4th Space Imaging Workshop

October 7-9, 2024

Global Learning Center (GLC)
Georgia Institute of Technology
Atlanta, GA

A Special Thanks to the Sponsors

Georgia Institute of Technology

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Find more information online at https://seal.ae.gatech.edu/workshop-2024

Monday: 7 October 2024

7:00	**Registration**
8:00	Welcome
8:20	**Monocular Horizon Navigation** W. H. Driessen (Georgia Tech), A. J. Liounis (NASA GSFC), S. Kaki (Jacobs Technology), D. McGann (Carnegie Mellon University), P. Mckee (NASA JSC), A. G. Yew (NASA GSFC), and A. Tennenbaum (NASA GSFC)
8:40	**A Radiometric Calibration Procedure for Optical Hardware-In-the-Loop Stimulators** F. Ornati, P. Panicucci, A. Pizzetti, and F. Topputo (Politecnico di Milano)
9:00	**Camera Exposure Time Determination for Artemis I Lunar Flyby** K. R. Kobylka (NASA JSC)
9:20	**Initial Concept of Operations for OSIRIS-APEX Optical Navigation and Astrometry Science at Apophis** C. Adam, D. S. Nelson, E. M. Sahr, J. Y. Pelgrift, J.M. Leonard, D. Wibben, P. G. Antreasian (KinetX), A. J. Liounis, K.M. Getzandanner, M. C. Moreau (NASA GSFC), D. R. Golish, A. T. Polit, M. C. Nolan, and D. N. DellaGiustina (University of AZ)
9:40	**BREAK**
10:00	**Towards Autonomous Optical Navigation: Approach and Proximity Operations Strategy for the Emirates Mission to the Asteroid Belt** J. Villa (Laboratory for Atmospheric and Space Sciences), M. Pugliatti (University of Colorado Boulder), M. Salem, R. Klaib (Laboratory for Atmospheric and Space Sciences), J. McMahon (University of Colorado Boulder), and J. Knittel (Laboratory for Atmospheric and Space Sciences)
10:20	**Optical Navigation and Orbit Reconstruction of NASA's Lucy Flyby of Asteroid Dinkinesh and Its Moon** D. Nelson, E. M. Sahr, J. Fischetti, J. L. Geeraert, E. Lessac-Chenen, C. D. Adam, J. Y. Pelgrift, D. Stanbridge (KinetX), and K. Berry (NASA GSFC)
10:40	**The Lunar Flashight Optical Navigation Experiment** J. Christian, A. Thrasher, P. Soni, L. Smego, R. Isaac, J. Nolan, M. Pledger, E. G. Lightsey (Georgia Tech), and W. J. Ready (Georgia Tech Research Institute)
11:00	**BREAK**
11:10	**KEYNOTE: Geometry and Motion in Projective Grassmann and Clifford Algebras** Eric Lengyel, CTO, Terathon Software
12:10	**LUNCH**
1:40	**Software for Optical Navigation and Instrument Calibration (SONIC)** T. Y. Mina, A. Thrasher, S. Henry, M. Mancini, P. Soni, J. Nolan, B. Benjadol, and J. Christian (Georgia Tech)
2:00	**In-Flight Calibration of the Intuitive Machines IM-1 Optical Navigation Imagers** J. Y. Pelgrift, D. S. Nelson, C. Adam (KinetX), G. Molina, M. Hansen, and A. Hollister (Intuitive Machines)
2:20	**Demonstration of the Orion Optical Navigation System on Artemis I** R. J. Inman (NASA JSC)
2:40	**BREAK**
3:00	**Simultaneous Orientation and Scale Estimator** Y. Cheng and A. Ansar (Jet Propulsion Laboratory)
3:20	**Kaguya Terrian Camera DEM Improvement** Y. Cheng, A. Ansar, and Y. Iwashita (Jet Propulsion Laboratory)

3:40	**Learning Illumination Invariant Features for Lunar South Pole with Deep Learning** G. Georgakis, A. Ansar (Jet Propulsion Laboratory)
4:00	**Tutorial: LuNaMaps Developed Tools and Processes for Mapping the Lunar Surface** The LunaMaps Team
4:30	**BREAK**
4:50	**Tutorial: Mathematical Foundations of Projective Exterior Algebra** Eric Lengyel (Terathon Software)
5:45	**FINISH**

Keynote Speaker 11:10–12:10

Monday, October 7 2024

11:10–12:10

Dr. Eric Lengyel

CTO, Terathon Software

Eric Lengyel is a computer scientist and mathematician specializing in computer graphics, real-time rendering, game engine architecture, and physical simulation. He has written numerous technical books on these subjects since he began working in industry in the early 1990s. His most recent book, Projective Geometric Algebra Illuminated, presents a complete picture of the modern conceptual foundations for widely applicable and practical computation with Grassmann and Clifford algebras.

