

XPONENTIAL 2018

All Things Unmanned

Denver, Colorado, USA
30 April - 3 May 2018

Volume 1 of 4

ISBN: 978-1-5108-7327-8

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2018) by Association for Unmanned Vehicle Systems International

All rights reserved.

Printed by Curran Associates, Inc. (2018)

For permission requests, please contact Association for Unmanned Vehicle Systems International at the address below.

Association for Unmanned Vehicle Systems International
2700 South Quincy Street
Suite 400
Arlington, VA 22206
USA

Phone: (703) 845-9671

Fax: (703) 845-9679

www.auvsi.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

VOLUME 1

HURRICANE IRMA	1
<i>N/A</i>	
THE DRONE UNIVERSE	15
<i>S. Fredricks</i>	
VERIFICATION AND VALIDATION TESTING OF UNMANNED SYSTEMS	20
<i>C. Conti, M. Scavone, J. Lemanski</i>	
USING GPS SPOOFING TO HIJACK UNMANNED SYSTEMS	37
<i>G. Cohen, J. Wagner, Y. Zangvil</i>	
USING ARTIFICIAL INTELLIGENCE IN PRECISION AGRICULTURE TO INCREASE YIELD AND PROFITABILITY	45
<i>J. Cahill</i>	
ARTIFICIAL INTELLIGENCE IN PRECISION AGRICULTURE - INCREASING YIELD AND PROFITABILITY	50
<i>N/A</i>	
COMPUTER VISION AND AI FOR CONSUMER DRONES IN AG	60
<i>C. Rankine</i>	
THE POWER OF COMPUTER VISION AND ARTIFICIAL INTELLIGENCE FOR CONSUMER DRONE USE IN AGRICULTURE	76
<i>C. Rankine, N. Sabzevar</i>	
THE PATH TO REAL WORLD AUTONOMY FOR ASVS	87
<i>V. Dobbin</i>	
THE PATH TO REAL WORLD AUTONOMY FOR AUTONOMOUS SURFACE VEHICLES	94
<i>H. Tripp, R. Daltry</i>	
THE DARK ARTS OF JAMMING OR SPOOFING GPS TO DISRUPT DRONE FLIGHTS	102
<i>G. Buesnel, S. Hickling</i>	
THE AUTONOMOUS IMPACT PROTECTION VEHICLE DEPLOYMENT IN COLORADO	111
<i>M. Factor</i>	
HETEROGENEOUS SEARCH AND RESCUE SWARM COMPOSITION OPTIMIZATION USING GENETIC ALGORITHMS	124
<i>W. Stamm, B. Bishop</i>	
SWARM DEVELOPMENT FOR MARITIME SEARCH AND RESCUE USING GENETIC ALGORITHMS	134
<i>W. Stamm, B. Bishop</i>	
UAS FLIGHT TRAINING THROUGH THE LENS OF A TRADITIONAL FLIGHT TRAINING UNIVERSITY	147
<i>D. Thirtyacre</i>	
SMALL UNMANNED AIRCRAFT SYSTEMS FLIGHT TRAINING PROGRAMS THROUGH THE LENS OF A TRADITIONAL FLIGHT TRAINING UNIVERSITY	153
<i>D. Thirtyacre, C. Woodyard</i>	
SECURE DRONE-TO-X COMMUNICATION: APPLICABILITY OF IEEE 1609.2	161
<i>J. Petit, D. Duren</i>	
ARTIFICIAL INTELLIGENCE IN CRITICAL SYSTEMS	170
<i>F. Govers</i>	
THE RISK OF ARTIFICIAL INTELLIGENCE: EVALUATION OF RISK AND SAFETY IN LEARNING CAPABLE UNMANNED SYSTEMS	185
<i>F. Govers</i>	
RELIABILITY FOR UNMANNED AERIAL VEHICLES THROUGH AUTOMATIC FLIGHT DATA ANALYSES: FROM SINGLE FLIGHT LOGS, TO POPULATION STATISTICS, TO ANOMALY DETECTION USING ARTIFICIAL NEURAL NETWORKS	195
<i>J. Brand, B. Kung, K. Sartori, L. Meier</i>	
RECONCILING UNMANNED AIRCRAFT SYSTEM TRAFFIC MANAGEMENT (UTM) AND AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B)	205
<i>J. Davis</i>	
WHAT ARE THE ODDS? DEFINING RISK USING ALTERNATIVE DATA SOURCES	212
<i>K. Szathmary, H. Aguirre</i>	
USING SWARMING ROBOTICS AND ADVANCED TEAMING TO ADDRESS THE TACTICAL CHALLENGES OF URBAN RECONNAISSANCE	220
<i>J. Northrop, B. Hennessey</i>	
SYSTEMS INTEGRATION: CONNECTING UNDERSEA, SURFACE, LAND AND AIR UNMANNED AND MANNED ASSETS AT ANT-X 2017	230
<i>T. Haid</i>	
INTELLIGENCE AND CONNECTIVITY PLATFORM FOR SCALING DRONE APPLICATIONS	237
<i>N. Gupta</i>	
INTEGRATION OF LIDAR SENSORS WITH DRONES: WHAT CAN YOU EXPECT?	248
<i>J. Young</i>	

