# STRATUS 2024 Conference

Systems and Technologies for Remote Sensing Applications Through Unmanned Aerial Systems

20-22 May 2024, Gateway Center,
State University of New York College of Environmental Science and Forestry (SUNY-ESF), Syracuse, New York, USA

STRATUS 2024 Conference May 20 – 22, 2024: stratus-conference.com


**The 2024 Systems & Technologies for Remote Sensing Applications Through Unmanned Aerial Systems Conference is hosted by SUNY ESF in partnership with IEEE.**

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## Table of Contents

# Welcome from the General Chair

Unmanned Aerial Vehicles (UAV) have captured significant attention within the remote sensing community, spanning diverse fields such as environmental studies, natural resource management, agriculture, and water management. The continuous evolution in UAV hardware, algorithms, data processing, and applications necessitates frequent gatherings to share the latest advancements in UAV remote sensing.

The STRATUS annual conference, initiated as a workshop in 2016 at the Rochester Institute of Technology, has evolved into a vital platform, with subsequent editions held in 2017, 2019, a virtual conference in 2021, and physical gatherings in 2022 and 2023 at various esteemed institutions. This year marks the 7th installment of STRATUS and the second time it's being organized and hosted by SUNY ESF, promising a stimulating exchange of ideas.

Set against the picturesque backdrop of the SUNY ESF campus in Syracuse, New York, STRATUS 2024 convenes a diverse assembly of over 100 professionals from academia, federal and state governments, and industry, representing 12 U.S. states. Additionally, international participants from Canada, Austria, England, Nepal, and Ghana enrich the discourse. Notably, the conference extends its warmth to more than 30 high school students and teachers from various Central New York school districts.

With 10 technical sessions featuring nearly 40 oral and poster presentations, STRATUS 2024 explores a broad spectrum of topics, encompassing UAV educational programs, operational aspects, hardware innovations, and applications spanning mapping, agriculture, forestry, flood monitoring, water quality assessment, and specialized areas. Complementing these sessions are three keynote speeches, engaging workshops, exhibitor showcases, and captivating demonstration flights.

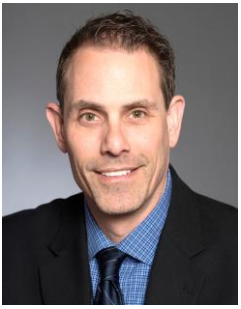
The success of STRATUS 2024 is made possible through generous financial backing from industry leaders such as NUAIR, Genius NY, HySpex, HeadWall, Spectral Evolution, and Spectral Vista, alongside the support of LabSphere, Arcadis, Imagine Aerial, and the American Society for Photogrammetry and Remote Sensing (ASPRS). Notably, the conference features a student competition recognizing excellence in presentations, posters, and UAV trivia games.

As we embark on this journey of knowledge exchange and collaboration at STRATUS 2024, I extend my best wishes for a fruitful and rewarding conference experience. For those traveling, may your journeys be safe, and let us endeavor to nurture and expand our networks of collaboration.

Warm regards,

Bahram Salehi, Ph.D., P.Eng
SUNY College of Environmental Science and Forestry
STRATUS 2024 General Chair

# Welcome from Co-Chair



On behalf of the organizing committee, and the general chair for this year's event, I would like to welcome everyone to the 7th conference (2016, 2017, 2019, 2021, 2022, 2023, 2024) on Systems and Technologies for Remote Sensing Applications Through Unmanned Aerial Systems or simply STRATUS 2024. It's hard to believe we have had seven of these events already. Where has the time gone? For 2024, the three-day conference is being held in Syracuse, New York, on May 20-22, 2024 at the SUNY College of Environmental Science and Forestry (ESF). My college, Dr Bahram Salehi, has been generous enough to host the 2024 version of the event, again, at his university.

The idea of this workshop started in 2016 as a result of a conversation between myself and my RIT colleague, Dr. John Kerekes. From this, a proposal was submitted to the IEEE Geoscience and Remote Sensing Society (GRSS) for financial support to host a workshop on UAS's. At that time, we had a one-day workshop with a series of talks by individuals from academia and industry. The total number of abstract submissions was 11 with around 30 participants. The 2016 workshop proved to be very successful and warranted a follow-on meeting which was held in October of 2017. The sold-out 2017 workshop included vendor participation and was expanded to two days (one day for tutorials, one day for talks). I am proud to say that, eight years later, we have changed from a workshop to a 3-day conference!

In general, the aim of this conference has always been to facilitate interaction between academic researchers, industry researchers and students working in the field of remote sensing utilizing unmanned aerial systems. I believe our 2024 program will promote the dissemination of research results and technical advances in this new emerging field of unmanned aerial systems. I hope you enjoy the talks, sponsor tables, demos, trivia, and opportunity to network!!

Best,

Emmett Ientilucci, Ph.D.
Rochester Institute of Technology
STRATUS 2024 Conference CoChair

# Program Committee

## General Chair
## Technical Program Chair

Bahram Salehi
SUNY College of Environmental Science and Forestry

## Co-chair
## Financial Chair

Emmett Ientilucci
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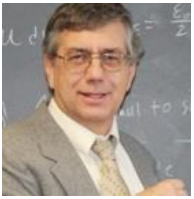
## Students Involvement Chair
## web Administrator

Sina Jarahizadeh
SUNY College of Environmental Science and Forestry, Syracuse, NY

## Workshop chair
## Tutorial Chair



Peter Spacher
Rochester Institute of Technology

## Local Arrangements Chair

Brandon Murphy, Associate Director, Open Academy at SUNY College of Environmental Sciences and Forestry

## Sponsorship Chair

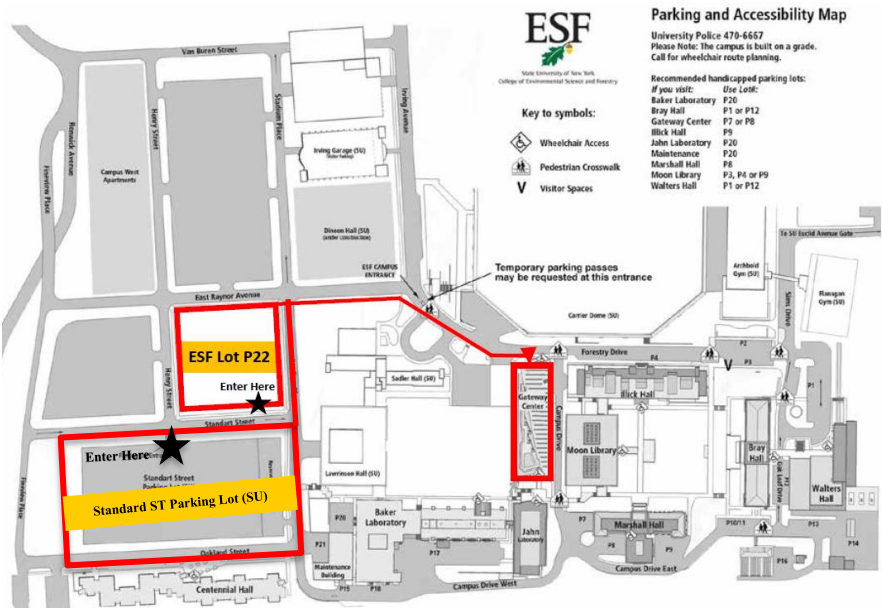
Timothy Bauch
Research Engineer, Rochester Institute of Technology

# Driving Direction to SUNY ESF:

On your phone, enter **Parking 22**, SUNY ESF as your destination. **If P-22 is full, park in the Standard ST Parking Lot (SU) accessible via the entrance on Henry Street.**

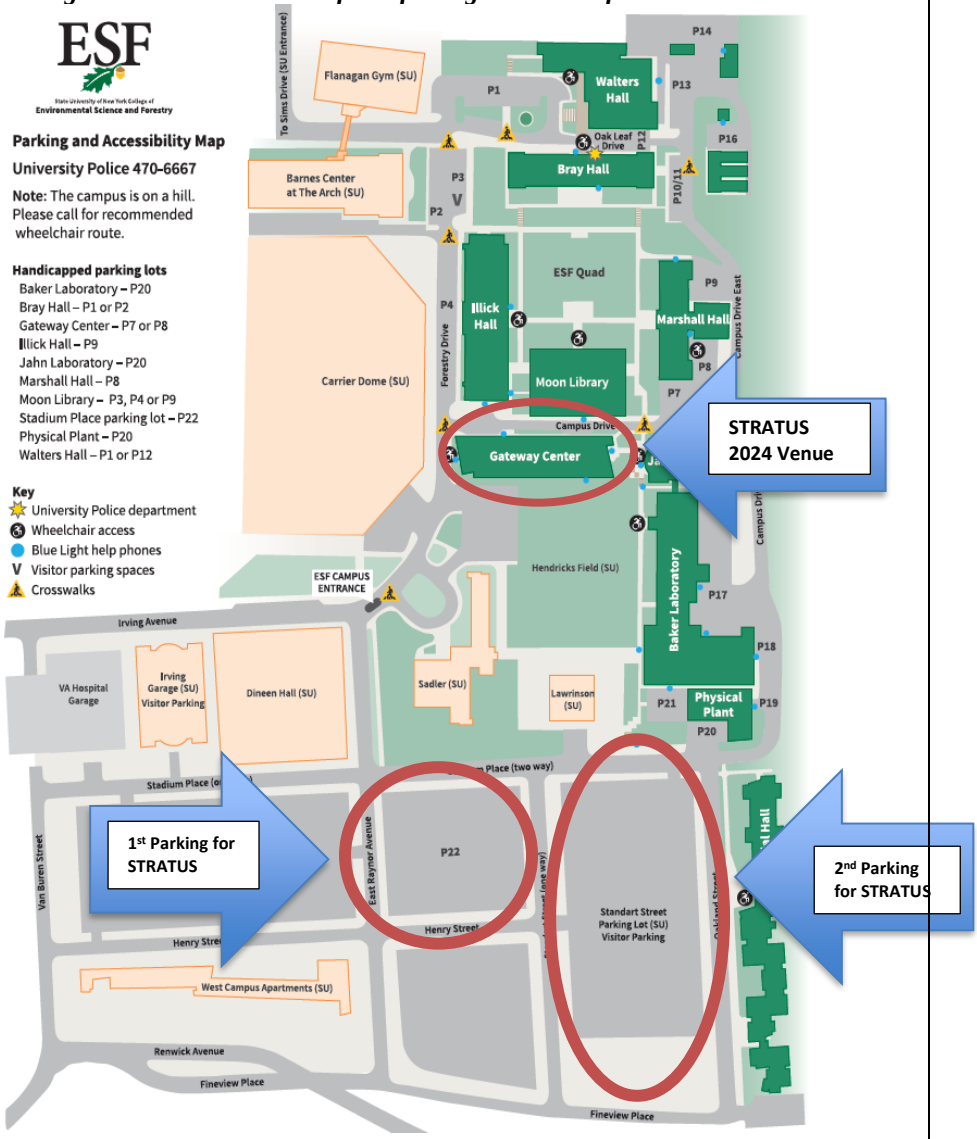
## Walking from Parking to Gateway Center:

https://goo.gl/maps/oTzHJpC7CSHXkzd26



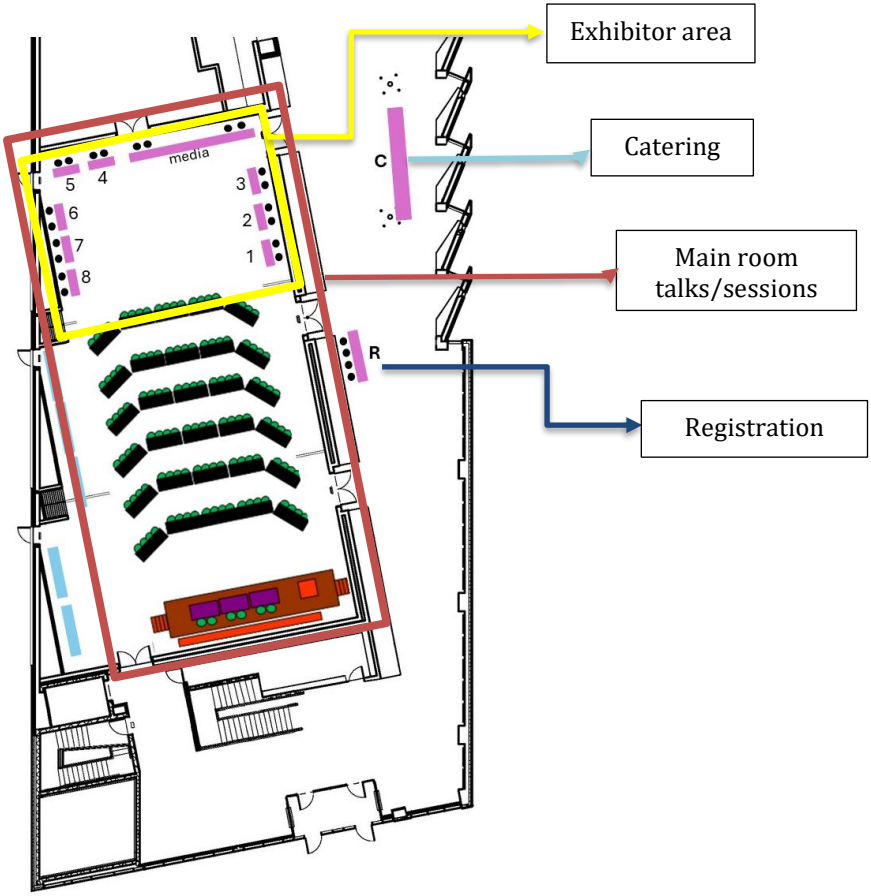
# ESF Campus Map with Parking Lot.

