Unmanned Aerial Systems

Regulations and Purdue Involvement

Associate Professor, Mike Leasure
Director Unmanned Operations, BECK Ag Center, Purdue University
Part 107 Unmanned Pilot
Private Pilot (manned)
Author: "Unmanned Aviation Systems:
The Definitive Guide"

leasurem@purdue.edu


Regulations and airspace
Interpretation and compliance
New aircraft and sensors development, integration
Presentations and outreach
Existing aircraft maintenance, repair, service
(3D printing, CNC laser)
Personnel recruiting, training, supervising
Consulting for PACS, researchers, administration
Director, Unmanned Aerial Operations

CFR14 – FAR Part 107

Part 107 is now used instead of the old 333 exemption and COA flight approvals (still an option)

Part 107 provides for licensing of commercial unmanned pilots, FAA refers to them as Remote Pilot in Command

107 also includes all the operating restrictions for RPIC

Recreational flight is defined as purely for fun (Part 101)

99% of UAS flights, as part of farming operations, grants, or research are commercial as defined by FAA

We have determined you are probably operating commercially. What now?

“Furtherance of business”

Questions? UAShelp@faa.gov

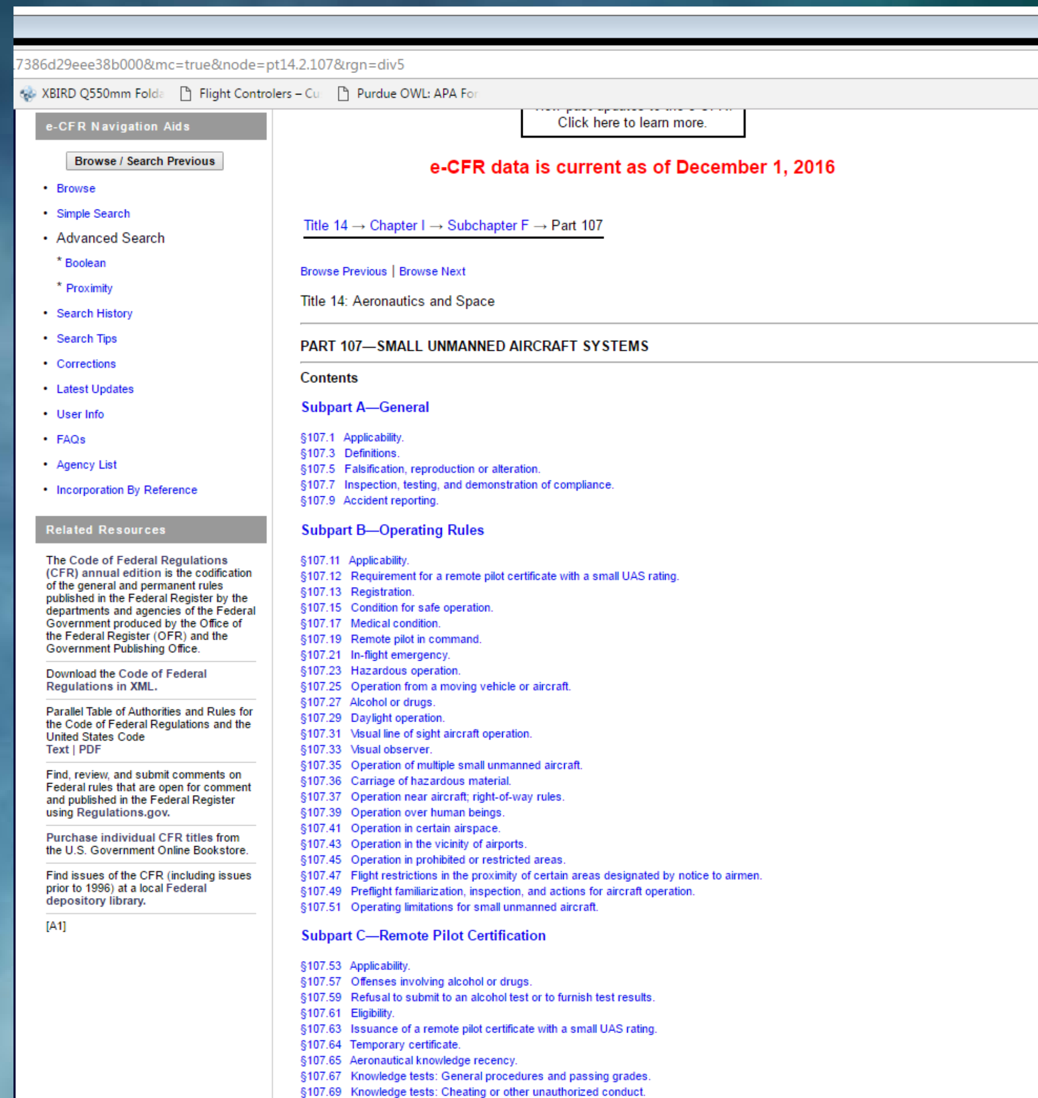
sUAS Part 107 Summary:

(The full text is 624 pages including a 600 page preamble)

Summary of Major Provisions Under 14 CFR 107

Category	Proposed Provisions
Aircraft Requirements	The sUAS must be registered with the FAA prior to flight.
	Aircraft markings are required.
	FAA airworthiness certification not required. However, the Remote Pilot in Command (Remote PIC) must maintain small unmanned aircraft systems (sUAS) in a condition for safe operation and prior to flight must inspect the UAS to ensure that it is in a condition for safe operation.
	14 CFR part 107 does not apply to model aircraft that satisfy all of the criteria specified in Public Law 112–95 section 336.
	14 CFR part 107 codifies the FAA's enforcement authority in part 101 by prohibiting model aircraft operators from endangering the safety of the National Airspace System (NAS).
Remote Pilot in Command (Remote PIC) Certification and Responsibilities	Remote PICs are required to: • Be at least 16 years old • Be able to read, speak, write, and understand the English language (FAA may make exceptions for medical reasons) • Be in a physical and mental condition that would not interfere with the safe operation of sUAS • Pass an initial aeronautical knowledge test at an FAA-approved knowledge testing center (or pass this online course, for part 61 certificate holders) • Obtain an unmanned aircraft operator certificate with a small UAS rating (like existing pilot airman certificates, never expires) • Pass a recurrent aeronautical knowledge test every 24 months
	Prior to flight, the Remote PIC must: • Conduct a preflight inspection, to include specific aircraft and control station systems checks, to ensure the sUAS is safe for operation • Make available to the FAA, upon request, the sUAS for inspection or testing, and any associated documents/records
	Report an accident to the FAA within 10 days if the sUAS operation results in serious injury or property damage.
Operational Limitations	Unmanned aircraft must weigh less than 55 lbs. (25 kg).
	Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the operator or visual observer. At all times the small unmanned aircraft must remain close enough to the operator for the operator to be capable of seeing the aircraft with vision unaided by any device other than corrective lenses.
	May use visual observer (VO) but not required.
	Unmanned aircraft must weigh less than 55 lbs. (25 kg).

ECFR: (electronic code of federal regulations)



The RPIC test is knowledge only and does not qualify anyone to operate a UAV safely or competently

Your pilot should have experience and training in actual operations on the equipment being used

Knowledge and demonstrated Competence:

Demonstrate

Beck Center Check Flight Outline

In order to fly unmanned aircraft at the ACRE facility you must meet certain requirements. Those requirements include a current remote pilot's license (FAA), having passed a pilot performance evaluation (check flight), and WPS training. Successful completion of the following list of demonstrations will constitute approval for flight of a specific aircraft at the center. It is highly recommended that training and practice flights be performed away from the ACRE facility prior to scheduling a check flight. Because of diverse power and control systems, the demonstrations must be completed for each (by registration number) aircraft to be flown:

Note: Competency in data gathering systems is not expected from the remote pilot and is the responsibility of the researcher or data specialist.