HYDROGEN LONG-DURATION UAV FIELDING: REFUELING OPTIONS	253
<i>J. Sisco, P. Robinson</i>	
HIVE MENTALITY FOR AUTONOMOUS SWARM BEHAVIORS	274
<i>D. Christman, T. Weingart, T. Sarmiento</i>	
HARDWARE-IN-THE-LOOP (HIL) IMPLEMENTATION AND VALIDATION OF SAE LEVEL 2 AUTOMATED VEHICLE WITH SUBSYSTEM FAULT TOLERANT FALLBACK PERFORMANCE FOR TAKEOVER SCENARIOS	287
<i>A. Joshi</i>	
HIGH PERFORMANCE SOLAR POWER FOR LONG ENDURANCE AUTONOMOUS PLATFORMS	322
<i>A. Vijh, R. Kapusta</i>	
LESSONS LEARNED FROM FIELD TESTING SWARMING UNMANNED AIRCRAFT AT THE UNIVERSITY OF COLORADO	330
<i>E. Frew, C. Dixon, S. Borenstein, K. Glasheen, R. Rajasekaran, S. Watza, A. Mills</i>	
DETECTING EMERALD ASH BORER WITH UAVS AND MULTISPECTRAL SENSORS IN DENVER, COLORADO	342
<i>D. Staley, T. Haynie, L. Anderson</i>	
MIMIR: COUNTERING AUTONOMOUS SYSTEMS USING MACHINE LEARNING	361
<i>R. Sen, T. Hoefl</i>	
COUNTERING AUTONOMOUS SYSTEMS USING MACHINE LEARNING	369
<i>R. Sen</i>	
WHITEFOX	378
<i>L. Fox</i>	
COUNTER-SUAS: ELEVATING PROTECTION TO ACHIEVE UTM	383
<i>L. Fox, R. Jenkins, B. DeBruhl</i>	
COORDINATED UNMANNED MARITIME VEHICLE OPERATIONS	391
<i>V. Pradith</i>	
AN ECONOMIC AND FEASIBLE SOLUTION TO INTEGRATING UNMANNED AIRCRAFT INTO THE NAS	404
<i>S. Siewert</i>	
AUTOMATED UNMANNED TRAFFIC MANAGEMENT: A COMPREHENSIVE AND ECONOMICAL SOLUTION TO SAFELY INTEGRATING UNMANNED AIRCRAFT INTO THE NATIONAL AIRSPACE SYSTEM	413
<i>J. Perry, S. Nilsson, J. Young, S. Siewert</i>	
ANALYSIS OF EVOLVEMENTS IN UAS AND THEIR OPERATIONAL ENVIRONMENT AND THE RESULTING EFFECT ON FUTURE TRAINING	420
<i>E. Mollenhauer</i>	
SURVEILLANCE SYSTEM PERFORMANCE AND POSSIBLE PATHS FORWARD FOR SMALL UAS	442
<i>R. Guterres, G. Orrell, R. Strain</i>	
ASSESSING RISK OF UAS OPERATIONS TO PEOPLE AND PROPERTY	453
<i>K. McDonough, J. Castagno, J. Player, E. Atkins</i>	
RANGR: RISK AWARE NAVIGATION AND GUIDANCE FOR RESILIENCE	474
<i>K. McDonough, J. Castagno, J. Player, E. Atkins</i>	
CYBER-VULNERABILITIES OF USING UAVS IN POWER LINE INSPECTIONS	490
<i>L. Krishna, R. Murphy</i>	
A TEAM PERSPECTIVE: INTEGRATED TRAINING IN REMOTELY PILOTED AIRCRAFT SYSTEMS	501
<i>L. Rowe, R. Vickhouse</i>	
COUNTER-UAS: THE RACE AGAINST TIME	508
<i>B. Hetsko</i>	
A RACE AGAINST THE CLOCK: WHY COUNTER-UAS IS NEEDED TODAY	513
<i>B. Hetsko</i>	
A REVIEW ON CYBERSECURITY VULNERABILITIES FOR UNMANNED AERIAL VEHICLES	520
<i>L. Krishna, R. Murphy</i>	
ICEFIN: LESSONS LEARNED FROM THE 2017 ANTARCTIC FIELD SEASON	532
<i>A. Spears, M. Meister, D. Dichek, C. Ramey, B. Hurwitz, J. Lawrence, J. Lutz, J. Lawrence, K. Phileo, B. Schmidt</i>	
LESSONS LEARNED FROM THE 2017 ANTARCTIC DEPLOYMENT OF THE ICEFIN UNMANNED UNDERWATER VEHICLE	543
<i>A. Spears, M. Meister, D. Dichek, C. Ramey, B. Hurwitz, J. Lawrence, J. Lutz, J. Lawrence, K. Phileo, B. Schmidt</i>	
AUTOMATED DRONE INFRASTRUCTURE	550
<i>D. Henry, A. Mohamed, B. McLaughlin, B. Hull, J. Park</i>	
ROBOTS FOR ENVIRONMENTAL MONITORING	556
<i>N. Olmedo</i>	
THE WORLD'S LARGEST BUSINESS ACCELERATOR COMPETITION FOR UNMANNED SYSTEMS	562
<i>J. Parry</i>	
IRIS AUTOMATION - THE FUTURE IN SIGHT	603
<i>N/A</i>	

