Unmanned Aerial Systems for Agriculture

by
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Agricultural Challenges

• FAO predicts need to feed 9.6 billion people on planet 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 plant and animals
• Future of agriculture = smart farming
• Agriculture expected to be one of largest users of UAS

Issues

• Who can and cannot fly UAS?
• Privacy concerns
• What can I do with UAS?
• Will the regulations hinder growth of UAS use?

The National Airspace - Classes

Airspace Classification

MSL = Mean Sea Level
AGL = Above Ground Level

Class G (uncontrolled) airspace is mostly used for a small layer of airspace near the ground, but there are larger areas of Class G airspace in remote regions.

Can I Fly an UAV? – Yes, No, Maybe

>500 Feet = Navigable Airspace

<500 Feet = Non-Navigable Airspace

Property Rights?
Can I Fly an UAV? – Yes, No, Maybe

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

- The aircraft is flown strictly for hobby or recreational use;
- The aircraft is operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization;
- The aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization;

Further Interpretations – June 25, 2014

<table>
<thead>
<tr>
<th>Allowed</th>
<th>Not Allowed</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.</td>
</tr>
<tr>
<td>Using a model aircraft to move a box from point to point without any kind of compensation.</td>
<td>A person photographing a property or event and selling the photos to someone else.</td>
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<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>
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FAA Draft Regulations

- “Operator” must be 17 years of age or older; pilot’s license not required
- Pass an FAA-approved aeronautical knowledge test and retest every 2 years
- Obtain an unmanned aircraft operator certificate with a small UAS rating
- Obtain an FAA Class II airmen medical certificate (need 20/20 vision)
- Be vetted by the Transportation Security Agency (TSA)
- Daytime use only
- Maintain visual line of sight without aids (except corrective lenses)

FAA Draft Regulations

- Not operate over any person who is not part of the mission
- Maximum UAS weight of 55 pounds
- Maximum airspeed of 100 MPH
- Maximum altitude of 500 feet above ground level
- Minimum weather visibility of 3 miles
- Yield right-of-way to other manned and unmanned aircraft
- Contact air traffic control or airport operator when flying within 5 miles of an airport
Can I Fly an UAV? – Yes, No, Maybe

- Nationwide Community-Based Organization

Academy of Model Aeronautics National Model Aircraft Safety Code

Privacy Concerns

- Laws already control taking picture and videos of people, especially in areas where they have reasonable expectation of privacy
- People and what they are doing are clearly visible
- “Sight” crosses your property boundaries
- New laws are likely

The view from UAS

UAS best suited for the Four D’s

- Dirty
- Dangerous
- Difficult
- Dull

How Does a UAS Work?

- More than a flying device
- UAS gives you a unique perspective that is “easy”, fast, and not hindered by roads, fences, crops, and other barriers to movement
  - Navigate by GPS, auto-return to home hover
- Sensor: normal digital videos and photos
  - Controllable with joysticks, vision goggles or smartphone
Possible Jobs for UAS

- Crop and animal monitoring
- Environmental research
- Disaster assessment
  - Tornadoes, floods, wildfires, earthquakes, etc.
  - Emergency response
- Tower, bridge and power line inspection
- Hazardous site (chemical, nuclear, etc.) evaluation
- Archeology - locating dig sites
- Agri-tourism
- Package delivery
- Entertainment - unique photography, remote dog walking

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
Aeriality
Simple Tools for Aerial Imagery

Aeriality Video Pushbroom
Creates constant perspective images from aerial videos

http://www.aeriality.io/

Crop Scouting – Nitrogen Stress

Nitrogen Plots at FSRC on October 11, 2013

Crop Scouting – Nitrogen Stress

Nitrogen Rate Study at Graves-Chapple Farm on August 27, 2013

Corn - Cover Crop Plots - Image Captured on June 23, 2014

Corn - Cover Crop Plots - Image Captured on July 1, 2014

North View

South View

North View
Moving Ground-Based Sensor to UAVs

Crop Scouting – Corn Hybrid Differences

170 acres. 15cm ground resolution. About 20 minutes flying – Fixed Wing

Photo from a DJI Phantom 1 with Go Pro 3 camera. Corn field on July 15, 2014 in Cooper County
Possibilities with Other Sensors

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

Monitoring of Beef Cattle and Pastures

Lightning strikes

Unmanned Sprayer

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).
SenseFly – eBee - $12,000

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.

Trimble® UX5 Aerial Imaging Solution

LA100 - Lehmann Aviation - $990
http://www.lehmannaviation.com/

3 feet - wingspan
1.9 pounds - weight

Flight time only 5 minutes

Cost: $50,000

6.6 feet - wingspan
14 pounds – weight
payload of 4.4 lbs – 30 min of flight time
payload of 0.9 lbs – 120 min of flight time

Volt Aerial Robotics
http://www.voltaerialrobotics.com/
Chesterfield, MO

Cost: $10,770

6.6 feet - footprint
4.4 pounds – max takeoff weight
payload of 1.1 lbs – 18 min of flight time
payload of 0.22 lbs – 25 min of flight time

Volt Aerial Robotics
http://www.voltaerialrobotics.com/
Chesterfield, MO

Cost for Kit: $7,500

Scout
http://www.precisiondrone.com/
Noblesville, Indiana
Cost for Kit: $17,500

Noblesville, Indiana

http://www.precisiondrone.com/

Cost: $3,698 without camera

AG Pro Scout Kit by Aerial Media Pros

http://aerialmediapros.com/

Costa Mesa, CA

Cost for Kit: $900

http://www.bladehelis.com/350QX2AP/

14 inch - footprint
2.2 pounds – max takeoff weight
10 min of flight time with just a GoPro Hero 3 camera

Cost (Begin at): $479

http://www.dji.com/product/phantom/

Total Kit (Begin at): $1,200

Cost (Begin at): $679

With Zenmuse H3-3D gimbal: $959


Cost (Begin at): $679

Total Kit (Begin at): $2,100 + camera

FAA Exemptions for UAS = 14
as of Jan. 9, 2015

- TV and movie making (7),
- Construction site monitoring (1)
- Precision aerial surveys (3)
- Flare stack inspections on 14 Shell Oil Gulf of Mexico production platforms (1)
- Aerial video to augment real-estate listings (1)
- Photogrammetry and crop surveying for precision agriculture (1)

FAA Regulations on UAS

- Began process about 6 years ago
- Rules due by 9/30/2015
- Posted to Federal Register on 2/23/2015
- Public comments due by 4/24/2015 11:59 p.m. ET
- Final rule expected 90-120 days after public comment period
- FAA regulations delay currently costing the U.S. $10 billion/year in potential economic benefit

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

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 AM/EM Office
  109 F. Whitten Hall, Columbia, MO 65211
- MU Human Resources Office
  130 Henkel Bldg, Columbia, MO 65211

USDA
- Office of Civil Rights, Director
  Room 326-W, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-0400

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