***Parking lot 22 will be available free of charge to the conference attendees.***



# Venue Map

The Venue is in the ESF Gateway Center (See the ESF map).

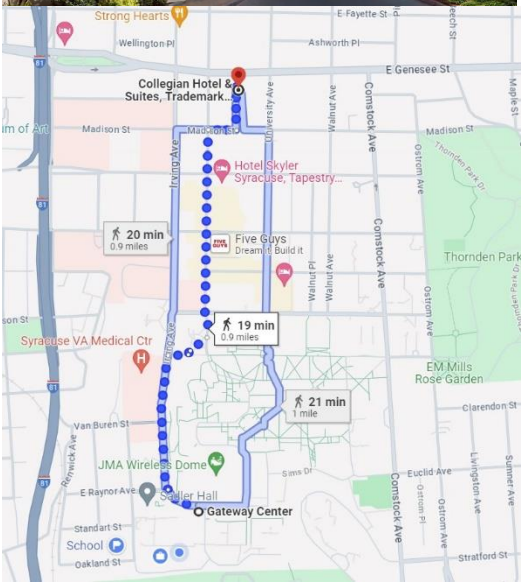



| Table # | Company | Table # | Company |
|---|---|---|---|
| **1** | ARCADIS | **5** | Headwall |
| **2** | HySpex | **6** | Spectral Vista |
| **3** | NUAIR | **7** | Labsphere |
| **4** | Spectral Evolution | **8** | Genius NY |

# Map to Social Gathering on Tuesday Evening

- **Tuesday, May 21**
- **5:30 PM to 7:30 PM**
- **Collegian Hotel and Suites, Finger foods and one free drink**
- **19 min walk from the venue**

**Collegian Hotel and Suites,**
**1060 E Genesee St, Syracuse, NY 13210**



# WiFi Instructions

Visitors to campus can connect to the ESF-Guest wireless network in all campus buildings. Please note that in order to register on the ESF-Guest, visitors must be able to provide a 10-digit cell phone number that is capable of receiving text messages.

**How to connect to ESF Guest Network**

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4. Click on "I agree to ESF Terms."
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6. Click Validate Pin.
7. You will be connected to the ESF wireless network and will have access to the internet.
8. After 24 hours of use, you will have to re-agree to ESF's Terms & Conditions.

**Standard messaging & data rates may apply. ESF is not responsible for any mobile carrier charges.**

# Sponsorship

We would like to graciously thank the financial support of our sponsors!


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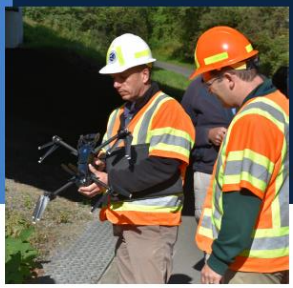
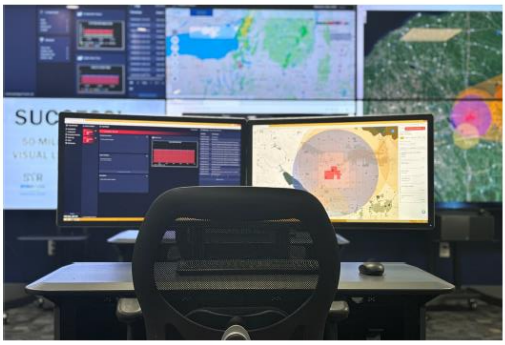
# Bridging UAS and AAM in NYS & Beyond



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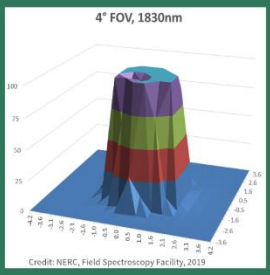


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# Program Agenda in one view.

| | Day 1: Monday May 20 | Day 2: Tuesday May 21 | Day 3: Wednesday May 22 |
|---|---|---|---|
| **8:00-8:30** | Registration & Breakfast | Registration & Breakfast | Registration & Breakfast |
| **8:30-9:00** | **Welcome, Opening Remarks**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>SUNY-ESF President:<br>Joanie Mahoney | **Welcome, Opening**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>SUNY-ESF Provost:<br>Dr. Sam Mukasa | **Welcome, Opening**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>SUNY-ESF VP Research:<br>Dr. John Stella |
| **9:00-9:30** | **Keynote-1:** ***Ken Stewart***<br>President and Chief Executive Officer, NUAIR<br>*"Progress in UAS and Aviation in Central New York: An Enhancement to Airspace Integration"* | **Keynote-2:** ***Dr. Steven Thomson***<br>National Program Leader, USDA National Institute Food and Agriculture (NIFA)<br>*"Funding for Unmanned Systems Research and Related Technologies in Agriculture at the USDA-NIFA"* | **Keynote-3:** ***Dr. Qassim Abdullah***<br>Vice President and Chief Scientist<br>Woolpert, Inc.<br>*"Drones Use in United States of America and Market Dynamics"* |
| **9:30-10:50** | **Technical Session A:** (4 talks)<br>**UAV for Forest Applications** | **Technical Session E:** (4 talks)<br>**UAV rules and regulation, Educations, and more** | **Technical Session H:** (3 talks)<br>**UAV Hardware and Software Developments** |
| **10:50 - 11:20** | Coffee Break/Exhibit Hall | Coffee Break/Exhibit Hall | Coffee Break/Exhibit Hall |
| **11:20 - 12:20** | **Technical Session B:** (3 talks)<br>**Hyperspectral & Energy Applications** | **Workshop and Demo 1 by Telops:** *Indoor Gas Detection and Identification with Telops Hyperspectral Mini xLW System* | **Technical Session I:** (3 talks)<br>**UAV for Civil and Infrastructure Monitoring** |
| **12:20 -1:30** | Lunch/Group Photo/ Networking/ Exhibit Hall | Lunch/Group Photo/ Networking/ Exhibit Hall<br>**Workshop and Demo 2 by Spectral Evolution:** *Intro to field reflectance spectroscopy and Demonstration of dual field of view spectroradiometer systems* | Lunch/Group Photo/ Networking/ Exhibit Hall |
| **1:30-2:00** | *Exhibit Hall and Meet Vendors* | *Exhibit Hall and Meet Vendors* | **UAV Trivia Game-2** |
| **2:00-3:20** | **Technical Session C:** (4 talks)<br>**UAV for Agricultural Applications- I** | **Technical Session F:** (5 posters)<br>**Poster Presentations** | **Technical Session J:** (3 talks)<br>**UAV for Agricultural Applications- II** |
| **3:20-3:50** | Coffee Break/Exhibit Hall | Coffee Break/Exhibit Hall | **Awards and Closing Remarks**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>**Student Poster and Presentations and UAV Trivia Winners** |
| **3:50-5:10** | **Technical Session D:** (4 talks)<br>**UAV for Water & Flood Monitoring** | **Technical Session G:** (4 talks)<br>**UAV for Transportation and Construction** | |
| **5:10-5:30** | **Wrap Up of the Day** | **UAV Trivia Game-1** | |
| **5:30-7:30** | | **Happy Hours/Social**<br>At Collegian Hotel and Suites, Syracuse | |

# Monday 20 May

**REGISTRATION & BREAKFAST: 8:00 AM to 8:30 AM**

**WELCOME: 8:30 AM TO 9:00 AM**
Dr. Bahram Salehi, ESF, Conference General Chair
Dr. Emmett Ientilucci, RIT, Conference General Chair
Joanne Mahoney, ESF President

**KEYNOTE: 9:00 AM TO 9:30 AM**
Moderator: Dr. Bahram Salehi, ESF
**Ken Stewart**,
President and Chief Executive Officer, NUAIR
**Progress in UAS and Aviation in Central New York: An Enhancement to Airspace Integration**

**SESSION A: 9:30 to 10:50 (4 talks)**
**UAV for Forest Applications**
Session Chair: Dr. Parinaz Rahimzadeh-Bajgiran
9:30 **Advancement in NIR Reflectance measurements of small leaves and pine needles and analysis of differing spectral resolution**, Nicolas Venjean and Mckenzie Woodman, Spectral Evolution Inc.

9:50 **Enhanced Individual Tree Detection in Forested Areas using YOLO-based Object Detection on UAV LiDAR Data**, Sina Jarahizadeh and Bahram Salehi, SUNY ESF.

10:10 **Modelling Forest productivity using UAS-derived canopy structural complexity metrics**, Tahrir Siddiqui, Brandon Alveshere, Christopher Gough and Jan van Aardt, RIT; Virginia Commonwealth University.

10:30 **Detection and Delineation of Regenerating Conifer Crowns using UAV Imagery and Mask-RCNN Deep Learning Model**, Abishek Poudel and Eddie Bevilacqua, SUNY ESF.

**Coffee Break and Exhibit Hall: 10:50-11:20**

**SESSION B: 11:20 to 12:20 (3 talks)**
**Hyperspectral & Energy Applications**
Session Chair: Alex Fraess-Ehrfeld
11:20 **Air6 Systems Drone Solar - DrSOLAR**, Alex Fraess-Ehrfeld and Keagan Schiff, AIR6 SYSTEMS.

11:40 **Effects of Calibration on Spectral Classification of Hyperspectral Imagery**, Carson Roberts, Headwall Photonics, Inc.

12:00 **Hyperspectral Multisensor Payload for UAS-based Mapping in Mining and Beyond**, Hyperspectral Multisensor Payload for UAS-based Mapping in Mining and Beyond, HySpex.

**Lunch/Group Photo/ Networking/ Exhibit Hall: 12:20 PM to 1:30 PM**

**Exhibit Hall and Meet Vendors: 1:30 PM to 2:00 PM**
Moderator: Emmett Ientilucci, RIT

**SESSION C: 2:00 to 3:20 (4 talks)**
**UAV for Agricultural Applications- I**
Session Chair: Dr. Lindi Quackenbush
2:00 **Regional Aboveground biomass density modeling using UAS/ALS simulated GEDI waveform LiDAR in Western Amazonia**, Nadeem Fareed and Izaya Numata, South Dakota State University.

2:20 **Detecting Spatial Variation in Wild Blueberry Water Stress using UAV-Borne Thermal Sensor**, Kallol Barai,

Parinaz Rahimzadeh-Bajgiran and Yongjiang Zhang; University of Maine.

2:40 **A Novel Multi-Channel Deep Learning Object Detector Architecture for Individual Tree Detection on UAV LiDAR Data**
Sina Jarahizadeh and Bahram Salehi, SUNY ESF.

3:00 **Detecting Nitrogen deficiency and Potato Leafhopper (Hemiptera: Cicadellidae) infestation in green beans using multispectral imagery from unmanned aerial vehicle**, Detecting Nitrogen deficiency and Potato Leafhopper (Hemiptera: Cicadellidae) infestation in green beans using multispectral imagery from unmanned aerial vehicle, University of Connecticut.

**Coffee Break and Exhibit Hall: 3:20 to 3:50**

**SESSION D: 3:50-5:10 (4 talks)**
**UAV for Water & Flood Monitoring**
Session Chair: Dr. Hamid Norouzi
3:50 **A Database of Environmental Bacterial Flora for Remote Sensing Applications**, Jacob Alberti, Gianna Raqueño, Nina Raqueño, Raunak Al-Rubayie, Maryann Herman and Fernando Ontiveros, St. John Fisher University; University of Rochester; RIT.

