Drones in Education Research Perspective

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CCE Geomatics at OSU

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Many additional geospatial faculty in other departments
Remote Sensing Platforms from the Ground Up
OSU Autonomous Systems Research Group (ASRG)

• Brief History
  • Proposal for FAA test site, 2012-3 (successful)
  • First COAs and official research flights (Wing)
  • FAA Center of Excellence selection, 2015

• Housed officially in OSU Research Office
  • Mark Peters, operational lead

• Steering committee
  • Rob Holman and Ann Schmierer, co-chairs
  • Mark Peters, Research Office
  • Michael Wing, Forestry
  • John Talbott, Agriculture
  • Roberto Albertani, Engineering
  • Geoff Hollinger, Engineering

• Advisor
  • Brian Whiteside, VDOS Global

• Plans
  • Flight Operations Group
  • Flying field
  • OSU Fleet
The Autonomous Systems Research Group (ASRG) at Oregon State has been formed to accomplish two primary objectives:

› To assist Oregon State University faculty and staff to gain access to unmanned systems in support of their research, and
› To connect industry, state and federal interests in unmanned systems to Oregon State expertise, students, labs and resources.

The ASRG’s mission is to provide a research and development capability for the advancement of autonomous systems to promote economic benefit to the state of Oregon through innovation, expertise and workforce talent.

This web site will evolve over 2015 to build out information and connections to all stakeholders—thanks for your patience while this occurs.

Please join the Autonomous Systems Research Group’s LinkedIn group

http://research.oregonstate.edu/unmanned-systems-initiative
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

CERTIFICATE OF WAIVER OR AUTHORIZATION

ISSUED TO
Oregon State University

This certificate is issued for the operations specifically described hereinafter. No person shall conduct any operation pursuant to the authority of this certificate except in accordance with the standard and special provisions contained in this certificate, and such other requirements of the Federal Aviation Regulations not specifically waived by this certificate.

OPERATIONS AUTHORIZED
Operation of small Unmanned Aircraft System(s) weighting less than 55 lbs., in Class G airspace at or below 400 feet Above Ground Level (AGL) under the provisions of this authorization. See Special Provisions.

LIST OF WAIVED REGULATIONS BY SECTION AND TITLE
N/A

STANDARD PROVISIONS
1. A copy of the application made for this certificate shall be attached and become a part hereof.
2. This certificate shall be presented for inspection upon the request of any authorized representative of the Federal Aviation Administration, or of any State or municipal official charged with the duty of enforcing local laws or regulations.
3. The holder of this certificate shall be responsible for the strict observance of the terms and provisions contained herein.
4. This certificate is nontransferable.

Note: This certificate constitutes a waiver of those Federal rules or regulations specifically referred to above. It does not constitute a waiver of any State law or local ordinance.

SPECIAL PROVISIONS

Special Provisions are set forth and attached.

This certificate, 2016-WSA-101-COA, is effective from May 12, 2016 through May 11, 2018 and is subject to cancellation at any time upon notice by the Administrator or his/her authorized representative. Should a renewal become necessary, the Proponent shall advise the Federal Aviation Administration (FAA), in writing, no later than 45 business days prior to the requested effective date.

BY DIRECTION OF THE ADMINISTRATOR
Title 14 CFR Part 107

• New FAA Small UAS Rule (Part 107)
  • “First operational rules for routine commercial use of small unmanned aircraft systems (UAS or “drones”)” (FAA)
  • Goal to open operation of sUAS in the National Airspace System (NAS) to commercial use

• Went into effect **August 29, 2016**

• Background:
  • FAA Modernization and Reform Act of 2012 (PL 112-95). PL 112-95, Section 333 directed Secretary of Transportation to determine whether UAS operations ...could safely be operated in the NAS
  • Before Part 107, private sector firms had to obtain Section 333 exemption and obtain a COA
    • Time consuming and expensive => prohibitive for commercial firms to enter into UAS operations
What’s easier/better/less restrictive under Part 107?

• Do not need pilot’s license (private or commercial)
  • But, need Remote Pilot Certificate
    • Pass an initial aeronautical knowledge test
    • Be vetted by TSA
    • ≥ 16 yrs old

• Airworthiness certification not required for aircraft
• Not required to file a NOTAM
• Do not need a visual observer
• Not required to coordinate with or give notice to airports in Class G (uncontrolled) airspace
• Allows for the use of UAS for educational purposes
  • Important for some of our work at OSU
What limitations are still in place?

