments in Exhibit Hall

4:00. Mortar Trajectory Estimation by a Deep Error-State Kalman Filter in a GNSS-Denied Environment, Alicia Roux, French-German Research Institute of Saint-Louis / Université de Haute-Alsace; Sébastien Changey, French-German Research Institute of Saint-Louis; Jonathan Weber, Jean-Philippe Lauffenburger, Université de Haute-Alsace

4:23. Machine Learning for Monocular-Vision based Spacecraft Pose Estimation, Quang Tran, Jeffrey Choate, Clark Taylor, Scott Nykl, David Curtis, Air Force Institute of Technology

4:46. Deep Learning-Driven Automatic Estimation of Smartphone Installation Angles for Vehicle Navigation, Jingxian Wang, Weihao Ding, Dept. of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University; Bingbo Cui, Key Laboratory of Modern Agricultural and Technology, Jiangsu University; Jianbo Shao, Dept. of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University & School of Instrumentation Science and Engineering, Harbin Institute of Technology; Duojie Weng, Wu Chen, Dept. of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University.

5:08. Q-Learning Model Covariance Adaptation of Rao-Blackwellized Particle Filtering Estimations for Airborne Geomagnetic Navigation, Andrei Cuenca and Hever Moncayo, Embry-Riddle Aeronautical University

Alternate Presentations:

1. **Uncertainty Analyses of Deep Reinforcement Learning Algorithm for Highway Trajectory Planning**, Majid Moghadam, Nahid Nasiri, Engin Tekin, and Gabriel Hugh Elkaim, University of California, Santa Cruz

D4b: Ground Vehicle Navigation

Date: Wednesday, April 26, 2023

Time: 1:45 p.m. - 5:30 p.m.

Room: Cypress

Session Chair:



Dr. Hadi Wassaf
Volpe USDOT

1:50. Fault Detection and Exclusion for INS/GPS/5G Tightly-Coupled Navigation, Mu Jia and Zak (Zaher) M. Kassas, The Ohio State University

2:12. Ego Lane Estimation Using Visual Information and High Definition Map, Wei Yan, Ning Xiao, Pan Jiang, Hongkai Wang, Yilong Yuan, Liang Lin, Chang Liu, Tencent Technology (Beijing) Co., Ltd.

2:35. Resiliency Characterization of Navigation Systems for Intelligent Transportation Applications, Hadi Wassaf, Volpe National Transportation Systems Center; Jason Rife, Tufts University

2:58. Event-Based Risk Assessment for Alert Limits in Automotive Lane Keeping, Jason Rife and Patrick Elwood, Tufts University; Hadi Wassaf, Volpe National Transportation Systems Center

3:25 - 3:55, Break. Refreshments in Exhibit Hall

4:00. Extending Navigation Service under Sensor Failures: An Approach by Integrating System Identification and Vehicle Dynamic Model, Penggao Yan, Li-Ta Hsu, Weisong Wen, Dept. of Aeronautical and Aviation Engineering, The Hong Kong Polytechnic University

4:23. GNSS-Assisted System Identification of Autonomous Ground Vehicle Model and Sensor Parameters, Aaron Hunter, Renwick Curry, Gabriel Elkaim, University of California, Santa Cruz

4:46. PNT Threat and Vulnerability Analysis for the CAVs Using Cooperative Navigation Algorithm, Rahan Rasheed Khan, Athar Hanif, Qadeer Ahmed, The Ohio State University (OSU) Center for Automotive Research (CAR)

5:08. LiDAR Feature Outlier Mitigation Aided by Graduated Non-Convexity Relaxation for Safety-Critical Localization in Urban Canyons, Jiachen Zhang, Weisong Wen, Li-Ta Hsu, Department of Aeronautical and Aviation Engineering, the Hong Kong Polytechnic University; Zheng Gong, the China Academy of Information and Communications Technology, Dongzhe Su, Hong Kong Applied Science and Technology Research Institute (ASTRI)

Alternate Presentations:

- 1. Improving Odometry Performance on Radar Data by Filtering Surface Normals with Constant Curvature Modeling**, Arthur Venon, IRSEEM, Normandie University, UNIROUEN; Yohan Dupuis, LINEACT CESI, CESI, Paris La Défense; Pascal Vasseur, MIS, Université de Picardie Jules Verne; Pierre Merriaux, LeddarTech

A5a: Inertial Measurement Units

Date: Thursday, April 27, 2023

Time: 8:30 a.m. - 10:05 a.m.

