

2019 INTERNATIONAL CONFERENCE ON UNMANNED AIRCRAFT SYSTEMS

ICUAS' 19

June 11-14, 2019

Atlanta Marriott Buckhead Hotel & Conference Center
3405 Lenox Road NE, Atlanta, Georgia 30326

FINAL PROGRAM

Technical Sponsorship Organizations



www.icuas.com

www.uasconferences.com

Academic Sponsors



UNIVERSITY of
DENVER



UNIVERSITY of
DENVER

DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE



UNIVERSITY of
WEST FLORIDA

Legal Track Sponsors



State Bar
of Georgia

Exhibitors



<http://www.fttechnologies.com>



<https://quanser.com>



<https://www.rcbenchmark.com>

ICUAS ASSOCIATION EXECUTIVE COMMITTEE MEMBERS

Randal Beard, BYU, USA
Pascual Campoy, Universidad Politecnica Madrid, Spain
Ben M. Chen, Chinese University of Honk Kong, China
YangQuan Chen, University of California, Merced, USA
Rogelio Lozano, Université de Technologie de Compiègne, France
James R. Morrison, KAIST, South Korea
Paul Oh, University of Nevada Las Vegas, USA
Anibal Ollero, Universidad de Sevilla, Spain
Daniel Pack, University of Tennessee, Chattanooga, USA
Fulvia Quagliotti, Politecnico di Torino, Italy
Camille-Alain Rabbath, Defence R&D, and Concordia University, Canada
Matthew J. Rutherford, University of Denver, USA
Roberto Sabatini, RMIT University, Melbourne, Australia
Hyunchul (David) Shim, KAIST, South Korea
Salah Sukkarieh, University of Sydney, Australia
George Vachtsevanos, Georgia Institute of Technology, USA
Kimon Valavanis, University of Denver, USA
Youmin Zhang, Concordia University, Canada

2019 ICUAS STEERING COMMITTEE

Tor Arne Johansen	Fulvia Quagliotti	Anibal Ollero
Nikos Tsourveloudis	Youmin Zhang	

2019 ICUAS ASSOCIATION LIAISON

Kimon P. Valavanis, University of Denver, kimon.valavanis@du.edu

2019 GENERAL CHAIRS

Didier Theilliol, U of Lorraine, Didier.theilliol@univ-lorraine.fr
YangQuan Chen, UC Merced, yangquan.chen@ucmerced.edu

2019 PROGRAM CHAIRS

James Morrison, KAIST, Korea, james.morrison@kaist.edu
Antonios Tsourdos, Cranfield Univ., a.tsourdos@cranfield.ac.uk

2019 PROGRAM Co-CHAIR

Mário Sarcinelli-Filho, UFES, Vitória, mario.sarcinelli@ufes.br
Rajnikant Sharma, U of Cincinnati, rajnikant.sharma@uc.edu

2019 INVITED SESSIONS CHAIR

Kostas Kanistras, U of Alabama, konstantinos.kanistras@uah.edu
Han-Lim Choi, KAIST, Korea, hanlimc@kaist.ac.kr

2019 TUTORIAL/WORKSHOP CHAIR

Andrea Monteriù, UNIVPM, a.monteriu@univpm.it

2019 PUBLICATIONS/PUBLICITY CHAIR

Matthew Rutherford, University of Denver, mjr@cs.du.edu

2019 LEGAL TRACK CHAIR

Justin Martin, EPRI and ACC-Tennessee, jmartin@epri.com
Dawn Zoldi, Col. U.S. Air Force (Ret.), zoldidmk@gmail.com

2019 INDUSTRY LIAISON CHAIR

Jonathan Kretz, U of Texas at Arlington, kretz@uta.edu

2019 REGISTRATION/FINANCE CHAIR

Dina Fragedaki, University of Denver, dina.fragkedaki@du.edu

2019 IEEE CSS LIAISON

Randal Beard, BYU, beard@byu.edu

2019 ELECTRONIC SERVICES COORDINATOR

Pradeep Misra, Wright State University, p.x.misra@gmail.com

INTERNATIONAL PROGRAM COMMITTEE MEMBERS (IPC)

R. Ajaj, F. Alarcón, K. Alexis, F. Andert, D. Azimov, I. F. Mondragón Bernal, S. Bogdan, A. S. Brandao, T. Brown, J. Caetano, L. R. G. Carrillo, P. Castillo, H. Chao, A. Chamseddine, J. Chudoba, L. Ciarletta, J. A. Cobano, J. Colorado, C. Coopmans, H. Rodríguez Cortes, C. Cuerno, J. Cui, G. de Croon, R. Czyba, A. Dolgikh, H. B. Duan, S. Durand, H. Edge, G. Fasano, A. T. Espinoza Fraire, M. Geiser, L. Felipe Gonzalez, I. Kaminer, J. Keller, Y. Kim, Z. Kowalczyk, K. Kyriakopoulos, A. D. Lara, N. Larrieu, D. Lee, D. F. Lin, S. Longhi, G. Lu, J. Luo, A. Mancini, C. Martinez, I. Maza, D. Melita, M. A. Olivares-Mendez, L. Merino, A. Monteriu, M. Mueller, M. Nahon, H. Noura, D. Nolan, U. Ozdemir, Z.-R. Peng, J. Qi, Y. H. Qu, S. Rathinam, H. Romero, J. M. Martin-Sanchez, S. Park, S. Salazar, S. Saripalli, M. Saska, A. Savvaris, H. Sevil, M. Shaqura, R. Sharma, S. Schopferer, A. Schulte, T. Sobh, R. Stansbury, B. Stark, K. Stol, P. B. Sujit, B. Theys, B. Upcroft, K. Uchiyama, J. Verbeke, A. Viguria, H. Voos, E. Voulgarelis, Y. Wan, S. Wilkerson, T. Yang.

ASSOCIATE EDITORS FOR PAPER REVIEWS

Adolf, Florian; Andert, Franz; Brandao, Alexandre Santos; Caballero, Fernando; Campoy, Pascual; Capello, Elisa; Chamseddine, Abbas; Chao, Haiyang; Choi, Han-Lim; Ciarletta, Laurent; Colorado, Julian; Coopmans, Calvin; de Croon, Guido; Durand, Sylvain; Espinoza Fraire, Arturo Tadeo; Fasano, Giancarmine; Fossen, Thor I.; Ghose, Debasish; Hasan, Agus; Johansen, Tor Arne; Keller, James; Kim, A Ram; Kowalczyk, Zdzislaw; Kulshrestha, Sanatan; Liu, Cunjia; Liu, Hugh H.T.; Lozano, Rogelio; Lu, Geng; Mancini, Adriano; Maza, Ivan; Mejias Alvarez, Luis; Merino, Luis; Monteriù, Andrea; Morrison, James R.; Nahon, Meyer; Nikolakopoulos, George; Noura, Hassan; Olivares-Mendez, Miguel A.; Pack, Daniel; Ponsart, Jean-Christophe; Puig, Vicenç; Rabbath, Camille Alain; Rathinam, Sivakumar; Rodriguez Cortes, Hugo; Rutherford, Matthew; Sarcinelli-Filho, Mário; Schopferer, Simon; Shanmugavel, Madhavan; Sharma, Rajnikant; Sobh, Tarek; Sousa, Joao; Sujit, P. B.; Tsourveloudis, Nikos; Uchiyama, Kenji; Vachtsevanos, George; Valavanis, Kimon; Viguria, Antidio; Whidborne, James; Xu, Bin; Yang, Hao; Zhang, Wenlong; Zhao, Shiyu.

Welcome Message from the ICUAS Association

Dear participants and attendees:

On behalf of the ICUAS Association Inc., and in my capacity as President, it is a great pleasure and honor to welcome you to ICUAS'19. The ICUAS Association is a non-profit organization. Its vision is threefold: i) Establish the annually organized and fully sponsored ICUAS as the flagship technical conference in unmanned aerial vehicles, both nationally and internationally, eventually expanding conference objectives to include all types of unmanned systems; ii) Through the Association's activities and initiatives, contribute to pushing forward the frontiers of unmanned systems leading to the next generation of fully autonomous and fully functional prototypes, and, iii) Contribute to educating students, researchers, scientists, engineers and practitioners, as well as the general public, about unmanned systems.

The mission of the Association is to advance knowledge, education, basic and applied research and development in unmanned systems by: Organizing annual conferences, workshops, tutorials and other technical meetings in unmanned systems in general, and in Unmanned Aircraft Systems in particular; Offering short courses and other technical courses in unmanned systems to scientists, engineers, researchers and practitioners who are interested in learning and/or improving their knowledge in this area; Publishing annually the ICUAS proceedings; Publishing on an 'as needed basis' highly technical research monographs and textbooks in topics of interest in unmanned systems.

Our goals are to: Benefit researchers, scientists, engineers and practitioners; Advance the state-of-the-art in unmanned systems; Contribute to developing the next generation of unmanned systems; Contribute to the advancement of higher education; Educate the public about how unmanned systems may be used in a wide spectrum of civilian and public domain applications like search and rescue, emergency response, early fire detection and forest protection, environmental monitoring, to name but a few applications.

We are looking forward to your involvement, contributions and feedback. We welcome your participation and we are open to your ideas and suggestions to register the ICUAS Association as the primary organization that: Benefits students, researchers, scientists, engineers, practitioners and end-users; Advances the state-of-the-art in UAS; Contributes to the advancement of higher education.

My best wishes for a successful and productive conference, and I look forward to seeing you in Atlanta.

