

UAS Basics for Transportation

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UAS in Transportation Workshop

July 30-31, 2018



Why use UAS in Transportation?



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- Good Reason  
 - Documented data needs
 - Benefit from camera, lidar or other sensor that can maneuver in 3D space and obtain data from difficult-to-access locations
- Bad Reason  
 - Drones are cool/exciting/fun!

Drone Racing!*

<https://www.youtube.com/watch?v=GTifvVZBNWs>



Search



** NOT what we do...*



Top 7 (?)

1. Bridge inspection
2. Rockfall site monitoring
3. Communication tower inspection
4. Construction site monitoring
5. Transportation network monitoring
6. Geotechnical engineering analysis
7. Effective messaging/outreach/storytelling

Applications found in literature review



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Current Use of UAS in U.S. DOTs

DOT	Traffic Monitoring	Structural Inspection	Construction Site Inspection	Other Applications
Arkansas	X			
California				X
Connecticut		X		
Florida ¹		X		
Georgia	X			
Kansas		X	X	X
Michigan	X	X		X
Minnesota ²		X		
Missouri		X		
North Carolina				X
Ohio		X		X
Texas				X
Utah			X	
Washington	X			X
West Virginia	X		X	

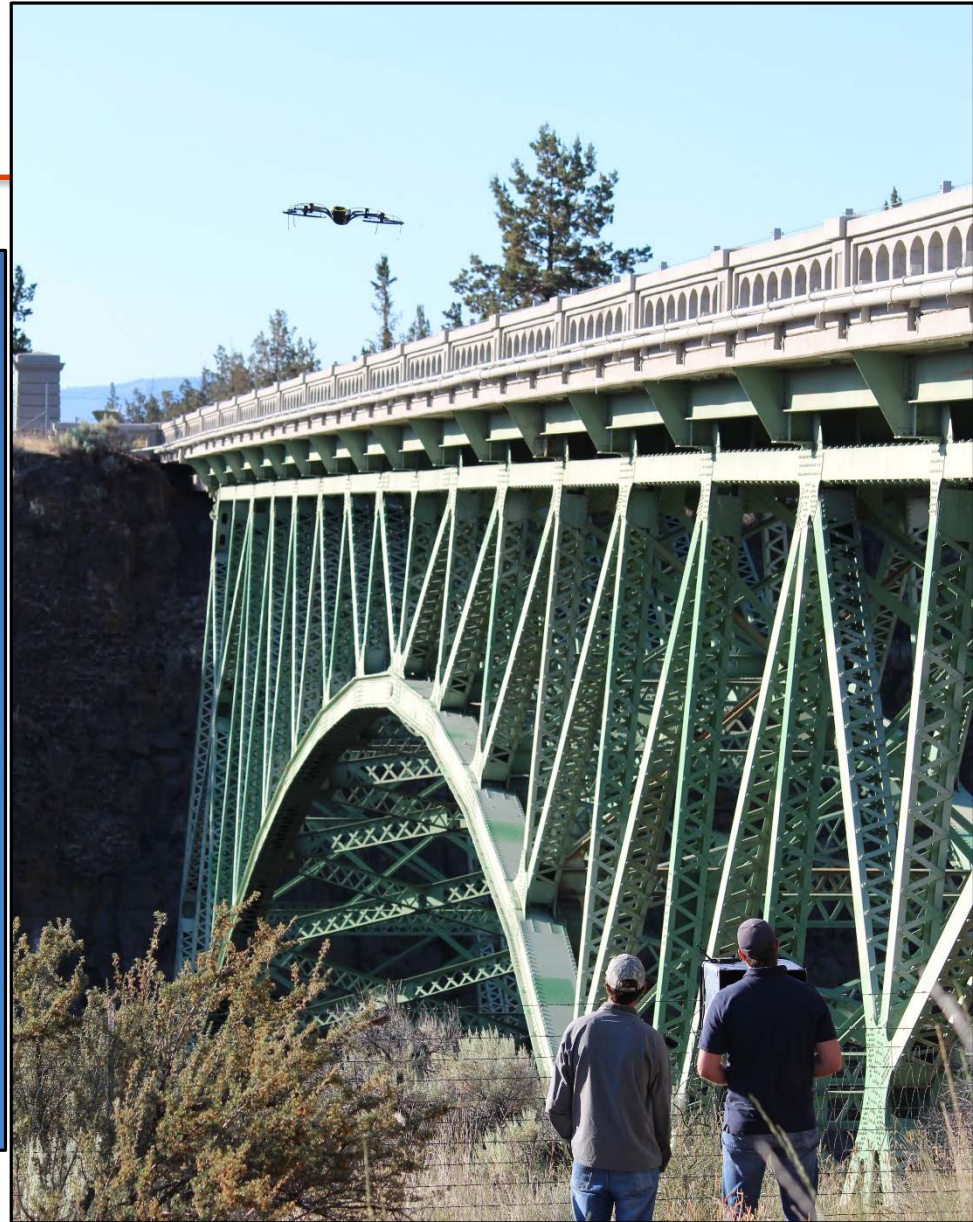
1. Otero, L.D., N. Gagliardo, D. Dalli, W. H. Huang, and P. Cosentino. Proof of Concept for Using Unmanned Aerial Vehicles for High Mast Pole and Bridge Inspections. No. BDV28 TWO 977-02, Florida Institute of Technology, 2015.
2. Lovelace, B. Unmanned Aerial Vehicle Bridge Inspection Demonstration Project, Minnesota DOT Report No. MN/RC 2015-40, Minnesota Dept. of Transportation, 2015, 214 pp.