1. Demonstration of manual flight control of the aircraft including turns, ascents, descents, takeoff, and landing
2. Demonstration of autonomous flight control with programmed waypoints
3. Demonstration of failsafe in the event of system malfunction or emergency
4. Demonstration of telemetry link operation and ground control station if used
5. Safety protocols and checklists, demonstrated use
6. Answer questions regarding knowledge of airspace, weather, and regulations applicable to the specific check flight being attempted
7. Answer questions regarding knowledge of ACRE facility restrictions and guidelines

Date ________________

Remote pilot Name ____

Aircraft Registration # ____

Approval (examiner) ____

Notes:

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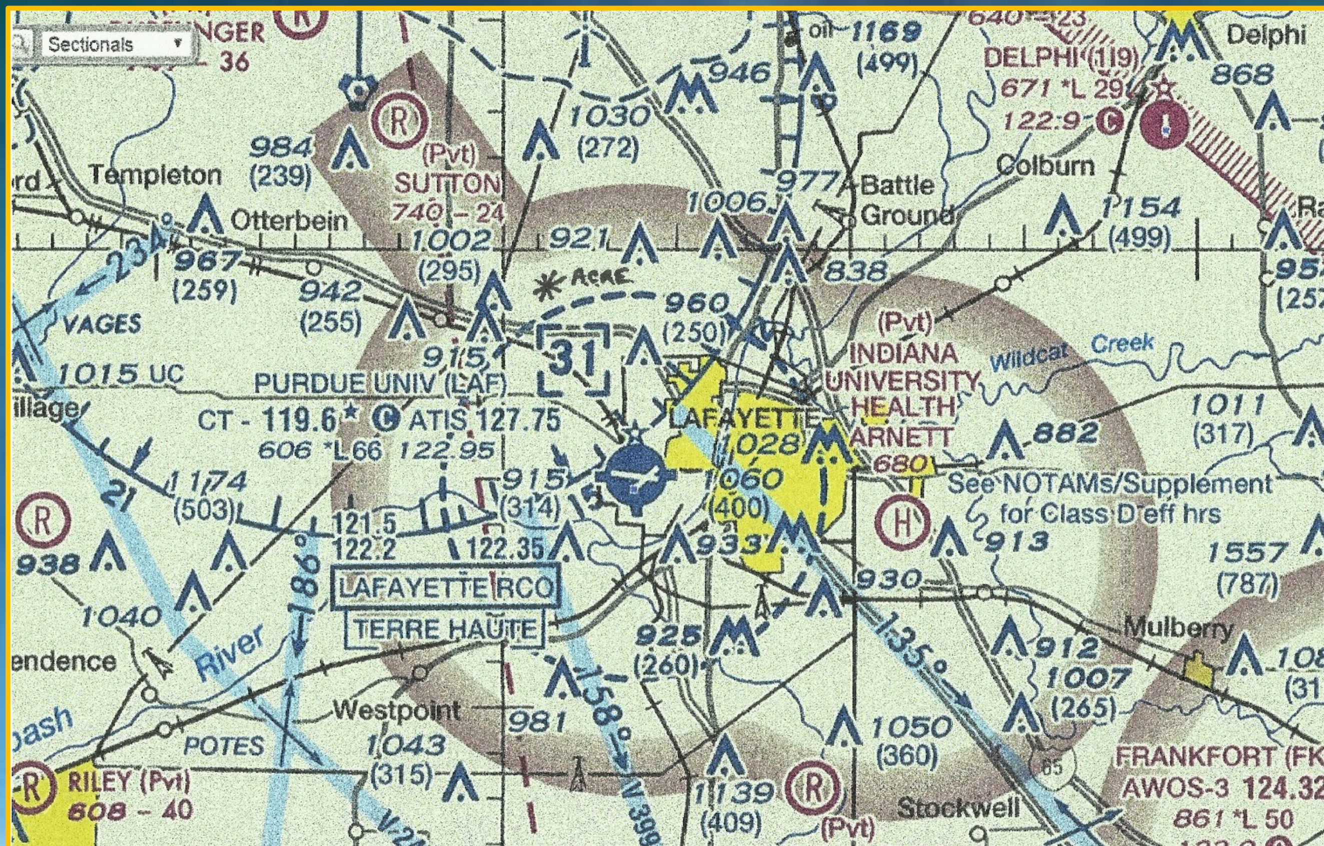
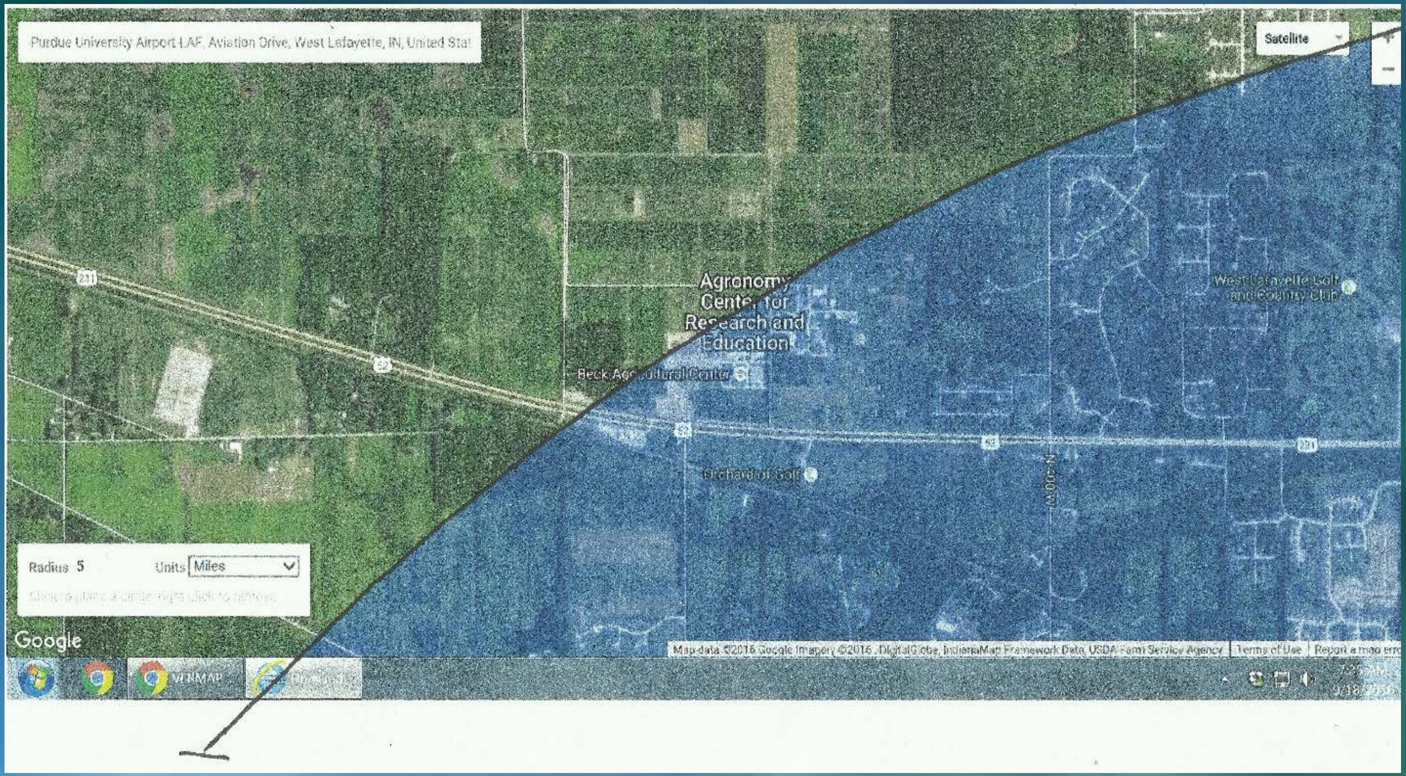
This license must be carried by the pilot when flying:

RPIC's are required to know and understand airspace, weather, and regulations:



NOTAMS, TFR's, MOA's, Class A – B – C – D – E and G

Airspace at our Purdue ag facility:



Class D in blue (5 statute mile radius from Purdue airport)
Class G in green
Class D flights require ATC (KLAF tower) approval

The aircraft we fly and why:

Robinhood:

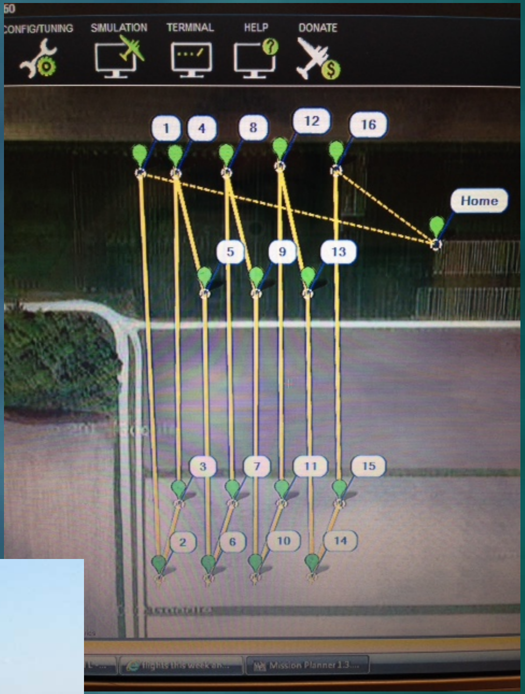
- Slow flight
- Inexpensive
- Stable
- Payload capacity of 5 pounds
- Hand launch capable
- Electric power
- Pixhawk autopilot (fully autonomous)
- Modified model aircraft design
- Entry level trainer and test bed

3DR Hexacopter:

- Entry level copter
- Micasense multispec, Gopro, etc.
- Inexpensive
- Easy to repair
- Small plot capable

Telemaster:

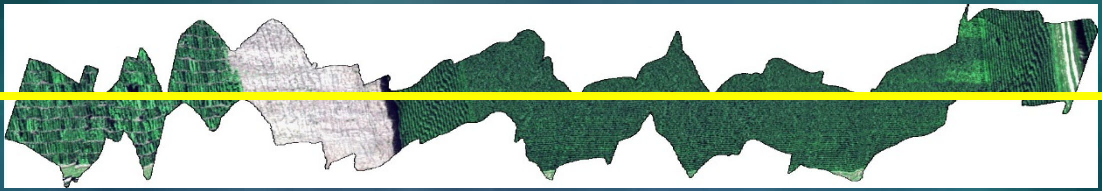
- Modified model aircraft
- Headwall Nano Hyper-spectral (270 bands)
- 8 pound payload, spans 8 ft.
- 7-9 m/s
- Fully autonomous
- Pixhawk autopilot



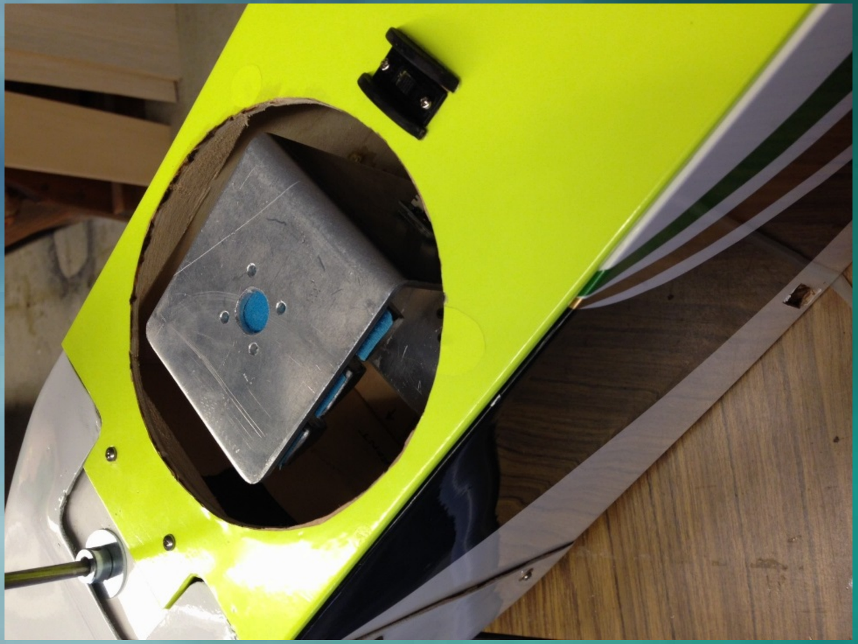
DJI-S1000:

- Heavy lift rotorcraft
- LIDAR and RGB simultaneous
- 15 minute flight time
- Very slow ~ 5 m/s
- Pixhawk autopilot

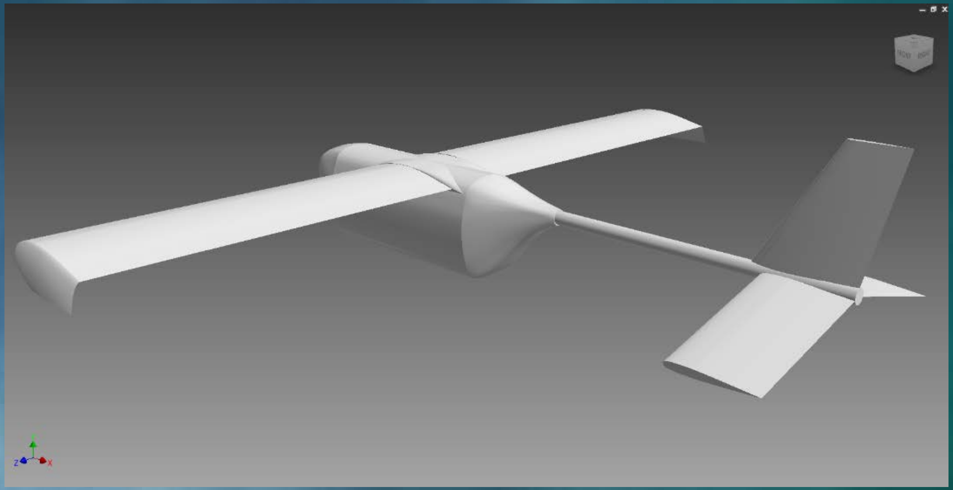
AGUAV:



- Prototype for Nano gimbal test (crosswinds)
- Heavy lift 8-10 pounds payload
- Large flaps for slow flight and short field ops



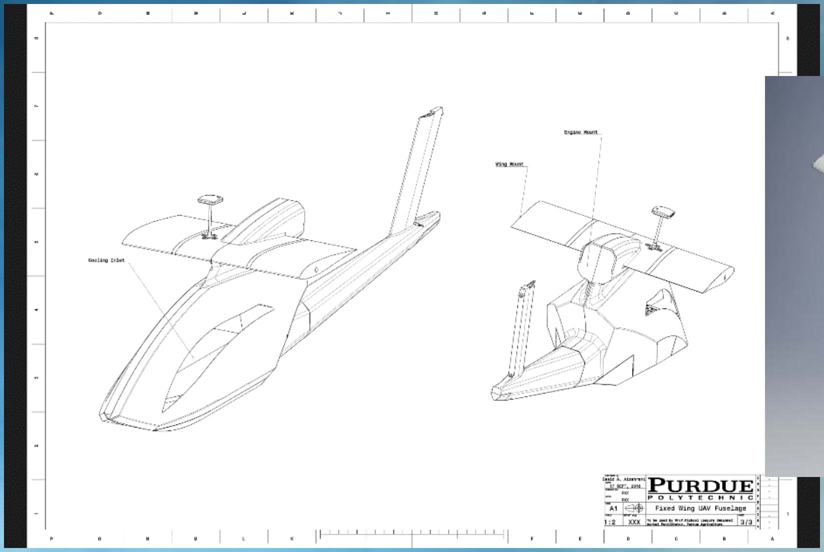
NEXGEN:

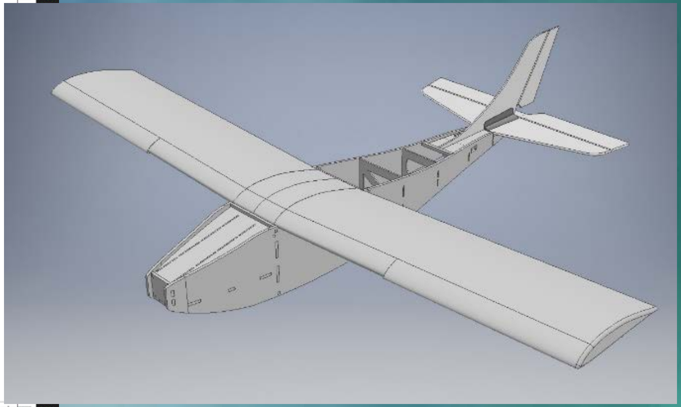


- ➢ Heavy lift
- ➢ Rough field ops
- ➢ CNC laser cut
- ➢ Design/build Purdue SATT
- ➢ Deployed Summer 2017 (LIDAR)