Kimon P. Valavanis

Welcome Message from the General Chairs

Dear participants and attendees:

On behalf of the 2019 ICUAS Organizing Committee, it is a privilege and a pleasure to welcome you to this year's conference, on June 11-14, 2019. The three-day Conference is preceded by a one-day Workshops / Tutorials program, on Tuesday, June 11. We are certain you will be very pleased with the conference venue, and you will enjoy all the attractions Atlanta offers.

Conference participants represent academia, industry, government agencies, lawyers, policy makers, manufacturers, students and end-users, all having deep interest in the state-of-the-art and future directions in unmanned aircraft systems. We received 237 contributed/invited session papers. This is the second highest number since launching ICUAS. Following a very thorough and in-depth peer review process in which each paper had at least four reviews (three external reviewers plus a member of the organizing committee), and in some cases as many as eight, roughly 77% of contributed, invited session and poster papers were accepted. All papers were also checked following the *iThenticate* Document Viewer Guide receiving a 'similarity score' and a 'max percentage match' before final decision was made. We have assembled a full three-day top-quality Technical Program. We also have three Plenary Lectures in which the keynote speakers address pressing and important issues related to unmanned aviation in civil and restricted airspace.

The Organizing Committee members have devoted an enormous amount of time and effort to make sure

that the conference is exciting, informative and educational. We are privileged and honored to have worked with all the members and we are truly indebted to everyone for their dedication and professionalism. We also extend a wholehearted “thank you” to all reviewers, Associate Editors and members of the Technical Program Committees; their help was integral to assembling a top-quality Technical Program. The peer review process was coordinated by the Program Chairs and Co-Chairs. Dr. Pradeep Misra was the essential “glue” that kept everything together, since all papers were submitted through <https://controls.papercept.net>. We wouldn’t have been able to complete the paper review process without his help.

We thank you for your participation and contributions. We hope you enjoy the conference, as well as Atlanta and the other surrounding areas.

Didier Theilliol and Yang-Zuan Chen

Welcome Message from the Program Chairs

Dear participants and attendees:

Welcome to ICUAS’19. This year we received 237 contributed, invited session full-length papers and poster papers. This number is the second highest compared to any previous ICUAS. The paper review process has been extremely thorough and rigorous. All papers were also checked for originality using the *iThenticate* Document Viewer Guide. Our initial goal was for each paper to have at least three reviews. We exceeded this goal; each paper had on average more than 3 reviews and some papers had as many as 8 reviews! However, considering that the Program Chairs and other members of the Organizing Committee coordinated all paper reviews and read all papers, each paper received an average of more than 4 reviews.

Authors of submitted papers used among the following key words to classify their paper: Airspace Control, Airspace Management, Airworthiness, Air Vehicle Operations, Autonomy, Biologically Inspired UAS, Certification, Control Architectures, Energy Efficient UAS, Environmental Issues, Fail-Safe Systems, Frequency Management, Integration, Interoperability, Levels of Safety, Manned/Unmanned Aviation, Micro- and Mini- UAS, Navigation, Networked Swarms, Payloads, Path Planning, Regulations, Reliability of UAS, Risk Analysis, See-and-avoid Systems, Security, Sensor Fusion, Simulation, Smart Sensors, Standardization, Swarms, Technology Challenges, Training, UAS Applications, UAS Communications, UAS Testbeds.

The review process resulted in accepting 188 contributed, invited and poster session papers. The technical program spans three days, during which all accepted, and poster papers will be presented. Submitted/accepted papers are from the following countries (listed in ascending order of submissions): USA, Mexico, Brazil, India, Canada, France, Spain, China, Italy, Norway, Singapore, South Korea, Denmark, Germany, Portugal, Hungary, Japan, Australia, United Kingdom, Argentina, Croatia, Cyprus, New Zealand, Pakistan, Paraguay, Poland, Qatar, South Africa, Switzerland, Taiwan, United Arab Emirates.

We would like to thank all the authors for their contributions. Our rigorous review process would not have been possible if we did not have such a strong community of expert reviewers in unmanned aircraft systems. We thank all reviewers for their professional service.

Pradeep Misra helped us in working and using effectively the on-line paper submission and review system. He has been very responsive and helpful in issues related to the system. Our questions were mostly due to our novice and inexperience with the on-line system. We acknowledge that this on-line system is very sophisticated and yet very practical to use for both small and large-scale conferences. It is very hard to imagine how things would have been done without this excellent on-line system!

We hope you enjoy not only the technical aspects of the conference but also beautiful Atlanta. Fly high and safe, to the next ICUAS!

James Morrison and Antonios Tsourdos

ICUAS'19 Tutorials and Workshops

ICUAS'19 offers three pre-conference Workshops/Tutorials addressing current and future topics in unmanned aircraft systems from experts in academia, national laboratories, and industry. Interested participants may find details on the Conference web, www.uasconferences.com, and they may use the on-line system for registration.

All Tutorials / Workshops will take place on Tuesday, June 11, 2019. See the attached map for the location of the rooms. Tutorial/Workshop duration is either **Full-Day** (9:00 AM – 5:30 PM) or **Half-Day** (09:00 AM – 01:00 PM).

Location	Time	Title
T1 <i>Heritage A</i>	Full-Day 9:00 AM–5:30 PM	NEW DEVELOPMENTS ON SENSE-AND-AVOID (S&A), FAULT-TOLERANT CONTROL (FTC) AND FAULT-TOLERANT COOPERATIVE CONTROL (FTCC) TECHNIQUES FOR UNMANNED SYSTEMS AND THEIR APPLICATIONS <i>Organizers: Drs. Youmin Zhang and Didier Theilliol</i>
T2 <i>Heritage B</i>	Half-Day 9:00 AM-1:00 PM	TOWARDS NETWORKED AIRBORNE COMPUTING: APPLICATIONS, CHALLENGES, AND ENABLING TECHNOLOGIES <i>Organizers: Drs. Yan Wan, Kejie Lu, Shengli Fu, Junfei Xie</i>
T3 <i>Heritage C</i>	Half-Day 9:00 AM-1:00 PM	UAV HEALTH MANAGEMENT ISSUES: CAN SMALL UAVS SURVIVE EXTREME DISTURBANCE ENVIRONMENTS? <i>Organizers: Drs. George J. Vachtsevanos and Kimon P. Valavanis</i>

ICUAS'19 Plenary Lectures

ICUAS'19 includes three Keynote / Plenary Lectures given by leading authorities in their respective fields. We are honored to include their talks as part of this year's Conference program. All Plenary/Keynote lectures will be in the General Session Room, **Heritage B**. There will be two Plenary/Keynote lectures on Wednesday, June 12, and one on Thursday, June 13. The schedule for the lectures is shown next.

WEDNESDAY – JUNE 12 – HERITAGE B	
8:45 – 9:45 AM	LAW, LAWFARE AND TECH: AN ARGUMENT FOR COLLABORATION <i>CHARLES J. DUNLAP (MAJ. GEN. USAF, RET.), Professor of the Practice of Law, Executive Director of the LENS Center on Law, Ethics & National Security, Duke Law School</i>
1:45 – 2:45 PM	THE 2018 FAA REAUTHORIZATION ACT – WHERE TO FROM HERE? <i>JAMES O. POSS (MAJ. GEN. USAF, RET.), Chief Executive Officer, ISR Ideas</i>
THURSDAY - JUNE 13 – HERITAGE B	
8:45 – 9:45 AM	THE INVASIONS OF DRONES - PUBLIC PERCEPTION AND SAFETY <i>Dr. Brandon Stark, Center of Excellence for Unmanned Aircraft System Safety University of California - Merced</i>

ICUAS'19 Information

The Venue

The Conference venue is the Atlanta Marriott Buckhead Hotel & Conference Center, located in the heart of Atlanta. There is a plethora of Local Attractions close to the venue, including: Lenox Square Mall; Phipps Plaza Mall; World of Coca Cola; Callanwolde Fine Arts Center; The King Center; Stone Mountain Park; Georgia Aquarium; College Football Hall of Fame; Underground Atlanta; North Georgia Premium Outlet Mall; Buckhead Shops and Restaurants; CNN Center; Georgia Governor's Mansion; High Museum of Art; Martin Luther King Jr Center; Six Flags Over Georgia; World Congress Center, and, Atlanta Zoo.



Travel Directions

The hotel does not provide shuttle services.

Hartsfield-Jackson Atlanta International Airport (ATL)

Hotel direction: 17 miles N

Estimated taxi fare: 40 USD (one way). Subway service, fee: 2.5 USD (one way)

Driving directions: Take I-85 North to Exit #87 (Georgia 400), to Exit #2 (Lenox Road); Turn right and follow Lenox Road Signs, cross Peachtree Road. The Hotel is 1.5 blocks on the left.

Dekalb-Peachtree Airport (PDK)

Hotel direction: 5 miles E

Estimated taxi fare: 18 USD (one way). Subway service, fee: 2.5 USD (one way)

Driving directions: Going South on Clairmont Road NE toward 9th Street, turn right at Dresden Drive NE, turn left at Peachtree Road NE, turn left at Lenox Road NE. The hotel is on the left side.

Conference Registration

All Conference attendees must register by using the on-line registration when they upload the final version of their papers. It is not required to upload a paper to register for the conference. Late and on-site registration is also available for non-authors who want to attend the conference. To register, follow the steps:

- ✓ Go to <https://controls.papercept.net>
- ✓ Scroll down the list until you find ICUAS 2019 - Choose ICUAS 2019 (from the list of conferences)
- ✓ Click on Register for ICUAS'19
- ✓ Login with your PIN and Password. *First time users must create a 'profile', get a PIN and Password.*
- ✓ After you Log in, choose **Registree**
- ✓ Follow the self-explained screens to register.

