Development and Testing of an Unmanned Aircraft Safety Beacon for Aerial Application Safety

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Overview

* Unmanned Aircraft
  * Emerging technology
  * Disruptive innovation
* Example Agricultural Applications
  * Crop scouting
  * Irrigation management
  * Livestock stress detection
  * Drainage systems

Acknowledgments:  Nebraska Aviation Trades Association
University of Nebraska - Extension
Motivation

- Unmanned aircraft are legal for commercial flight
- Agriculture projected to be 70% of UAS market
- New sUAS rules were finalized on August 29, 2016
- Aerial view offers a strategic advantage

- Over the next 10 years, worldwide UAS production will rise from $4 billion annually to $14 billion annually.¹

Types of (small) unmanned aircraft

Fixed wing
Types of (small) unmanned aircraft

Multi-rotor
Airframe

Tempest by UASUSA
- 11 foot wingspan
- 10 to 15 pound payload
- 40 mph cruise
- 1.5 hour flight duration

2.3 horsepower motor
Elevator
Flaps
Rudder
Ailerons
Ground Station and Autopilot

- 3 axis IMU
- GPS with WAAS
- Static pressure
- Indicated Air Speed

Blackswift Technologies
- Altitude (msl)
- In-flight limits
- Orbiting capable
- Dynamic waypoints
The Aircraft / Sensors

* FLIR Tau 2 thermal sensor
* Mica-sense multi-spectral
* 3-D printed sensor mount

- Early detection
- Crop stress
- Pest management

* Mention of any product or trade name does not constitute endorsement
Overview of UAS Flight Operations

- Define the mission
- Purpose, Area, Strategy, Preflight

Diagram showing a UAS with a range of 180 feet, a climb to 390 feet agl, and a boundary of 180 feet.
Onboard Mission Sensor -> Image

Mosaic to field level NDVI

8 cm resolution

22 GB per 160 acres
Unmanned Aircraft: Regulatory

- Recreation/Hobby
  - Non-commercial
  - Registration is required
  - Community standards (AMA)
- Commercial / Civil
  - Part 107
  - Remote Pilot with small UAS rating
- Public Aircraft Statues
  - Certificate of Authorization
Agriculture projected to be 70% of UAS market
  * If true - there will be a large number of UAS deployed across the agricultural landscape
  * Operating in low altitude airspace
* Aerial application industry
  * High velocity / high value aircraft
  * With human(s) on board!
* Operating in the same airspace
Background

* Need to understand more about the risk of collision between low flying aircraft and UAS!
* But UAS have been illegal to fly
  * Lack of data to understand risk
* Use collisions with birds as analog
  * Based on report for period 1990 to 2014

Need to understand more about the risk of collision between aircraft and UAS!

- 11 bird strikes resulting in 25 fatalities
- 198 bird strikes resulting in 353 injuries
- 23,000 bird strikes with reported damage
- 72% of bird strikes occur below 122 m.
- $193 million dollars in damage per year
- $163,883 per bird strike
Background

* Need to understand more about the risk of collision between low flying aircraft and UAS!

* General agreement (*NAAA):
  * Collision with an unmanned aircraft system will be **worse** than collision with a bird

* Carbon fiber, LiPo batteries, and metal parts

* Up to 25 kg!

Federal Aviation Regulations

* Aircraft separation

* 91.111 - prohibits operation so close to another aircraft so as to create a collision hazard

* 91.113 – lays out structure of right-of-way priorities in the air

* 91.113(b) – vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft

* paraphrased
Visibility of Unmanned Aircraft


“The results of the test show that UAS are indeed difficult to see. What I heard from a majority of the pilots was that we knew UAVs would be difficult to see, but it turns out they’re more difficult to see than we thought. It’s clear that it will take a cultural change on both our parts [ag aviators and UAS operators] if we’re going to work cooperatively in the airspace... operating line-of-sight isn’t enough to mitigate safety issues.” [Sam Rogge, CoAAA Board President]
Need a Safety Solution

- Deploy at ground control station
- Place beacon on top of field operations vehicle

Whelen M-9
Red
White
Green
Safety Beacon

- Extremely bright
- Strobe provide directional cues
- Beacon elevated on vehicle or tripod for visibility
- Relatively low cost for commercial operators
- Easy to set up and store
- Or permanent mount
Safety Beacon
Flight Test

- Methodology
  - Five flights
  - Cessna 172 at 120 kts
  - Pilot and student volunteer
  - Both with tablet computers
Flight Test
Flight Test

Tap tablet upon visual acquisition of beacon
Safety Beacon: Performance

Minimum = 0.45 mile
Average = 1.4 miles
Maximum = 3.1 miles
Summary

* Established motivation for safety beacon
* Introduced NU-AIRE Safety Beacon
* Initial flight test results look promising
* Part of a “layered” approach to safety
  * TBYL, mapping, aircraft, electronic, etc.
* Unmanned Aircraft Systems in Agriculture
  * www.learnUASag.org

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Thoughts? Ideas? Questions?

University of Nebraska-Lincoln
Nebraska Unmanned Aircraft Integration Research and Education

NU-AIRE

- Unmanned Aircraft Systems in Agriculture
- Precision Agriculture - Big Data
- Natural Resources Management
  - Improved water and irrigation management
  - Early detection of crop and livestock stress
  - Real time data and information
  - Improved crop scouting
  - Soil moisture
  - Better weed detection
  - Range management
  - Better livestock management

- Sustainability of food, fuel, water, landscapes and people

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Thank you!