4:10 **KAMERA: A Multi-camera, Multi-modal Open-Source Platform for Aerial Wildlife Surveillance Above the Arctic Circle**, Adam Romlein, Erin Moreland and Keith Fieldhouse, Kitware, Inc.; NOAA.

4:30 **Assessment of structural differences in a Mediterranean ecosystem using UAS-based structure-from motion (SfM) data**, Ramesh Bhatta, Rob Chancia, Glenn Moncrieff, Jasper Slingsby and Jan Van Aardt, RIT; The Nature Conservancy; University of Cape Town.

4:50 **Ai Analyses developed for Structures Translates to Predictive use for Sustainable Energy - Construction, Commissioning, Drainage & Waste Stream Management**.
Gavin Snyder, Imagine Aerial

**Wrap Up of the Day: 5:10 PM**

# Tuesday 21 May

**REGISTRATION & BREAKFAST: 8:00 AM to 8:30 AM**

**WELCOME: 8:30 AM TO 9:00 AM**
Dr. Bahram Salehi, ESF, Conference General Chair
Dr. Emmett Ientilucci, RIT, Conference Co-Chair
Dr. Sam Mukasa, ESF Provost

**KEYNOTE: 9:00 AM TO 9:30 AM**
Moderator: Dr. Bahram Salehi, ESF
**Dr. Steven Thomson**,
National Program Leader, USDA National Institute Food and Agriculture (NIFA)
**Funding for Unmanned Systems Research and Related Technologies in Agriculture at the USDA-NIFA**

**SESSION E: 9:30 to 10:50 (4 talks)**
**UAV rules and regulation, Educations, and more**
Session Chair: Emmett Ientilucci
9:30 **TM-62M landmine detection using an affordable UAV-based differential magnetometer system**, Xander Fries, Ivan Dudiak, Lillian Vernooy, Sorin Jayaweera, Carlos Ojeda de Silva, Tjaard van Löben Sels, Dominick Quaye, Jason Gallicchio and Alex Nikulin, Harvey Mudd College; SUNY Binghamton.

9:50 **Remote Sensing Course at a Small Liberal Arts College**, Ileana Dumitriu and John Halfman, Hobart and William Smith Colleges.

10:10 **Development and Implementation of a UAS Certificate Program at Vaughn College of Aeronautics and Technology,** Ghania Benbelkacem

10:30 **Flight Rulebook: Comprehending FAA Regulations for UAS**, Taylor Elia Aviation Safety Inspector (Avionics) FAA and Janet Porter Aviation Safety Inspector (Operations) FAA, FAA.

**Coffee Break and Exhibit Hall: 10:50-11:20**

**Workshop and Demo 1 by Telops: 11:20 to 12:20**
Indoor Gas Detection and Identification with Telops Hyperspectral Mini xLW System

**Lunch/Group Photo/ Networking/ Exhibit Hall: 12:20 PM to 1:30 PM**
**Workshop and Demo 2 by Spectral Evolution:**
Intro to field reflectance spectroscopy and Demonstration of dual field of view spectroradiometer systems.

**Exhibit Hall and Meet Vendors: 1:30 PM to 2:00 PM**
Moderator: Emmett Ientilucci, RIT

**SESSION F: 2:00 to 3:20 (5 posters)**
**Poster Presentations**
Session Chair: Dr. Peter Spacher

**Addressing the Dynamic Nature of Scatterable Mines: A Hyperspectral and Machine Learning Framework**, Sharifa Karwandyar and Alex Nikulin, SUNY Binghamton.

**Low-Cost Environmental Monitoring Applications in Homeland Security**, Eric Best and Radhakrishnan Venkatakrishnan, University at Albany.

**Leveraging UAVs for Conservation Planning in Vermont**, Will Ebby, Luc Burnier and Shannon Harty, Vermont

Association Conservation Districts (VACD).

**Successful Integration of UAV Aeromagnetic Mapping with Terrestrial Methane Emissions Surveys in Orphaned Well Remediation**, Timothy de Smet, Alex Nikulin, Nicholas Balrup and Nathan Graber, "Aletair LLC; SUNY Binghamton; Atlas Technical Consultants; NYS DEC ".

**Automated Thermal Anomaly Detection through Deep Learning-based Semantic Segmentation of Building Envelope Images**, Shayan Mirzabeigi, Paul Crovella and Mohamad Razkenari, SUNY ESF.

**Coffee Break and Exhibit Hall: 3:20 to 3:50**

**SESSION G: 3:50-5:10 (4 talks)**
**UAV for Transportation and Construction**
Session Chair: Dr. Reihaneh Samsami
3:50 **UAS for Transportation Incident Management**, William Howard, Pennsylvania Turnpike Commission.

4:10 **Construction Progress Monitoring and Visualization Using Unmanned Aerial Systems (UAS), Building Information Modeling (BIM), & Computer Vision (CV)**, Reihaneh Samsami, Sonica Karki, Amlan Mukherjee and Colin Brooks, Western New England University; University of New Haven; WAP Sustainability; Michigan Tech Research Institute.

4:30 **Automated Bridge Inspection Using UAS Collected Data: A Machine Learning Approach**, Reihaneh Samsami, Rojal Pokhrel, Saida Elmi and Colin Brooks, Assistant Professor at Western New England University; University of New Haven; Michigan Tech Research Institute.

4:50: **Assessing the Effectiveness and Practical Utility of UAV-based Aerial GPR Surveys in Humanitarian Mine Action**, Alex Nikulin, Gabriel Chen, Jasper Baur, Gabriel Steinberg and Timothy de Smet, SUNY Binghamton; Columbia University; Safe Pro AI; Aletair Geophysics and Remote Sensing.

**UAV Trivia Game-5:10- 5:30 PM**
Moderated by Tim Buch and Peter Spacher

**Social Gathering and Happy Hours: 5:30 to 7:30**

Collegian Hotel and Suites, Syracuse
Finger foods and one free drink
19 min walk from the venue.

# Wednesday 22 May

**REGISTRATION & BREAKFAST: 8:00 AM to 8:30 AM**

**WELCOME: 8:30 AM TO 9:00 AM**
Dr. Bahram Salehi, ESF, Conference General Chair
Dr. Emmett Ientilucci, RIT, Conference Co-Chair
Dr. John Stella, ESF VP Research

**KEYNOTE: 9:00 AM TO 9:30 AM**
Moderator: Dr. Emmett Ientilucci, ESF
**Dr. Qassim Abdullah**,
Vice President and Chief Scientist
Woolpert, Inc
**Drones Use in United States of America and Market Dynamics**

**SESSION H: 9:30 to 10:50 (3 talks)**
**UAV Hardware and Software Developments**
Session Chair: Dr. Ayman Habib
9:30 **Low-Cost Collision Avoidance for Unmanned Aerial Vehicle Delivery Networks in Microverse**, Qian Qu, Yu Chen, Erik Blasch and Erika Ardiles-Cruz, SUNY Binghamton; AFOSR; AFRL.

9:50 **Developing an Open-Source Object Counting Workflow for Aerial Imagery**, Corey Snipes and Sarah Dalrymple, Twomile Heavy Industries, Inc.; Royal Society for the Protection of Birds (RSPB).

10:10 **An Automated In-situ LiDAR System Calibration and Trajectory Enhancement Strategy for UAS Mapping of Seed Breeding Trials**, Raja Manish and Ayman Habib, Purdue University.

**Coffee Break and Exhibit Hall: 10:50-11:20**

**SESSION I: 11:20 to 12:20 (3 talks)**
**UAV for Civil and Infrastructure Monitoring**
Session Chair: Gavin Snyder
11:20 **Applications of UAV for the evaluation of civil infrastructure and urban planning**, Bhagawat Rimal, Uttam Pudasaini and Upendra Oli, Nepal, Tribhuvan University, Kathmandu; Nepal flying Labs; NAXA Pvt.

11:40 **A versatile data collection system for non-imaging UAV data collection**, Robert Kremens, Emmett Ientilucci and Martin Held, RIT; Austin Powder, Inc.

12:00 **Utilizing a Building Analysis Approach to Accelerate Catastrophic Storm Damage Recovery After New York State EF-3 Tornados.**
Gavin Snyder, Imagine Aerial

**Lunch/Group Photo/ Networking/ Exhibit Hall: 12:20 PM to 1:30 PM**

**UAV Trivia Game-2: 1:30 PM to 2:00 PM**
Moderator by Tim Bauch and Tim Spacher

**SESSION J: 2:00 to 3:20 (3 talks)**
**UAV for Agricultural Applications- II**
Session Chair: Dr. William Stiteler
2:00 **A comparison of VNIR range sensors for assessing canopy variability in vineyards**, Robert Chancia, Tim Bauch, Nina Raqueno, Terry Bates and Jan van Aardt, RIT; Cornell University.

2:20 **Agricultural Disease Management: Estimation of Cercospora Leaf Spot severity in Table Beets using UAS**, Mohammad S Saif, Robert Chancia, Pratibha Sharma, Sean Murphy, Sarah Jane Pethybridge and Jan van Aardt, RIT; Cornell University.

2:40 **Revolutionizing RPAS Logistics: An Innovative Multi-Objective Hybrid Optimization Framework Utilizing the SORA Methodology for Advanced Delivery Systems**, Revolutionizing RPAS Logistics: An Innovative Multi-Objective Hybrid Optimization Framework Utilizing the SORA Methodology for Advanced Delivery Systems, Carleton University.

**Awards and Closing Remarks: 3:00 to 4:00**

- **Student Oral Presentation**
- **Student Poster Presentation**
- **Trivia- 1winner**
- **Trivia-2 winner**

Dr. Bahram Salehi, ESF, Conference General Chair
Dr. Emmett Ientilucci, RIT, Conference Co-Chair

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# Monday Keynote Speaker

**Ken Stewart**

**Progress in UAS and Aviation in Central New York: An Enhancement to Airspace Integration**

Ken Stewart has served as the President and Chief Executive Officer of NUAIR since Dec 2020. Prior to joining NUAIR, Stewart held several leadership positions at General Electric including CEO of AiRXOS, a GE aviation company, where he led innovation, development, and commercialization of Unmanned Traffic Management services, and Managing Director at GE Ventures overseeing the new business creation function for GE. Prior to that Mr. Stewart served in executive roles with several venture capital and private equity-backed companies commercializing and scaling pre-revenue start-ups and transforming organizations for growth. Mr. Stewart also serves on the board of New York Aviation Management Association (NYAMA) as well as the Commercial Drone Alliance, (CDA) organizations that work with federal policymakers and industry stakeholders to help create relevant rules to scale commercial UAS and Advanced Air Mobility operations.

# Tuesday Keynote Speaker

**Steven J. Thomson**

**Funding for Unmanned Systems Research and Related Technologies in Agriculture at the USDA-NIFA**

Dr. Steven J. Thomson is National Program Leader (NPL) with the USDA National Institute Food and Agriculture (NIFA). He engages Universities, other federal agencies, and industry to provide national leadership in Capacity and Competitive Grant programs. The Research, Education, and Outreach programs he leads focus on engineering processes to improve systems relevant to agriculture. These include Engineering for Agricultural Production Systems and NSF-collaborative programs such as the National Robotics Initiative, Cyber-Physical Systems, and AI Institutes. Dr. Thomson received his Ph. D from the University of Florida in the Ag. And Bio. Engineering Dept. and has background in aerial application of crop protection materials, irrigation management, water balance and crop modeling, decision support systems for agricultural management, sensing systems and electronics, precision agriculture, applied statistics, and agricultural safety. Dr. Thomson was incoming Associate Professor at Virginia Tech in the College of Engineering and had received the Alpha Epsilon Award for his Research/Extension program and Outstanding Faculty Award in the Biological Systems Engineering (BSE) Department. He was a Lead Scientist with the USDA ARS before joining USDA-NIFA in early 2016. He has authored or co-authored over 100 publications, two book chapters, and several Extension publications and software.