All registered participants must **check in at the Registration Desk** to pick up their registration packages. Personal badges will be provided to all registered participants. **Attendees must wear their badges at all times when attending any ICUAS'19 event** (technical sessions, exhibits, and social functions). This is very important for security reasons.

Registration will be in the **Heritage Prefunction** area. Registration hours will be open as follows:

TUESDAY, JUNE 11- **Workshop/Tutorial Registration ONLY** 8:00 AM – 11:00 AM
Conference Registration 1:00 PM – 5:00 PM
 WEDNESDAY, JUNE 12: 8:00 AM – 5:00 PM
 THURSDAY, JUNE 13: 8:00 AM – 3:00 PM
 FRIDAY, JUNE 14: 8:30 AM – 11:00 AM

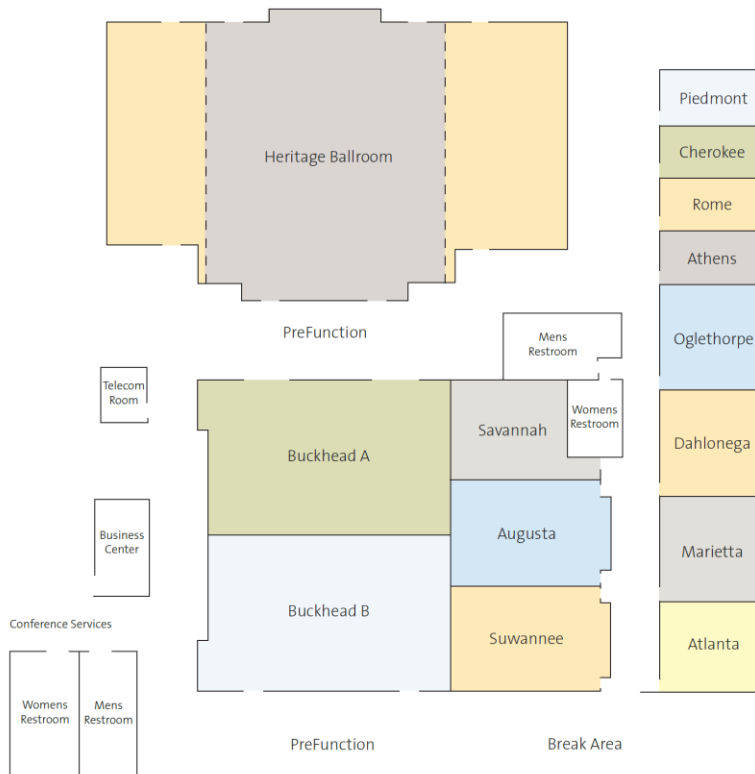
On-site conference registration policy and fees: Attendees will be able to register for the Conference under the following registration categories/rates:

ATTENDEES	ON-SITE REGISTRATION
Academic, Industry, Government	\$600
Legal and Policy Track (only)	\$300
Student	\$350
Workshop / Tutorials	\$150 / \$180
Extra Banquet Ticket	\$100
Extra Proceedings	\$40

Meeting Area and Exhibits

The meeting area is in the same floor, see attached floorplan. All activities, Registration, Workshops / Tutorials, Technical Sessions, Exhibits and Coffee Breaks will take place in one level, for the duration of the Conference.

- ✓ Workshops/Tutorials will be in: **Heritage A, Heritage B** and **Heritage C**.
- ✓ The Legal and Policy Track (Wednesday, June 13) will be in **Oglethorpe**.
- ✓ Technical Sessions will be in: **Heritage A, Heritage B, Heritage C**, and, **Savannah**.



Internet Access

All *registered attendees* will have complementary internet access in the meeting space area. Log in and Password information will be provided at the conference registration desk.

Continental Breakfast and Coffee Breaks

Continental Breakfast will be served in the morning, Wednesday to Friday, for all *registered attendees*, 7:45-8:30 AM. There will be two coffee breaks per day, one in the morning and one in the afternoon. Continental Breakfast and coffee breaks will be served in the *Heritage Prefunction* area.

Events and Receptions

The ICUAS'19 social agenda include:

Welcome Reception, 7:00 PM:	<i>Winning Edge</i> (Lobby Level)	Tuesday, June 11
Gala Dinner: 7:30 PM	<i>Buckhead Ballroom</i>	Thursday, June 13

Conference Technical Sessions - Wednesday, June 12 – Friday, June 14

In addition to the Plenary/Keynote lectures, there will be four parallel technical sessions each day. All Technical Sessions will be in *Heritage A, Heritage B, Heritage C*, and, *Savannah*.

Exhibits

Exhibits will be in the *Heritage Prefunction* area to guarantee maximum traffic and exposure.

Poster Papers

Poster papers will be presented on Wednesday, June 12, in the *Heritage Prefunction* area.

ICUAS'19 Legal and Policy Track Information

Location: Oglethorpe Wednesday, June 12

10:00 – 11:00 AM	<p>LAWYERING FOR DRONE CLIENTS IN THE U.S.: BASICS OF FEDERAL DRONE REGULATION, UTM, AND CORPORATE BEST PRACTICES <i>M. A. SWANSON, Partner, Wilkinson, Barker, Knauer, LLP., Washington, D.C.</i> <i>D. E. GRIFFITH, Esq., Attorney, Jones Day, Washington, D.C.</i> <i>M. BLANKS, Director, Virginia Tech Mid-Atlantic Aviation Partnership, Virginia Tech</i></p>
11:00 AM–12:15 PM	<p>ROUND TABLE PANEL DISCUSSION: THE LEGAL, POLICY AND ETHICAL IMPLICATIONS OF AI Moderator: <i>R. G. GROSS (Brig. Gen. USA, Ret.), Former Legal Counsel, Chair Joint Chiefs of Staff, Self-Employed Senior Counsel/Strategic Advisor, Knoxville</i> Panelists <i>L. R. BLANK, Clinical Professor of Law/Dir. Center for International and Comparative Law and International Humanitarian Law Clinic, Emory Univ. School of Law, Atlanta</i> <i>F. COPPERSMITH, CEO/Founder, Smarter Reality, Austin</i> <i>J. Z. MALEKOS SMITH, J.D., Reuben Everett Cyber Scholar, Duke Law, Center of Law & Technology/Center for Law, Ethics & National Security, Durham</i> <i>S. V. DAVIS, Lt Col, USAF, Chief, Air & Space Law Division, Operations & International Law Directorate, Headquarters Air Force, Office of The Judge Advocate General</i></p>
12:15 – 12:45 PM	LUNCH
12:45 – 1:45 PM	<p>SPECIAL CLE PROFESSIONAL WELLNESS SESSION SUPER LAWYERS: ETHICAL IMPLICATIONS OF STRESS, BURNOUT AND WELL-BEING <i>C. W. PATTON, J.D., M.ED. ED.D., National Legal Education Speaker, Professor, Executive Well-Being Advisor, ChildAdvocateLaw.com, KY & ID</i> <i>J. W. PATTON, LL.M., M.DIV., Chief Legal Officer & Vice President for Advancement, The Broadhurst Group, KY & ID</i></p>
3:00 – 4:15 PM	<p>ROUND TABLE PANEL DISCUSSION: AN UPDATE ON INTERNATIONAL RPAS REGULATION Moderator: <i>J. MARTIN, Esq., Associate General Counsel, Electric Power Research Institute (EPRI)</i> Panelists <i>A. KONERT, PhD, Dean, Faculty of Law and Administration and Law Professor, Director of Institute of Air & Space Law, Lazarski Univ., Warsaw, Poland</i> <i>P. KASPRZYK, PhD, Attorney at Law & Research Fellow, Institute of Air and Space Law, Lazarski Univ. Warsaw, Poland</i> <i>E. BASSI, PhD, Nexa Center for Internet & Society, Dept. of Control & Computer Engineering, Politecnico di Torino, Italy</i></p>
4:15 – 5:30 PM	<p>LEGAL JEOPARDY GAMESHOW LIGHTNING ROUND: CONTEMPORARY GLOBAL LEGAL & POLICY ISSUES IN DRONE OPERATIONS” Moderator: <i>D. M. K. ZOLDI (Col USAF, Ret.), Associate General Counsel, U.S. Air Force Academy Business Matters, Office of Air Force General Counsel, CO & DC</i> Panelists <i>S. J. NILSSON, PhD, J.D., M.A.S., Assistant Professor of Aviation and UAS Law Embry Riddle Aeronautical University, Prescott</i> <i>C. CHAN, Esq., Partner, Eversheds Sutherland (U.S.) LLP, Atlanta</i> <i>F. QUAGLIOTTI, Professor Ing., Department of Mechanical & Aerospace Engineering, Politecnico di Torino, Italy</i> <i>F. X. NOLAN IV, Esq., Counsel, Eversheds Sutherland (U.S.) LLP, New York</i></p>
SOCIAL HOUR 5:45PM – 7PM, CLE participants only	

ICUAS'19 TECHNICAL PROGRAM AT A GLANCE

Wednesday, June 12

Heritage B	Heritage A	Heritage C	Savannah
10:00-12:00 WeA1 Path Planning I	10:00-12:00 WeA2 Swarms I	10:00-12:00 WeA3 Risk and Reliability	10:00-12:00 WeA4 Control Architectures I
15:00-17:00 WeB1 Path Planning II	15:00-17:00 WeB2 Swarms II	15:00-17:00 WeB3 UAS Applications I	15:00-17:00 WeB4 Control Architectures II
17:00-19:00 WeC1 Fault Diagnosis, Accommodation & Fault- Tolerant Control	17:00-19:00 WeC2 Regulations	17:00-19:00 WeC3 UAS Applications II	17:00-19:00 WeC4 Control Architectures III

Poster Papers WeP5: Heritage Prefunction – Exhibit and Presentation Timeframe: 13:00 – 18:00 PM

Coffee Breaks: 9:45 AM – 10:00 AM and 14:45 – 15:00 PM

Thursday, June 13

10:00-12:00 ThA1 Path Planning III	10:00-12:00 ThA2 Micro and Mini UAS	10:00-12:00 ThA3 UAS Applications III	10:00-12:00 ThA4 Energy Efficient UAS
13:30-15:30 ThB1 Path Planning IV	13:30-15:30 ThB2 Sensor Fusion I	13:30-15:30 ThB3 UAS Applications IV	13:30-15:30 ThB4 Airspace Management
16:00-18:00 ThC1 See-and-Avoid Systems	16:00-18:00 ThC2 Sensor Fusion II	16:00-18:00 ThC3 UAS Applications V	16:00-18:00 ThC4 Airspace Control

18:00-19:00 PM: **Heritage B - Round Table: - UAV Contributions and Challenges to Society**
Chair: G. J. Vachtsevanos, Georgia Institute of Tech.