VOLUME 2

DEVELOPING POWERFUL UAVS AND REALISTIC FLYING CARS TO REVOLUTIONIZE THE WAY WE TRANSPORT PRODUCTS AND PEOPLE	612
<i>N/A</i>	
THE FUTURE OF UNMANNED TRAFFIC MANAGEMENT, APPLIED TODAY	619
<i>N/A</i>	
STARBURST ACCELERATOR - AEROSPACE INNOVATION IN ACTION	624
<i>V. Espahbodi, F. Chopard</i>	
THE OPPORTUNITY LANDSCAPE FOR COGNITIVE ROBOTICS SYSTEMS	632
<i>D. Kara</i>	
OPPORTUNITIES IN AI SELF-DRIVING CARS	650
<i>L. Eliot</i>	
THE INTEGRATION OF ROBOTS AND OTHER TECHNOLOGIES INTO TACTICAL TEAM OPERATIONS	659
<i>C. Bethel</i>	
MEASURING AND COMPARING SMALL UNMANNED AIRCRAFT SYSTEM CAPABILITIES AND REMOTE PILOT PROFICIENCY	674
<i>A. Jacoff, P. Mattson</i>	
SECURE GLOBAL SOLUTIONS - IDENTITY & TRACKING	689
<i>S. Brown</i>	
MEETING THE CHALLENGES OF UNMANNED INTEGRATION INTO ALL DOMAINS - A MARITIME PERSPECTIVE	699
<i>J. Fanshawe</i>	
AUTONOMOUS VESSELS ON THE NOT-SO-DISTANT HORIZON	711
<i>S. Pribyl</i>	
MEETING THE CHALLENGES OF UNMANNED INTEGRATION INTO ALL DOMAINS - SMART-PORTS PROSPECTIVE FOR AIR, LAND & MARINE	723
<i>A. Robinson</i>	
VAHANA SUMMARY AND LESSONS LEARNED	740
<i>N/A</i>	
INTEGRATING UAS TECHNOLOGIES WITHIN STATE AND LOCAL GOVERNMENT AGENCY OPERATIONS	750
<i>B. Yap, D. Divakaran</i>	
ADVANCED PERFORMANCE COMPUTING POWER FOR LARGE DATA SET PROCESSING AND ANALYSIS	779
<i>K. Rosenberger, S. Blackmer</i>	
A HETEROGENEOUS UNMANNED SYSTEM FOR MARITIME AIR AND SURFACE OPERATIONS	792
<i>G. Collins</i>	
INTEGRATING UNMANNED AIRCRAFT GLOBALLY	801
<i>L. Cary</i>	
REMOTE PILOTS COUNCIL SUMMIT	812
<i>N/A</i>	
UNDERSTANDING AND APPLYING THE UAS PILOTS CODE	817
<i>K. Kiernan</i>	
XPONENTIAL REMOTE PILOTS COUNCIL SUMMIT	836
<i>J. Morra</i>	
LICENSING REMOTE PILOTS FOR BETTER INTEGRATION	839
<i>D. Jauvin</i>	
ISSUE FACING THE FUTURE OF DRONES	846
<i>J. King, M. King</i>	
UNMANNED SYSTEMS INDUSTRY SURVEY	850
<i>S. Kleinke</i>	
IRIS GCS - REMOTE OPERATIONS CENTERS BEYOND VISUAL LINE OF SIGHT	854
<i>N/A</i>	
MINI IS MIGHTY: UPDATES TO THE RIEGL MINIVUX LINE AND RIEGL UAV SOLUTIONS	873
<i>M.-L. Truong</i>	
FIRST UL 3030 CERTIFIED UNMANNED AIRCRAFT SYSTEM ANNOUNCEMENT	892
<i>I. Jilani</i>	
PLUS BY IAI	901
<i>D. Dagan</i>	
ECOSOAR: BUILDING A DRONE ECOSYSTEM IN THE DEVELOPING WORLD	911
<i>K. Kochersberger</i>	
THE GOOD DRONE REVOLUTION	921
<i>N/A</i>	
ALTISCOPE	931
<i>J. Polastre</i>	
UNIFY SET-UP FIRST AFRICAN UTM IN MALAWI DRONE TEST CORRIDOR WITH UNICEF	942
<i>N/A</i>	
FLORIDA POWER & LIGHT - EMERGENCY RESPONSE WITH TECHNOLOGY	952
<i>E. McConnell</i>	