Image Credit: NASA/JPL-Caltech

Tuesday: 8 October 2024

7:00	**Registration**
8:00	**Multi-modal, Multi-scale Representation Learning for Satellite Imagery Analysis Just Needs a Good ALiBi** P. Kage and P. Andreadis (University of Edinburgh)
8:20	**Applying Neural Radiance Fields to Asteroid Shape Modeling** M. W. Givens (Advanced Space)
8:40	**Seeing in the Dark: Feature Extraction and Matching in Low-light Regions Using Deep Learning** D. Kapu, T. Driver, P. Tsiotras (Georgia Tech)
9:00	**BREAK**
9:20	**Machine Learning for Autonomous Visual Navigation Under Variable Illumination Conditions** A. M. Mitchell (Massachusetts Institute of Technology), A. Johnson (Jet Propulsion Laboratory), and R. Linares (Massachusetts Institute of Technology)
9:40	**Keypoint-Based Stereophotoclinometry** T. Driver (Georgia Tech), A. Vaughan, Y. Cheng, A. Ansar (Jet Propulsion Laboratory), J. Christian, and P. Tsiotras (Georgia Tech)
10:00	**High-Precision Terrain Relative Navigation for Terminal Descent and Landing** I. R. Witte, L. A. Marinello, and S. N. Jenkins (John Hopkins University Applied Physics Laboratory)
10:20	**BREAK**
10:40	**Progress on Development of an Intelligent Landing System for Europa and Other Planetary Bodies** A. E. Johnson, A. Katake, T. Setterfield, and J. Butler (Jet Propulsion Laboratory)
11:00	**On-Orbit Detection, Identification, and Tracking of Geographic Targets with a Long Wave Infrared Camera** J. Carragher, A. Tyler, B. Gunter (Georgia Tech), D. Rowen, P. Leeds, and S. Cortes (The Aerospace Corporation)
11:20	**LiDAR-based Lunar Crater Volume Estimation** E. R. Damon, C. R. Valenta, and D. A. Carr (Georgia Tech)
11:40	**Crater Detector Evaluation Using Artemis I Imagery** J. S. McCabe (NASA JSC) and S. G. Catalan (University of Texas at Austin)
12:00	**LUNCH**
1:40	**Optimal Multi-View Pushbroom Triangulation** M. Mancini, S. Henry, and J. Christian (Georgia Tech)
2:00	**Gaussian Process Sequential Filtering for Small Body SLAM with Silhouette-Based Measurements** Q. P. Moon (University of Texas at Austin), C. Hollenberg (Jet Propulsion Laboratory), N. Lifset, E. M. Zucchelli (University of Texas at Austin), D. P. Lubey (Jet Propulsion Laboratory), B. A. Jones, R. P. Russell, and S. Bhaskaran (University of Texas at Austin)
2:20	**Autonomous Horizon-Based Optical Navigation on Near-Planar Cislunar Libration Point Orbits** Y. Shimane, K. Ho (Georgia Tech), and A. Weiss (MitsubishiELectric Research Laboratories)
2:40	**Autonomous Horizon-based Asteroid Navigation With Observability Enhancing Maneuvers** A. A. Anibha and K. Oguri (Purdue University)
3:00	**BREAK**
3:20	**Optical Deep-space Instrument for Navigation (ODIN)** A. Thrasher (Georgia Tech), R. Inman, R. Pecourt, R. Lovelace (NASA JSC), B. Russell-McCorkle, J. Christian (Georgia Tech)
3:40	**Field Testing of a Wearable Vision Navigation System for Astronaut Navigation on the Lunar Surface** C. E. Mario, B. Streetman, C. Cruz, T. J. Steiner, and K. R. Duda (The Charles Stark Draper Laboratory)