Motivation



- New tool in bridge inspector's tool box to help:
 - Provide mechanism to remotely view bridge elements at high resolution, while keeping both feet on ground
 - Reduce lane closures, snooper crane use, and climbing in some inspections
 - Enhance safety and reduce costs in some inspections

UAS in Structural Inspections



Basic Components of UAS

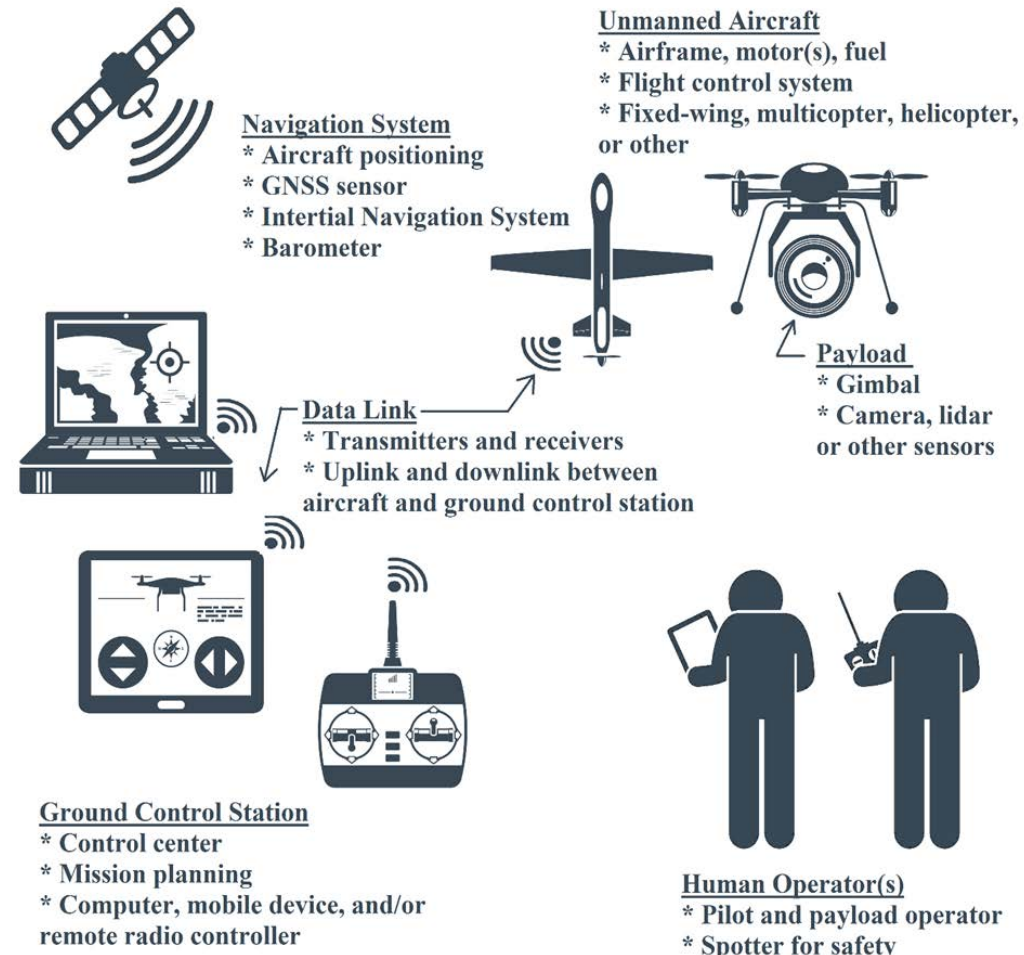
Unmanned Aircraft System Definition



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UAS Definition (FAA)

- Not just the aircraft
- Also all associated support equipment
 - Control station
 - Data links
 - Telemetry
 - Communications
 - Navigation equipment
 - Payload



Additional UAS Components

UAS Ground Control Station (GCS)