Coffee Breaks: 9:45 AM – 10:00 AM and 15:30 – 16:00 PM

Friday, June 14

9:00-11:00 FrA1 UAS Design	9:00-11:00 FrA2 Autonomy I	9:00-11:00 FrA3 UAS Navigation I	9:00-11:00 FrA4 Environmental Issues
11:30-13:30 FrB1 Risk Analysis and Risk- Based Methods for UAS	11:30-13:30 FrB2 Autonomy II	11:30-13:30 FrB3 UAS Navigation II	11:30-13:30 FrB4 UAS Testbeds

Coffee Break: Continuous Coffee starting at 11:00 AM

ICUAS'19 CONTENT LIST

Technical Program for Wednesday June 12, 2019

WeA1 - Heritage B: Path Planning I

Chair: Sharma, Rajnikant Co-Chair: Rathinam, Sivakumar

10:00-10:20 WeA1.1

(77) Onboard Generation of Optimal Flight Trajectory for Delivery of Fragile Packages

Yuan, Weihong; Rodrigues, Luis

10:20-10:40 WeA1.2

(86) Smooth Path Planning for Fixed-Wing Aircraft in 3D Environment Using a Layered Essential Visibility Graph

D'Amato, Egidio; Notaro, Immacolata; Blasi, Luciano; Mattei, Massimiliano

10:40-11:00 WeA1.3

(112) Hu-Moment-Based Autonomous Landing of a UAV on a Hemispherical Dome

K, Ravi Chandra; Ghosh, Satadal

11:00-11:20 WeA1.4

(206) Nonlinear Model Predictive Control to Aid Cooperative Localization

Manoharan, Amith; Sharma, Rajnikant; Sujit, P. B

11:20-11:40 WeA1.5

(207) Landmark Placement for Cooperative Localization and Routing of Unmanned Vehicles

Wang, Bingyu; Rathinam, Sivakumar; Sharma, Rajnikant

11:40-12:00 WeA1.6

(211) Encirclement of Moving Targets Using Relative Range and Bearing Measurements

Jain, Puneet; Peterson, Cameron

WeA2- Heritage A: Swarms I

Chair: Pack, Daniel Co-Chair: Tsourdos, Antonios

10:00-10:20 WeA2.1

(21) Software Defined Network Based Architecture to Improve Security in a Swarm of Drones

Guerber, Christophe ; Larrieu, Nicolas ; Royer, Mickaël

10:20-10:40 WeA2.2

(22) Efficient Decentralized Task Allocation for UAV Swarms in Multi-Target Surveillance Missions

Li, Teng; Shin, Hyo-Sang; Tsourdos, Antonios

10:40-11:00 WeA2.3

(48) Cooperative Target Tracking by Altering UAVs' Linear and Angular Velocities

Ma, Lili

11:00-11:20 WeA2.4

(83) A Fast, Robust and Decentralized Approach for Altitude De-Confliction of Multiple UAVs

Cao, Jiawei; Teo, Rodney; Huang, Sunan; Ren, Qinyuan

11:20-11:40 WeA2.5

(148) A Hybrid Algorithm for Modifying and Tracking Connectivity in UAV Teams

Trimble, James; Pack, Daniel; Ruble, Zachary

11:40-12:00 WeA2.6

(223) UAVs Formation Control with Dynamic Compensation Using Neuro Adaptive SMC

Rosales, Claudio Dario; Gimenez, Javier; Rossomando, Francisco; Soria, Carlos; Sarcinelli-Filho, Mário; Carelli, Ricardo

WeA3 - Heritage C: Risk & Reliability

Chair: Ciarletta, Laurent Co-Chair: Jensen, Kjeld

10:00-10:20 WeA3.1

(27) Improving Redundancy and Safety of UTM by Leveraging Multiple UASs

Schwalb, Edward; Schwalb, Joseph

10:20-10:40 WeA3.2

(28) Monitor-Centric Mission Definition with Sophrosyne

Viard, Louis ; Ciarletta, Laurent ; Moreau, Pierre-Etienne

10:40-11:00 WeA3.3

(128) Game Theoretic Strategies for an Unmanned Aerial Vehicle Network Host under DDoS Attack

Aakif Mairaj, Subhrajit Majumder, Ahmad Y. Javaid

11:00-11:20 WeA3.4

(175) A Methodology for Evaluating Commercial Off the Shelf Parachutes Designed for sUAS Failsafe Systems

Tofterup, Vincent Klyverts; Jensen, Kjeld

11:20-11:40 WeA3.5

(182) Embedding Consequence Awareness in Unmanned Aerial Systems with Generative Adversarial Networks

Zhang, Guoxiang; Alcalá, Jose; Ng, Jeffrey; Chen, Mighty; Wu, Xiangyu; Mueller, Mark Wilfried; Chen, Y.-Q.

WeA4 – Savannah: Control Architectures I

Chair: Sarcinelli-Filho, Mário Co-Chair: Kuchwa-Dube

10:00-10:20 WeA4.1

(58) Quadrotor-Based Aerial Manipulator Altitude and Attitude Tracking Using Adaptive Super-Twisting Sliding Mode Control

Kuchwa-Dube, Chioniso; Pedro, Jimoh Olarewaju

10:20-10:40 WeA4.2

(69) Robust Control Architecture for Wind Rejection in Quadrotors

Verberne, Johannes; Moncayo, Hever

10:40-11:00 WeA4.3

(117) Input Shaped Trajectory Generation and Controller Design for a Quadrotor-Slung Load System

Fielding, Sean; Nahon, Meyer

11:00-11:20 WeA4.4

(137) Adaptive Control for a Tilted-Motors Hexacopter UAS Flying on a Perturbed Environment

Arizaga-Leon, Jorge Manuel; Castaneda, Herman; Castillo, Pedro

11:20-11:40 WeA4.5

(195) Architecture-Independent Quaternion-Based Attitude Planning and Control Allocation for Multirotors

Borges Façoni, Leonardo; Terra, Marco Henrique; Inoue, Roberto Santos

11:40-12:00 WeA4.6

(209) Trajectory-Tracking of a Heterogeneous Formation Using Null Space-Based Control

Ernandes, Valentim; Sarcinelli-Filho, Mário; Brandao, Alexandre Santos

WeB1 - Heritage B: Path Planning II

Chair: Rothmund, Sverre Velten Co-Chair: Morrison, James R.

15:00-15:20 WeB1.1

(32) A 3D Mobility Model for Autonomous Swarms of Collaborative UAVs

Falomir, Ema; Chaumette, Serge; Guerrini, Gilles

15:20-15:40 WeB1.2

(72) Robust Multi-UAV Route Planning Considering UAV Failure

Patel, Ruchir; Rudnick-Cohen, Eliot; Azarm, Shapour; Herrmann, Jeffrey

15:40-16:00 WeB1.3

(79) Routing Problems for Reconnaissance Patrolling Missions

Rajan, Sudarshan; Sundar, Kaarthik; Gautam, Natarajan

16:00-16:20 WeB1.4

(110) Risk-Based Obstacle Avoidance in Unknown Environments Using Scenario-Based Predictive Control for an Inspection Drone Equipped with Range Finding Sensors

Rothmund, Sverre Velten; Johansen, Tor Arne

16:20-16:40 WeB1.5

(130) Flight Patterns for Clouds Exploration with a Fleet of UAVs

Verdu, Titouan ; Hattenberger, Gautier ; Lacroix, Simon

16:40-17:00 WeB1.6

(200) On Systems of UAVs for Persistent Security Presence: A Generic Network Representation, MDP Formulation and Heuristics for Task Allocation

Kim, Minjun; Morrison, James R.

WeB2 - Heritage A: Swarms II

Chair: Castaneda, Herman Co-Chair: Castillo, Pedro

15:00-15:20 WeB2.1

(76) A Computational Tool to Assess Communications' Range and Capacity Limits of Ad-Hoc Networks of UAVs Operating in Maritime Scenarios

Oliveira, Tiago; Agamyryzansc, Anna; Correia, Luis

15:20-15:40 WeB2.2

(91) Probabilistic Search and Track with Multiple Mobile Agents

Papaioannou, Savvas; Kolios, Panayiotis; Theocharides, Theocharis; Panayiotou, Christos; Polycarpou, Marios M.