4:00	**Simulation of Lunar Terrain for Hazard Detection and Relative Navigation Development and Testing** M. E. Mohammadi, T. Stephans, L. Moon, T. Lincoln, R. Chen, P. Ribas, A. Horacio, B. Podobnik, A. Begley, C. Owens, and A. Horchler (Astrobotic)
4:20	**Using Simulated Lunar Imagery to Train Real Networks** K. McCleary, H. Zhang, P. R.M. Fisch, Z. Manchester, and B. Lucia (Carnegie Mellon University)
4:40	**BREAK**
5:00	**RECEPTION (GT Hotel)**
6:00	**DINNER AND SOCIAL (GT Hotel)**

Keynote Speaker 11:20–12:20

Wednesday, October 9, 2024

Dr. Marcus Holzinger

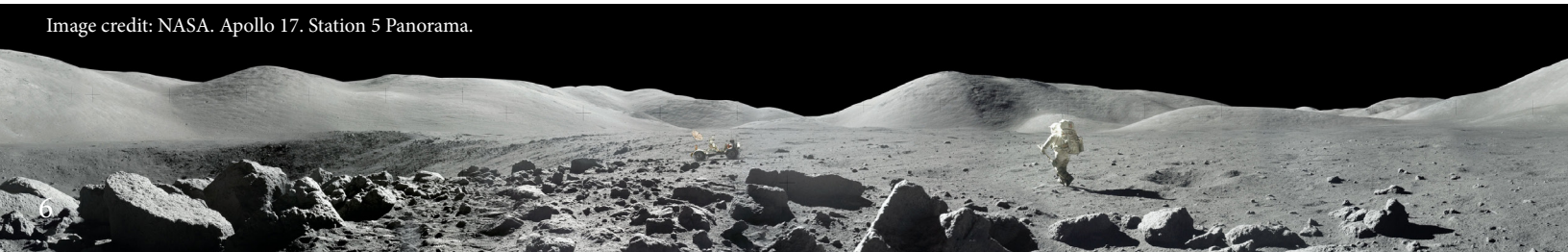
Professor, University of Colorado Boulder

Prof. Holzinger is a Professor and Endowed Joseph T. Negler Professor in the Smead Aerospace Engineering Sciences Department at the University of Colorado Boulder. His research focuses on theoretical and empirical aspects of space development, strategy, and domain awareness, for which he has testified to congress, authored or co-authored over 150 conference & journal papers, served as PI for $20M in external research funding, and built several Raven-class telescope systems. He served as the lead author for AFRL's 'A Primer on Cislunar Space' white paper, is a recipient of an AFOSR Young Investigator Award and the National Academies Grainger Award, and is a National Academies selectee for the US Frontiers of Engineering Symposium. Prof. Holzinger is a Fellow in the American Astronautical Society (AAS) and an Associate Fellow in the American Institute for Aeronautics & Astronautics (AIAA).