- Aircraft must be registered
- Visual line of sight (VLOS) only (unless you have an exemption)
  - First-person view cannot satisfy “see-and-avoid”
- Daylight and civil twilight only
- May not operate over any persons not directly participating, not under a covered structure, and not inside covered stationary vehicle
- Below 400 ft AGL or within 400 ft of a structure
- Class G airspace
- Min wx visibility of 3 miles
- Required to log flights and report maintenance on aircraft to FAA
Something else to consider

- FAA only regulates NAS – airspace safety
- Property and privacy rights under it are where state and local laws come into effect
  - It is not enough to just make sure you are complying with FAA regulations
  - Firms operating UAS must be aware of all state and local laws regrading
    - Privacy, licensure, registration, etc.

* Thanks to Matt Kumpula, PLS, of DEA, Inc. for summary from which this info was adapted
Drone Complier
The FAA’s Center of Excellence for UAS Research

Concept created as a result of the FAA Modernization and Reform Act of 2012
  ◦ Goal: find ways to integrate UAS into NAS

15 core universities (including OSU) + 5 associate members

Over 100 industry and government partners
  ◦ NOAA, NASA, USGS
  ◦ Amazon Prime Air, Ratheon, Disney, VDOS
Pan Pacific UAS Test Range Complex

- One of six test range complexes in US
- University of Alaska Fairbanks is lead
- 3 approved test ranges
  - Tillamook
  - Warm Springs
  - Pendleton
- collectively cover the whole state
UAS for Structural Inspections
Structural Inspections with UAVs: Motivation
Aircraft Types

(a) Helicopters        (b) Fixed-wing        (c) Multi-rotor
senseFly eXom (albris)

- Front-mounted camera head that can be rotated 180° from nadir to zenith
- HD video camera, 38 MP still camera
- Thermal IR camera
- Navcams and ultrasonic sensors
- Flight planning software designed to facilitate inspection projects
eXom navcams and ultrasonic sensors
Thermal imagery
Flight planning for structural inspections with eXom
Horizontal mapping mission
UAS Bridge Inspections Completed to Date

- Independence Bridge
- Crooked River Bridge
- Mill Creek Bridge
- St Johns Bridge
Example of identifying a defect in UAS imagery of tower
Results

Cracks

Rusting Pins
Results

Paint Failure

Pack Rust
Structure from Motion (SfM)

- Relatively new photogrammetric approach
  - Leverages advanced image matching algorithms from the field of computer vision

- Many requirements are relaxed, as compared with conventional photogrammetry:
  - Can work with a wide range of viewing geometries and consumer-grade cameras
  - **Well suited to UAV imagery!**
  - Highly automated, easy to use software
SfM Processing Steps

• Basic processing steps:
  • Image matching step
    • Algorithms, such as the scale invariant feature transform (SIFT) keypoint detector (Lowe, 2004)
  • Recovery of camera parameters and 3D reconstruction
  • Typically employs bundle adjustment
  • Dense point generation
  • Output products
    • Point clouds and orthoimages
Ground control – photo targets for SfM
Point cloud of Crooked River Bridge
Point cloud zoomed in on bridge deck
Washburn Butte Tower
Path survey - conceptualization
UAS in Power Equipment Inspections

• Goals:
  • UAS inspection and mapping of transmission towers, lines, and substations
  • Determine optimal flight missions, platforms and sensors
Pacific Power facility at Brownsville

20-foot clearance with all electrical equipment
Coastal UAV work
UAV River Mapping
UAS as tools for K-12 STEM outreach/education
Middle School Remote Sensing Workshops

• Lesson plan development
• Collaboration between OPRD (Brady Callahan), OSU and AmericaView partners
• 2 workshops given in 2016:
  • 6th Grade classroom in March
  • 5th Grade classroom in May
How does your map compare?
CareerView / OregonView

• Mission:
  • Enhance the beneficial use of remotely sensed data and derived geospatial products in Oregon through
    • Partnerships extending across the government, commercial and academic sectors
    • Applications research
    • Education and outreach

• Website: http://research.engr.oregonstate.edu/parrish/oregonview
UAS in the classroom: Kinematic Positioning and Navigation: CE661
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Questions and Additional Information

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Oregon State University

Land, Sea, & Air
Autonomous Systems Research
Autonomous Systems Research

- OSU Robotics program- “Best in the West”
- UAS Flights and autonomous systems being used by:
  - Agriculture
  - Oceanography
  - Fish & Wildlife
  - Earth Sciences
  - Forestry
  - Engineering
  - Liberal Arts
- OSU UAS program one of most active in country
- Partners in PPUTRC and ASSURE
OSU UAS Operations