15:40-16:00 WeB2.3

(93) Backstepping-Based Controller for Flight Formation

Flores Palmeros, Pedro; Castillo, Pedro ; Castanos, Fernando

16:00-16:20 WeB2.4

(218) Containment Control Based on Adaptive Sliding Mode for a MAV Swarm System under Perturbation

Katt, Carlos; Castaneda, Herman

16:20-16:40 WeB2.5

(168) Time-Delay Control of a Multi-Rotor VTOL Multi-Agent System towards Transport Operations

Alvarez Muñoz, Jonatan Uziel; Castillo Zamora, Jose de Jesus; Escareno Castro, Juan Antonio; Boussaada, Islam;

Méndez-Barrios, César Fernando; Labbani, Ouidad

16:40-17:00 WeB2.6

(160) Formation Control and Navigation of a Quadrotor Swarm

Fernando, Malintha; Liu, Lantao

WeB3 - Heritage C: UAS Applications I

Chair: Vitzilaios, Nikolaos

15:00-15:20 WeB3.1

(63) Discrete-Time Control of LineDrone: An Assisted Tracking and Landing UAV for Live Power Line Inspection and Maintenance

Hamelin, Philippe; Mirallès, François; Lambert, Ghislain; Lavoie, Samuel; Pouliot, Nicolas; Montfrond, Matthieu; Montambault, Serge

15:20-15:40 WeB3.2

(152) Autonomous Aerial Robotic Exploration of Subterranean Environments Relying on Morphology-Aware Path Planning

Papachristos, Christos; Khattak, Shehryar; Mascarich, Frank; Dang, Tung; Alexis, Kostas

15:40-16:00 WeB3.3

(173) Building Mosaics Using Images Autonomously Acquired by a UAV

Amorim, Lúcio André; Vassallo, Raquel; Sarcinelli-Filho, Mário

16:00-16:20 WeB3.4

(213) Planning System for Integrated Autonomous Infrastructure Inspection Using UAVs

Ramon Soria, Pablo; Perez Jimenez, Manuel; Arrue, B.C.; Ollero, Anibal

16:20-16:40 WeB3.5

(205) Dynamic Structural Health Monitoring Using a DIC-Enabled Drone

Kalaitzakis, Michail; Kattil, Sreehari Rajan; Vitzilaios, Nikolaos; Rizos, Dimitris; Sutton, Michael

16:40-17:00 WeB3.6

(197) UAV Aided Dynamic Routing of Resources in a Flood Scenario

Kashyap, Abhishek; Ghose, Debasish; Prathyush, Purushothama Menon; Sujit, P. B; Das, Kaushik

WeB4 – Savannah: Control Architectures II

Chair: Sharma, Rajnikant

15:00-15:20 WeB4.1

(4) Design and Implementation of an Artificial Neural Network Wavelet for Load Transportation with Two Unmanned Aircraft Systems

Juarez Vargas, Cesar Eduardo; Suárez Cansino, Jól; Espinoza Quesada, Eduardo Steed; Garcia Carrillo, Luis Rodolfo; Ramos-Velasco, Luis Enrique; Lozano, Rogelio

15:20-15:40 WeB4.2

(7) Robustness Studies on Quadrotor Control

Brossard, Jérémy; Bensoussan, David; Landry, René Jr.; Hammami, Maher

15:40-16:00 WeB4.3

(111) Flight Control Methods for Multirotor UAS

Ackerman, Kasey; Gregory, Irene; Hovakimyan, Naira

16:00-16:20 WeB4.4

(171) A Survey of Artificial Neural Networks with Model-Based Control Techniques for Flight Control of Unmanned Aerial Vehicles

Gu, Weibin; Valavanis, Kimon; Rutherford, Matthew; Rizzo, Alessandro

16:20-16:40 WeB4.5

(174) Centroid Vectoring Control Using Aerial Manipulator: Experimental Results

Ivanovic, Antun; Car, Marko; Orsag, Matko; Bogdan, Stjepan

16:40-17:00 WeB4.6

(191) Robust and Synchronous Nonlinear Controller for Autonomous Formation Flight of Fixed Wing UASs

Cordeiro, Thiago; Ferreira, Henrique Cezar; Ishihara, João Yoshiyuki

WeC1 - Heritage B: Fault Diagnosis, Accommodation and Fault-Tolerant Control

Chair: Hasan, Agus

17:00-17:20 WeC1.1

(145) Interactive Multiple Neural Adaptive Observer Based Sensor and Actuator Fault Detection and Isolation for Quadcopter

Lee, Woo-Cheol; Choi, Han-Lim

17:20-17:40 WeC1.2

(42) Observer-Based Super Twisting Controller Robust to Wind Perturbation for Multirotor UAV

Hamadi, Hussein; Lussier, Benjamin; Fantoni, Isabelle; Francis, Clovis; Shraim, Hassan

17:40-18:00 WeC1.3

(154) Model-Based Fail-Safe Module for Autonomous Multirotor UAVs with Parachute Systems

Hasan, Agus; Tofterup, Vincent Klyverts; Jensen, Kjeld

18:00-18:20 WeC1.4

(103) Actuator Fault Diagnosis and Fault Tolerant Control Using Intelligent-Output-Estimator Applied on Quadrotor UAV

Al Younes, Younes; Noura, Hassan; Rabhi, Abdelhamid; El Hajjaji, Ahmed

18:20-18:40 WeC1.5

(178) Fault-Tolerant Adaptive Neural Control of Multi-UAVs against Actuator Faults

Yu, Ziquan; Zhang, Youmin; Qu, Yaohong; Su, Chun-Yi; Zhang, Yintao; Xing, Zhewen

WeC2 - Heritage A: Regulations

Chair: Bassi, Eleonora

17:00-17:20 WeC2.1

(26) Drones Are Flying Outside of Segregated Airspace in Poland – New Rules for BVLOS UAVs Operations

Konert, Anna; Kasprzyk, Piotr

17:20-17:40 WeC2.2

(52) A Survey of Unmanned Aircraft System Technologies to Enable Safe Operations in Urban Areas

Bloise, Nicoletta; Primatesta, Stefano; Antonini, Roberto; Fici, Gian Piero; Gaspardone, Marco; Guglieri, Giorgio;

Rizzo, Alessandro

17:40-18:00 WeC2.3

(55) European Drones Regulation: Today's Legal Challenges

Bassi, Eleonora

18:00-18:20 WeC2.4

(119) Risk Assessment Based on SORA Methodology for a UAS Media Production Application

Capitán, Carlos; Capitan, Jesus; Castaño, Ángel Rodríguez; Ollero, Anibal

18:20-18:40 WeC2.5

(210) Towards a Tool for Assessing UAS Compliance with the JARUS SORA Guidelines

Terkildsen, Kristian Husum; Jensen, Kjeld

WeC3 - Heritage C: UAS Applications II

Chair: Lozano, Rogelio University of Technology of Compiègne

17:00-17:20 WeC3.1

(17) Comparative Study for Coordinating Multiple Unmanned HAPS for Communications Area Coverage

Anicho, Ogbonnaya; Charlesworth, Philip; Baicher, Gurvinder; Nagar, Atulya; Buckley, Neil

17:20-17:40 WeC3.2

(172) Water Take-Off and Landing - Hybrid Copter Approach for Maritime CONOPs

Galante, João; Manuel, Ribeiro; de Nobrega, Roberto; Neiva, Jorge; Ferreira, António Sérgio; Sousa, Joao

17:40-18:00 WeC3.3

(196) Three Dimensional UAV Path Following Using SDRE Guidance

Singh, Mandeep; Manoharan, Amith; Ratnoo, Ashwini; P. B., Sujit

18:00-18:20 WeC3.4

(198) Satellite and UAV Data for Precision Agriculture Applications

Mancini, Adriano; Frontoni, Emanuele; Zingaretti, Primo

18:20-18:40 WeC3.5

(230) Attitude and Altitude Control for a Fixed Wing UAV Applied to Photogrammetry

Hernandez, Jorge Luis; Gonzalez-Hernandez, Ivan; Lozano, Rogelio

18:40 – 19:00 WeC3.6

(180) Wildfire Monitoring with Uneven Importance Using Multiple Unmanned Aircraft Systems

Hu, Xiaolin; Bent, John; Sun, Jiawei

(Moved to this Session for presentation from FrA4)

WeC4 – Savannah: Control Architectures III

Chair: Azimov, Dilmurat Co-Chair: Zhang, Fu

17:00-17:20 WeC4.1

(96) Nonlinear Model Predictive Attitude Control for Fixed-Wing Unmanned Aerial Vehicle Based on a Wind Frame Formulation

Reinhardt, Dirk; Johansen, Tor Arne

17:20-17:40 WeC4.2

(143) Integrated Optimal Control and Explicit Guidance for Quadcopters

Kawamura, Evan; Azimov, Dilmurat

17:40-18:00 WeC4.3

(105) Deep Reinforcement Learning Attitude Control of Fixed-Wing UAVs Using Proximal Policy Optimization

Bøhn, Eivind; Coates, Erlend M.; Moe, Signe; Johansen, Tor Arne

18:00-18:20 WeC4.4

(113) Enabling Bidirectional Thrust for Aggressive and Inverted Quadrotor Flight

Jothiraj, Walter; Miles, Corey; Bulka, Eitan; Sharf, Inna; Nahon, Meyer

18:20-18:40 WeC4.6

(146) Full Attitude Control of an Efficient Quadrotor Tail-Sitter VTOL UAV with Flexible Modes

Xu, Wei; Gu, Haowei; Qin, Youming; Lin, Jiarong; Zhang, Fu

WeP5 - Heritage Foyer: Poster Papers

Chair: Morrison, James R.