# Wednesday Keynote Speakers

**Dr. Qassim Abdullah**

**Drones Use in United States of America and Market Dynamics**

Dr. Qassim Abdullah is a highly accomplished scientist boasting over 45 years of expertise in analytical photogrammetry, digital remote sensing, and civil and surveying engineering across industrial, research and development (R&D), and academic realms. With a doctorate and master's degrees in photogrammetry from the University of Washington, he currently serves as Vice President and Chief Scientist at Woolpert Inc., spearheading the design and management of strategic programs for the development and implementation of new remote sensing technologies tailored to the evolving needs of geospatial users. Additionally, Dr. Abdullah holds adjunct professor roles at the University of Maryland and Penn State, where he instructs graduate courses on unmanned aircraft systems (UAS), photogrammetry, and remote sensing. Notable achievements include his pioneering introduction of Geiger-mode and single photon lidar to the geospatial industry, his leadership in Woolpert's research endeavors encompassing intelligent transportation systems, digital twin technologies, smart cities, and UAS sensor calibration, as well as his pivotal role as the creator and principal author of the ASPRS Positional Accuracy Standards for Digital Geospatial Data. Recognized as a Fellow with ASPRS and the recipient of numerous awards, including the organization's Lifetime Achievement Award, Dr. Abdullah continues to make significant contributions to the field, evident in his editorial column for the ASPRS journal, participation in esteemed panels and committees such as the NOAA Hydrographic Services Review Panel and the Transportation Research Board, and his extensive certifications as a photogrammetrist, licensed professional surveyor and mapper, thermographer, and Certified GEOINT Professional in Remote Sensing and Imagery Analysis.

# Abstracts

## SESSION A: UAV for Forest Applications

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| Title | Advancement in NIR Reflectance Measurements of Small Leaves and Pine Needles and Analysis of Differing Spectral Resolution |
| Author keywords | UV-VIS-NIR<br>VEGETATION<br>HYPERSPECTRAL<br>SPECTROMETER<br>REFLECTANCE |
| Abstract | With rapidly changing environmental conditions due to climate change, novel UV-VIS-NIR remote sensing techniques for vegetation are critical to observe environmental metrics. Capturing reflectance data of small vegetation samples such as pine needles, blades of grass, and tiny leaves is a technical challenge to overcome. The very small field of view needed for the measurement, as well as the required high sensitivity of the spectrometer can be an obstacle in obtaining high quality data. To combat this challenge, researchers have taken to measuring the combined spectrum of many small samples bunched together. Arranging mats or needle holders, in turn, enhance mutual shading of adjacent needles, multiple scattering, or re-absorption. (Rajewicz et al. 2019) There is also difficulty in repeatability that should be avoided. The resulting measurements will represent an average of the spectral features of all samples, not necessarily of the individual sample. Advancements in field and laboratory vegetation spectra are needed to study small leaves. To address this problem, we deployed Spectral Evolution's novel leaf clip reflectance probe and small leaf adapter using both a standard and high-resolution spectroradiometer. This method allows for reflectance measurements of individual needles and more control on the target. 3 types of small vegetation samples were measured with this method including small leaves and two species of pine needles. The enhanced spectral resolution combined with the ability to control the field of view, targeting individual needles allows for more accurate measurements of small vegetation samples. |


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| Title | Enhanced Individual Tree Detection in Forested Areas using YOLO-based Object Detection on UAV LiDAR Data |
| Author keywords | UAV<br>LiDAR<br>Photogrammetry<br>Tree Detection<br>Deep Learning<br>Object Detector<br>YOLO |
| Abstract | Individual Tree Detection (ITD) is the primary step to determine the tree parameters including tree count, spatial distribution, height, volume, crown dimensions, and species identification within urban and forest environments. ITD is useful for urban forest inventory, planning, and calculating tree carbon. Traditionally, airborne and spaceborne remote sensing data have been used for ITD while they have lacked the required precision for ITD because of their low spatial resolution. On the other hand, high-resolution multispectral and LiDAR data collected by Unmanned Aerial Vehicle (UAV) sensors shows a promising solution that enables a detailed ITD and tree parameter estimation. However, high-resolution data presents processing challenges. Recent developments in the field of Deep Learning (DL) offer promising solutions for ITD using UAV data. In this paper, we introduce a novel method based on an object detector DL called You Only Look Once (YOLO) employed on UAV LiDAR data to address the important task of ITD in forested areas.<br>Our approach consists of three main steps including ground point removal, point cloud rasterization, and tree detection. After the ground points have been removed, the rest of the points are rasterized into various raster channels including Vertical Density (VD), Canopy Height Model (CHM), Gradient of the CHM (G-CHM), and Local Binary Pattern of the CHM (LBP-CHM). Finally, a YOLO object detector is utilized on the combination of raster channels to detect the bounding box of each tree. The modified YOLO version 7 is trained and tested on UAV LiDAR data collected over diverse regions of interest, encompassing pine, deciduous, and mixed tree types with varying tree densities.<br>The results show a considerable ITD improvement over the previously developed YOLOv3 on airborne LiDAR data, showcasing heightened accuracy, precision, and recall within the ranges of 0.7-0.94, 0.76-0.99, and 0.8-0.97, respectively. From a practical aspect, our method is automated and holds potential for urban tree inventory updates as well as enabling tree parameter estimation including tree count, height, volume, and crown dimensions. It also serves as a valuable tool for ground-truthing large-scale satellite-based forest structure and biomass estimation, among various other applications. |

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|---|---|
| Title | Modelling Forest Productivity Using UAS-derived Canopy Structural Complexity Metrics |
| Author keywords | Canopy Structural Complexity<br>VLP16 LiDAR<br>Forest Mortality |
| Abstract | Canopy structural complexity (CSC) traits, which describe heterogeneity in vegetation structure, are strongly tied to numerous forest ecosystem functions, including primary productivity. Light detection and ranging (LiDAR) systems have proven to be an effective tool for quantifying forest structural diversity related to CSC. Recent studies have demonstrated that CSC metrics derived from portable canopy LiDAR (PCL) data outperform conventional canopy traits as predictors of forest productivity. However, although terrestrial LiDAR systems like PCL provide highly detailed information on internal canopy structure, they remain limited in terms of spatial coverage. Airborne laser scanning (ALS), on the other hand, offers a way to rapidly measure CSC traits over large areas, but its potential for capturing CSC traits that are tightly coupled with forest productivity is yet to be investigated. Here, we derived a novel suite of CSC metrics from a dense LiDAR scan from a section of Harvard Forest, acquired using VLP16 LiDAR. Contrary to studies conducted using PCL, none of the UAS-derived CSC metrics had strong positive correlations with net primary productivity (NPP), and some had strong negative correlations. We attributed this finding to significant tree mortality across the eight measured plots that were used in the analysis, as evidenced by 91% of the variation in standing dead trees being explained by the top-selected CSC metrics in a stepwise regression analysis. Furthermore, compared to a univariate model including only mean normalized difference vegetation index (NDVI; a common proxy for NPP), explained variance in NPP nearly doubled (from 44 - 80%) when CSC metrics were also included. Our findings suggest that disturbance can alter the relationship between CSC and productivity observed in intact forests, and illustrate how CSC can mediate the relationship between mortality and NPP in disturbed forests. |

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| Title | Oral Presentation "Detection and Delineation of Regenerating Conifer Crowns Using UAV Imagery and Mask-RCNN Deep Learning Model" |
| Author keywords | Crown Delineation<br>UAV Imagery<br>Mask-RCNN<br>Seedlings |
| Abstract | Forest Regeneration Assessment is a crucial aspect of sustainable forest management, providing essential insights into current stocking levels, potential future stand density, and spatial arrangement of the desired forest stand. Recently, Unmanned Aerial Vehicles (UAVs) have been used to collect forest attributes at high spatial and temporal resolution. Additionally, a combination of high-resolution UAV imagery and deep-learning object detection models has shown a potential to outperform conventional techniques for detecting and delineating individual tree/seedling crowns. This study uses UAV imagery with an average ground sampling distance of 6 cm to train a region-based convolutional neural network (Mask-RCNN) model for detecting and delineating individual red pine seedling crowns. We assessed the performance of 5-band multispectral imagery and 3-band red-green-blue (RGB) imagery on detecting and delineating individual crowns. Models trained on RGB imagery were slightly better than those trained on multispectral bands. It shows that the detection and delineation of individual red pine seedlings can be performed using RGB imagery. |

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# SESSION B: Hyperspectral & Energy Applications

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| Title | AIR6 SYSTEMS Drone Solar - DrSOLAR |
| Author keywords | |
| Abstract | With the US Clean Energy Revolution & EU Green Deal's national commitments, massive growth in solar energy is expected, leading to an increased number of areas to be covered and with regular inspection and maintenance work. This poses a significant cost burden while emphasizing the importance of early detection for warranty provision, insurance requirements, and maximizing energy output; but also offers an opportunity in solar O&M services, with 14% annual market growth globally until 2030 (source: Wood Mackenzie) and expected total annual market of USD 15bn+. At AIR6 SYSTEMS, AI plays a significant and increasing role as we strive towards full "end-to-end, systems-of-systems" autonomy by 2025. In the realm of commercial drone services, data is key. It offers superior quality, provides better information, and streamlines the collection process. Automated data collection and analysis through AI is an essential element for our customers and our journey towards full autonomy. Drone Solar (DrSOLAR) offers an automated drone-based solution for solar panel inspection, specifically for fault detection. Our solution involves a semi-autonomous drone equipped with high-resolution RGB (visual) and SWIR (short-wave |

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| | infrared) cameras. The drone performs an orthophoto mapping of the entire solar farm, whilst the SWIR sensor analyzes individual solar panels with the help of the electroluminescence method to classify faulty modules using AI and their geo-referenced locations autonomously.<br>Solar panels are exposed to harsh weather conditions which can damage them and reduce their efficiency. Regular inspection and maintenance is crucial to ensuring optimal performance and insurance coverage. Manual inspection can be time-consuming, which has led to the adoption of drones for this task. Traditionally, thermal imaging combined with RGB cameras has been used to gather data. However, our project aims to enhance this process by utilizing SWIR sensors with improved resolution and detail, ideal for AI-enhanced autonomy. This innovative approach allows for a more comprehensive analysis using AI algorithms, enabling accurate and automatic identification of faults. While thermal cameras can detect faults better than the human eye, their image quality may not always be sufficient for precise analysis. By incorporating SWIR sensors, we enhance the likelihood of exact fault identification, enabling more targeted maintenance and repairs. The generated orthophoto provides a comprehensive overview of the repairs needed. Additionally, the images taken by the SWIR camera are stored in a cloud database for further visual analysis, if required.<br>Fault detection requires machine learning and AI for classification purposes, along with significant amounts of sample data that exhibit clear patterns (fault signatures) to develop robust fault recognition algorithms. The drone autonomously follows waypoints at a low height above the solar panels (<10m), eliminating the need for a pilot. Automatic flight missions and the collected data can be reused for repeat missions and time comparisons to monitor changes over time. During the inspection flight, RGB images are continuously captured at calculated intervals (coverage approximately 70% side overlap) to create an orthophoto of the entire solar farm, aiding user orientation. As the drone moves along the flight path, SWIR frames from a live video feed are analyzed in real-time using AI to identify solar panels (Step 1: AI detection). When a solar panel is detected, the SWIR camera captures high-resolution images of the panel, storing its location and mapping it to the corresponding solar panel in the maintenance records. AI algorithms are then employed to classify the panel image and identify any faults (Step 2: AI classification). The high resolution of the SWIR camera enables precise fault identification, allowing for accurate determination of maintenance needs such as cleaning, repair, or replacement. Once the entire solar farm is inspected, users can access a true-to-scale map (orthophoto) displaying the geo-referenced location and ID number of each solar panel, color-coded to indicate its maintenance status. The user interface provides cloud-based access from anywhere to all data and images captured by both the RGB and SWIR cameras for further human analysis, if necessary. Overall, our DrSOLAR solution streamlines solar panel inspections through the use of AI, enabling quicker and more accurate fault detection. This leads to an up-to-date maintenance record, faster replacement schedules, and increased energy production and efficiency. |


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| Title | Effects of Calibration on Spectral Classification of Hyperspectral Imagery |
| Author keywords | Hyperspectral Imaging<br>Spectral Classification<br>Atmospheric Compensation<br>Radiometric Correction<br>Real-Time Intelligence |
| Abstract | Hyperspectral image analysis typically involves comparing reflectance spectra from pixels in imagery to stored reflectance spectra of known materials. To convert the Hyperspectral image from raw data to reflectance, typically a conversion to radiance, and then an atmospheric compensation to correct for the downwelling irradiance at the time of collection.<br><br>The goal of many hyperspectral image analyses is to segment the image according to spectral types, with the assumption that spectrally similar pixels come from chemically similar objects. Logically, if the comparison is to be based on chemical differences leading to spectral features, then it is best to do the classification on reflectance data.<br><br>The processes of converting raw data to radiance and then to reflectance are computationally intensive and take time. If it were possible to perform the spectral classification on less processed data, the hyperspectral image processing could be performed much more quickly, and potentially in real time.<br><br>In this study, we look at two hyperspectral data sets, and compare the quality of the image classification on reflectance, radiance, and raw data. For each data set, a spectral library was generated from the imagery. The spectral libraries for each data type were then used to classify each full data set, creating classified orthomosaics of the scanned area. We present the result that, though reflectance data give a better classification than raw data, there will be some applications for which the raw data will suffice, indicating that real-time object identification from Airborne Hyperspectral imaging may be possible. |