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Laptop/Computer

Datalink Antenna

Sun-Shade

Various Trays

Portable Music Stand

Marine Battery

Selection of Airframe

Various Airframes

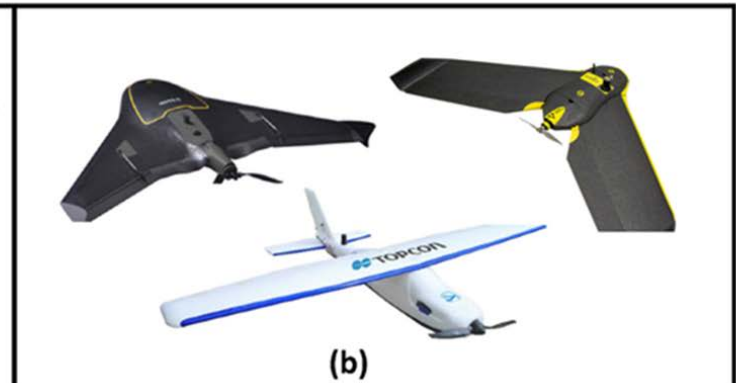


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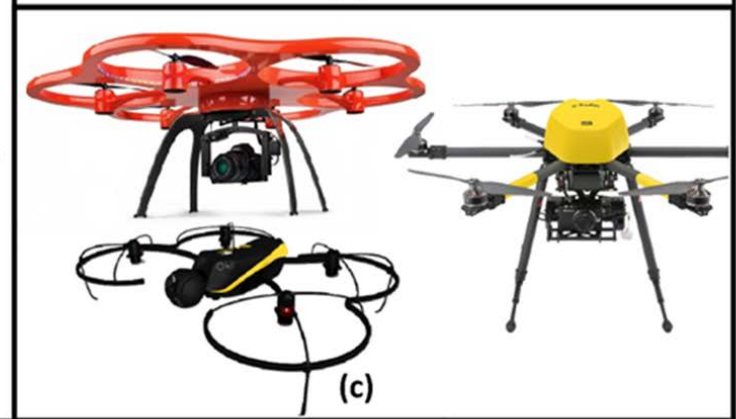
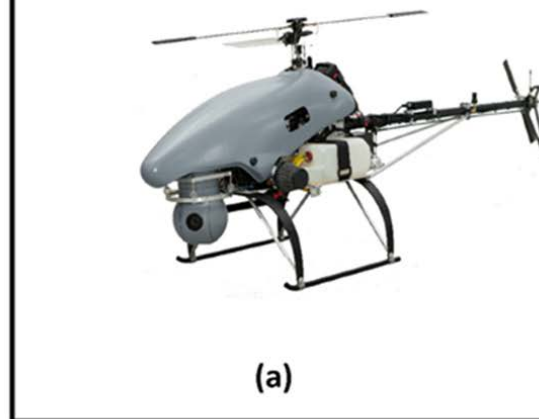
(a) Helicopters



(b) Fixed-wing



(c) Multi-Rotor



Payloads / sensors



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- RGB still cameras

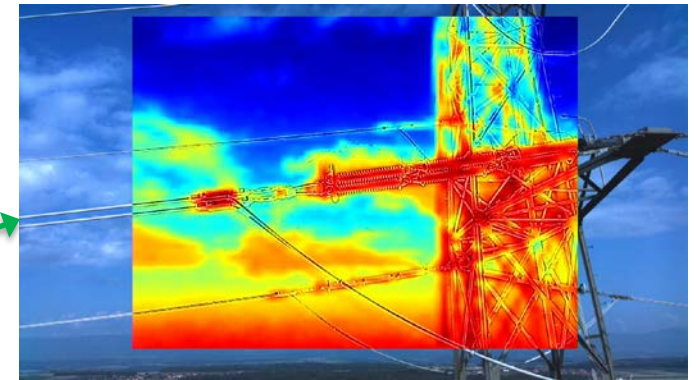
- RGB video cameras



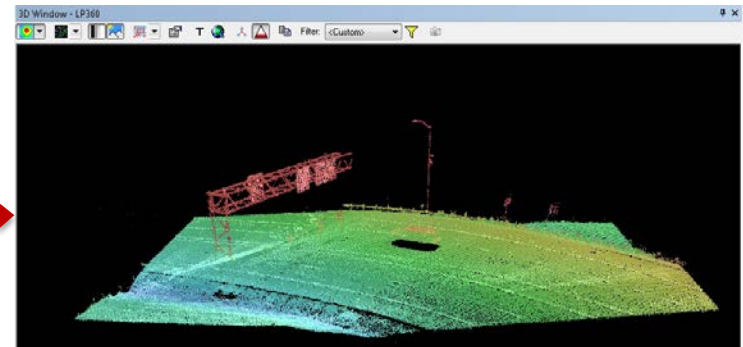
- Multispectral cameras

- Hyperspectral cameras

- Thermal cameras



- Lidar



Lidar UAS



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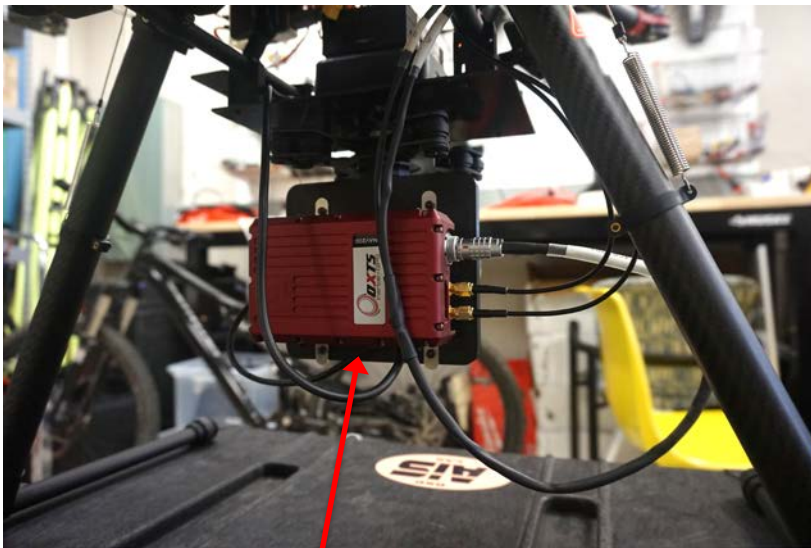


Direct Georeferencing Component

GNSS-aided INS



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Inertial Navigation
System (INS)