INTEGRATING UAS OBSERVATIONS INTO AN AR COMMON OPERATING PICTURE	962
<i>B. Schmidt</i>	
SEEING IS BELIEVING? A PICTORIAL STUDY OF SENSORS IN UAV'S	972
<i>R. Gann</i>	
UNLOCKING THE ACTUAL ROI FOR COMMERCIAL DRONES	983
<i>J. Williams, M. Scott, A. Carey, R. Lopez</i>	
UAV COMMUNICATIONS ENABLERS, GLOBAL STANDARDISATION STATUS	990
<i>A. Munro</i>	
IEEE 1920.1 – AERIAL NETWORKS AND COMMUNICATIONS STANDARDS	992
<i>K. Namuduri, R. Pragada</i>	
COMMUNICATIONS FRAMEWORK FOR INTEGRATION OF UAVS INTO NATIONAL AIR SPACE	994
<i>N. Mahalingam</i>	
CRFD UAS PROGRAM	997
<i>N/A</i>	
RESCUAV USING UAVS TO SAVE LIVES - WHEN DISASTER STRIKES	1010
<i>R. Singh</i>	
UAS IN SUPPORT OF ROUTINE PUBLIC HEALTH – CHALLENGES AND OPPORTUNITIES	1031
<i>N/A</i>	
DEVELOPMENT & HUMANITARIAN WORK	1039
<i>R. Durscher</i>	
UAS IN SUPPORT OF HUMANITARIAN MISSIONS AND IN PUBLIC HEALTH	1053
<i>E. Anderson</i>	
SUAS OPERATIONS IN HURRICANES HARVEY, IRMA AND MARIA	1074
<i>M. Bauman, C. Todd, J. Adams, J. Broder</i>	
CHOOSING THE RIGHT PROPULSION SYSTEM	1079
<i>M. DeAngelo</i>	
CHOOSING THE RIGHT PROPULSION SYSTEM	1089
<i>P. Pierz</i>	
WHY WE NEED REMOTE ID: THE CRIMINAL, CLUELESS AND CARELESS	1093
<i>J. Poss</i>	
AT&T DRONES	1101
<i>G. Belaus</i>	
PUBLIC SAFETY INTEGRATION INTO THE NAS AT AIRPORTS -MOUS, PRE-PLANNING AND COAS	1106
<i>T. Oatmeyer, J. Nunes, C. Sadler, J. Shea, J. Willmott</i>	
UNMANNED AIRCRAFT SYSTEMS (UAS) INTEGRATION IN THE NATIONAL AIRSPACE SYSTEM (NAS) PROJECT	1110
<i>J. Shively</i>	
UNMANNED AIRCRAFT SYSTEMS (UAS) INTEGRATION IN THE NATIONAL AIRSPACE SYSTEM (NAS) PROJECT - GROUND BASED DETECT AND AVOID	1117
<i>J. Murphy</i>	
UAS MISSIONS WITH LOW COST, SIZE, WEIGHT, AND POWER (C-SWAP) SENSORS	1121
<i>G. Wu</i>	
MARKET INSIGHTS: WHERE WE'VE BEEN, WHERE WE ARE AND WHERE WE'RE HEADED	1124
<i>A. Holtslander</i>	
ICAO REMOTELY PILOTED AIRCRAFT SYSTEMS (RPAS) PANEL - UPDATE	1128
<i>R. Willis</i>	
WFP AVIATION CARGO DELIVERY	1131
<i>N/A</i>	
INSPECTING CRITICAL INFRASTRUCTURE AND UTILITIES FOLLOWING DISASTER	1134
<i>S. Jones</i>	
FAST ACCESS TO CONTROLLED AIRSPACE WITH SKYWARD & LAANC	1143
<i>N/A</i>	
IMPARTING AN AEROSPACE MENTALITY AND METHODOLOGY IN COMMERCIAL UAS OPERATIONS - ESAERO MANUFACTURING & INTEGRATION APPROACH	1145
<i>T. Foster</i>	
DARPA SUBTERRANEAN (SUBT) CHALLENGE	1153
<i>J. Pippine</i>	
UAV OPERATIONAL CHALLENGES IN UNDERGROUND MINES	1156
<i>D. Snyder</i>	
USG PANEL ON SUBTERRANEAN CHALLENGES AND OPPORTUNITIES AT AUVSI	1159
<i>R. Hastie</i>	
GOING UNMANNED IN OIL AND GAS	1162
<i>J. Manley</i>	
FAA PATHFINDER FOCUS AREA 1	1167
<i>G. Agvent</i>	
GO INSIDE THE FAA PATHFINDER PROGRAM: A FINAL REPORT	1175
<i>D. Cooper, M. DeGarmo, G. Agvent, T. Graetz, A. Ferguson</i>	
EARTH TO UNMANNED SYSTEMS – HOW DO UNMANNED SYSTEMS COMMUNICATE?	1196
<i>J. Richter, A. Lewis, C. Kucera</i>	