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| Title | Hyperspectral Multisensor Payload for UAS-based Mapping in Mining and Beyond |
| Author keywords | |
| Abstract | HySpex has been providing the hyperspectral market with combined VNIR and SWIR UAV systems of the highest quality since 2018. Data management and real time decision making have been of interest for many UAV applications for some time, but hyperspectral data rates have constrained the capability to perform these functions. While HySpex already has the capability for real time georeferencing, there is a market need to take real time and near real time results further for many applications. This presentation aims to provide information on advancements in the HySpex hyperspectral UAS infrastructure from a mining perspective through HySpex's involvement in the M4mining consortium. |

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| | Within the current European-funded M4mining project, both hardware and software are being taken to the next level with a focus on mining activities.<br>The M4Mining project aims to champion sustainable mining through integrated remote sensing data. Its overarching mission is to develop comprehensive remote sensing solutions for mining and tailing sites. The project development includes real-time mapping, a multi-sensor UAV infrastructure, establishing best practices, user-friendly interfaces, and effective data analysis techniques. The initiative strives to advance mining via closing resolution gaps, empowering decision-makers, and enhancing sustainable practices. Its aspirations align with the EU's raw material security and environmental sustainability objectives.<br>Achieving real-time mineral classification with UAVs, yielding seamless 3D visualization for decision-makers on the ground, allows mining companies to streamline raw material extraction, reduce environmental impact, and to focus on and comply with proper waste management and mine safety measures. |

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# SESSION C: UAV for Agricultural Applications- I

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| Title | Regional Aboveground Biomass Density (AGBD) Modeling Using Simulated Global Ecosystem Dynamics Investigation (GEDI) Waveform LiDAR in Western Amazonia |
| Author keywords | |
| Abstract | Onboard the International Space Station (ISS), NASA Global Ecosystem Dynamics Investigation (GEDI) full waveform LiDAR's primary science mission is to estimate the global forest aboveground biomass density (AGBD) – carbon sequestration – carbon pools held within trees. In the timeframe (2018 – 2023), the GEDI has deciphered the global forests with three-dimensional (3D) horizontal-vertical stratification at a nominal footprint (~25 m) diameter with eight laser beams separated 600 m distance across-the-track and each footprint at 60 m along-the-track. The full waveform is used to extract the GEDI relative height (RH) metrics (i.e., quantitative distribution of laser energy relative to forest vertical heights) for the predictive modeling of AGBD using forest field inventory data as a valid reference – AGBD originating from allometric equations – a standard approach for AGBD estimation. The present study therefore aims at calibrating the linear regression (i.e., least square, ridge, and lasso) and non-linear models (i.e., polynomial, random forest, and gradient boosting) using field-measured AGBD and GEDI RH metrics as predictive variables in the Western Amazonia region. For that reason, a total of 107 forest field plots comprised of tree attributes e.g., diameter at breast height (DBH), wood density, and tree height were used to produce the reference field measured AGBD. Spatio-temporally concurrent to forest field plots, GEDI full-waveform LiDAR data was simulated using airborne laser scanning (ALS) and unmanned aerial vehicles (UAS) datasets to extract RH predictive variables of RH10, RH25, RH50, RH75, RH78, and RH98. Linear and non-linear models were then fitted using field-measured AGBD as a dependent variable and RH predictive metrics as independent variables. The present study also aims to investigate all |

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| | possible combinations of RH predictive variables to achieve the best RH variables achieving the lowest root mean squire error (RMSE) and highest coefficient of determination ($r^2$) for linear and non-linear AGBD predictive models. For the Amazonia region, our results showed that the linear regression predictive models yield the lowest AGBD error (RMSE = 3.32 kg/m$^3$), and highest coefficient of determination ($r^2$ =0.69) compared with non-linear models (RMSE = 3.92 kg/m$^3$, and $r^2$ =0.57). Likewise, RH10, RH50, and RH98 are the best predictive variables among all other combinations of RH metrics extracted from the GEDI waveform. Our approach provides a state-of-the-art automated framework for processing, calibrating, and |

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| Title | Detecting Spatial Variation in Wild Blueberry Water Stress using UAV-Borne Thermal Sensor |
| Author keywords | Water potential<br>CWSI<br>Crop water status<br>Irrigation<br>Thermal<br>Remote sensing<br>Wild blueberry<br>UAV |
| Abstract | Thermal-based crop water stress index (CWSI) is an effective and cost-friendly method for remote and non-destructive monitoring of crop water status in large commercial fields. However, its utility in wild blueberries, a temperate crop, has not been studied before. Additionally, the impact of crop growth stage and reference temperatures on the predictive model needs further research. In this multi-year study, an Unmanned Aerial Vehicle (UAV)-based thermal sensor was used in 2019, 2020, and 2021 to validate different Twet and Tdry reference-based CWSI in two large adjacent wild blueberry fields in Maine, United States, for estimating real-time leaf water status remotely. Different approach-based Twet and Tdry references for calculating CWSI were tested. CWSI calculated with bio-indicator-based Twet and Tdry reference was found effective ($r^2$ = 0.78, RMSE = 0.05) in detecting leaf water potential (LWP) in 2021, whereas the statistical Twet and Tdry reference-based approach was less effective in 2019 ($r^2$ = 0.34, RMSE = 0.12), 2020 ($r^2$ = 0.38, RMSE = 0.17) and 2021 ($r^2$ = 0.43, RMSE = 0.12). We found that different crop growth stages have a significant impact on CWSI-LWP models. CWSI-LWP model-based crop water status maps showed high variation in the crop water status of wild blueberries, even in an evenly irrigated field. Therefore, UAV-based thermal sensors can detect real-time crop water status within the field, with the CWSI calculated from bio-indicator-based references being more reliable. Our results could be used for precision irrigation to increase the overall water use efficiency and profitability of wild blueberry production. |

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|---|---|
| Title | A Novel Multi-Channel Deep Learning Object Detector Architecture for Individual Tree Detection on UAV LiDAR Data |
| Author keywords | UAV<br>LiDAR<br>Photogrammetry<br>Individual Tree Detection<br>Deep Learning<br>Object Detector<br>YOLO |
| Abstract | We have two abstracts presented in STRATUS 2024. In our first study, we tackled the challenge of utilizing the YOLO Deep Learning Object Detector (DLOD) for Individual Tree Detection (ITD) on UAV LiDAR data. While the YOLO detector is widely used in computer vision applications, it wasn't originally designed for remote sensing data with multiple bands. Our study introduces and develops a novel DLOD architecture based on YOLO, specifically tailored to handle 4-channel input data comprising VD, CHM, G-CHM, and LBP-CHM. The outcomes of our designed architecture show substantial improvements in ITD compared to the standard YOLO network. We observed improvement in accuracy, precision, and recall, ranging from 0.71 to 0.94, 0.85 to 0.98, and 0.77 to 0.99, respectively, over the previously developed YOLO network. Furthermore, the result of our design DLOD architecture demonstrates an average improvement of 0.01-0.2 in accuracy, 0.01-0.14 in precision, and 0.01-0.14 in recall. This methodology can be extended to incorporate other sources of remotely sensed data, such as multispectral or hyperspectral imagery, which offer additional data (i.e., channels). |

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| Title | Detecting Nitrogen deficiency and Potato Leafhopper (Hemiptera: Cicadellidae) infestation in green beans using multispectral imagery from unmanned aerial vehicle. |
| Author keywords | potato leafhopper<br>nitrogen<br>remote sensing<br>spectral reflectance<br>beans |
| Abstract | The detection of crop stress is one of the major applications of remote sensing in agriculture. Multiple studies have demonstrated the capability of remote sensing using Unmanned Aerial Vehicle (UAV)-based multispectral imagery to detect the plant stress, but none so far on detection of nitrogen (N) deficiency and Potato leafhopper (PLH) feeding stress on green beans. Empoasca fabae (Harris) (PLH) is a key pest in several countries due to its wide host range and damage potential. Monitoring methods for PLH damage as well as laboratory techniques for detecting nitrogen deficiency are time-consuming and costly. A study was initiated to demonstrate if the multispectral sensor attached to a drone can detect PLH stress and N deficiency in beans. Small-plot trials were conducted in the summer of 2023, where cages were used to manipulate PLH infestation in green beans (Provider cultivar) at their first-trifoliate stage. Half of the plots were infested with PLH, and the others were kept insect-free. The two levels of PLH infestation were combined with two N treatments: commercial level N applications and no N application. Canopy reflectance was captured using a five-band multispectral sensor. Our findings indicate that drone imagery could detect N deficiency and PLH damage in beans. |

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# SESSION D: UAV for Water & Flood Monitoring

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| Title | A Database of Environmental Bacterial Flora for Remote Sensing Applications |
| Author keywords | remote sensing<br>bacteria<br>freshwater<br>Great Lakes<br>UAV |
| Abstract | High confidence prediction of bacterial populations in bodies of water using remote sensing approaches can dramatically expand our understanding of bacterial ecology and potentially assist in decision making regarding safe access to water in low resource locations. Over a period of 10 years we have collected water samples in the Rochester-Lake Ontario Embayment Area and have isolated over 1,100 bacterial specimens. This UAV-assisted, ground-truth collection, has taken place on specific dates and locations to |

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| | coincide with data acquisition by the Landsat 8 OLI and TIRS sensors. Partial sequencing results to date have found over 150 bacterial species belonging to 40 distinct genera, of which Acinetobacter is the most highly represented. Mapping of species using GIS tools and preliminary results using hyperspectral data suggest that it might be possible to predict the occurrence of some bacterial populations using parameters like suspended solids and chlorophyl concentration. The work presented here is an update on our progress in completing a biological inventory that can be used in conjunction with remote sensing data across time and locations. |

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|---|---|
| Title | KAMERA: A Multi-camera, Multi-modal Open Source Platform for Aerial Wildlife Surveillance Above the Arctic Circle |
| Author keywords | Open Source<br>Deep Learning<br>Multi-modal Fusion<br>Environmental Surveillance |
| Abstract | Tracking Arctic ecosystems and how they evolve is an increasingly important task as we try to preserve these fragile environments and species. NOAA's Marine Mammal Laboratory (MML) Polar Ecosystems Program has been tackling this problem by examining population trends and distribution of seals in Arctic and sub-Arctic ecosystems. Kitware has worked with MML for the last 5 years, developing a system of 9 tightly synchronized and calibrated cameras covering 3 modalities (IR, UV, and EO) to assist with detection and mapping of ice-associated seals and glacial harbor seals. We will present KAMERA, our open-source software platform for data collection, management, and analysis for crewed and uncrewed aerial platforms. KAMERA includes deep-learning-based AI models for seal detection and classification. We will discuss the challenges that arose from the development of the system, lessons learned, and sample results from the operation of the system above the Arctic Circle. In addition, we will briefly discuss KAMERA's peer system, ADAPT, a similarly open-sourced platform we developed for ice flow and forestry mapping. |

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| **Submission 19** | |
|---|---|
| Title | Assessment of Structural Differences in a Mediterranean Ecosystem Using UAS-based Structure-from Motion (SfM) data |
| Author keywords | Mediterranean Ecosystem<br>Fynbos<br>Structure-from-motion |
| Abstract | The Greater Cape Floristic Region (GCFR), located near South Africa's southern tip, is the world's smallest floral kingdom, known for its hyper-diverse endemic ecology. The region covers around 90,000 km2 and is home to approximately 9,250 plant species, 70% of which are indigenous to the area. The fynbos biome, a Mediterranean-type, fire-prone shrubland, accounts for a significant portion of the plant diversity; in fact, this biome contains approximately 8500 (80%) species, of which around 6000 species are endemic. This makes the region a global hotspot for ecological studies. Fynbos' high rate of species turnover across sites and abundance of locally endemic species account for the region's diversity. Fynbos is a fire-adapted vegetation and needs regular burning to prevent it from being gradually replaced by invasive species. The characterization of plots as a function of time-since-last-burn therefore is one of the important assessments related to fynbos ecology. In this study we propose four structural metrices, namely Canopy Height, Top Rugosity, Gap Fraction, and Surface Point Density, derived from unmanned aerial system (UAS)-based 3D point cloud data, extracted via the structure-from-motion (SfM) technique. We used imagery collected from a DJI Mavic 3M, which is a compact and affordable UAS platform, boasting a RGB camera and a 4-band (green, red, red edge, and near-infrared; NIR) multispectral camera to generate point cloud data for six study plots that were burnt in different years viz. 2006, 2016, 2017, 2019, 2020, and 2022. Each burn plot was divided into several 5m x 5m subplots and structural metrices for those small subplots were used to classify the subplots according to burn year. Six classification algorithms, namely K nearest-neighbor (KNN), support vector machines (SVM), Decision Tree, Naive Bayes, 1D CNN, and Random Forest were used, and the initial analysis showed that Random Forest resulted in the best classification accuracy (85%), followed by 1D CNN (83%), Naive Bayes (81%), Decision Tree (76%), SVM (76%), and KNN (75%). Our analysis showed that the most confusion occurred between plots that were burnt in year 2016 vs. 2017 and year 2019 vs. 2020, which was attributed to the fact that these do not exhibit significant difference in structural complexity, as they are just one year apart in their growth cycle. Next steps will evaluate our ability to map alpha-diversity and extending our efforts to large area waveform lidar systems. |