13:00-18:00 WeP5.1

(24) Robust Flight Control of a Tri-Rotor UAV Based on Modified Super-Twisting Algorithm

Paiva, Enrique; Rodas, Jorge; Kali, Yassine; Gregor Recalde, Raul Igmari; Saad, Maarouf

13:00-18:00 WeP5.2

(61) On Coordination in Multiple Aerial Engagement, pp. 549-554.

Strickland, Laura; Squires, Eric; Day, Michael; Pippin, Charles

13:00-18:00 WeP5.3

(135) Planning for Decentralized Formation Flight of UAV Fleets in Uncertain Environments with Dec-POMDP

de Oliveira Floriano, Bruno Rodolfo; Borges, Geovany Araújo; Ferreira, Henrique Cezar

13:00-18:00 WeP5.4

(215) Smart City Investments: A Rapid Decision Framework for Public Private Partnerships

Rayi, Paul Sujith; Bothra, Rishie Lavendra; Wallace, Stephen; Venkatesh, Murali

13:00-18:00 WeP5.5

(217) Sense-And-Avoid System Development on an FPGA

Kóta, Fülöp; Zsedrovits, Tamás; Nagy, Zoltán

Technical Program for Thursday June 13, 2019

ThA1 - Heritage B: Path Planning III

Chair: Darbha, Swaroop Co-Chair: Choi, Youngjun

10:00-10:20 ThA1.1

(45) Cooperative Search Area Optimization Using Multiple Unmanned Aerial Vehicles in a GPS-Denied Environment

Misra, Sohumi; Biswas, Srijanee; Minai, Ali; Sharma, Rajnikant

10:20-10:40 ThA1.2

(109) Randomized Continuous Monitoring of a Target by Agents with Turn Radius Constraints

Stephens, Shawn; Manyam, Satyanarayana Gupta; Casbeer, David; Cichella, Venanzio; Kunz, Donald

10:40-11:00 ThA1.3

(122) A Multi-UAS Trajectory Optimization Methodology for Complex Enclosed Environments

Barlow, Sarah; Choi, Youngjun; Briceno, Simon; Mavris, Dimitri

11:00-11:20 ThA1.4

(139) Efficient Computation of Optimal UAV Routes for Persistent Monitoring of Targets

Hari, Sai Krishna Kanth; Rathinam, Sivakumar; Darbha, Swaroop; Kalyanam, Krishna; Manyam, Satyanarayana Gupta; Casbeer, David

11:20-11:40 ThA1.5

(141) Bounding Algorithms for Persistent Monitoring of Targets Using Unmanned Vehicles

Hari, Sai Krishna Kanth; Rathinam, Sivakumar; Darbha, Swaroop; Kalyanam, Krishna; Manyam, Satyanarayana Gupta; Casbeer, David

11:40-12:00 ThA1.6

(225) System Design and Resource Analysis for Persistent Robotic Presence with Multiple Refueling Stations

Park, Hyorin; Morrison, James R.

ThA2 - Heritage C: UAS Applications III

Chair: Johansen, Tor Arne

10:00-10:20 ThA2.1

(20) Feasibility Study for a MEDEVAC Electric UAS Capability

Pickell, William; Kopeikin, Andrew; Bristow, Elizabeth; Bluman, James

10:20-10:40 ThA2.2

(39) Multi-UAV Based Autonomous Wilderness Search & Rescue Using Target Iso-Probability Curves

Kashino, Zundai; Nejat, Goldie; Benhabib, Beno

10:40-11:00 ThA2.3

(99) Cooperative Load Transportation Using Three Quadrotors

Pizetta, Igor; Brandao, Alexandre Santos; Sarcinelli-Filho, Mário

11:00-11:20 ThA2.4

(115) Colored-Noise Tracking of Floating Objects Using UAVs with Thermal Cameras

Helgesen, Haakon Hagen; Stendahl Leira, Frederik; Johansen, Tor Arne

11:20-11:40 ThA2.5

(179) A Solution for Searching and Monitoring Forest Fires Based on Multiple UAVs

Zhang, Yintao; Zhang, Youmin; Yu, Ziquan

11:40-12:00 ThA2.6

(219) Anomaly Detection and Cognizant Path Planning for Surveillance Operations Using Aerial Robots

Dang, Tung; Khattak, Shehryar; Papachristos, Christos; Alexis, Kostas

ThA3 - Heritage A: Micro and Mini UAS

Chair: Chao, Haiyang

10:00-10:20 ThA3.1

(47) A Novel Quadcopter with a Tilting Frame Using Parallel Link Mechanism

Sakaguchi, Akinori; Takimoto, Takashi; Ushio, Toshimitsu

10:20-10:40 ThA3.2

(100) Direct Position Control of an Octarotor Unmanned Vehicle under Wind Gust Disturbance

Baldini, Alessandro; Felicetti, Riccardo; Freddi, Alessandro; Longhi, Sauro; Monteriù, Andrea

10:40-11:00 ThA3.3
(106) Smooth Saturation Function-Based Position and Attitude Tracking of a Quad-Rotorcraft Avoiding Singularity
 Dasgupta, Ranjan

11:00-11:20 ThA3.4
(133) Error-State LQR Control of a Multirotor UAV
 Farrell, Michael David; Jackson, James; Nielsen, Jerel; Bidstrup, Craig; McLain, Timothy W.

11:20-11:40 ThA3.5
(169) A Fuzzy Gain Scheduling Control Algorithm for Formation Flight of Multi-UAVs
 Rojo Rodriguez, Erik Gilberto; Ollervides Vazquez, Edmundo Javier; Zambrano-Robledo, Patricia; Garcia Salazar, Octavio

11:40-12:00 ThA3.6
(214) Model Based Roll Controller Tuning and Frequency Domain Analysis for a Flying-Wing UAS
 Flanagan, Harold; Chao, Haiyang; Hagerott, Steven G.

ThA4 – Savannah: Energy Efficient UAS

Chair: Ollero, Anibal Co-Chair: Bezzo, Nicola

10:00-10:20 ThA4.1
(71) A Simple Model for Gliding and Low-Amplitude Flapping Flight of a Bio-Inspired UAV
 Martín-Alcántara, Antonio; Grau, Pedro; Fernandez-Feria, Ramón; Ollero, Anibal

10:20-10:40 ThA4.2
(74) Multiphysical Modeling of Energy Dynamics for Multirotor Unmanned Aerial Vehicles
 Michel, Nicolas; Sinha, Anish Kumar; Kong, Zhaodan Kong; Lin, Xinfan

10:40-11:00 ThA4.3
(101) Propulsion System Modeling for Small Fixed-Wing UAVs
 Coates, Erlend M.; Wenz, Andreas Wolfgang; Gryte, Kristoffer; Johansen, Tor Arne

11:00-11:20 ThA4.4
(116) Grid-Based Coverage Path Planning with Minimum Energy Over Irregular-Shaped Areas with UAVs
 Cabreira, Tauã; Di Franco, Carmelo; Ferreira Jr., Paulo R.; Buttazzo, Giorgio

11:20-11:40 ThA4.5
(162) Exploiting Ground and Ceiling Effects on Autonomous UAV Motion Planning
 Gao, Shijie; Di Franco, Carmelo; Carter, Darius; Quinn, Daniel; Bezzo, Nicola

11:40-12:00 ThA4.6
(189) Mission Planning Strategy for Multirotor UAV Based on Flight Endurance Estimation
 Schacht Rodríguez, Ricardo; Ponsart, Jean-Christophe; Garcia Beltran, Carlos Daniel; Astorga-Zaragoza, Carlos; Theilliol, Didier

ThB1 - Heritage B: Path Planning IV

Chair: Morrison, James R. Co-Chair: Ahmadian, Navid

13:30-13:50 ThB1.1
(80) A Study on 3D Optimal Path Planning for Quadcopter UAV Based on D Lite*
 Kim, Hyowon; Jeong, Jinseok; Kim, Namyool; Kang, Beomsoo

13:50-14:10 ThB1.2
(98) Collision-Free Multi-UAV Flight Scheduling for Power Network Damage Assessment
 Ahmadian, Navid; Lim, Gino; Torabbeigi, Maryam; Kim, Seon Jin

14:10-14:30 ThB1.3
(114) Multi-UAS Path-Planning for a Large-Scale Disjoint Disaster Management
 Choi, Younghoon; Choi, Youngjun; Briceno, Simon; Mavris, Dimitri

14:30-14:50 ThB1.4
(184) A UAV Resolution and Waveband Aware Path Planning for Onion Irrigation Treatments Inference
 Niu, Haoyu; Zhao, Tiebiao; Wang, Dong; Chen, YangQuan;

14:50-15:10 ThB1.5
(229) Data Quality Aware Flight Mission Design for Fugitive Methane Sniffing Using Fixed Wing SUAS
 Hollenbeck, Derek; Dahra, Moataz ; Christensen, Lance; Chen, YangQuan

15:10-15:30 ThB1.6
(237) A Unified Framework for Reliable Multi-Drone Tasking in Emergency Response Missions
 Terzi, Maria; Kolios, Panayiotis; Panayiotou, Christos; Theocharides, Theocharis

ThB2 - Heritage C: UAS Applications IV

Chair: Quagliotti, Fulvia

13:30-13:50 ThB2.1

(66) Patrolling a Terrain with Cooperative UAVs Using Random Walks

Caraballo de la Cruz, Luis Evaristo; Díaz-Báñez, José-Miguel; Fabila-Monroy, Ruy; Hidalgo-Toscano, Carlos

13:50-14:10 ThB2.2

(107) Rapid and Automated Urban Modeling Techniques for UAS Applications

Choi, Youngjun; Pate, David; Briceno, Simon; Mavris, Dimitri

14:10-14:30 ThB2.3

(126) Communication Technology for Unmanned Aerial Vehicles: A Qualitative Assessment and Application to Precision Agriculture

