Unmanned Aerial Systems (Drones) for Ozarks Agriculture

by
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for
Christian County Livestock and Forage Conference
Clever, MO
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Farming looks mighty easy when your plow is a pencil and you’re a thousand miles from a corn field.

— Dwight Eisenhower
Agricultural Progress
What is agriculture to you?
Agricultural Challenges

• FAO predicts need to feed 9.6 billion people on planet Earth by 2050

• Food production must increase by 70% by 2050, in spite of:
  – Limited availability of arable lands
  – Increasing need for fresh water
    • Agriculture consumes 70% of the world’s fresh water supply
  – Impact of climate change affecting seasonal events in the life cycle of plants and animals

• Future of agriculture = smart farming
Economic Impact of UAS

• **Precision agriculture** and **public safety** are the most promising commercial and civil markets = 90% of the known potential markets for UAS

• Agriculture in U.S. anticipated to provide:
  – $65 billion of $82 billion UAS business from 2015-2025
  – 103,700+ new jobs (at least 34,000 jobs over $40K/year)
  – $13.6 billion in first 3 years
  – $1.56 billion in Missouri with 1,970+ jobs over 10 years

• Every year that integration is delayed, the U.S. loses over $10 billion in potential economic benefit = $27 million loss per day

Source: Association for Unmanned Vehicle Systems International (AUVSI)
UAS best suited for the Four D’s

- Dirty
- Dangerous
- Difficult
- Dull
Possible Jobs for UAS

- Agricultural monitoring (crops & animals)
- Weather monitoring
- **Disaster assessment** & management (tornadoes, floods, wildfires, earthquakes)
- Tower, bridge, rail and power line surveys
- Hazardous site evaluation (fire, chemical, nuclear, etc.)
- Law enforcement (locate lost people, threats, document site for evidence)
- **Environmental monitoring & research**
- Aerial imaging/mapping (real estate)
- Oil and gas exploration
- Telecommunications (news coverage, sporting events, moviemaking)
- Freight transport/package delivery
- Agri-tourism
- **Entertainment** (unique photography, remote dog walking 😊)
UAS, UAV, drone

Next High-Tech Tool for Agriculture and Beyond

Photo credit: http://modernfarmer.com/2014/01/precision-hawk/

Photo credit: http://hoosieragribusiness.wordpress.com/2014/09/22/are-drones-the-next-big-thing-in-ag/

Photo credit: http://nimbus.unl.edu/projects/crop-surveying-using-aerial-robots/
Most Common Uses by Farmers

• “Directed scouting” of animals and crops, which involves “ground-truthing” what you observe from air
  – Crop condition (growth, insects, diseases)
  – Cattle counts, rustler monitoring

[Photo credit: CBS News]
Crop Scouting

Assess stand establishment of crop
Crop Scouting
Crop Scouting

SPARC Plots at South Farm on August 28, 2014
Crop Scouting – Nitrogen Stress

Nitrogen Rate Study at Graves-Chapple Farm on August 27, 2013
Corn Yield in bu/acre

willot_yld_northplots_buff25ft_cln

YLD_VOL_DR
- 56.8 - 96.8
- 96.9 - 130.8
- 130.9 - 156.7
- 156.8 - 177.7
- 177.8 - 207.7

North View
Crop Scouting – Corn Hybrid Differences

Hundley-Whaley Farm on August 28, 2013
Crop Scouting – Autonomous Flight
Capture Images via Autonomous Flight
DJi Phantom Vision +

Mosaic of 77 images taken on August 14, 2015 – flying at 50 meters
Doing Stand Counts
Doing Stand Counts
Possibilities with Other Sensors

- **Thermal** (infrared)
  - Livestock detection, sick animals
  - Fires, farm safety
  - Water temperature, source identification
- **Multispectral**
  - Crop growth, plant identification
- **LiDAR** (Light Detection And Ranging)
  - Measuring plant height, 3-D terrain mapping

*Photo credit: www.lidarbasemaps.org/*
Utilizing a Thermal Camera

$10,229.00
Utilizing a Thermal Camera

Find lost people or accident victims night and day
Utilizing a Thermal Camera

See through smoke and guide water application for efficient attacks
Utilizing a Thermal Camera

Find invisible water damage in seconds
Crop Growth / Sensor Technology

from DJI Phantom 3 with Standard RGB Camera and Sentera Single NIR Sensor
Spray-Swath Overlaps?