- Over 200 Missions in 2016
- Drone Complier (OR company)-
  - Software tool to manage missions & compliance
  - VDOS support for pilot requirements
- OSU institutional COA and Specialized Ops COAs
- Leveraging Part 107 & Educational determination
- 50+ OSU Drone pilots
- Operations from Arctic to New Zealand, many altitudes and working conditions.
Current OSU Fleet

Over 40 drones in research fleet

- 23 DJIs
- 6 3d Robotics Solos
- 5 TAROT Sports
- 3 3d Robotics Iris+
- 2 Honeycomb Agdrones
- 1 Sensefly Albris
OSU’s early investment in Autonomous Systems

- 25 robotics and AI faculty (50+ across OSU)
- 120+ Grad Students
  80+ Undergrads
- PhD and MS degrees in Robotics (ranked #4)
- $6 M expenditures (2015)
- $10 M in new grants (2015)
Advancing how to manage intelligent systems in the national airspace and beyond. Examples:

- "Typecasting Agents for Managing Human-system Interactions in the National Air-space System," -NASA
- "Towards Secure and Trustworthy Unmanned Aerial Systems," -NSF

OSU Recruiting top researchers in advanced UAS systems

- Julie Adams-
  - Member of the Counter UAS study committee for the Board of Army Science and Technology associated with the National Academies of Science, Engineering and Medicine.
  - 2015-2016 - Member of the Mainstreaming Unmanned Underwater Vehicles into the Fleet study committee for the Chief Naval Officer conducted by the National Academies of Science, Engineering and Medicine
AIS Research Objectives

Forest management:
- fire monitoring and assisting with firefighting operations
- fire impact measurements and preparation for regeneration activities
- stand mapping, disease detection
- vegetation health assessment
- height and age estimation
- fertilization sensitivity stand exams
- regeneration surveys
- inventory and analysis

Agricultural applications:
- vineyard health and vigor
- crop assessment and yield
- area measurements

Forest protection applications:
- fire monitoring, hotspot detection
- boundary protection
- search and rescue and grow operation detection

Wildlife applications:
- fishery population estimation
- wildlife detection and tracking
- habitat assessment
- wildlife opening detection

Forest engineering applications:
- logging system design
- road and bridge design
- site layout
- terrain modeling and slope stability assessment

Search and rescue operation applications:
- finding people in rugged and hard to reach areas
- reducing risk to search and rescue teams
- increasing the efficiency of search and rescue efforts

http://ais.forestry.oregonstate.edu/
With partners from NOAA and Oceans Unmanned, we are testing if murrelet nests can be detected using UAVs, which will reduce costs and minimize bird disturbance relative to traditional tree climbing methods.

Using a DJI Phantom 4 fitted with a FLIR VUE Pro thermal infrared camera, we were able to quickly and efficiently locate murrelet nest proxies (domestic quail in cages) placed high within the canopy of old-growth trees.

Given our success, the next step is to evaluate whether this approach works for locating real murrelet nests. If it does, it will enhance our ability to collect data critical to the conservation of this imperiled species.

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Nursery Inventory Management
Whale Studies

A still shot captured from the drone footage of two adult blue whales surfacing in close proximity. (Photo credit: T. Chandler)

http://www.nbcnews.com/nightly-news/how-drones-are-helping-scientists-study-future-whales-n706996

Drone operator and videographer, Todd Chandler (OSU) under the towel (crucial piece of gear) to minimize glare on the screen as he locates and records blue whales. (Photo credit: K. Hodge)
## Future OSU Industry Collaboration?

Bringing research and commercialization together
(Public Private Partnership- Business incubator/research space)

### OSU:

1. Research in varied areas
   - Remote Sensing
   - Airspace management
   - Autonomous flight
   - Precision Agriculture
   - Forest Mgmt.
   - Marine studies
   - Swarm Technology
2. Great Robotics/AI program
3. Feeder to Test Ranges & partner with ASSURE
4. Data pipeline

### Oregon Businesses:

1. Electronics/Sensors Mfg.
2. Software/data mgmt.
3. Flight Ops
4. Ag. Applications
5. Innovation/small business
Training for COA & Part 107 & Partnering with OR Dept. of Ed for STEM

- 50+ OSU faculty and staff FAA drone pilots
- Program designed in cooperation with VDOS
- Project to reach OR K-12 educators
- Prepare for classroom and recruitment of OR students to OSU.
- PACE-National demonstration project June 2017

VDOS Team, Mitch Swecker, and OSU staff during first proficiency testing.
Thank you!

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