Neji, Najett; Mostfa, Tumader

14:30-14:50 ThB2.4

(161) UAVs at Your Service: Towards IoT Integration with HAMSTER

Rodrigues, Mariana; Branco, Kalinka Regina Lucas Jaquie Castelo

14:50-15:10 ThB2.5

(235) Urban Monitoring of Smart Communities Using UAS

Pannozzi, Pierluigi; Valavanis, Kimon; Rutherford, Matthew; Guglieri, Giorgio; Scanavino, Matteo; Quagliotti, Fulvia

15:10-15:30 ThB2.6

(88) Control of a PVTOL with Tilting Rotors

Offermann, Alexis; Castillo, Pedro; De Miras, Jérôme *(Moved to this Session for presentation from FrB4)*

ThB3 - Heritage A: Sensor Fusion I

Chair: Pereira, Guilherme

13:30-13:50 ThB3.1

(8) Increasing Perception Space of a Ground Standing Robot Via Data Transmission from an Aerial Robot

Sohn, Kiwon; Murshid, Mohammad

13:50-14:10 ThB3.2

(15) Perceptual Ability Advancement of a Humanoid with Limited Sensors Via Data Transmission from an Aerial Robot

Sohn, Kiwon; Murshid, Mohammad

14:10-14:30 ThB3.3

(29) State Estimation for Aerial Vehicles in Forest Environments

Chiella, Antonio Carlos Bana Chiella; Teixeira, Bruno Otávio S.; Pereira, Guilherme;

14:30-14:50 ThB3.4

(64) Deep Learning Based Semantic Situation Awareness System for Multirotor Aerial Robots Using LIDAR

Sanchez-Lopez, Jose Luis; Sampedro, Carlos; Cazzato, Dario; Voos, Holger

14:50-15:10 ThB3.5

(208) Networked Radar Systems for Cooperative Tracking of UAVs

Anderson, Brady; Ellingson, Jaron; Eyer, Michael; Buck, David; Peterson, Cameron; McLain, Timothy W.; Warnick, Karl

15:10-15:30 ThB3.6

(232) Depth Map Estimation Methodology for Detecting Free-Obstacle Navigation Areas

Trejo, Sergio Marcelino; Martínez, Karla; Flores, Gerardo

ThB4 – Savannah: Airspace Management

Chair: Ko, Woo-Hyun

13:30-13:50 ThB4.1

(73) Optimum Design for Drone Highway Network

Hamanaka, Masatoshi;

13:50-14:10 ThB4.2

(199) Distributed Bidding-Based Detect-And-Avoid for Multiple Unmanned Aerial Vehicles in National Airspace

Scott, Drew; Radmanesh, Mohammadreza; Sarim, Mohammad; Deshpande, Aditya; Kumar, Manish; Pragada, Ravikumar

14:10-14:30 ThB4.3

(85) A Lane-Based Approach for Large-Scale Strategic Conflict Management for UAS Service Suppliers

Sacharny, David; Henderson, Thomas

14:30-14:50 ThB4.4

(121) Probability-Based Collision Detection and Resolution of Planned Trajectories for Unmanned Aircraft System Traffic Management

Ko, Woo-Hyun; Kumar, P. R.

14:50-15:10 ThB4.5

(157) Evolutionary Optimization-Based Mission Planning for UAS Traffic Management (UTM)

Tan, Qingyu; Wang, Zenkun; Yew Soon, Ong; Low, Kin Huat

15:10-15:30 ThB4.6

(102) Enable UAVs Safely Flight in Low-Altitude: A Preliminary Research of the Public Air Route Network of UAVs

Liao, Xiaohan; Xu, Chenchen; Yue, Huanyin

ThC1 - Heritage B: See-And-Avoid Systems

Chair: Briese, Christoph

16:00-16:20 ThC1.1

(2) Below Horizon Aircraft Detection Using Deep Learning for Vision-Based Sense and Avoid

James, Jasmin; Ford, Jason; Molloy, Timothy L.

16:20-16:40 ThC1.2

(60) High-Speed Obstacle-Avoidance with Agile Fixed-Wing Aircraft

Bulka, Eitan; Nahon, Meyer

16:40-17:00 ThC1.3

(92) Deep Learning with Semi-Synthetic Training Images for Detection of Non-Cooperative UAVs

Briese, Christoph; Günther, Lukas

17:00-17:20 ThC1.4

(183) Flight Test Validation of Collision Avoidance System for a Multicopter Using Stereoscopic Vision

Ma, Demetria; Tran, Alex; Keti, Nick; Yanagi, Ryan; Knight, Peter; Joglekar, Kedar; Tudor, Nicholas; Cresta, Burt; Bhandari, Subodh

17:20-17:40 ThC1.5

(159) Three-Dimensional (3D) Dynamic Obstacle Perception in a Detect-And-Avoid Framework for Unmanned Aerial Vehicles

Lim, Catrina; Li, Boyang; Ng, Ee Meng; Liu Xin; Low, Kin Huat

ThC2 - Heritage C: UAS Applications V

Chair: Peterson, Cameron Co-Chair: Brandao, Alexandre Santos

16:00-16:20 ThC2.1

(62) The Urban Last Mile Problem: Autonomous Drone Delivery to Your Balcony

Brunner, Gino; Szebedy, Bence; Tanner, Simon; Wattenhofer, Roger

16:20-16:40 ThC2.2

(97) Real-Time Single Object Detection on the UAV

Wu, Hsiang-Huang

16:40-17:00 ThC2.3

(131) Gesture Commands for Controlling High-Level UAV Behavior

Akagi, John; Moon, Brady; Chen, Xingguang; Peterson, Cameron

17:00-17:20 ThC2.4

(202) UAS-Based Crack Detection Using Stereo Cameras: A Comparative Study

Benkhoui, Yasmina; Reinhold, Ludwig; El Korchi, Tahar

17:20-17:40 ThC2.5

(233) Rod-Shaped Payload Transportation Using Multiple Quadrotors

Villa, Daniel Khede Dourado; Brandao, Alexandre Santos; Sarcinelli-Filho, Mário

ThC3 - Heritage A: Sensor Fusion II

Chair: Sun, Liang

16:00-16:20 ThC3.1

(78) Observability Analysis and Bayesian Filtering for Self-Localization of a Tethered Multicopter in GPS-Denied Environments

Al-Radaideh, Amer; Sun, Liang

16:20-16:40 ThC3.2

(149) A Survey of Inertial Sensor Fusion: Applications in sUAS Navigation and Data Collection

Givens, Matthew; Coopmans, Calvin

16:40-17:00 ThC3.3

(147) An Estimation-Domain Approach to MEMS Multi-IMU Fusion for SUAS

Givens, Matthew; Coopmans, Calvin; Christensen, Randall

17:00-17:20 ThC3.4

(220) Robust Thermal-Inertial Localization for Aerial Robots: A Case for Direct Methods

Khattak, Shehryar; Mascarich, Frank; Dang, Tung; Papachristos, Christos; Alexis, Kostas

17:20-17:40 ThC3.5

(236) A Software in the Loop (SIL) Kalman and Complementary Filter Implementation on X-Plane for UAVs

Michailidis, Michail; Agha, Mohammed; Rutherford, Matthew; Valavanis, Kimon

ThC4 – Savannah: Airspace Control

Chair: Uchiyama, Kenji

16:00-16:20 ThC4.1

(25) Linear Quadratic Formulation of the Target Defense Differential Game

Pachter, Meir; Casbeer, David; Garcia, Eloy

16:20-16:40 ThC4.3

(156) Controller Design Using Backstepping Algorithm for Fixed-Wing UAV with Thrust Vectoring System

Hirano, Shogo; Uchiyama, Kenji; Masuda, Kai

16:40-17:00 ThC4.4

(201) Least Square Policy Iteration for IBVS Based Dynamic Target Tracking

Srivastava, Raunak; Lima, Rolif; Das, Kaushik; Maity, Arnab

17:00-17:20 ThC4.5

(49) Robust Trajectory Tracking for UAS: Dynamics Sliding Mode Approach

Reynoso, Martin; rivastava, Raunak; Lima, Rolif; Das, Kaushik; Maity, Arnab

Technical Program for Friday June 14, 2019

FrA1 - Heritage B: UAV Design

Chair: Cawthorne, Dylan Co-Chair: Kim, Yongjae

09:00-09:20 FrA1.1

(3) Design and Shape Optimization of Unmanned, Semi-Rigid Airship for Rapid Descent Using Hybrid Genetic Algorithm

Singh, Vinay; Lanteigne, Eric

09:20-09:40 FrA1.2

(31) Preliminary Design, Modeling and Control of a Fully Actuated Quadrotor UAV

Nigro, Michelangelo; Pierri, Francesco; Caccavale, Fabrizio

09:40-10:00 FrA1.3

(59) Value Sensitive Design of a Humanitarian Cargo Drone

Cawthorne, Dylan; Cenci, Alessandra

10:00-10:20 FrA1.4

(70) Design of a Class I Unmanned Aircraft for Maritime Surveillance

Franco, Vasco; Correia, João; Caetano, Joao Vieira; Félix, Luís

10:20-10:40 FrA1.5

(144) Design Methodology of a Small Unmanned Airship with Optimized Fins

Suvarna, Sohan; Chung, Hoam; Pant, Rajkumar

10:40-11:00 FrA1.6

(87) Optimal Guidance for Range Maximization of Guided Projectile: The Effects of Autopilot Delay and Fin Deployment Timing on the Flight Range

Kim, Yongjae; Kim, Gyeong Hun; Choi, Jae-Hyun

FrA2 - Heritage A: Autonomy I

Chair: Bezzo, Nicola

09:00-09:20 FrA2.1

(9) Singular Trajectories in the Two Pursuer One Evader Differential Game

Pachter, Meir; Von Moll, Alexander; Garcia, Eloy; Casbeer, David; Milutinovic, Dejan

09:20-09:40 FrA2.2

(12) Deep RC: Enabling Remote Control through Deep Learning

Ellingson, Jaron; Ellingson, Gary; McLain, Timothy W.