DEMONSTRATORS AND UTM AN INTERNATIONAL PERSPECTIVE	1212
<i>M. Wuennenberg</i>	

VOLUME 3

UTM: CREATING A NATIONAL FRAMEWORK THAT CAN RESPOND TO LOCAL CONCERNS.....	1215
<i>D. Cooper</i>	
ONESKY	1219
<i>C. Kucera</i>	
JAPAN UTM DEMONSTRATION	1224
<i>H. Nakamura</i>	
COOPERATIVELY MANAGED AIRSPACE: STRUCTURING CLASS E ABOVE CLASS A	1230
<i>J. Walker, L. Bouygues, A. Thurling, J. Rios, M. Reid, R. Thomas</i>	
AUTONOMY AND BVLOS	1242
<i>C. Snow, L. Ellman, P. Kopardekar, H. Loewen, S. Roberts, R. Kapusta</i>	
UNMANNED AERIAL VEHICLES: STATE LEGISLATIVE TRENDS (2013-2018).....	1247
<i>N/A</i>	
ALTERNATIVE GAS TURBINE PROPULSION AND POWER CONCEPTS FOR UNMANNED AIRCRAFT SYSTEMS.....	1260
<i>K. Rouser</i>	
EXPLORING TELEMATICS BIG DATA FOR TRUCK PLATOONING OPPORTUNITIES	1273
<i>M. Lammert, B. Bugbee, Y. Hou, A. Mack, M. Muratori, J. Holden, A. Duran, E. Swaney</i>	
ARMY AUTOMATED CONVOY CAPABILITY: GOING FORWARD	1285
<i>S. McKay, M. Boyer, N. Beyene, K. Giglio, M. Lerario, M. Lewis, K. Stanley, R. Steeb, B. Wilson</i>	
THE AUTONOMOUS SYSTEMS INTELLIGENCE PLATFORM.....	1295
<i>D. Kovar</i>	
BRINGING THE POWER OF SIGHT TO AUTONOMOUS MACHINES: NEW APPLICATIONS FOR LIDAR TECHNOLOGY	1301
<i>L. Eldada</i>	
AQUANAUT	1319
<i>N. Radford</i>	
"HARMLESS" DRONES - DEFINING A LOWEST RISK UAS CATEGORY	1328
<i>B. Schulman</i>	
ARMY UNMANNED SYSTEMS ROADMAP THROUGH 2035 (DRAFT)	1341
<i>M. Dvorak</i>	
WHAT IS YOUR CAR'S IQ?.....	1349
<i>D. Baxter</i>	
RADAR VISION PLATFORM FOR THE AUTONOMOUS ERA	1365
<i>E. Frankenberg, T. Driscoll</i>	
SEA HUNTER AND MARITIME AUTONOMOUS BEHAVIORS	1373
<i>T. Barton, D. Brintzinhoffer</i>	
THE KEY ROLE OF STANDARDS IN SUPPORT OF SAFE, EFFICIENT AND ECONOMICAL FUTURE UAS AIRSPACE INTEGRATION.....	1380
<i>P. Kenul</i>	
DESTINATION INTEGRATION: UTM INTEGRATION -- ACHIEVING ROUTINE BVLOS OPERATIONS AND HIGH-ALTITUDE AUTONOMY	1391
<i>A. Carter</i>	
60 TIPS YOU NEED TO SUCCEED - FOR DRONE SERVICE PROVIDERS AND ENTERPRISE SUAS INTEGRATORS.....	1396
<i>E. Schaefer</i>	
AIR FORCE ENGAGEMENT OF COMMERCIAL UAS TECHNOLOGY	1406
<i>R. Melville</i>	
THE IMPORTANCE OF HAVING UAS INSURANCE	1417
<i>N/A</i>	
BUILDING RISK-BASED SAFETY CASES AT A UAS TEST SITE	1422
<i>M. Blanks</i>	
DON'T BE LED ASTRAY - ADVANCED UAS SAFETY TRAINING CONCEPTS	1433
<i>S. Strimple</i>	
UNMANNED SYSTEMS & ROBOTICS DATABASE.....	1449
<i>D. Klein</i>	
HOW DRONE OPERATIONS WILL BENEFIT FROM AVIATION RISK MANAGEMENT.....	1471
<i>J. King, M. King</i>	
AUGMENTED REALITY SOFTWARE	1486
<i>A. Kaplan</i>	
U.S. COMMERCIAL SERVICE OVERVIEW	1495
<i>S. Nickle</i>	
SINGAPORE UAS LANDSCAPE.....	1501
<i>N. Cheng</i>	