Room: Spyglass

Session Chairs:



Dr. Kari Moran
NIWC Pacific



Sam Dimashkie
Northrop Grumman

8:35. IMU Based Context Detection of Changes in the Terrain Topography, Taylor Knuth, University College London & Northrop Grumman Corporation; Paul Groves, University College London

8:57. MIMU Error Calibration Method of Turntable Free Platform Based on Improved Genetic Algorithm, Zixuan Ning, Ya Zhang, Xiaofeng Wei, Yanyan Wang, Longkang Chang, Wen Xing, Harbin Institute of Technology

9:20. Optimal Two-Position Alignment Algorithm Based on FUKF for Polar Regions in the Transversal Coordinate System, Longkang Chang, Yanyan Wang, Shiwei Fan, Ya Zhang, Jianxiong Wei, Xiaofeng Wei, Wei Gao, Harbin Institute of Technology

9:43. Deep Learning based Online Extrinsic Calibration of IMU and Monocular Camera Using Smartphone Devices, Ilyar Asl Sabbaghian Homabadi, Mengchi Ai, Chrysostomos Minaretzis, Naser El-Sheimy, University of Calgary

10:05-10:35, Break. Refreshments served outside of session rooms

A5b: Integrated Inertial Navigation Systems

Date: Thursday, April 27, 2023

Time: 10:35 a.m. - 12:15 p.m.

Room: Spyglass

Session Chairs:



Phil Bruner

Northrop Grumman



James McDonald

Honeywell

10:40. A Computer Vision Approach for Pedestrian Walking Direction Estimation with Wearable Inertial Sensors: PatternNet, Hanyuan Fu, Univ Gustave Eiffel, AME-GEOLOC; Thomas Bonis, Univ Gustave Eiffel, Univ Paris Est Creteil, CNRS, LAMA; Valérie Renaudin, Univ Gustave Eiffel, AME-GEOLOC; Ni Zhu, Univ Gustave Eiffel, AME-GEOLOC

11:03. Inertial Aiding for Moving GPS Receiver Carrier Phase Estimation Through Interference, Wengxiang Zhao, Samer Khanafseh, and Boris Pervan, Illinois Institute of Technology

11:26. A New Fusion Algorithm for Attitude Estimation Based on MACO-NLCF, Fei Yu, Wen Xing, Ya Zhang, Shiwei Fan, Longkang Chang, Xiaofeng Wei, Zixuan Ning, Harbin Institute of Technology

11:48. Inertial Navigation on Extremely Resource-Constrained Platforms: Methods, Opportunities and Challenges, Swapnil Sayan Saha, University of California, Los Angeles; Yayun Du, Northwestern University; Sandeep Singh Sandha, Abacus.AI; Luis Garcia, University of Southern California; Mohammad Khalid Jawed, Mani Srivastava, University of California, Los Angeles

12:15 p.m. – 1:45 p.m. Awards Luncheon (late arrivals cannot be served after 12:30 p.m.)

B5: Receiver Design, Signal Processing, and Antenna Technology 1

Date: Thursday, April 27, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Windjammer

Session Chairs:



Dr. Thomas Pany

University of Bundeswehr Munich



Dr. Joe Khalife

Apple

8:35. SNAP: A Xona Space Systems and GPS Software-Defined Receiver, Noah S. Miller, J. Tanner Koza, Samuel C. Morgan, and Scott M. Martin, Auburn University; Andrew Neish, Robert Grayson, and Tyler Reid, Xona Space Systems

8:57. Required Memory Analysis of a GPS Receiver for Implementing CHIMERA SCA, Hyoungmin So, Agency for Defense Development; Sanjeev Gunawardena, Air Force Institute of Technology; Jeffrey Hebert, Air Force Research Laboratory

9:20. Precise Direct Position Estimation: Validation Experiments, Shuo Tang, Haoqing Li, Helena Calatrava and Pau Closas. Electrical, and Computer Engineering Dept., Northeastern University

9:43. Self-Contained Implementation of Nullsteering and Beamforming with a Standalone Array Antenna for GNSS Signals under Interference, Chun Yang and Andrey Soloviev, QuNav