09:40-10:00 FrA2.3

(226) Parameter-Free Regression-Based Autonomous Control of Off-The-Shelf Quadrotor UAVs

Peddi, Rahul; Bezzo, Nicola

10:00-10:20 FrA2.4

(163) Towards Breaching a Still Water Surface with a Miniature Unmanned Aerial-Underwater Vehicle

Zha, Jiaming; Thacher, Eric William; Kroeger, Joseph; Makiharju, Simo; Mueller, Mark Wilfried

10:20-10:40 FrA2.5

(158) A Vision-Based Unmanned Aircraft System for Autonomous Grasp & Transport

Liu, Xu; He, Yuqing; Chen, Bo; Hou, Yongqiang; Bi, Kaiyuan; Li, Decai

FrA3 - Heritage C: Navigation I

Chair: Campoy, Pascual Co-Chair: Huang, Sunan

09:00-09:20 FrA3.1

(11) Visual Controllers for Relative Positioning in Indoor Settings

Mejias Alvarez, Luis; Campoy, Pascual

09:20-09:40 FrA3.2

(82) Towards Automated Under-Canopy Exploration of Plantation Forests

Lin, Tzu-Jui; Stol, Karl

09:40-10:00 FrA3.3

(34) Laser-Based Collision Avoidance and Reactive Navigation Using RRT and Signed Distance Field for Multirotor UAVs*

Lu, Liang; Sampedro, Carlos; Rodriguez-Vazquez, Javier; Campoy, Pascual

10:00-10:20 FrA3.4

(51) Computationally Efficient Visibility Graph-Based Generation of 3D Shortest Collision-Free Path among Polyhedral Obstacles for Unmanned Aerial Vehicles

Huang, Sunan; Teo, Rodney

10:20-10:40 FrA3.5

(53) A Cloud-Based Framework for Intelligent Navigation and Coordination for UASs in Urban Areas

Primatesta, Stefano; Bloise, Nicoletta; Antonini, Roberto; Fici, Gian Piero; Gaspardone, Marco; Guglieri, Giorgio;

Rizzo, Alessandro

10:40-11:00 FrA3.6

(19) A Carrot in Probabilistic Grid Approach for Quadrotor Line Following on Vertical Surfaces

Liu, Jyi-Shane; Lee, Gong-Yi

FrA4 – Savannah: Environmental Issues

Co-Chair: Chen, YangQuan

09:00-09:20 FrA4.1

(1) Visual Servoing for Multirotor Precision Landing in Daylight and After-Dark Conditions

Wynn, Jesse S.; McLain, Timothy W.

09:20-09:40 FrA4.2

(185) Pitch and Roll Effects of On-Board Wind Measurements Using SUAS

Hollenbeck, Derek; Oyama, Madoka; Garcia, Andrew; Chen, YangQuan

09:40-10:00 FrA4.3

(108) Hybrid AutoGyro: Airborne Wind Energy Conversion Using Autorotation

Flores, Jonathan; Salazar, Sergio; Lozano, Rogelio

10:00-10:20 FrA4.4

(150) Modeling of Aerodynamic Disturbances for Proximity Flight of Multirotors

Jain, Karan; Fortmuller, Trey; Byun, Jaeseung; Makiharju, Simo; Mueller, Mark Wilfried

10:20-10:40 FrA4.5

(13) Asymptotic Stability Controller Design of Three Fixed-Wing UAVs Formation with Windy Field
Pu, Zhang; Huifeng, Xue; Shan, Gao

FrB1 - Heritage B: Risk Analysis and Risk-Based Methods for UAS

Chair: Bertrand, Sylvain Co-Chair: la Cour-Harbo, Anders

Organizers: Bertrand, Sylvain; la Cour-Harbo, Anders

11:30-11:50 FrB1.1

(57) Feasibility Analysis of UAV Operations for Monitoring of Infrastructure Networks: A Risk-Based Approach (I)

Bertrand, Sylvain; Raballand, Nicolas; Lala, Stephanie; Flavien, Viguier;

11:50-12:10 FrB1.2

(94) Modeling Unmanned Aerial System (UAS) Risks Via Monte-Carlo Simulation (I)

Rudnick-Cohen, Eliot; Herrmann, Jeffrey; Azarm, Shapour

12:10-12:30 FrB1.3

(104) Planning Unmanned Aerial System (UAS) Takeoff Trajectories to Minimize Third-Party Risk (I)

Rudnick-Cohen, Eliot; Azarm, Shapour; Herrmann, Jeffrey

12:30-12:50 FrB1.4

(155) Compromising Flight Paths of Autopiloted Drones

Chen, Wenxin; Dong, Yingfei; Duan, Zhenhai

12:50-13:10 FrB1.5

(212) Safe Decision Making for Risk Mitigation of UAS (I)

Castano, Lina; Xu, Huan

FrB2 - Heritage A: Autonomy II

Chair: Rodriguez Cortes, Hugo

11:30-11:50 FrB2.1

(204) Towards a Weather Analysis Software Framework to Improve UAS Operational Safety, pp. 1372-1380.

Lundby, Tobias; Christiansen, Martin Peter; Jensen, Kjeld

11:50-12:10 FrB2.2

(84) A Convolutional Neural Network Vision System Approach to Indoor Autonomous Quadrotor Navigation

Garcia, Adriano; Mittal, Sandeep; Kiewra, Edward; Ghose, Kanad

12:10-12:30 FrB2.3

(129) Flying through Gates Using a Behavioral Cloning Approach

Rodriguez Hernandez, Erick; Vasquez-Gomez, Juan Irving; Herrera Lozada, Juan Carlos

12:30-12:50 FrB2.4

(136) Monocular SLAM Position Scale Estimation for Quadrotor Autonomous Navigation

Rodriguez Cortes, Hugo; Gómez-Casasola, Alejandro; Luis Daniel, Nieto-Hernandez

12:50-13:10 FrB2.5

(177) Gaussian Mixture Model (GMM) Based Dynamic Object Detection and Tracking

Hariharan Anand, Vishnu; Pushp, Durgakant; Raj, Rishin; Das, Kaushik

13:10-13:30 FrB2.6

(54) Radius of Turn and Flight Path Angle Estimation from Unmanned Aircraft Flight Trajectories

Benders, Sebastian; Koch, Simon

FrB3 - Heritage C: Navigation II

Chair: Fossen, Thor I.

11:30-11:50 FrB3.1

(41) Approximating UAV and Vision Feature Point Correlations in a Simplified SLAM Problem

Lewis, Jeffrey; Johnson, Eric

11:50-12:10 FrB3.2

(67) Null Space Based Formation Control for a UAV Landing on a UGV

Mafra Moreira, Mauro Sergio; Brandao, Alexandre Santos; Sarcinelli-Filho, Mário

12:10-12:30 FrB3.3

(127) Field Test Results of GNSS-Denied Inertial Navigation Aided by Phased-Array Radio Systems for UAVs

Gryte, Kristoffer; Bryne, Torleiv Håland; Albrektsen, Sigurd M; Johansen, Tor Arne

12:30-12:50 FrB3.4

(188) UAV Based Survivor Search During Floods

Ravichandran, Rahul; Ghose, Debasish; Das, Kaushik
12:50-13:10 FrB3.5

(203) Robust Navigation System for UAVs in GNSS and Magnetometer-Denied Environments

Mathisen, Paal Holthe; Fossen, Thor I.
13:10-13:30 FrB3.6

(216) Pose Estimation of UAVs Based on INS Aided by Two Independent Low-Cost GNSS Receivers

Sollie, Martin Lysvand; Bryne, Torleiv Håland; Johansen, Tor Arne

FrB4 – Savannah: UAS Testbeds

Chair: Theilliol, Didier Co-Chair: Ahmad, Shakeeb
11:30-11:50 FrB4.1

(38) A New Facility for UAV Testing in Climate-Controlled Environments

Scanavino, Matteo; Vilaridi, Andrea; Guglieri, Giorgio
11:50-12:10 FrB4.2

(81) Pitching Moment Analysis and Adjustment for Tilt-Wing UAV in VTOL Mode

Sanchez-Rivera, Luz; Lozano, Rogelio; AriasMontano, Alfredo
FrB4.3

(88) Control of a PVTOL with Tilting Rotors, pp. 1451-1457.

Offermann, Alexis; Castillo, Pedro; De Miras, Jérôme
12:10-12:30 FrB4.4

(Will be presented in ThB2)

(134) A Full Distributed Multipurpose Autonomous Flight System Using 3D Position Tracking and ROS

Gargioni, Gustavo; Peterson, Marco; Persons, Jeffrey; Schroeder, Kevin; Black, Jonathan
12:30-12:50 FrB4.5

(153) Real-Time Quadrotor Navigation through Planning in Depth Space in Unstructured Environments

Ahmad, Shakeeb; Fierro, Rafael
12:50-13:10 FrB4.6

(190) ROS-MAGNA, a ROS-Based Framework for the Definition and Management of Multi-UAS Cooperative Missions

Millán Romera, José Andrés; Perez-Leon, Hector; Castillejo-Calle, Alejandro; Maza, Ivan; Ollero, Anibal