Old N&S Dead-Furrows

Use of Multispectral Cameras
Slantrange – Multispectral Camera

1 Field, 3 Layers of Insight

- Vegetation Stress
- Relative Biomass
- Yield Potential
Lightning strikes
Using DJI Go App
Rural Property Evaluation
Rural Property Evaluation

Drone photo - March 24, 2014
Monitoring of Beef Cattle and Pastures

Work being conducted through Kansas State University

Color infrared photos can help ranchers manage invasive species. This picture of an Old World bluestem pasture was taken in the fall, after the grass browned down, but the image still showed the bluestem (light pink), annual broomweed (yellow) and invasive sericea (reddish areas). Photo courtesy of Kevin Price
The Yamaha RMAX crop sprayer (246cc gasoline twin) with an AUW of 207 lb. has an endurance of 60-90 minutes with a payload capacity of 66 lb. (equivalent to about 10 gallons of gasoline, which could be used for extending endurance)
23 cc two-cycle engine from a Yamaha weed whacker. A tank of mixed gas keeps the chopper flying for an hour.

The G15 weighs 15 pounds and is capable of carrying 15 lb. The carbon fiber rotors have a 71 inch span.

G15 AutoCopter - $50,000 to $75,000
The eBee has a flight time of up to 45 minutes allowing to cover areas of up to 2400 acres in a single flight. With its 16MP camera it can shoot aerial imagery at down to 3cm/pixel resolution.
Can I Fly a Drone Today?

• What are you using the drone for?
  – Recreation / Hobby
  – Business
<table>
<thead>
<tr>
<th><strong>Allowed</strong></th>
<th><strong>Not Allowed</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hobby or Recreation</td>
<td>Not Hobby or Recreation</td>
</tr>
<tr>
<td>Flying a model aircraft at the local model aircraft club.</td>
<td>Receiving money for demonstrating aerobatics with a model aircraft.</td>
</tr>
<tr>
<td>Taking photographs with a model aircraft for personal use.</td>
<td>A realtor using a model aircraft to photograph a property that he is trying to sell and using the photos in the property’s real estate listing. A person photographing a property or event and selling the photos to someone else.</td>
</tr>
<tr>
<td>Using a model aircraft to move a box from point to point without any kind of compensation.</td>
<td>Delivering packages to people for a fee.</td>
</tr>
<tr>
<td>Viewing a field to determine whether crops need water when they are grown for personal enjoyment.</td>
<td>Determining whether crops need to be watered that are grown as part of commercial farming operation.</td>
</tr>
</tbody>
</table>
Can I Fly a Drone?

• The aircraft is flown strictly for hobby or recreational use
• Fly below 400 feet and remain clear of surrounding obstacles
• Keep the aircraft within visual line of sight at all times
• Remain well clear of and do not interfere with manned aircraft operations

SEC. 336. SPECIAL RULE FOR MODEL AIRCRAFT – FAA Modernization and Reform Act of 2012

AC 91-57A - Model Aircraft Operating Standards - Including Change 1
Can I Fly a Drone?

- Don't fly within 5 miles of an airport unless you contact the airport and control tower before flying
- Don't fly near people or stadiums
- Don't fly an aircraft that weighs more than 55 lbs.
- Don't be careless or reckless with your unmanned aircraft – you could be fined for endangering people or other aircraft

SEC. 336. SPECIAL RULE FOR MODEL AIRCRAFT – FAA Modernization and Reform Act of 2012

AC 91-57A - Model Aircraft Operating Standards - Including Change 1
SUMMARY OF SMALL UNMANNED AIRCRAFT RULE (PART 107)

June 21, 2016
went into effect August 29, 2016
Operational Limitations

• Unmanned aircraft must weigh less than 55 lbs.

• Visual line-of-sight (VLOS) only;
  – The unmanned aircraft must remain within VLOS of the remote pilot in command and the person manipulating the flight controls of the small UAS
  – Alternatively, the unmanned aircraft must remain within VLOS of the visual observer
Operational Limitations (cont.)

• Small unmanned aircraft may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle.

• Daylight-only operations, or civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting (need FAA waiver for night operations).

• Must yield right of way to other aircraft.

• May use visual observer (VO) but not required.
Operational Limitations (cont.)

• First-person view camera cannot satisfy “see-and-avoid” requirement but can be used as long as requirement is satisfied in other ways

• Maximum ground speed of 100 MPH

• Maximum altitude of 400 feet above ground level (AGL) or, if higher than 400 feet AGL, remain within 400 feet of a structure

• Minimum weather visibility of 3 miles from control station
Operational Limitations (cont.)

- Operations in Class B, C, D and E airspace are allowed with the required ATC permission.

- Operations in Class G airspace are allowed without ATC permission.
Operational Limitations (cont.)

• No person may act as a remote pilot in command or VO for more than one unmanned aircraft operation at one time

• No operations from a moving aircraft

• No operations from a moving vehicle unless the operation is over a sparsely populated area (need FAA waiver)

• No careless or reckless operations

• No carriage of hazardous materials
Operational Limitations (cont.)