10:05-10:35, Break. Refreshments served outside of session rooms

10:40. Low-Complexity Multipath Mitigation Technique Based on Multi-Correlator Structures, Christian Siebert, Institute of Communications and Navigation, German Aerospace Center (DLR) & Chair of Navigation, RWTH Aachen University; Andriy Konovaltsev, Institute of Communications and Navigation, DLR; Michael Meurer, Institute of Communications and Navigation, DLR & Chair of Navigation, RWTH Aachen University

11:03. Theoretical Performance Analysis of GNSS Tracking Loops, Samy Labsir, IPSA; Gael Pages, ISAE-SUPAERO; Lorenzo Ortega, IPSA; Jordi Vilà-Valls, Eric Chaumette, ISAE-SUPAERO

11:26. Innovative Multicarrier Broadband Waveforms for Future GNSS Applications – A System Overview, Tien M. Nguyen, Charles H. Lee, Yinwei Chen, and Sam Behseta, California State University Fullerton; Dan Shen, Genshe Chen, John Nguyen, and Xiwen Kang, Intelligent Fusion Technology; Khanh D. Pham, Air Force Research Laboratory, Space Vehicles Directorate

11:48. Receiver Clock Estimation for RTK-Grade Multi-GNSS Multi-Frequency Synthetic Aperture Processing, Mohamed Bochkati, Jürgen Dampf, Thomas Pany; Institute of Space Technology and Space Applications (ISTA), Space Systems Research Center (FZ-Space); Universität der Bundeswehr München

Alternate Presentations:

- Heading Determination for a Single GNSS Patch Array Antenna**, Wenxin Jin, Wenfei Gong, Tianwei Hou, Xin Sun, and Hao Ma, School of Electronic and Information Engineering, Beijing Jiaotong University

12:15 p.m. – 1:45 p.m. Awards Luncheon (late arrivals cannot be served after 12:30 p.m.)

C5a: Frontiers of Radionavigation: Signals of Opportunity, 5G, LEO, and Beyond

Date: Thursday, April 27, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Cypress

Session Chairs:



Dr. Jeffrey Hebert

Air Force Research Laboratory



Dr. Gonzalo Seco Granados

Universitat Autònoma de Barcelona

8:35. OTFS Enabled RIS-Aided Localization: Fundamental Limits and Potential Drawbacks, Don-Roberts Emenonye, Anish Pradhan, Harpreet S. Dhillon, and R. Michael Buehrer, Virginia Tech

8:57. Beyond 5G Localization at mmWaves in 3GPP Urban Scenarios with Blockage Intelligence, Gianluca Torsoli, University of Ferrara; Moe Z. Win, Massachusetts Institute of Technology; and Andrea Conti, University of Ferrara

9:20. Joint Detection and Tracking of Starlink LEO Satellite OFDM Downlink Signals, Mohammad Neinavaie and Zak (Zaher) M. Kassas, The Ohio State University

10:40. Doppler Processing for Satellite Navigation, Frank van Graas, Air Force Institute of Technology

11:03. Cooperative Radio Navigation for Robotic Exploration: Evaluation of a Space-Analogue Mission, Robert Pöhlmann, Emanuel Staudinger, Siwei Zhang, Fabio Broghammer, Armin Dammann, Institute of Communications and Navigation, German Aerospace Center (DLR); Peter A. Hoeher, Faculty of Engineering, University of Kiel

11:26. Simulations Using LEO-PNT Systems: A Brief Survey, Fabricio S. Prol, M. Zahidul H. Bhuiyan, Sanna Kaasalainen, Dept. of Navigation and Positioning, Finnish Geospatial Research Institute, National Land Survey of Finland; Elena S. Lohan, Electrical Engineering Unit, Faculty of Information Technology and Communication Sciences, Tampere University; Jaan Praks, Dept. of Radio Science and Engineering, Aalto University; Heidi Kuusniemi, Tampere University and Digital Economy Research Platform, University of Vaasa

11:48. PNT as a Service (PNTaaS): Providing a Resilient Back-up to GPS by Leveraging Broadband Satellite Constellations and Ground Infrastructure, Alison Brown, Dien Nguyen, Tom Silva, Jarrett Redd, Adrin Linan, NAVSYS Corporation

12:15 p.m. – 1:45 p.m. Awards Luncheon (late arrivals cannot be served after 12:30 p.m.)