Grasshoppers:

- Small, light, easy to build and repair (5 ft. span)
- Inexpensive, ~ $900 ready to fly autonomous
- Designed to carry Micasense multispec, thermal
- Off-the-shelf wings and tail
- Flying Summer of 2017, Purdue SATT





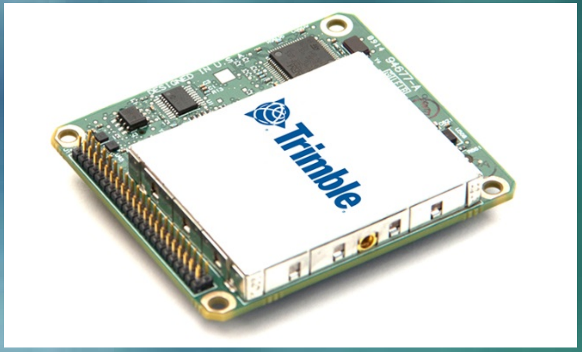
The payloads we fly and why:

Multispectral:

- Micasense RedEdge – 5 band multispec
- Small, light, easy to use with phone app

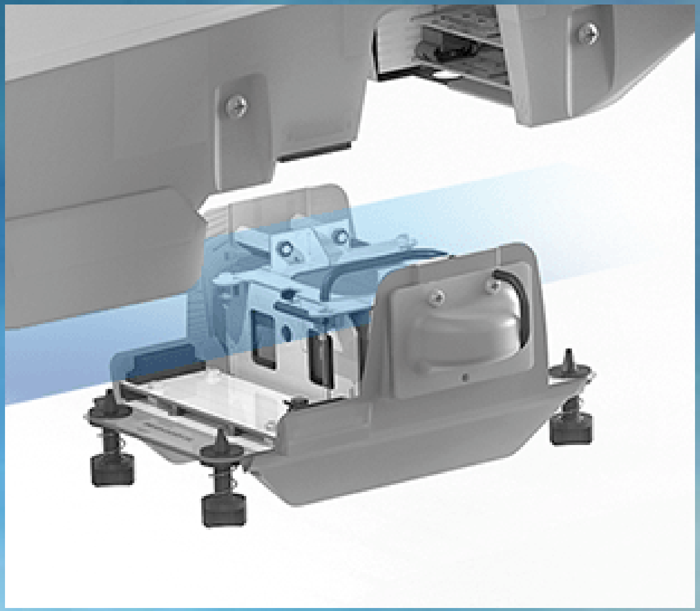
LIDAR:

- Velodyne VLP-16, Applanix AP-15 GNSS/IMU
- Crop growth rates, structure, and shape (3D)
- Data acquisition each week for growth models
- Affordable, high resolution, relatively light



Thermal Infrared (TIR, FLIR):

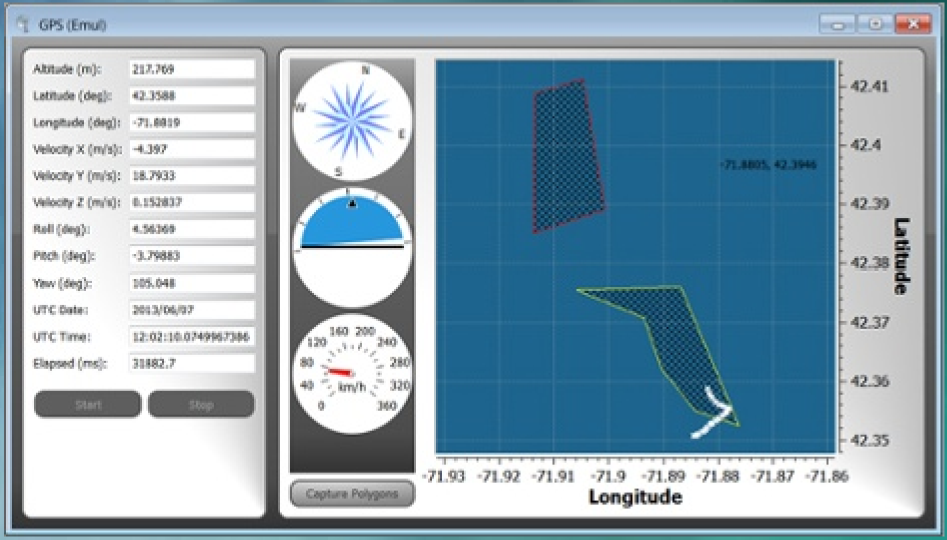
- Testing these for data comparison
- Heat stress, irrigation issues, livestock