• Requires preflight inspection by the remote pilot in command

• A person may not operate a small unmanned aircraft if he or she knows or has reason to know of any physical or mental condition that would interfere with the safe operation of a small UAS

• External load operations are allowed if the object being carried by the unmanned aircraft is securely attached and does not adversely affect the flight characteristics or controllability of the aircraft
Remote Pilot in Command Certification and Responsibilities

• Establishes a remote pilot in command position

• A person operating a small UAS must either hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of a person who does hold a remote pilot certificate (remote pilot in command)
Remote Pilot in Command Certification and Responsibilities

• To qualify for a remote pilot certificate, a person must:

  – Demonstrate aeronautical knowledge by either:

    • Passing an initial aeronautical knowledge test at an FAA-approved knowledge testing center; or

    • Hold a Part 61 pilot certificate other than student pilot, complete a flight review within the previous 24 months, and complete a small UAS online training course provided by the FAA

  – Be vetted by the Transportation Security Administration

  – Be at least 16 years old
The wind direction and velocity at KJFK is from:

1. 180° magnetic at 4 knots
2. 180° true at 4 knots
3. 040° true at 18 knots
Remote Pilot Knowledge Test – What to Expect

<table>
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<tr>
<th>Airport</th>
<th>Code</th>
<th>Weather</th>
<th>Visibility</th>
<th>Temperature</th>
<th>Pressure</th>
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<tbody>
<tr>
<td>KINK</td>
<td>121845Z</td>
<td>11012G18KT</td>
<td>15SM SKC</td>
<td>25/17</td>
<td>A3000</td>
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<tr>
<td>KBOI</td>
<td>121854Z</td>
<td>13004KT</td>
<td>30SM SCT150</td>
<td>17/6</td>
<td>A3015</td>
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<tr>
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<td>1/2SM FG RO4/2200 OVC005</td>
<td>20/18</td>
<td>A3006</td>
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</table>

**Figure 12.**—Aviation Routine Weather Reports (METAR).

The wind direction and velocity at KJFK is from:

1. 180° magnetic at 4 knots
2. **180° true at 4 knots**
3. 040° true at 18 knots
Remote Pilot Knowledge Test – What to Expect

What is the floor of the Savannah Class C airspace at the shelf area (outer circle)?

1. 1,300 feet AGL
2. 1,300 feet MSL
3. 1,700 feet MSL
Remote Pilot Knowledge Test – What to Expect

What is the floor of the Savannah Class C airspace at the shelf area (outer circle)?

1. 1,300 feet AGL
2. 1,300 feet MSL
3. 1,700 feet MSL
**DID YOU KNOW?**

Unmanned aircraft must follow temporary flight restrictions around stadiums and racetracks.

Click here to learn more.

**DID YOU KNOW?**

Universities need permission from the FAA in order to use unmanned aircraft for research.

Click here to learn more.

**DID YOU KNOW?**

The FAA Modernization Reform Act of 2012 required the FAA to create rules for the use of unmanned aircraft in the U.S.

Click here to learn more.

**DID YOU KNOW?**

Operators must keep unmanned aircraft in their sight.

Click here to learn more.

knowbeforeyoufly.org
As of December 21, 2015, FAA requires drone registration
https://registermyuas.faa.gov/

Federal law requires owners to pay $5 to register their aircraft.
Do you need to register your drone?

You need to register your aircraft if it weighs between 0.55 lbs. (250 grams) and up to 55 lbs. (25 kg).

You will be subject to civil and criminal penalties if you meet the criteria to register a drone and do not register.

If you purchase your UAS after Dec. 21, 2015, you must register before you operate it outdoors.

Exception: Special Rule for Model Aircraft (P.L. 112-95, Section 336)
Certificate of Registration – Business Use

Small UAS Certificate of Registration

Name: University of Missouri Extension
Manufacturer: DJI
Model: Phantom 3 Professional
Serial Number: P77DCL18B26813
Certificate Number: FA34KPCRY9
Issued: 10/13/2016 Expires: 10/13/2019

For U.S. citizens, permanent residents, this document constitutes a Certificate of Registration. Document represents a recognition of the registration of a Small UAS.

For all holders, for all operations of a Small UAS, as defined in 14 CFR 101.1, additional safety training or certification from DOT may be required.

This Small UAS Certificate of Registration is valid for flight operations with an unmanned aircraft system in accordance with the applicable Federal Aviation Administration (FAA) regulations. You are responsible for knowing and understanding the FAA regulations. For more information on flying for non-recreational purposes, visit www.faa.gov/uas.
Final Thoughts

• There is information in your pastures and fields that remote sensing can help you extract and use
• Other forms of remote sensing (airplane, satellite) are expensive and frustrating
• UAS puts the control in your hands either directly or through your adviser
• Are you prepared to make use of all the additional data?
A 10:1 return on investment of taxpayer funds
Questions??

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Program Complaint Information
To file a program complaint you may contact any of the following:

University of Missouri
- MU Extension AA/EEO Office
  109 F. Whitten Hall, Columbia, MO 65211
- MU Human Resources Office
  130 Heinkel Bldg, Columbia, MO 65211

USDA
- Office of Civil Rights, Director
  Room 326-W, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-9410

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