C5b: Vision-Based Navigation Systems

Date: Thursday, April 27, 2023

Time: 8:30 a.m. - 12:15 p.m.

Room: Big Sur

Session Chairs:



Dr. John Raquet

IS4S



Dr. Maarten Uijt de Haag

TU Berlin

8:35. A Framework for Visual-Inertial Object-Level Simultaneous Localization and Mapping, Jae Hyung Jung, Department of Aerospace Engineering, Seoul National University; Chan Gook Park, Department of Aerospace Engineering / Automation and Systems Research Institute, Seoul National University

8:57. EssentialPoseSLAM: An Efficient Landmark-Less Approach to Visual-Inertial Navigation, Matthew Boler, Scott Martin, Auburn University

9:20. Robust Absolute Headset Tracking for Extended Reality, Robert M. Tenny, Lisong C. Sun, Alperen Duru, and Todd E. Humphreys, The University of Texas at Austin

9:43. GPS-denied Vehicle Localization for Augmented Reality Using a Road-Aided Particle Filter and RGB Camera, Tomihisa Welsh, Sean Marks, Alex Pronschinske, Applied Research Associates

10:05-10:35, Break. Refreshments served outside of session rooms

10:40. Ground Vehicle Navigation Based on the Skylight Polarization, Guillaume Courtier, French-German Research Institute of Saint-Louis (ISL) / Université de Haute-Alsace, IRIMAS UR 7499; Pierre-Jean Lapray, Université de Haute-Alsace, IRIMAS UR 7499; Ronan Adam, Sébastien Changey, ISL; and Jean-Philippe, Lauffenburger, Université de Haute-Alsace, IRIMAS UR 7499

11:03. A Low-Cost Lane-Level Navigation Algorithm Based on Visual Information, Pan Jiang, Wei Yan, Hong kai Wang, Yi long Yuan, Jin He, Liang Lin, Chang Liu, Tencent Technology (Beijing) Co., Ltd.

11:26. Accurate and Scalable Contour-based Camera Pose Estimation Using Deep Learning With Synthetic Data, Ilyar Asl Sabbaghian Hokmabadi, Mengchi Ai, Chrysostomos Minaretzis, Michael Sideris, Naser El-Sheimy, University of Calgary

11:48. Camera Calibration Error Modelling and Its Impact on Visual Positioning, Wenhan Hao, Chen Zhu, Michael Meurer, German Aerospace Center, Institute of Communications and Navigation

12:15 p.m. – 1:45 p.m. Awards Luncheon (late arrivals cannot be served after 12:30 p.m.)

A6: Alternative Sensors for Aiding INSs and Precision Timing

Date: Thursday, April 27, 2023

Time: 1:45 p.m. - 3:20 p.m.

Room: Spyglass

Session Chairs:



Dr. Gabriel Elkaim

University of California, Santa Cruz



Brian Schipper

Honeywell

1:50. UWB-Foot-SLAM: Bounding Position Error of Foot-mounted Pedestrian INS with Simultaneously Localized UWB Beacons, Chi-Shih Jao, Danmeng Wang, Microsystems Lab, Department of Mechanical and Aerospace Engineering, University of California, Irvine; Joseph Grasso, Public Safety Communications Research Division, National Institute of Standard and Technology; and Andrei M. Shkel, Microsystems Lab, Department of Mechanical and Aerospace Engineering, University of California, Irvine

2:12. INS/MPS/LiDAR Integrated Navigation System Using Federated Kalman Filter in an Indoor Environment, TaeHoon Lee, ByoungJin Lee, JaeHyun Yun, SangKyung Sung, Konkuk University

2:35. UWB-aided GNSS/INS Fusion for Resilient Positioning in GNSS Challenged Environments, Christophe Villien and Benoît Denis, CEA-Leti, Université Grenoble Alpes

2:58. Simultaneous LEO Satellite Tracking and Differential LEO-Aided IMU Navigation, Joe Saroufim, Samer Watchi Hayek, and Zak (Zaher) M. Kassas; The Ohio State University

Alternate Presentations:

1. **Performance Verification of AC Magnetic Positioning System for Unmanned Vehicle Navigation and Control**, DaeHyeon Jeong, Byungjin Lee, Dong Gyun Kim, Sangkyung Sung, Konkuk University
2. **UAV Navigation During Active GNSS Jamming Using Phased-Array-Radio Positioning**, Mika Okuhara, Oliver Hasler, Kristoffer Gryte, Torleiv H. Bryne, and Tor Arne Johansen, Norwegian University of Science and Technology (NTNU)

B6a: Receiver Design, Signal Processing, and Antenna Technology 2

Date: Thursday, April 27, 2023

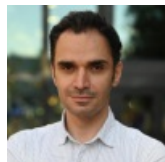
Time: 1:45 p.m. - 4:50 p.m.

Room: Windjammer

Session Chairs:



Dr. Gianluca Caparra
European Space Agency



Mohammad Neinaiaie
The Ohio State University

1:50. Maximum Likelihood Code Phase Discriminator for GNSS, Rabih Chrabieh, Nathan Arbeid, Nestwave SAS

2:12. Super-Resolution GPS Receiver: User's Acceleration Computation, Yiran Luo, and Naser El-Sheimy, Department of Geomatics Engineering, University of Calgary

2:35. Detecting GNSS misbehavior leveraging secure heterogeneous time sources, Marco Spanghero and Panos Papadimitratos, KTH

2:58. HT-MCBBW Ground Receiver Terminal for Future GNSS Applications, Tien M. Nguyen, Charles H. Lee, Sam Behseta, California State University Fullerton; Xiwen Kang, Dan Shen, Genshe Chen, John Nguyen, Intelligent Fusion Technology; Khanh D. Pham, Air Force Research Laboratory, Space Vehicles Directorate

3:20. Machine Learning Assisted Multipath Signal Parameter Estimation and its Evaluation Under Weak Signal Environment, Xin Qi and Bing Xu, Department of Aeronautical and Aviation Engineering, The Hong Kong Polytechnic University

3:42. Identification of Authentic GNSS Signals in Time-Differenced Carrier Phase Measurements with a Multi-Constellation Software Defined Radio Receiver, Zhen Zhu, East Carolina University Sanjeev Gunawardena, AFIT Eric Vinande, AFRL Jason Pontious, AFRL

4:04. Built-In Tri-Band Inter-Frequency Group Delay Calibration, Matthew Strong, Jackson Miller, and Nathan Green, LeTourneau University

4:26. Full Wideband Calibration for an Array of Spatially Distributed Subarrays, Marius Brachvogel, Michael Niestroj, Chair of Navigation, RWTH Aachen University, Germany; Michael Meurer, Chair of Navigation, RWTH Aachen University, Germany & Institute of Communications and Navigation, German Aerospace Center (DLR), Germany

Alternate Presentations:

- Innovative Machine Learning Approach for GNSS Signal Quality Monitoring and Grown Robustness to RF Threats Distortions**, A. Emmanuele, R. Colombo, D. Montani, A. Turano, L. Siniscalco, Thales Alenia Space Italia

B6b: GNSS Integrity and Augmentation Systems

Date: Thursday, April 27, 2023

Time: 1:45 p.m. - 4:50 p.m.

Room: Big Sur

Session Chairs:



Dr. Ilaria Martini

European Commission JRC



Dr. Mathieu Joerger

Virginia Tech

1:50. A Simple and Robust K-Factor Computation Method for GNSS Integrity Needs, Kin Mimouni, TeSA; Odile Maliet, Julie Antic, Thales Alenia Space

2:12. Evaluation of the Advanced RAIM Threat Model, Juan Blanch, Xinwei Liu, Todd Walter, Stanford University

2:35. Integrity-constrained Factor Graph Optimization for GNSS Positioning, Xiao Xia, Weisong Wen, Li-Ta Hsu, Department of Aeronautical and Aviation Engineering, The Hong Kong Polytechnic University

2:58. Towards a Set-Based Detector for GNSS Integrity Monitoring, Jingyao Su, Steffen Schön, Leibniz University Hannover; Mathieu Joerger, Virginia Tech

3:20. Integrity Analysis for Greedy Search Based Fault Exclusion with a Large Number of Faults, Chen Zhu, German Aerospace Center (DLR); Michael Meurer, German Aerospace Center (DLR); Mathieu Joerger, Virginia Tech