Wednesday: 9 October 2024

8:00	**Registration**
8:20	**Uncertainty Quantification of a Machine Learning-Based Pose Estimation Measurement Model** S. A. Agrawal, B. A. Jones, and M. R. Akella (University of Texas at Austin)
8:40	**Line-based Monocular SLAM for Spacecraft RPO** I. G. Velentzas, M. Dor, and P. Tsiotras (Georgia Tech)
9:00	**On Non-Gaussian Noise In Angles-Only Navigation** J. S. McCabe (NASA JSC)
9:20	**Relative Navigation Performance of a Constellation of Small Satellites for Radio Astronomy about the Earth-Sun L2 Point** G. P. Badura, N. Un, E. Arunkumar, K. Meng (Georgia Tech Research Institute), S. Henry (Georgia Tech), S. Storm, K. Burkhardt, R. Decker, C. R. Valenta (Georgia Tech Research Institute), J. Wise, and J. Christian (Georgia Tech)
9:40	**BREAK**
10:00	**SatSplatYOLO: 3D Gaussian Splatting-based Virtual Object Detection Ensembles for Satellite Feature Recognition** V. M. Nguyen, E. Sandidge, T. Mahendrakar, and R. T. White (Florida Institute of Technology)
10:20	**Lightweight Unknown Spacecraft Tracking During Proximity Operations** K. D. Shiller and M. R. Akella (University of Texas at Austin)
10:40	**A Fizeau Imaging Telescope for Detection of Faint Stellar Companions and Exo-Planets** D. Hope (Georgia Tech Research Institute), S. Prasad (University of Minnesota), S. Jefferies, F. Baron, L. Garcia (Georgia State University), and Megan Birch (Georgia State University and Georgia Tech Research Institute)
11:00	**BREAK**
11:20	**KEYNOTE: Event Camera Applications in Space Domain Awareness** Marcus Holzinger, Professor, University of Colorado Boulder
12:20	**LUNCH**
2:00	**Real-time Event-based Sensor Simulation for Space Applications** I. M. Martin, M. N. Dunstan (University of Dundee), M. Sanchez-Gestido, and J. Belhadj (ESTEC ESA)
2:20	**A Radiometric Consistent Render Procedure for Planets and Moons** A. Pizzetti, P. Panicucci, and F. Topputo (Politecnico di Milano)
2:40	**Generative Modeling for Topography Super-Resolution on the Moon** M. Repasky (Georgia Tech), E. Mazarico, S. Bertone, M. Barker, T. Sabaka (NASA GSFC), and Y. Xie (Georgia Tech)
3:00	**BREAK**
3:20	**Tutorial: Mathematical Foundations of Projective Geometric Algebra** Eric Lengyel (Terathon Software)
4:20	**Tutorial: Applications of Geometric Algebra** Russell Carpenter (NASA GSFC)
4:50	**CLOSING REMARKS**
5:00	**FINISH**

Image credit: NASA. Apollo 17. Station 5 Panorama.



About Georgia Tech

The Georgia Institute of Technology is one of the nation's top public research universities with nearly 40,000 students who study in person at the main campus in Atlanta, at Georgia Tech-Lorraine in France, at Georgia Tech-Shenzhen in China, as well as through distance and online learning. With more than $1 billion annually in research awards across all six Colleges and the Georgia Tech Research Institute (GTRI), Georgia Tech is among the nation's most research-intensive universities. It is an engine of economic development for the state of Georgia, the Southeast, and the nation.

Top-Ranked Aerospace Programs

The Daniel Guggenheim School of Aerospace Engineering (AE School) boasts one of the oldest and largest aerospace programs in the country. Whether students want to build and fly aircraft or dream of going into space, the AE School's focus on problem-solving propels them into a rewarding career with many top aerospace firms and government-research labs. The U.S. News & World Report has ranked the AE School #2 for Best Undergraduate Aerospace Programs in the Nation (September 2024) and #2 for Best Graduate Aerospace Programs in the Nation, #1 amongst publicly-funded institutions (June 2024).

Connecting with Industry Partners

To better service our student population as well as connect with industry partners, the AE School recently established a Corporate Affiliates Program (CAP), which connects the aerospace community with students enrolled in our bachelor, master's and doctoral programs. The program has structured a diverse set of activities that make it easy for organizations to engage with our students and explore opportunities, such as involvement with the AE School Career Fair, specific one-on-one meetings with students, and an invitation to the AE School's Mentor-in Residence program to name a few.

In addition, many of our students embark on summer internships at top aerospace engineering companies and start-ups where they demonstrate their technical knowledge, as well as showcase their hands-on skill in various aerospace domains.

Research

All graduate students - and a growing number of undergraduate students - are involved in aerospace research at the AE School. Our research efforts are organized around eight multidisciplinary research areas:

- Space Exploration & Earth Monitoring
- Robotics, Autonomy and Human Interaction
- Sustainable Transportation & Energy Systems
- Large-Scale Computations, Data, & Analytics
- System of Systems and Complex Systems Integration
- Cyberphysical Systems, Safety, Security, & Reliability
- Mechanics of Multifunctional Structures and Materials
- Systems Integration Vertical Lift and Urban Air Mobility

4th Space Imaging Workshop

Hosted and Organized by:
Space Exploration Analysis Laboratory (SEAL)
Space Systems Design Lab (SSDL)
Daniel Guggenheim School of Aerospace Engineering
Georgia Institute of Technology

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