Flir Vue PRO Thermal Imaging Camera

Hyperspectral:

- Headwall Nano – 270 spectral bands
- Comparing light signatures to crop phenomics
- Remote sensing of sugar content of Sorghum?
- “polygon” conserves data space onboard



Systems Summary:

ARPA-E 2016 Unmanned Aircraft Systems Fact Sheet

Telemaster- N16PU

- **Weight-** Approximately 15lbs with payload
- **Payload-** Headwall Nano Hyperspectral Camera, Applanix AP-15 GNSS/IMU
- **Power-** 8s (30v) Lithium Polymer Batteries, E-Flite (.90 size) brushless motor
- **Autopilot-** 3DRobotics Pixhawk (manual hand launch and landings due to varying conditions)
- **Flight Time-** 30min
- **Speed-** 10m/s cruise
- **Construction-** "Built up" balsa and lite-ply. Modified from popular model aircraft design. Added access to payload area from top, more powerful power system, wing tip plates… Modified for slow flight and weight lifting.
- **Aircraft Price (no sensors)-** Approximately $2000

DJI S1000- N636CU

- **Weight-** Approximately 18lbs (varying with payload)
- **Payload-** Velodyne VLP-16 (LiDar), Applanix AP-15 GNSS/IMU, Sony A7R (RGB) with Zeiss 35mm Lens
- **Power-** 6s (22.2v) Lithium Polymer Batteries, 8 DJI 4114 Brushless Electric Motors
- **Autopilot-** 3DRobotics Pixhawk (manual take off and auto landings)
- **Flight Time-** 15min with payload
- **Speed-** 0-10m/s
- **Construction-** Carbon fiber and aluminum. Pixhawk autopilot added to avoid waypoint restrictions with DJI's ground control software and autopilot firmware.
- **Aircraft Price (no sensors)-** Approximately $3000

NG-1 "Next Gen"- N660VP

- **Weight-** Approximately 20lbs (varying with payload)
- **Payload-** To be determined
- **Power-** 10s (37v) Lithium Polymer Batteries, AXI Brushless Electric Motor
- **Autopilot-** 3DRobotics Pixhawk (manual take off and landings due to varying conditions)
- **Flight Time-** 25min
- **Speed-** 14m/s cruise
- **Construction-** Plywood fuselage, hybrid carbon fiber tubular wing spar with basswood cap strips and shear webbing, balsa sheeted foam core. Carbon fiber aluminum infused tail-boom. Designed and built "in-house" to maximize payload carrying capability.
- **Aircraft Price (no sensors)-** Approximately $3000

3DRobotics Hexacopter

- **Payload-** MicaSense RedEdge, GoPro Hero 4, or similar
- **Power-** 4s (14.8v) Lithium Polymer
- **Autopilot-** 3DRobotics APM 2.5
- **Flight Time-** 12min
- **Speed-** 0-10m/s
- **Aircraft Price (no sensors)-** $1000

New 1000’ x 80’ Unmanned Runway, centrally located in ACRE plots:

Value Added:

- Retail cost of our current aircraft and sensor capability would have been (conservatively) $638,000.00
- We have expended (approx.) $106,500.00
- The majority of these savings are from designing and building our own aircraft, and integrating sensors utilizing Purdue, in-house expertise

QUESTIONS?