3:42. Kalman Filter-based Integrity Monitoring for MADOCA-PPP in Terrestrial Applications, Cheng-Wei Wang, Shau-Shiun Jan, Department of Aeronautics and Astronautics, National Cheng Kung University

4:04. A Map Based Multipath Error Model for Safety Critical Navigation in Railway Environments, Florian Röhl, Omar Garcia Crespillo, Oliver Heirich, Ana Kliman, German Aerospace Center (DLR)

4:26. BPF-MCBBW Ground Receiver Terminal for Future GNSS Applications, Aline Rohloff, Angelica Arredondo, Tien M. Nguyen, Charles H. Lee, Sam Behseta, California State University Fullerton; Xiwen Kang, Dan Shen, Genshe Chen, John Nguyen, Intelligent Fusion Technology; Khanh D. Pham, Air Force Research Laboratory, Space Vehicles Directorate

D6: Aerial Vehicle Navigation

Date: Thursday, April 27, 2023

Time: 1:45 p.m. - 4:50 p.m.

Room: Cypress

Session Chairs:



Dr. Demoz Gebre-Egziabher
University of Minnesota



Andrew Videmsek
Reliable Robotics

1:50. Accuracy Assessment of Two GPS Fidelity Prediction Services in Urban Terrain, Andrew Moore, Julian Gutierrez, Evan Dill, Michael Logan, J. Sloan Glover, Steven Young, Nathan Hoege, NASA Langley Research Center

3:12. Multi-Drone Cooperation to Improve Navigation Integrity in Low Altitude Urban Environments, Flavia Causa, Giancarmine Fasano, University of Naples "Federico II"

3:35. UAV Position Estimation Using a LiDAR-based 3D Object Detection Method, Uthman Olawoye and Jason N. Gross, West Virginia University

3:58. Capabilities of a Real-Time EKF Vector Tracking Algorithm for Dynamic Flight Maneuvers with Small UAVs, Philipp Rudnik, Lothar Kurz, Andreas Winterstein and Manuel Cuntz, German Aerospace Center (DLR)

3:20. Quality of Service Based Radar Resource Management for Navigation and Positioning, Tobias Müller, Sebastian Durst, Pascal Marquardt, Stefan Brüggewirth, Fraunhofer-Institut für Hochfrequenzphysik und Radartechnik FHR

3:42. Performance Analysis of UAV Control Architectures Over Urban Environments with Degraded GNSS Accessibility, Andrei Cuenca, Stephen Brutch, Hever Moncayo, Embry-Riddle Aeronautical University

4:04. High Sensitivity Receiver Design for High-Altitude Aircraft Navigation with Terrestrial Cellular Signals, Zak (Zaher) M. Kassas, Shaghayegh Shahcheraghi, and Ali Kaiss, The Ohio State University; Chiawei Lee, Juan Jurado, Steven Wachtel, Jacob Duede, Zachary Hoeffner, Thomas Hulsey, and Rachel Quirarte, United States Air Force; RunXuan Tay, Republic of Singapore Air Force

4:26. Rethinking Aircraft Landing Systems, Okuary Osechas, Gianluca Zampieri, Brandon Weaver, German Aerospace Center (DLR); Michael Felux, ZHAW

Alternate Presentations:

1. **Tolles-Lawson Coefficient Dependence Using F-16 Data Set,** Jonnathan Bonifaz, Aaron Nielsen, AFIT/ANT Center

Airports

- Monterey Peninsula Airport: 1.5 miles from hotel
- Mineta San Jose International Airport: 72 miles from hotel
- San Francisco International Airport: 106 miles from hotel

Shuttle Service

Complimentary shuttle service is provided between the hotel and the Monterey Peninsula Airport daily from 7:15 a.m. - 11:00 p.m. When you arrive at the airport, please call 831-372-1234 to request airport shuttle service. After placing the call, the hotel shuttle will pick you up curbside at the airport arrivals area. For departures, the hotel shuttle departs from the hotel lobby hourly, at 15 minutes past the hour; advance reservations are required.

Taxi

The Hyatt Regency Monterey is located approximately 1.5 miles from Monterey Peninsula Airport. Multiple taxicab companies serve the airport; a taxi coordinator is onsite to assist you with your taxi transportation needs. No reservations are needed. Taxi fare is approximately \$10.00 plus gratuity, and the trip takes about 5 minutes.