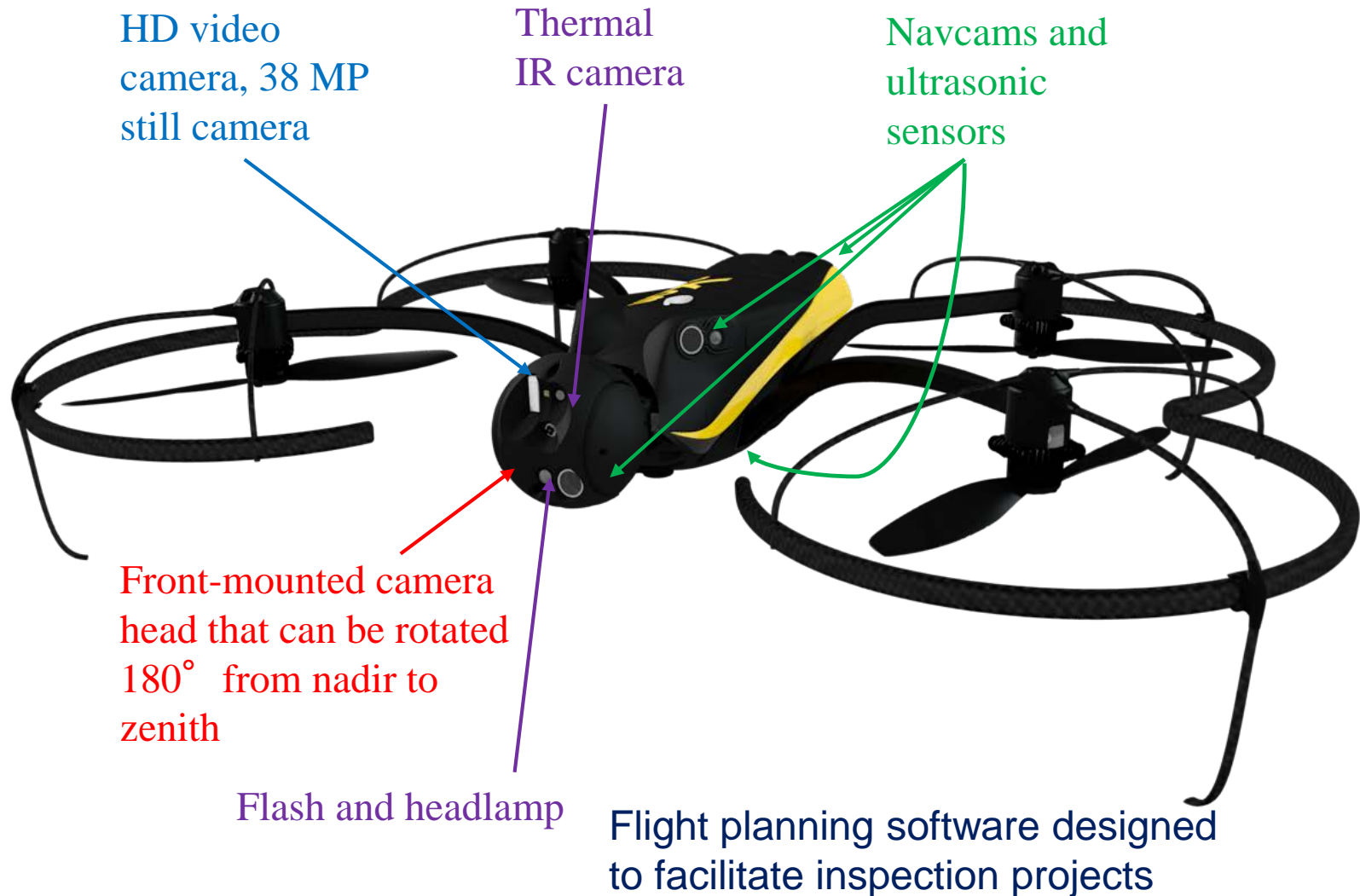
GNSS antennas

Example of inspection aircraft



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SenseFly Albris



HD video camera, 38 MP still camera

Thermal IR camera

Navcams and ultrasonic sensors

Front-mounted camera head that can be rotated 180° from nadir to zenith

Flash and headlamp

Flight planning software designed to facilitate inspection projects

Proximity/nav sensors

SenseFly Albris – Visual & Ultrasonic Sensors



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Navcams



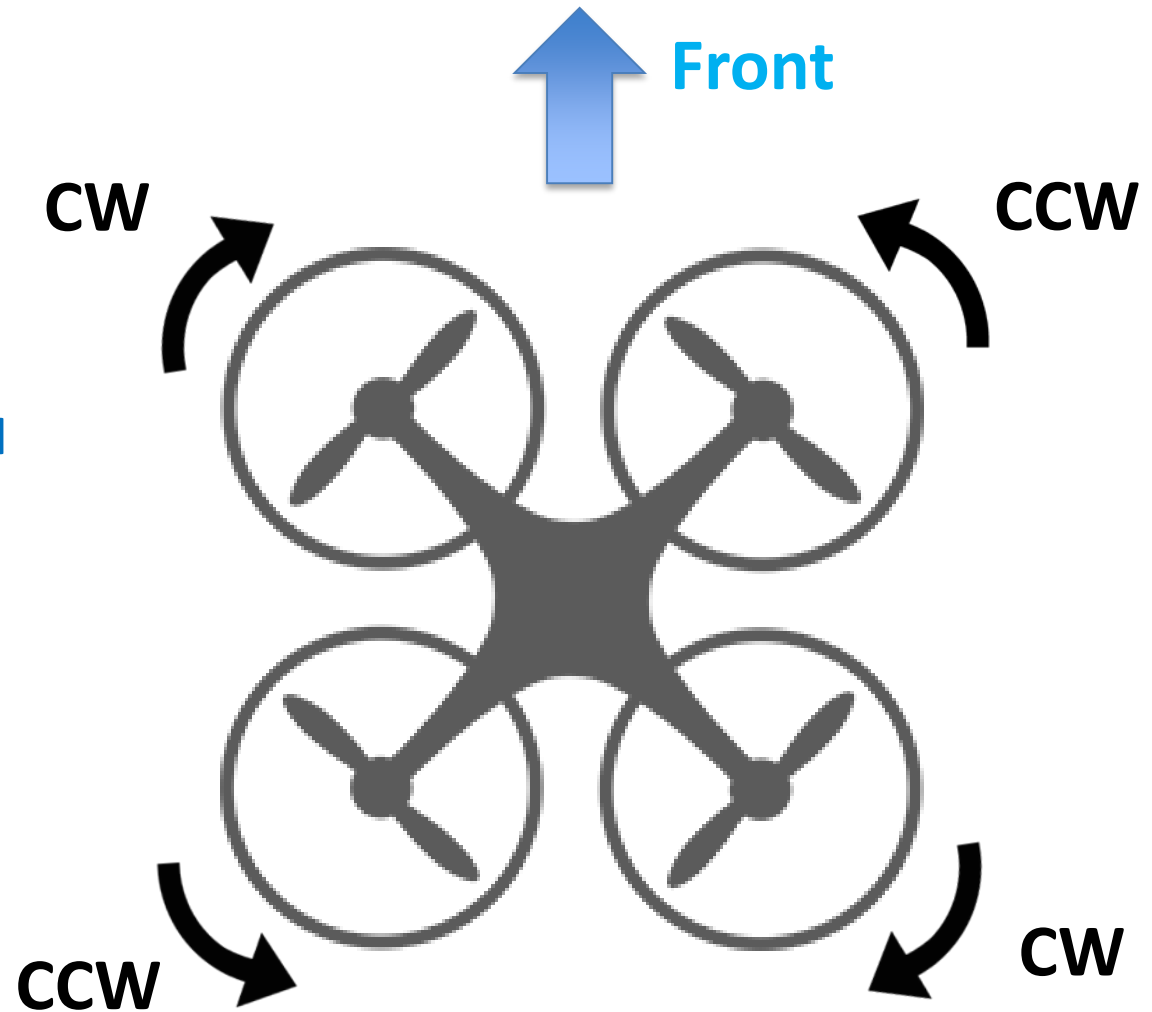
Ultrasonic sensors



Multi-rotor sUAS 101: ESCs & Motors

Electronic Speed Control (ESC)

- ESC on each motor controls how fast that motor spins



Multi-rotor sUAS 101: Controller

- **Control:** provided by transmitter (RC controller) and controller board

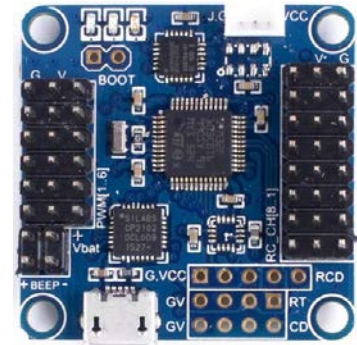


Tx

Transmitter (RC controller)

2.4 GHz

Rx



Controller board
(on aircraft)



- Controller Mode 2

- Left stick

- up: aircraft increases altitude
 - down: aircraft decreases altitude
 - left: aircraft yaws left
 - right: aircraft yaws right

- Right stick

- up: aircraft pitches nose down and moves forward
 - down: aircraft pitches nose up and moves backward
 - left: aircraft rolls and moves sideways left
 - right: aircraft rolls and moves sideways right

Alternative to manual flight mode:

Waypoint-based flight: pre-plan flightlines & photocenters

The screenshot displays the eMotion X software interface. The main window shows a satellite map of a residential area with a grid of waypoints and photocenters overlaid. The waypoints are represented by small white arrows pointing in a grid pattern, and the photocenters are represented by small white circles. The grid is overlaid on a large, semi-transparent circular area. The sidebar on the left contains the following information:

Mission: My mission

My mission ▶ My block #3 ▶

Description: My block #3

Camera: albris (eXom) maincam 38.4 MI

Plan above: Elevation data

Resolution: 1.00 cm/px

Overlap: 75 %

Area: 9.5 ha, 0.09 km²

Altitude: 57.3 m/AED

Number of photos: 479

Estimated flight time: 43:21

Estimated flight distance: 6986 m

At the bottom of the window, the coordinates are displayed: 44.8488512° N, 123.1858182° W, 51 m/AMSL.