BUILDING AN ENTERPRISE DRONE PROGRAM	1509
<i>N/A</i>	
MAKING THE MOVE TO UAS PROGRAMS AND MORE AUTONOMOUS INSPECTIONS	1520
<i>T. Chase</i>	
NEAR TERM VIABLE SOLUTION TO SMALL PACKAGE DRONE DELIVERY	1528
<i>C. Rizk</i>	
EXPORT CONTROL CONSIDERATIONS FOR AUVSI MEMBERS	1539
<i>S. Wise</i>	
JOIN STARBURST - THE #1 AEROSPACE ACCELERATOR	1557
<i>N/A</i>	
U.S. DOD AIRCRAFT & UAS ACQUISITION, RDT&E PROGRAMS & COMMERCIAL UAS MARKET EVOLUTION	1566
<i>R. Stearns</i>	
UAS: AN INDUSTRY BEYOND AEROSPACE	1578
<i>S. Baid, T. Owen</i>	
CHECK3GPS - SAFELY PLANNING YOUR FLIGHT	1584
<i>A. Pierce</i>	
TOWARD A FRAMEWORK FOR HIGHLY AUTOMATED VEHICLE SAFETY VALIDATION	1592
<i>P. Koopman, M. Wagner</i>	
ACCURACY IN DRONE IMAGERY: DOES IT REALLY MATTER?	1598
<i>B. Miller, R. Gann</i>	
BEYOND STOCKPILES: USING ACCURATE DATA TO TRACK PROGRESS AND PRODUCTIVITY	1616
<i>R. Hordern-Gibbings</i>	
TERRESTRIAL LIDAR OR UAV: A WORKFLOW AND DATA COMPARISON	1640
<i>B. Voorhees</i>	
UL - EVALUATING BATTERIES AND ELECTRICAL SAFETY OF DRONES	1651
<i>J. Bablo</i>	
COOPERATIVE UAS AND ROBOTS FOR REMOTE EOD (CURRE)	1664
<i>C. Fahrner, A. O'Toole</i>	
SHOOT- DON'T SHOOT: EMPOWERING THE BINARY DECISION	1675
<i>T. Sheehy</i>	
RURAL/REMOTE SEARCH & RESCUE	1683
<i>N/A</i>	
DENYING THE DENIER - REFLECTIONS ON PHOTOGRAMMETRY, GPS DENIED, AND SMALL UAS	1692
<i>M. Jones</i>	
DISTRIBUTED HIERARCHICAL AUTONOMY	1709
<i>B. Touchton, A. Genduso, B. Greene</i>	
THE OFFICE OF MANUFACTURING RESILIENCY AND ASSURANCE (MRA) - INDUSTRIAL BASE ANALYSIS AND SUSTAINMENT (IBAS) PROGRAM	1714
<i>A. Ratcliff</i>	
DRIVERLESS CARS & TRUCKS: OPPORTUNITIES OR BARRIERS TO ACHIEVING SOCIETAL GOALS?	1730
<i>R. Cunard</i>	
UAS PROGRAM	1756
<i>T. Graetz</i>	
HOW TO GET ENTERPRISES TO ADOPT GREAT SOLUTIONS! IT SHOULDN'T BE THIS HARD, RIGHT?	1772
<i>J. Rosen</i>	
IF THESE DRONES COULD SEE - USING AI FOR SAFER, MORE EFFICIENT INSPECTIONS	1779
<i>D. Glasser</i>	
INNOVATION, TRAINING & EXPERIENCE: HOW TO BUILD A PREMIER UAS PROGRAM	1792
<i>D. Phillips</i>	
MANEUVER BATTLE LAB	1800
<i>E. Davis</i>	
MARKET SIZING: TURNING GUESSES INTO DATA	1810
<i>D. Speedy, D. Dechant, C. Wheeler</i>	
MASS MARKET MULTI-BAND GNSS RECEIVERS: DELIVERING PRECISION AND CONTROL TO UNMANNED VEHICLE NAVIGATION	1819
<i>M. Strom</i>	

VOLUME 4

PILOT PROJECTS IN AN AUTONOMOUS WORLD	1828
<i>N/A</i>	
UTM TAKES OFF THROUGH PRIVATE-PUBLIC PARTNERSHIPS	1837
<i>G. McNeal</i>	
INDUSTRY STANDARDS FOR PUBLIC SAFETY UAS PROGRAMS	1843
<i>D. Shinnamon, D. Roby</i>	
THE USE OF UNMANNED AIRCRAFT SYSTEMS FOR EMERGENCY RESPONSE IN URBAN SETTINGS	1861
<i>M. Leo</i>	