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|---|---|
| Title | Utilizing a Building Analysis Approach to Accelerate Catastrophic Storm Damage Recovery After New York State EF-3 Tornados |
| Author keywords | |
| Abstract | Imagine Aerial was formed in 2017 and became a nationally leading data provider for building condition analyses, utilizing UAS-mounted multi-sensor technology. With a future in research using UAS, big-data and Ai solutions, Imagine's success in building and structural analyses propelled an expansion into additional markets during Covid. In August of 2023, The National Weather Service and a Structural Engineering Firm inquired as to whether Imagine Aerial's UAS, Sensor and Ai data process could help speed recovery from catastrophic EF-3 tornados the tore across New York State. The most destructive of these storms, an EF-3 with winds topping 140 MPH, tore a 700-foot wide, 16-mile path of destruction through the Mohawk Valley and Tug Hill Region. Due to the rugged terrain, widespread debris field and height of damaged structures, it was determined that drones could aid insurance and structural engineers to assess damage more accurately and safely, therefore speeding the recovery and rebuilding effort. Imagine Aerial deployed UAS equipped with multiple sensors to expedite aerial structural inspections. The firm has a strong understanding of disaster intelligence including a team that was deployed to the deadly 2018-19 California Wildfires. Imagine Aerial's fleet of advanced UAS conducted comprehensive aerial assessments of structures in the affected tornado path, providing valuable data to assessors and engineers just 18 hours after fully mobilizing. The company rapidly processed data to give immediate insight into the exact location, extent, and detail of structural damage. The technology accelerated the assessment and recovery process, expediting the community's rebuilding efforts. |

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# SESSION E: UAV rules and regulation, Educations, and more

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|---|---|
| Title | TM-62M Landmine Detection Using an Affordable UAV-based Differential Magnetometer System |
| Author keywords | UAV<br>UXO<br>magnetometry<br>gradiometry<br>TM-62<br>area reduction |
| Abstract | Russia's war on Ukraine resulted in the contamination of critical agricultural areas of Ukraine with both landmines and unexploded ordnance, causing severe economic and humanitarian losses during attempts to reclaim the fields for agricultural activity. The TM-62, the most prevalent and dangerous class of mines threatening agriculture, is an anti-tank metal-cased mine typically buried 5-15 centimeters below the ground. Its metal body produces a strong magnetic field, making detection possible with UAV-based aeromagnetic surveying.<br>We demonstrate that a low-cost magnetometer system mounted on a UAV is capable of rapidly detecting and locating metallic landmine analogs in field tests. Our algorithms enable a horizontal differential magnetometer created using $25 compass modules with 13 nT sensitivity to successfully measure emulated TM-62M magnetic fields from an altitude of 1 m. The system includes automatic flight control via ArduPilot software, custom software for analyzing magnetometer readings mid-flight, and a custom mobile application paired with an RTK GPS that guides the user to precise coordinates of magnetic signatures. This low-cost and scalable UAV magnetometry system, specialized for rapid detection of TM-62M mines, lowers the barrier for widespread area reduction surveys of arable land. In the near future, we will calibrate the system over inert TM-62M's and prepare for further testing in Ukraine. The accessibility and affordability of this remote sensing system could allow swarms of drones to collaboratively sweep acres of land in a day in rapid area reduction surveys to assist demining efforts. |

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|---|---|
| Title | Remote Sensing Course at a Small Liberal Arts College |
| Author keywords | Teaching Remote Sensing<br>Undergraduate Education<br>Interdisciplinary Education<br>Optics<br>GIS Practicality<br>Hands-On Activities |
| Abstract | ENV-281 Remote Sensing: Remote sensing by satellite, aerial photography and more recently sUAV (aka drones) is a rapidly growing tool to solve environmental issues. We initiated this interdisciplinary, co-taught course in 2022 to broaden a student's understanding of remote sensing, and the use of Geographic Information Systems (GIS) to perform and understand image analysis methodologies. Students are introduced to optics concepts, such as properties of light, its reflection and refraction, its interaction with mirrors, lenses, prisms, cameras, emission and absorption spectra, the electromagnetic spectrum, and energy sources. This fundamental understanding of optics is coupled with the extraction of relevant information from digital imagery using GIS. Individual exercises include an introduction of raster data and their manipulations, georeferencing, the display and manipulation of colors, the use of indices like NDVI and NBR to investigate vegetation health and forest-fire burn scars, and the development of image classification schemas to formulate impervious surface maps. Other exercises and lectures investigate 3D imagery using LiDAR data, thermal imagery, seismic profiling, and the process to download satellite imagery. Student hands-on activities process and analyze imagery collected by their cell phones, a FLIR thermal camera, spectrophotometers, and small drones. By the end of the course, students demonstrate their knowledge of the fundamental principles and methods of remote sensing and use of GIS software through the completion and presentation of a final project, and show their capability to think spatially and answer real world problems.<br><br>Presentation Mode: POSTER |

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|---|---|
| Title | The Development and Implementation of a UAS Certificate Program at Vaughn College of Aeronautics and Technology |
| Author keywords | |
| Abstract | Uncrewed Aircraft Systems (UAS) are gaining popularity across various industries, creating a heightened demand for UAS workforce. To address this demand, Vaughn College of Aeronautics and Technology offers a comprehensive certification program focused on UAS Design, Application, and Operation. Courses aim to equip students with the necessary knowledge and skills to safely design and operate UAS in a variety of settings. The program is thoughtfully designed to add a UAS focus within the existing engineering programs. Approved by the New York State Department of Education in 2021, the program comprises five courses. In 2022, Vaughn College received a grant from the Federal Aviation Administration (FAA) to offer the program to qualified high school students. This shows the profound meaning of the UAS certificate program and its robustness to embark students on a successful career and satisfy the fast-growing need in the industry. Survey analysis conducted in Summer 2023 showed that the majority of the program participants are highly satisfied with the UAS program, 12 students have completed the certificate program by the end of 2023 and 13 more graduates are expected in 2024. |

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| Title | Flight Rulebook: Comprehending FAA Regulations for UAS |
| Author keywords | |
| Abstract | 1. Commercial vs. Recreational UAS Operations:<br>- Definition and differentiation of commercial and recreational drone activities.<br>- Regulatory guidelines governing each category and their implications.<br><br>2. Understanding Part 107 Requirements:<br>- Overview of Part 107 regulations governing commercial UAS operations.<br>- Qualifications and prerequisites for obtaining a Part 107 certification.<br>- Compliance protocols and ongoing training obligations for certified operators.<br><br>3. Airspace Restrictions and Requirements:<br>- Importance of airspace awareness and adherence to regulatory constraints.<br>- Navigation of airspace classifications and limitations, particularly in controlled environments.<br>- Strategies for securing authorization and safely operating within restricted airspace zones.<br><br>4. Remote Identification (Remote ID): |

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| | - Introduction to Remote ID mandates and anticipated implementation timelines.<br>- Significance of Remote ID in bolstering airspace safety and regulatory oversight.<br>- Implications for UAS stakeholders, including manufacturers, operators, and regulatory bodies.<br><br>This presentation aims to provide an understanding of the regulatory, operational, and technological facets underpinning UAS operations, empowering stakeholders to navigate complexities and capitalize on opportunities within the drone ecosystem. |

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# SESSION F: Poster Presentations

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| Title | Addressing the Dynamic Nature of Scatterable Mines: A Hyperspectral and Machine Learning Framework |
| Author keywords | remote sensing<br>landmine detection<br>machine learning |
| Abstract | The challenges of detecting small non-magnetic scatterable landmines and unexploded ordnance (UXO) associated with cluster munition use lie in their small size, low metallic content, and ability to blend with the natural environment, making them difficult to identify through traditional electromagnetic methods. These landmines and cluster munition UXOs often evade conventional geophysical technologies, necessitating the adaptation of advanced remote sensing techniques, such as hyperspectral imaging integrated with unmanned aerial vehicles (UAVs). However, effectively integrating these technologies enhances the precision and efficiency of humanitarian landmine survey activities, but addressing the dynamic nature of scatterable mines and achieving a balance between accuracy and cost remains an ongoing challenge. I propose a method to quantify spectral bands within hyperspectral data that correspond to the spectral signatures of cluster munitions and anti-personnel (AP) mines. Hyperspectral data contains a large magnitude of the electromagnetic spectrum, which results in the introduction of noise in the data. I am interested in introducing machine learning models that can identify spectral bands that correspond to the spectral signatures of the mentioned landmines, along with pixel intensity detection algorithms to detect rare or unusual pixels in the imagery. This will require the incorporation of a Convolutional Neural Network (CNN) along with a Pixel intensity (PI) method to isolate rare or unique pixels located in hyperspectral data to detect UXOs, including plastics. The integration of a machine learning model will |

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| | allow the possibility to isolate certain bands within the hyperspectral data that correspond to different landmine types. |

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|---|---|
| Title | Poster: Low-Cost Environmental Monitoring Applications in Homeland Security |
| Author keywords | LIDAR<br>Photogrammetry<br>Homeland Security |
| Abstract | Rapid technological advances in photo and LIDAR sensor quality and cost reductions coupled with automated flight paths for small quadcopters has changed what is possible for repeated data gathering for research using point clouds and photogrammetry. We will present the work from the new Mobile Sensor Laboratory at the University at Albany, including analysis of structure damage before and after natural hazards, downstream effects of physical environmental modification, and repeated data collection from areas that are not observable by satellite or downward-pointing sensors. |

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|---|---|
| Title | Leveraging UAVs for Conservation Planning in Vermont (Poster Presentation) |
| Author keywords | UAV<br>Conservation Planning<br>Conservation<br>Agriculture<br>Vermont |
| Abstract | The Vermont Association of Conservation Districts (VACD) has developed a UAV program to support the conservation planning process of the Vermont Natural Resources Conservation Service (NRCS). NRCS-Vermont works to conserve Vermont's natural resources and provides conservation planning for agricultural producers and landowners through technical and financial assistance programs. In 2021, NRCS-Vermont expressed |

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| | interest in exploring the use of UAVs to support field staff in conservation planning. Due to federal restrictions on the acquisition and operation of UAVs, NRCS-Vermont supported VACD's development of a UAV program primarily through an NRCS Conservation Innovation Grant (CIG). VACD currently operates two UAVs, a DJI Phantom 4 and DJI Matrice 300 RTK, to assist in the implementation of agricultural and forestry conservation stewardship practices. VACD utilizes UAVs to document and identify resource concerns on agricultural and forested land, monitor wetland easements, and certify implemented conservation practices. UAV imagery is also used to generate digital elevation models and contours, providing NRCS engineers with accurate elevation products. With on-going support from NRCS-Vermont, VACD's UAV program is continuing to explore and document the benefits of UAV technology in expediting and improving conservation planning and practice implementation. VACD continues to experiment with different equipment and software, including adding a multi-spectral sensor to monitor vegetation health and identify invasive species as well as working to streamline data processing and product delivery. |

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|---|---|
| Title | Successful Integration of UAV Aeromagnetic Mapping with Terrestrial Methane Emissions Surveys in Orphaned Well Remediation |
| Author keywords | airborne survey<br>drones<br>geohazards<br>magnetics<br>methane emissions<br>near-surface<br>geophysics<br>remote sensing<br>UAVs<br>wells |
| Abstract | Oil and gas wells left without owners pose significant concerns for both the environment and economic development, particularly in regions where historical energy exploration occurred before proper regulations on well abandonment were in place. These orphaned wells present subsurface risks to infrastructure development and emit uncontrolled fluids and gases, notably methane, which contributes to global greenhouse gas levels and exacerbates climate change. The challenge lies in identifying and mitigating these emissions, as only a fraction of the wells are |