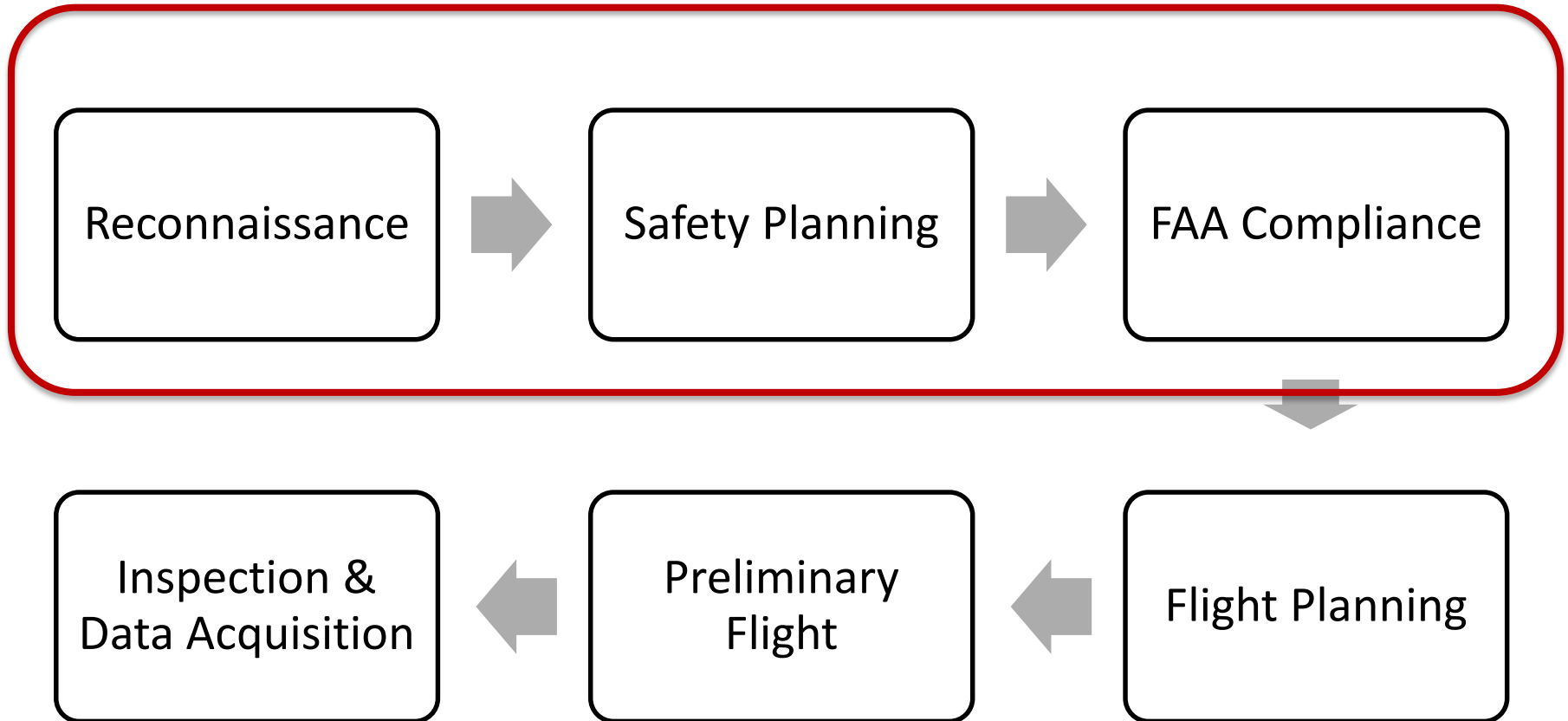
Waypoints and photocenters

Workflow for UAS Inspection

Overview Steps



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Reconnaissance, Safety, FAA Compliance



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Reconnaissance:

- Obtain permission from owner
- Check airspace restrictions
- Visit inspection site
- Set ground control points

Safety:

- Inventory safety hazards
- Fill out safety plan form
- Review form with field team

Regulatory Compliance

- Bring operational documents (COA or Part 107)
- Meet provisions in documents
- Designate Pilot In Command (PIC) and other required crew members

Background on FAA Regulations

Certificate of Authorization (COA)



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FAA FORM 7711-1 UAS COA Attachment
Blanket Area Public Agency COA
2016-WSA-101-COA

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- COA provides authorization to a public operator for a specific UAS activity
- Only method for legally operating UAS during Project SPR 787
- All flights in this project conducted under FAA COA 2016-WSA-101-COA

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	

Background on FAA Regulations

FAA Part 107



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

FAA Part 107

High-Level Summary

Easier/Less Restrictive

- Pilot license replaced with remote pilot certificate
- Airworthiness certification not required
- NOTAM not required practice
- Visual observer not required
- Coordination with airports in Class G uncontrolled airspace not required
- Use of UAS educational purposes allowed



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Requirements

- Aircraft must be registered
- VLOS
- Daylight and civil twilight only
- May not operate over nonparticipants
- < 400ft AGL (or within 400ft of a structure)
- Class G airspace only without waiver
- Min wx visibility of 3 miles

Safety Plan

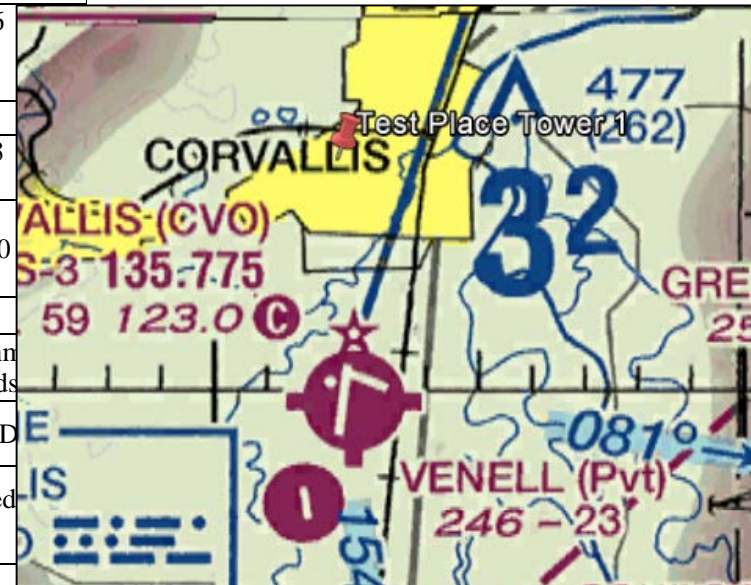


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Date of Assessment:	04/25/2016	Personnel:	Pilot in Command:	Tom Normandy
Structure Type:	Communication Tower	Primary Observer:	Matt Gillins	
Location of Structure:	44°26'10.8" N 122°59'07.1" W	Other Spotters:	Farid Javadnejad	
Owner of Structure:	ODOT		Dan Gillins Chris Parrish	
Owner's Contact info:	555 13th St NE Salem, OR 97301-6867 Phone (503) 986-2700	COA Number:	2015-AHQ-105-COA-TS	
		Team 's Emergency Contact Number:	(818)-497-8576	
Airport within 5 nm?	Yes: X	No:	Airport Manager:	Jacob Kropf
If Yes Which:	J & J airport		Manger Contact info:	(541)-766-6783
Distance from Airport:	3.2 nm		Radio Frequency Air Traffic Controller:	N/A UNICOM 123.0

Safety Inventory: Mark yes or no if any of the following hazards are potential for work site.