UASS IN THE GLOBAL AIRSPACE - PAST – PRESENT – FUTURE	1869
<i>T. Wierzbanski, J. Walker</i>	
FLIRTEY - ANYTHING, ANYTIME, ANYWHERE	1884
<i>N/A</i>	
THE ROLE OF RTK IN THE AUTONOMOUS SYSTEM SENSOR SUITE	1890
<i>D. Fischer, A. Bandiwdekar</i>	
THE USE OF LIDAR TECHNOLOGY FOR AERIAL AND SURFACE SECURITY APPLICATIONS	1900
<i>P. Church, C. Grebe, J. Matheson, B. Owens</i>	
TRAFFIC CRASH RECONSTRUCTION: THE HOW, WHEN AND WHY	1918
<i>D. Jurkofsky</i>	
UAV HEALTH CONDITON MONITORING: THE ALLROUND DIGITAL DRONE HEALTH CHECK	1933
<i>U. Hoffmann</i>	
UNLOCKING THE NATIONAL INFRASTRUCTURE FOR UNMANNED SYSTEMS	1946
<i>J. Burke</i>	
UNMANNED AIRCRAFT SYSTEMS DEMAND & ECONOMIC BENEFIT FORECAST STUDY	1950
<i>J. Linkel, R. Wolfe</i>	
MARINE CORPS INSTALLATIONS COMMAND (MCICOM) INSTALLATION NEXT	1959
<i>C. Bolden</i>	
USE OF A SMALL UAS-BASED PHOTOGRAMMETRY 3D MODEL IN CFD WIND SIMULATION	1964
<i>M. Bauer</i>	
RADIOMETRIC CALIBRATION OF MULTISPECTRAL UAS IMAGERY	1975
<i>J. Sloan, K. Mason</i>	
COLORADO DEPARTMENT OF TRANSPORTATION	1991
<i>N/A</i>	
WHOSE DRONE IS THAT? ACHIEVING A BALANCED AND FAIR UAS REMOTE IDENTIFICATION POLICY	2008
<i>B. Schulman</i>	
WELCOME GUESTS - WELCOME TO THE AUVSI XCELLENCE AWARDS WINNER CEREMONY!	2020
<i>B. Wynne</i>	
UAS BATTERY FLEET MANAGEMENT - IS YOUR OPERATION REALLY SAFE?	2035
<i>N/A</i>	
BRIEFINGS ON CHINA DRONES MARKET	2040
<i>S. Chu</i>	
DRONES IN THE AGE OF AUTOMATION	2059
<i>J. Millin</i>	
EMERGING TECHNOLOGY AND SOLUTIONS FOR UAS AIRSPACE INTEGRATION AND ACTIVE DAA FOR BVLOS	2075
<i>N/A</i>	
ENSURING SECURITY - IN CONNECTED AUTONOMOUS SYSTEMS	2095
<i>N. Tucker</i>	
HIGH THROUGHPUT SATELLITES: ENABLING RESILIENCY AND MISSION SUCCESS	2111
<i>P. Kwong</i>	
MEETING INTEGRATION, SAFETY AND SECURITY CHALLENGES IN AUTONOMOUS SYSTEMS SOFTWARE	2122
<i>N/A</i>	
REGULATORY FRAMEWORK AND STANDARDS FOR ACCEPTANCE OF UNMANNED AIR VEHICLES (UAV) WITH RESPECT TO COMPLEX SYSTEMS, SOFTWARE AND ELECTRONIC HARDWARE	2132
<i>A. Melles</i>	
SOLUTIONS FOR AVOIDING THAT “CRASH AND BURN” SCENARIO FROM GNSS SIGNAL JAMMING	2140
<i>F. Boynton</i>	
THE SMARTER DRONE INSURANCE EXPERIENCE: BUILT FOR DRONE OPERATORS BY DRONE OPERATORS	2155
<i>J. Griswold</i>	
YOUR TECH WORKS IN BOTH WORLDS: BRIDGING DEFENSE AND COMMERCIAL	2164
<i>M. Scassero</i>	
ABSTRACTION AND INTENT: HUMAN FACTORS FOR CONTROLLING MULTIPLE UAS	2172
<i>D. Richards</i>	
ARTIFICIAL INTELLIGENCE, AUTONOMY, AND HUMAN-MACHINE TEAMING: THE PROMISE AND THE PERIL FOR FUTURE MILITARY OPERATIONS	2181
<i>E. Powers</i>	
AUTONOMY AND THE FUTURE OF TRANSPORTATION	2201
<i>M. Muenster</i>	
CHALLENGES AND APPLICATIONS IN INTELLIGENT VIDEO ANALYTICS FOR UAS	2215
<i>J. Artolazabal, I. Alonso, R. Lago, D. Jimenez, D. Fernandez, J. Macias, D. Castro, V. Fernandes, H. Pardo, I. Sousa, P. Perez, S. Alfonso</i>	
CONVERGENCE IN MULTI-AGENT COOPERATIVE CONTROL SYSTEMS	2227
<i>S. Mukherjee, K. Namuduri</i>	
DRONE IMAGING OF ARCHAEOLOGICAL SITES FOR THE TOURISM INDUSTRY IN IRELAND	2234
<i>W. Baker, G. Bullock</i>	