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| | responsible for the majority of methane release, and there's currently no efficient method to pinpoint them without individually assessing each well. Our research shows that emitting wells exhibit specific characteristics, particularly in the metal casing's integrity, which can be detected through organized magnetic anomalies in low-altitude UAV-based aeromagnetic surveys. We've compiled a database linking identified wells to their magnetic signatures and propose using this data to prioritize remediation efforts in areas where traditional survey methods are impractical. Given limited resources for wellsite remediation, we advocate for integrating this methodology into targeted approaches for prioritizing remediation activities.<br><br>Want to present this as a poster. |

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|---|---|
| Title | Automated Thermal Anomaly Detection through Deep Learning-based Semantic Segmentation of Building Envelope Images |
| Author keywords | Building inspection<br>UAS<br>Thermal anomaly<br>Semantic segmentation<br>Building envelope |
| Abstract | Infrared Thermography (IRT) is a common approach used in building inspection for identifying building envelope thermal anomalies that cause energy loss and occupant thermal discomfort. Detecting these anomalies is essential to improve the thermal performance of energy-inefficient buildings through energy retrofit design, and correspondingly reduce operational energy costs and environmental impacts. While the existing literature underscores the significance of automatic thermal anomaly identification and offers insights into automated methodologies, there is a notable gap in addressing an automated workflow that leverages building envelope component segmentation for enhanced detection accuracy. Consequently, we created an automatic thermal anomaly identification workflow using visual and thermal infrared sensors installed on an Unmanned Aerial System (UAS) that enables fast and scalable data collection from buildings. Building envelope images (e.g., walls and windows) were |

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| | segmented based on a U-Net architecture. Then, thermal anomaly thresholds for different target domains were detected using probability distributions. Finally, thermal anomaly masks of those domains were computed. This study conducted a comprehensive examination of a campus building in Syracuse, New York, utilizing a drone-based data collection approach. The case study successfully detected diverse thermal anomalies associated with various envelope components. The proposed approach offers the potential for immediate and accurate in-situ thermal anomaly detection in building inspections. |

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# SESSION G: UAV for Transportation and Construction

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|---|---|
| Title | UAS for Transportation Incident Management |
| Author keywords | Transportation<br>Incident Management<br>Ethics<br>Vehicle Accidents |
| Abstract | Unmanned aerial systems (UAS), better known as drones, are becoming a large part of public safety operations. As this trend continues, traffic incident and emergency managers need to understand the capabilities and strategies for UAS use for traffic incidents and emergencies. This presentation will provide the information needed when considering the deployment of a new UAS program. This presentation will explore the use of Unmanned Aircraft Systems and their relevance to the incident and emergency management practices within transportation agencies. The presentation will identify key areas for coordination and collaboration for UAS from the local to the Interstate level. Transportation incident and emergency management specialists routinely find themselves with little to no information to make key decisions for transportation incidents and emergencies. The presentation will provide specifics regarding the rules of using UAS, ethical concerns, which type of UAS is best, use cases for UAS, and the recommendations for doing so regarding the incident and emergency management practices within transportation agencies. Finally, the presentation |

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| | will summarize and make recommendations for the use of UAS for emergency management, or, if UAS should not be used. |

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|---|---|
| Title | Construction Progress Monitoring and Visualization Using Unmanned Aerial Systems (UAS), Building Information Modeling (BIM), & Computer Vision (CV) |
| Author keywords | Progress Monitoring<br>Unmanned Aerial System (UAS)<br>Building Information Modeling (BIM)<br>As-Built<br>Computer Vision |
| Abstract | Construction progress monitoring is a critical aspect of project management, ensuring that construction projects adhere to schedules and budgets. While traditional manual methods are often time-consuming and prone to errors, the construction management sector lacks automated procedures that can help it find and resolve performance deviations. The objective of this research is to assist project managers in automatically and efficiently monitoring construction project progress during the construction phase, using Unmanned Aerial Systems (UAS), Building Information Modeling (BIM), and Computer Vision (CV). A Construction Progress Monitoring methodology is designed to integrate UAS, BIM, and CV to automatically: (1) monitor the progress of a project relative to an as-planned 3D model and (b) visualize the project and create a BIM. The proposed framework utilizes Python (a programming tool for CV) to analyze UAS collected 4D (3D + time) data in forms of Digital Elevation Models (DEM), Point Clouds, LiDAR data, and Orthographic photos and map them onto BIM parameters to create as-built models of the project at different intervals. The proposed methodology is illustrated using a highway construction project, named MDOT I-496 in three steps of (1) data acquisition, (2) data analysis, and (3) BIM model development. It is concluded that this methodology is an accurate and efficient solution to address shortcomings of manual progress monitoring, and assist project managers in decision-making. |

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|---|---|
| Title | Automated Bridge Inspection Using UAS Collected Data: A Machine Learning Approach |
| Author keywords | Bridge Inspection<br>Unmanned Aerial System (UAS)<br>Machine Learning<br>Convolutional Neural Network (CNN)<br>Vision Transformers (ViT) |
| Abstract | Bridges are one of the major infrastructures which connect and advance the development of any nation. According to National Bridge Inventory (NBI) and Federal Highway Administration (FHWA), the estimated cost to inspect and maintain US bridges nearly equals $164 billion. In a traditional inspection procedure, each bridge undergoes periodic manual and visual inspections to assess its physical and operational state. There are several safety, efficiency, and accessibility issues associated with these traditional inspection procedures. Understanding the difficulties of traditional bridge inspection, this research proposes a methodology to us Unmanned Aerial System (UAS) to automate bridge inspection. In this methodology visual images of bridge components are collected using UAS. Two Machine Learning approaches of Convolutional Neural Network (CNN) and Vision Transformers (ViT) are specifically developed by the Authors to detect different types of cracks and delamination on a bridge deck. A case study on Beyer Road Concrete Bridge, located in Michigan is used to validate the proposed methodology. A key finding of this research is that the developed ViT model is able to accurately detect the cracks on the bridge deck, using high resolution UAS collected images. |

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|---|---|
| Title | Assessing the Effectiveness and Practical Utility of UAV-based Aerial GPR Surveys in Humanitarian Mine Action. |
| Author keywords | Humanitarian Geophysics<br>Ground Penetrating Radar<br>Landmines |
| Abstract | This study assesses the utility of unmanned aerial vehicles (UAVs) equipped with ground-penetrating radar (GPR) systems in humanitarian mine action (HMA) initiatives, specifically targeting the detection of both metallic and non-metallic anti-vehicle landmines. Conventional terrestrial geophysical surveys encounter significant obstacles |

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| | when dealing with areas contaminated by low- and non-metallic landmines and unexploded ordnance (UXO). These challenges include limitations in electromagnetic induction methods and operational hazards such as false positives and risks to personnel safety. To address these issues, this research investigates the integration of UAVs and aerial GPR systems to improve accessibility, survey efficiency, and personnel safety. The study consists of two primary experimental phases: a controlled experiment at the Binghamton University Testing Facility aimed at calibrating the GPR system for detecting Soviet-designed TM-62 anti-tank landmines, and a blind trial at the Oklahoma State University CENFEX test site focused on detecting all-plastic VS-1.6 landmines. The objective is to evaluate the effectiveness of aerial GPR in identifying buried landmines across various field conditions. Initial findings suggest promising outcomes in detecting non-metallic anti-vehicle landmines through high-resolution radar-based subsurface imagery. Nevertheless, the methodology faces significant limitations, including signal attenuation in the air column, environmental challenges, and current technological constraints of UAV platforms and aerial GPR systems. Despite these limitations, the study underscores the potential of UAV-based aerial GPR systems to enhance the efficiency and safety of HMA surveys. |


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## SESSION H: UAV Hardware and Software Developments

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|---|---|
| Title | Low-Cost Collision Avoidance for Unmanned Aerial Vehicle Delivery Networks in Microverse |
| Author keywords | Unmanned Aerial Vehicles (UAV)<br>Collision Avoidance<br>Digital Twins (DT)<br>Metaverse |
| Abstract | Unmanned Aerial Vehicles (UAV) have been widely adopted in many applications, from surveillance to delivery. More UAV delivery businesses are expected to be launched in the foreseeable future to meet food, goods, and medicine needs for residents living in smart cities, remote areas, or places lacking runways. As the density of UAVs operating in a |

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| | community increases, collision avoidance becomes critical concerning the safety of on-ground personnel, properties, and UAVs. In the last decade, many solutions have been suggested in collision avoidance scenarios, where typical solutions require integrated sensing, information exchange, and on-board decision-making. However, including these essential components increases the cost and makes it unaffordable for small-size UAVs in terms of payload weight and power consumption. Inspired by the Metaverse-enabled by Digital Twins, Blockchain, Augmented Reality (AR)/Virtual Reality (VR), and the fifth generation (5G) wireless communication technologies, we present a low-cost collision avoidance scheme (LoCAS) leveraging Microverse, a local-scale Metaverse, for UAV delivery networks. LoCAS only requests position (GPS), altitude, velocity, and direction (PAVAD) information from each UAV, relieving the burden of expensive and energy-consuming components. By mirroring UAVs' PAVAD information and the city landscape in the Microverse, the computing-intensive tasks, including UAV tracking, trajectory prediction, and collision avoidance management, are migrated to the Microverse server on the ground. |

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| Title | Developing an Open-Source Object Counting Workflow for Aerial Imagery |
| Author keywords | UAS<br>Object Detection<br>Object Counting<br>Computer Vision<br>Photogrammetry<br>Open Source |
| Abstract | We are developing a workflow for object detection and counting from aerial imagery. This workflow consists of freely available open-source tools for photogrammetry (OpenDroneMap), computer vision model development and training (YOLOv7), and geospatial analysis (QGIS). The completed workflow will be publicly shared for use by the UAS research community.<br><br>This talk will present our work to date in developing and testing the workflow, and assessing the accuracy of the detection and count solution for subjects of interest (sea birds). We will share the list of software components and versions, as well as the source for workflow documentation and suggestions for future work. |

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|---|---|
| Title | An Automated In-situ LiDAR System Calibration and Trajectory Enhancement Strategy for UAS Mapping of Seed Breeding Trials |
| Author keywords | Field-based phenotyping<br>In-situ calibration<br>LiDAR<br>Mobile mapping system (MMS)<br>Uncrewed aerial system (UAS) |
| Abstract | Uncrewed aerial systems (UAS) carrying sensors such as light detection and ranging (LiDAR) and multiband cameras georeferenced by an onboard global navigation satellite system/inertial navigation system (GNSS/INS) have become a popular means to quickly acquire near-proximal agricultural remote sensing data. These platforms have bridged the gap between high-altitude airborne and ground-based measurements. UAS data acquisitions also allow for surveying remote sites that are logistically difficult to access from the ground. With that said, deriving well-georeferenced mapping products from these mobile mapping systems (MMS) is contingent on the accurate determination of platform trajectory along with inter-sensor positional and rotational relationships, that is, the mounting parameters of various sensors with respect to the GNSS/INS unit. Conventional techniques for estimating LiDAR mounting parameters (also referred to as LiDAR system calibration) require carefully planned trajectory and target configuration. Such techniques are time-consuming, and in certain cases, not feasible to accomplish. In this work, an in-situ system calibration and trajectory enhancement strategy for UAS LiDAR is proposed. The strategy uses planting geometry in mechanized agricultural fields (used in seed breeding trials) through an automated procedure for feature extraction/matching and using them to enhance the quality of LiDAR-derived point clouds. The proposed approach is qualitatively and quantitively evaluated using calibration datasets as well as separately acquired validation datasets to demonstrate the performance of the developed procedure. Quantitatively, the accuracy of the resulting UAS point clouds after system calibration and an accompanying trajectory enhancement improved from as much as 43 cm to 4 cm. |

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# SESSION I: UAV for Civil and Infrastructure Monitoring