Bus

The Monterey Airbus provides convenient and affordable transit from both San Jose International Airport and San Francisco International Airport to the Monterey Shuttle Station (1.5 miles from the hotel). Rates start at \$43 each way for one person (Booking multiple people together will save you money). Book online and save \$5, or call 1-831-373-7777.

Rental Car

Six rental car companies currently offer rental car services at Monterey Peninsula Airport. For a list of rental car companies and more information on rental cars available, please visit the airport's website: www.montereyairport.com.



Photo courtesy of the Monterey CVB

Weather

The average high in April is 78° F (26° C) and the average low is 54° F (12° C).

Visa Information

Visa Waiver Countries:

Visa waiver travelers from all 27 Visa Waiver Program countries must present either a machine-readable passport or a U.S. Visa. To learn more about the Visa Waiver Program & Machine Readable Passports see <http://travel.state.gov/visa>.

Non-Visa Waiver Countries:

We recommend that you apply for your Visa at least three months in advance. Currently there is a mandatory security check period of 30 days for people whose passports are issued from several countries. U.S. consular offices now interview most applicants as part of the application process. Please ensure you arrive at the embassy with all required documentation at the time of your interview.

Note that the Institute does not intervene in U.S. State Department's issuance of Visas.

Conference attendees requesting a visa letter to attend a conference must:

1. Submit the visa letter request form found at <http://www.ion.org/itm> or
2. Register and pay all conference registration fees BEFORE a letter of invitation will be sent.

Exemptions to this policy apply only to those authors whose papers have been accepted for presentation, company personnel working in the exhibit area or trade associated press.

If the attendee is unable to secure a Visa, he/she will need to apply for a refund according to the printed refund rules of the event.

Visa letter requests will only be reviewed AFTER you have submitted the Visa letter request form for your desired conference.

More Information

For more travel information, please see ion.org/plans/travel.cfm



Photo courtesy of the Monterey CVB



Conference Location

The conference will be held at the Hyatt Regency Monterey, located at 1 Old Golf Course Rd., Monterey, CA 93940.

Internet and Parking

- Complimentary In-room internet is available to attendees staying at the Hyatt.
- Parking at the Hyatt Monterey is free for meeting attendees
- Electric vehicle charging stations are available, and free for hotel guests

Reservations

A block of rooms have been set aside for conference attendees until Friday, March 24 (or until the room block sells out), at the discounted group rate of \$229 per night for single/double occupancy. Reservations made after this date will be on a space-available basis and may not be at the discounted rate. Please note that the room block does sell out quickly; we strongly encourage you to make your hotel reservations early.

Government Rates: The current government rate in Monterey is \$166 per night (subject to change). These rooms will be available until March 24, or until the government rate block fills up, whichever comes first. Government rates are only for U.S. government personnel paying for a room with a U.S. government issued credit card. Failure to pay with a U.S. government credit card will result in your reservation being honored at the group rate. Government contractors not traveling with government travel orders are not eligible for this rate. All Federally Funded Research and Development Centers qualify for government rates.

Make a Reservation Today:

- Online: Visit ion.org/plans/hotel.cfm
- By Phone: Call the hotel at 1-831-372-1234 and be sure to identify yourself as an IEEE/ION PLANS 2023 attendee to receive the special attendee rate!

Stay at the Hyatt Regency Monterey and Save \$200 on Your Registration

Before registering, make your hotel reservation with the Hyatt Regency Monterey. Conference attendees will save \$200 by entering their valid hotel confirmation number from the Hyatt Regency Monterey at the start of the registration process. You must have this confirmation number to claim your discount. Discounts will not be issued retroactively.

How to Register—www.ion.org

1. Make your hotel reservation at the Hyatt Regency Monterey. Write down your confirmation number; you'll need it to claim the \$200 registration fee discount you'll earn for staying in the official conference hotel.
2. Access the online registration form at www.ion.org/plans by clicking "Registration" in the navigation bar on the left. A PDF registration form is also available on this web page.
3. Complete the online registration process. Be sure to input your hotel confirmation number during the registration process to claim your discount as hotel discounts will not be issued retroactively.