DRONE NET, A PASSIVE INSTRUMENT NETWORK DRIVEN BY MACHINE VISION AND MACHINE LEARNING TO AUTOMATE UAS TRAFFIC MANAGEMENT	2243
<i>S. Siewert, M. Andalibi, S. Bruder, I. Gentilini, A. Dandupally, S. Gavvala, O. Prabhu, J. Buchholz, D. Burklund</i>	
POSITION ESTIMATION IN GPS-DENIED AREAS USING KALMAN FILTERING AND DEEP LEARNING	2263
<i>M. Walton, D. Howe, K. Namuduri</i>	
EDUCATIONAL DEMONSTRATION REGARDING THE SAFE DEPLOYMENT OF UAS ON HIGH INFRASTRUCTURE AND OTHER COMMERCIAL WORK SITES	2275
<i>N/A</i>	
IMPROVING AGRICULTURAL WATER EFFICIENCY WITH UNMANNED AIRCRAFT	2277
<i>W. Woldt, C. Neale, D. Heeren, E. Frew, G. Meyer</i>	
THE NEXT STEP BEYOND IDENTIFYING FIELD VARIABILITY: INTEGRATING UNMANNED AERIAL SYSTEMS INTO THE FARM MANAGEMENT WORKFLOW	2285
<i>K. Adkins, C. Bailey, A. Taylor</i>	
INTELLIGENT CHAFF	2295
<i>J. Rensvold, B. Bishop</i>	
MARS EXPLORATION UAV-GROUND ROVER COLLABORATION SYSTEM	2306
<i>D. Park, M. Lacerda, D. Schrage</i>	
NASA'S USE OF GENERAL AVIATION RESEARCH AIRCRAFT TO PERFORM UNMANNED SYSTEMS, AUTONOMY, AND ARTIFICIAL INTELLIGENCE RESEARCH	2322
<i>C. Howell</i>	
"OMNI-CHASSIS"; EVOLUTIONARY OR REVOLUTIONARY IN ROBOTICS?	2331
<i>W. Lovell</i>	
"WHAT ARE WE THINKING?" SAFETY CULTURE ACROSS AVIATION SEGMENTS: UNDERSTANDING PILOT POPULATIONS FROM MANNED AND UNMANNED INDUSTRY VERTICALS	2340
<i>H. Aguirre, K. Szathmary</i>	
SAFETY REINFORCED DRIVING	2348
<i>E. Schwalb, F. Taslimi, H. Kuecuekyan</i>	
SEEING THE FOREST & THE TREES: HABITAT RESTORATION ASSESSMENTS USING DRONES	2355
<i>R. Alward, T. Minnick</i>	
SOLID-STATE PROPULSION FOR ROTARY-AND FIXED-WING AIRCRAFT	2367
<i>O. Bilgen</i>	
STREAMING OF GEOGRAPHICALLY CORRECT AERIAL VIDEO USING REAL-TIME GEO-REGISTRATION AND SALIENT-BASED COMPRESSION ON LOW-BANDWIDTH NETWORKS	2373
<i>A. Kopansky, A. Texidor</i>	
UAS PROPELLER/ROTOR SOUND PRESSURE LEVEL REDUCTION THROUGH LEADING EDGE, UPPER SURFACE, AND TRAILING EDGE MODIFICATION	2377
<i>M. Callender</i>	
UAV INSPECTION OF WIND TURBINES USING AUTONOMOUS NAVIGATION TECHNIQUES	2387
<i>R. Schaffert, W. Tulli, R. Zavori</i>	
CAN A CONVENTIONAL PROPULSION SYSTEM MATCH THE EFFICIENCY OF AN UNDERWATER GLIDER BUOYANCY ENGINE?	2400
<i>C. Hockley, V. Rutenbeck, B. Butka</i>	
VARIABLE-CYCLE ENGINE AND AIRCRAFT TECHNOLOGY FOR SMALL UNMANNED AIRCRAFT SYSTEMS	2409
<i>K. Rouser</i>	
VISUAL SITUATIONAL AWARENESS: REVOLUTIONIZING UAV COMMUNICATION VIA SATELLITE	2423
<i>H. Skinnemoen, M. Minshin, F. Vamstad, A. Legg</i>	
Author Index	