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| Title | Applications of UAV for the Evaluation of Civil Infrastructure and Urban Planning |
| Author keywords | Drones<br>Web GIS<br>metric addressing<br>Orthophoto Map<br>street addressing<br>house number |
| Abstract | The current urban development in the developing countries presents significant challenges for city dwellers. The absence of proper street names, house numbers and addresses pose challenges for navigation, service delivery, emergency response and overall urban management. Traditional methods like what 3 words, plus codes, and satellite imagery while innovative, face limitations in localization, cost, and effectiveness, particularly in densely populated areas with narrow streets. To overcome this issues, an application of Unmanaged Aerial Vehicles (UAV), or drones, and mobile-based data collection tools has emerged as an effective technology for the monitoring and planning of public and private infrastructure in urban settings. This system supports the generation of individual building addresses, integrating this data into a comprehensive urban geodatabase. This database includes land use maps, road layers with names and widths, building footprints, and other crucial urban features. The metric house address generation system extends beyond mere generation of house numbers; it aids in overall municipal planning and informs major decision-making processes.<br>This study demonstrates the effective implementation of UAV technology in establishing details urban geodatabase for a rapidly urbanizing Changu Narayan Municipality of Kathmandu Valley, Nepal. We employed a semi-automated, web-based system to compute necessary distances and measurements over drone-based orthophoto maps, establishing a metric house address generation system. A unique identification code system was developed to link each building footprint to its corresponding road network within a GIS environment. This enabled the accurate assignment of street and house numbers. Mobile-based data collection tools were also applied to gather essential data and validated through fieldwork and ward level consultation workshop. Finally, an integrated geodatabase of the municipality was developed, adhering to specific requirements. This serves as a pioneering model for other urbanizing cities in Nepal, showcasing the potential of drone technology and web-based GIS in creating reliable street naming and house addressing systems, particularly in dense urban areas. |

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|---|---|
| Title | A Versatile Data Collection System for Non-imaging UAV Data Collection |
| Author keywords | UAV Data collection system<br>Non-imaging data<br>UAV custom payload |
| Abstract | We have developed a versatile, lightweight and easy to replicate data collection system for UAVs. The system consists of a custom printed wiring board (PWB), computer on a board (COB), a GPS receiver, independent battery power supply and the capability to employ a wide range of non-imaging sensors. The system is totally independent from the UAV and weighs under 50 grams, allowing the system to fly on UAVs with a wide range of payloads with very little UAV customization.<br>The system has the capability to collect data from a variety of sensor device interfaces including analog voltage, I2C, 1-Wire, SPI and RS232 serial. Also provided are a wide range of power supply voltages to power most available sensors. GPS-tagged data is stored locally on a microSD data card in comma delimited format (CSV) at sampling rates up to 50Hz.<br>The system has been deployed successfully on a small UAV. In these experiments, an electrochemical NO2 gas sensor was used to detect possible emissions from an explosive detonation. The UAV was flown through the post-detonation gas cloud and collected data at 1 Hz (appropriate for the sensor response time). The data allowed the research team to estimate the total volume and mass of NO2 emitted during the detonation. Performance during these experiments and extension to other sensors and scenarios will be discussed. |

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|---|---|
| Title | Ai Analyses developed for Structures Translates to Predictive use for Sustainable Energy - Construction, Commissioning, Drainage & Waste Stream Management |
| Author keywords | |

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| Abstract | Imagine Aerial was formed in 2017 and quickly became a national data provider of building condition analyses, utilizing UAS-mounted multi-sensor technology. With goals set on research of big-data and Ai solutions, Imagine's building and structure-specific success propelled a written plan for expansion into additional markets. As building construction paused due to Covid shutdowns, Imagine Aerial pivoted to operationalize its energy/infrastructure plan. With NY State's solar industry growth, Imagine Aerial was called upon to provide photogrammetry, modeling, data and Ai services to national utilities. Energy became Imagine's Aerial's top-selling market sector within one year. The firm utilize RGB photogrammetry during construction and RGB/IR fusion during commissioning, relaying critical data to utilities worldwide on a daily basis. This presentation shows how Imagine Aerial's Ai for construction quantity analysis detected multiple demonstrable construction issues, quantity and billing discrepancies along with operational and startup issues during commissioning on major utilities from 50 to 500 acres and 5 to 50MW. The data fusion led to a discovery that a major solid waste stream issue was well-underway with no plan for remediation on some sites and jurisdictions. This presentation shares our work and data across a year-long progression of highly-engaging UAS and Ai photographs, graphics and data. We outline what we did, why and how, with the findings and outcomes. We discuss the future of UAS technology and where we expect the industries of renewable energy and UAS/imaging to go including the possibility of fully automated operation and predictive maintenance monitoring. |


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# SESSION J: UAV for Agricultural Applications- II

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| Title | A Comparison of VNIR Range Sensors for Assessing Canopy Variability in Vineyards |
| Author keywords | Hyperspectral<br>Multispectral<br>Precision Agriculture<br>Viticulture |
| Abstract | Unmanned aerial systems (UAS) designed for precision agriculture primarily utilize sensors that sample some subset of the visible and near-infrared (VNIR) wavelength range. Multi-band images are commonly transformed to produce vegetation indices (VIs), designed to emphasize the contributions of especially vegetation within a pixel. Reflectance bands or VIs may then be used individually, in combination, or in concert with other datatypes to estimate various vegetation phenological, biochemical, and biophysical traits. Some traits of interest, like nitrogen content, exhibit the majority of their spectral features in the shortwave-infrared (SWIR) region, which is difficult to observe consistently and not accessible inexpensively with current sensor technology. However, general vegetation vigor is mapped effectively by VNIR sensors, which are well-suited to directly assess differences in chlorophyll absorption, canopy structure, and senescence. These relative maps are also often spatially correlated with nitrogen content, even if direct nutrient measurements are not accessible. Here we compare vine vigor VI maps, produced with four different sensors capturing near-coincident VNIR range imagery, over the same Concord grape vineyard in western New York. The sensors include UAS-based Headwall |

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| | Nano-HyperSpec (272-band), MicaSense-MX (5-band), DJI Mavic 3 Multispectral (4-band), and satellite-based PlanetScope SuperDove (8-band). We scrutinize each sensor's ability to capture the spatial variability of vegetation vigor within the vineyard through judicious exploration of the VIs available to each sensor's corresponding wavelengths. The resulting maps are further compared for consistency with an interpolated map of nitrogen content that was densely sampled throughout the same vineyard block. |

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|---|---|
| Title | Agricultural Disease Management: Estimation of Cercospora Leaf Spot severity in Table Beets using UAS |
| Author keywords | UAS<br>plant disease<br>texture<br>vegetation index<br>multispectral image<br>crop management |
| Abstract | Cercospora leaf spot (CLS), caused by the fungus, Cercospora beticola Sacc., is a severe foliar disease that affects the health of table beet crops. Unmanned aerial systems (UAS) present an innovative and promising method to enhance the management of CLS via precise estimation of disease severity to define action thresholds. We conducted UAS flights over C. beticola-inoculated table beet plots at Cornell Agritech in Geneva, NY, USA between June and September of 2021 2022, and 2023. Five wavelength band (475, 560, 668, 717 and 840 nm) multispectral images were collected for the 2021 and 2022 flights, while for the 2023 flights a different sensor was used (four bands; 560, 650, 730 and 860 nm). CLS disease severity was quantitatively evaluated by visual assessments at regular intervals coinciding with the flights. Various vegetation indices and texture features were derived from the UAS multispectral imagery, which then were used to train a machine learning model to predict CLS disease severity. Our best performing model produced an R2 = 0.81 and RMSE of 9.40%, based on field-based (visual) disease severity. This study demonstrates the efficacy of multispectral imagery via UAS as a surveillance tool, offering a streamlined and accurate approach to monitoring CLS in table beet production, which is critical for timely and targeted disease management interventions. |

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|---|---|
| Title | Revolutionizing RPAS Logistics: An Innovative Multi-Objective Hybrid Optimization Framework Utilizing the SORA Methodology for Advanced Delivery Systems |
| Author keywords | RPAS Routing Optimization<br>NSGA-II Algorithm<br>Multi-objective Location-Routing<br>SORA Methodology |
| Abstract | This study explores the diverse applications of Remotely Piloted Aircraft Systems (RPAS) for delivery systems, highlighting their potential for operational efficiency and cost reduction. RPAS offer swift deployment and effectiveness in various distribution systems, including crisis scenarios and overcoming ground transport challenges. To regulate and manage RPAS-based delivery systems effectively, this research presents a multi-objective location-routing optimization model. This model integrates time window constraints, concurrent pick-up and delivery demands, and rechargeable battery functionality. These integrations substantially reduce RPAS battery consumption, transportation costs, optimize delivery times, and mitigate operational risks. The model's refinement in optimizing delivery schedules considers uncertain traffic scenarios, enhancing accuracy and reliability in dynamic environments. Additionally, the model includes risk assessment, using the |

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| | Specific Operations Risk Assessment (SORA) methodology, as a third objective function. The employed NSGA-II algorithm achieves significant reductions across all objectives: 33.3% in cost, 6.48% in time, 33.3% in risk, and 35.7% in battery usage within 250 generations. Validation through the NSGA-II meta-heuristic approach solidifies the model's reliability and applicability. This study's contributions pave the way for future advancements in routing strategies, emphasizing efficiency, adaptability, and risk management in RPAS delivery operations. It offers a quantitative perspective on RPAS-based logistics optimization, bridging theory and practice. |


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# Program Agenda in one view.

| | Day 1: Monday May 20 | Day 2: Tuesday May 21 | Day 3: Wednesday May 22 |
|---|---|---|---|
| **8:00-8:30** | Registration & Breakfast | Registration & Breakfast | Registration & Breakfast |
| **8:30-9:00** | **Welcome, Opening Remarks**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>SUNY-ESF President:<br>Joanie Mahoney | **Welcome, Opening**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>SUNY-ESF Provost:<br>Dr. Sam Mukasa | **Welcome, Opening**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>SUNY-ESF VP Research:<br>Dr. John Stella |
| **9:00-9:30** | **Keynote-1:** ***Ken Stewart*** President and Chief Executive Officer, NUAIR<br>*"Progress in UAS and Aviation in Central New York: An Enhancement to Airspace Integration"* | **Keynote-2:** ***Dr. Steven Thomson*** National Program Leader, USDA National Institute Food and Agriculture (NIFA)<br>*"Funding for Unmanned Systems Research and Related Technologies in Agriculture at the USDA-NIFA"* | **Keynote-3:** ***Dr. Qassim Abdullah*** Vice President and Chief Scientist Woolpert, Inc.<br>*"Drones Use in United States of America and Market Dynamics"* |
| **9:30-10:50** | **Technical Session A:** (4 talks)<br>**UAV for Forest Applications** | **Technical Session E:** (4 talks)<br>**UAV rules and regulation, Educations, and more** | **Technical Session H:** (3 talks)<br>**UAV Hardware and Software Developments** |
| **10:501 1:20** | Coffee Break/Exhibit Hall | Coffee Break/Exhibit Hall | Coffee Break/Exhibit Hall |
| **11:201 2:20** | **Technical Session B:** (3 talks)<br>**Hyperspectral & Energy Applications** | **Workshop and Demo 1 by Telops:** *Indoor Gas Detection and Identification with Telops Hyperspectral Mini xLW System* | **Technical Session I:** (3 talks)<br>**UAV for Civil and Infrastructure Monitoring** |
| **12:20-1:30** | Lunch/Group Photo/ Networking/ Exhibit Hall | Lunch/Group Photo/ Networking/ Exhibit Hall<br>**Workshop and Demo 2 by Spectral Evolution:** *Intro to field reflectance spectroscopy and Demonstration of dual field of view spectroradiometer systems* | Lunch/Group Photo/ Networking/ Exhibit Hall |
| **1:30-2:00** | *Exhibit Hall and Meet Vendors* | *Exhibit Hall and Meet Vendors* | **UAV Trivia Game-2** |
| **2:00-3:20** | **Technical Session C:** (4 talks)<br>**UAV for Agricultural Applications- I** | **Technical Session F:** (5 posters)<br>**Poster Presentations** | **Technical Session J:** (3 talks)<br>**UAV for Agricultural Applications- II** |
| **3:20-3:50** | Coffee Break/Exhibit Hall | Coffee Break/Exhibit Hall | **Awards and Closing Remarks**<br>Conference General Chairs:<br>Dr. Bahram Salehi, SUNY-ESF<br>Dr. Emmett Ientilucci, RIT<br>**Student Poster and Presentations and UAV Trivia Winners** |
| **3:50-5:10** | **Technical Session D:** (4 talks)<br>**UAV for Water & Flood Monitoring** | **Technical Session G:** (4 talks)<br>**UAV for Transportation and Construction** | |
| **5:10-5:30** | **Wrap Up of the Day** | **UAV Trivia Game-1** | |
| **5:30-7:30** | | **Happy Hours/Social**<br>At Collegian Hotel and Suites, Syracuse | |

**NOTES**


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