YES	NO	Equipment Hazards	YES	NO	Personal Hazards	YES	NO	Environmental Hazards
X		Nearby Vehicular Traffic		X	Twisting/Bending/Awkward Positions/ Heavy Lifting		X	Falling D
	X	Nearby Heavy Equipment Operations		X	Working Over water		X	Confined Space
	X	Transport/Launch of Boat/ATV/Etc.		X	Loose unstable footing	X		Weather Related
	X	Boat/Watercraft Operations	X		Slip/Trip/Fall Hazard	X		Live Stock/Wildlife
	X	ATV Operations		X	Ladders/Elevated Platforms	X		Transients
X		Other		X	Other		X	Other



Drone Complier



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MISSION PLANNING

Hi, Chris Parrish Online for 2 minutes

OSU / Home / Projects / Edit Project / Mission Planning [Customer: College of Engineering - CCE]

MISSION PLANNING : Gillins - CCE Mapping Flights

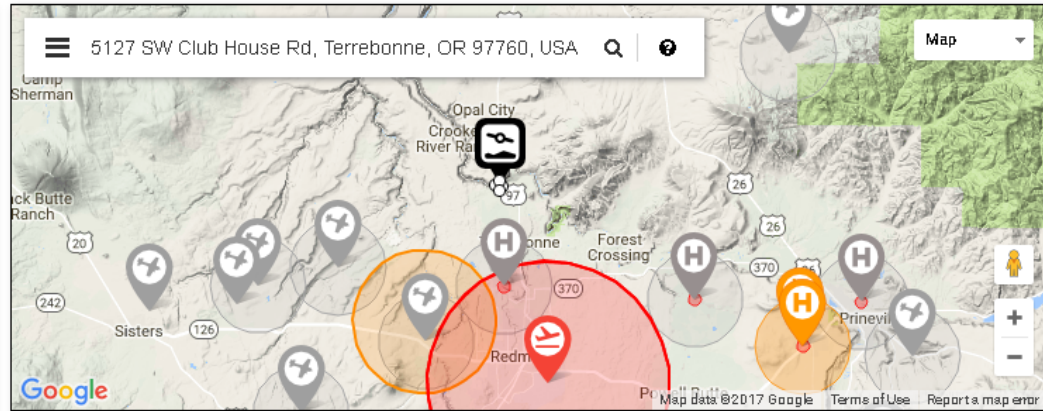
MISSION STATUS

Project : Gillins - CCE Mapping Flights
Dates : -
Address : 12898 NW Wimp Way
Terrebonne
OR 97760
USA

Location ●

Details ●

Aircraft ●



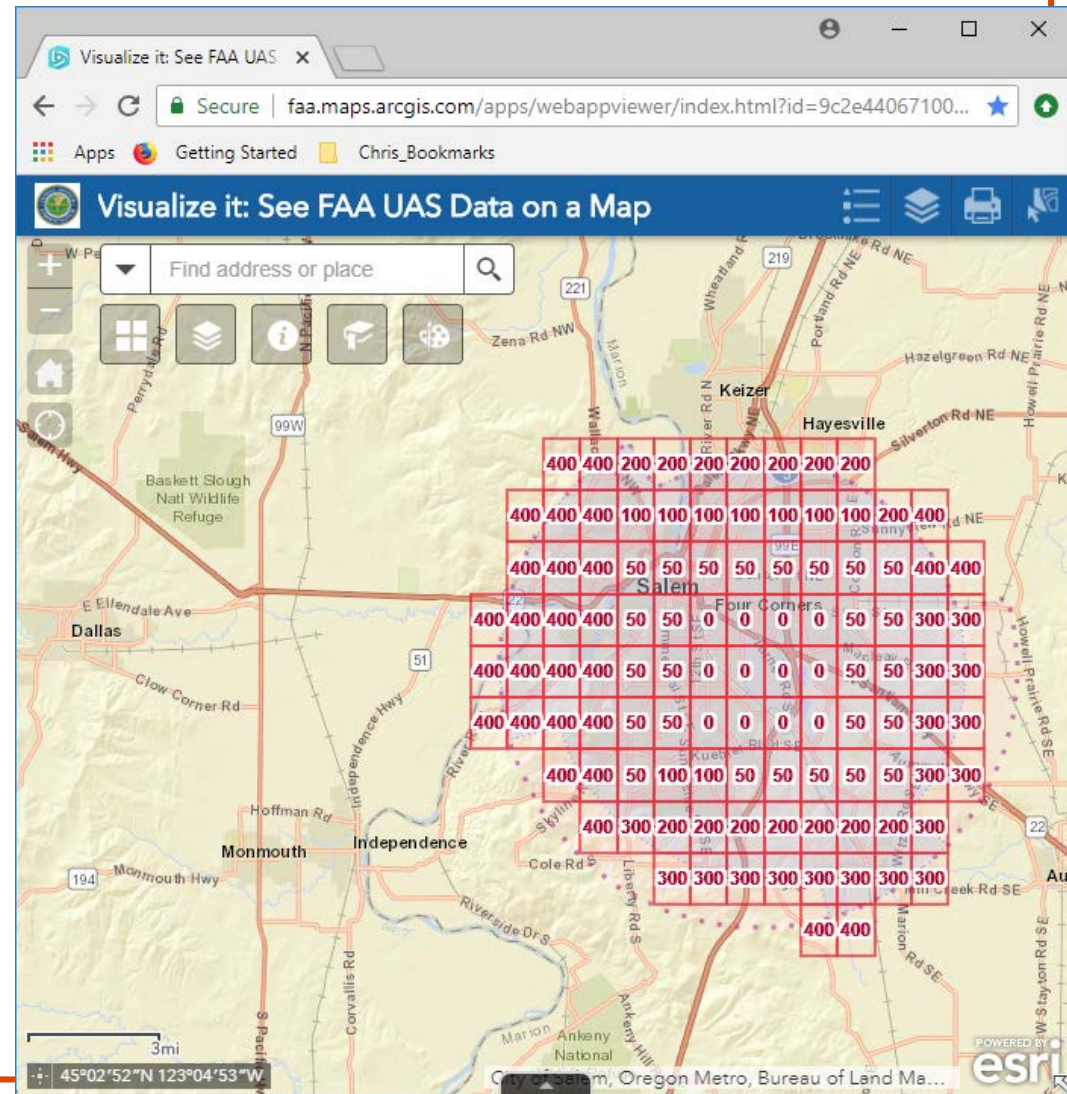
FAA UAS Facility Maps

https://www.faa.gov/uas/request_waiver/uas_facility_maps/



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- Show max altitudes around airports where the FAA may authorize part 107 UAS operations without additional analysis
- Must still apply to operate in controlled airspace (Class B, C, D, or surface area E)



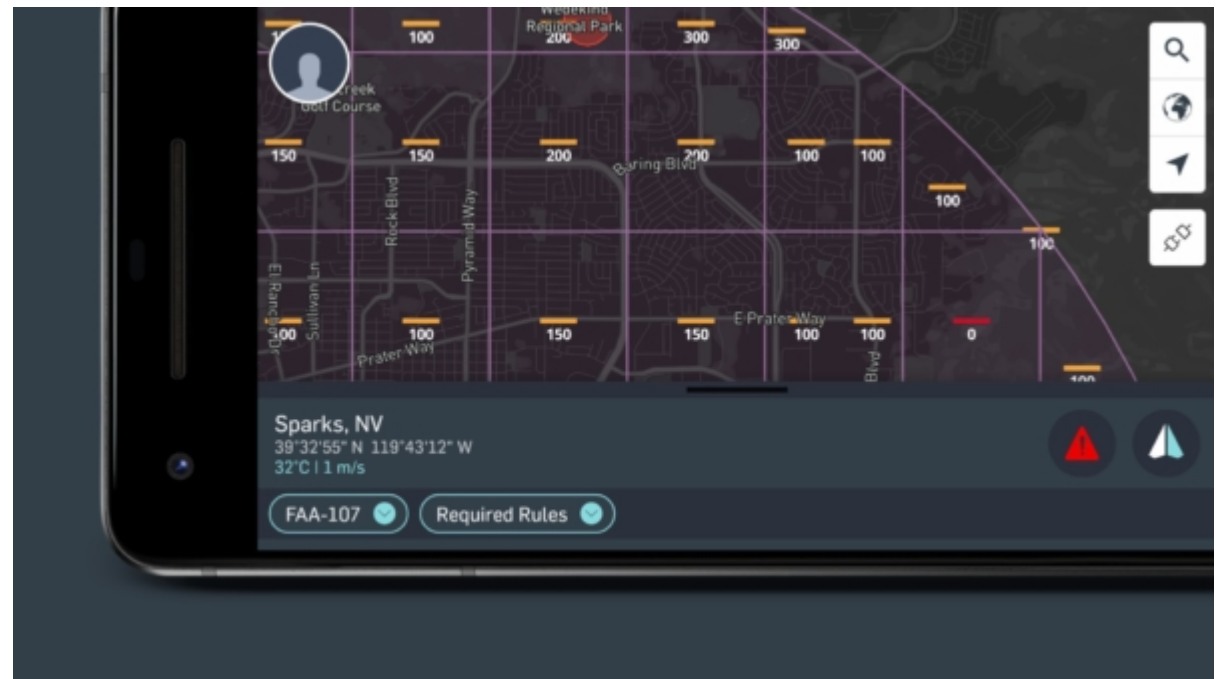
FAA Low Altitude Authorization and Notification Capability (LAANC)



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- Automates application & approval process for airspace authorizations
- “Near real-time processing of airspace authorizations below approved altitudes in controlled airspace.”

<https://www.airmap.com/category/laanc/>



Beyond Safety Planning



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Additional considerations:

- Privacy
 - Voluntary Best Practices for UAS Privacy, Transparency, and Accountability

- Annoyance factor



Bzzz...

- Property ownership and right of entry

Beyond Safety Planning



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Contingency Planning:

- Contingency Plans for
 - Flyaway event
 - Lost link
 - Auto return home at fixed radius or virtual fence
 - Secondary controller
 - Battery fire
 - Emergency landing on private property
 - “Landing” in tree
 - Crewmember medical emergency

Questions



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