SMALL UNMANNED AERIAL SYSTEMS (SUAS) IN EMERGENCY MANAGEMENT

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SUAS OR DRONE OR UAV

1) Small Unmanned Aerial System

2) Less than 55 pounds

3) An unmanned aerial vehicle (UAV), commonly known as a drone, unmanned aircraft system (UAS), or by several other names, is an aircraft without a human pilot aboard.
WHAT CAN A DRONE/ SUAS DO?

a) Think of it as a tool that can allow you to do different things.
b) What you want to accomplish affects the cost, and user interface of the unmanned system.
c) Technology changes (monthly) more things become possible.
d) Let's explore just a few tools a drone can give you today.
WHAT CAN THEY BRING TO THE TABLE?

• For Emergency Managers it brings a combination of benefits:
  • Increased Situational Awareness
  • Safety
  • Cost
  • Efficiency
The increased situational awareness allows for better decisions to be made earlier in the process.
NATURAL DISASTERS
a) Best access to the site
b) Areas most impacted
c) Direct your resources
d) Reach areas with no access
NATURAL DISASTERS
• Reduce the need for people to enter dangerous areas.
• Less expensive than other traditional aerial assets.
EFFICIENCY

• Reach the sight instantly
• Real time video and pictures that can be shared with other first responders.
• Get everyone the information to make decisions.
• Find the problem fast. No need to wait for aerial support.
How many contract aerial or satellite photography for assessment or in a catastrophe?
If you intend to do the work yourself with a UAS you are now a pilot, image processor, imaging scientist, data manager, and lawyer.
The type of UAS chosen will be based on mission requirements and rely heavily on payload and area coverage.
A sensors equipped UAV constitute a UAS: Unmanned Airborne System. Multi rotor are defined often by rotor configuration and number of motors.
Sensors should be mounted on a vibration stabilized gimbal mount to insure high quality data capture.
Imaging

Define the deliverable is the first step

Defining what is to be captured?

Does the end product require sensor fusion?

Is it a simple image or an extended data set?

Is it visualization or authoritative?
Imaging Metrics

- Spatial and Spectral metrics define what can be resolved by a sensor given understating of the device, imaging conditions, and the target.
Sensors can see details when specified accurately. Focal length, field of view all work in conjunction with the operations envelope.
Multiple Aspects of Making the Correct Data Set (Pun intended)

- Orthophoto, Oblique, 3D, Elevation, Planimetrics, Other?
- Authoritative or Visualization
- We will not be doing the math today…
Spatial Metrics define the resolution "possible" from a UAS

Understand Capture metrics
H  = Height
GSD= Ground Sample Distance
F  = Focal Length
P  = Pixel = Picture element

This is meant to be here....

A white target

On a white background doesn’t work
Despite the resolution

Modulation transfer function = MTF
Resolution on Targets depend on Background as well
Sensors can see details when specified accurately. Focal length, field of view all work in conjunction with the operations envelope.
Sample Resolution versus Area

UAS can be a fraction of an inch Ground Sample Distance (GSD) in a comparatively small coverage footprint.
Steps to measure Similar Triangles

- To find any unknown: Have 3 of FL H or GSD.
- Calculate the unknown using similar triangles.
- Key is to divide common units.
- Sample focal length of the lens: 12mm.
- Sample pixel size for the camera is 8 microns.
- A micron is 1000th of a mm so to keep common units 0.008mm should be used.
Spectral Metrics in UAS Data capture

Defines the understanding of imaging in terms of the electromagnetic spectrum.
Sensors can see more than the eye and classify different materials in an automated fashion.
The Spectral Bands

Approximate bandpass

Blue, 450-520 nm, is used for atmosphere and deep water imaging, and can reach depths up to 150 feet (50 m) in clear water.

Green, 520-600 nm, is used for imaging vegetation and deep water structures, up to 90 feet (30 m) in clear water.

Red, 600-700 nm, is used for imaging man-made objects, in water up to 30 feet (9 m) deep, soil, and vegetation.

Near infrared, 750-900 nm, red edge for reflected chlorophyll imaging vegetation.

SWIR 1550-2350 nm, is used for imaging vegetation, soil moisture content, and some forest fires.

MWIR 3-5 microns half emitted half reflected IR cross between solar and target radiated data.

Thermal infrared, 8-12 microns, uses emitted instead of reflected radiation thermal characterization.
Common Spectral Bands Groupings

Pan Chromatic an aggregation of all bands seen by the sensor into a single wide band shown often as B&W image

RGB Red-Green-Blue or True-color uses only red, green, and blue channels, mapped to same colors. As a Standard color image, traditional imaging

Green-red-infrared, where the blue channel has a yellow filter applied and no IR blocking to permit capture as NIR. is used for vegetation, which is highly reflective in near IR, NDVI is used to show the infrared to red green ratio
Your Phone is a great indicator of the drone’s technology
• Inertial
• Compass
• GPS
• Camera
• Transmit Receive
• Display
• Firmware/OS/Apps
• CPU
• Storage
• …
In most cases the success of a drone mission will only be as good as the images or data you can show.
Many terms have their roots in traditional imaging:

- ISO
- S
- P
- AE
- M
- EV
- A
Many terms have their roots in traditional imaging

- ISO: American Standards Association, but now ISO, Int’l Org for Standardization
- Gain: More isn’t always better based on signal to noise
- S: Shutter speed, 1/x seconds, key to the degree of blur
- P: Program, often lets system pick what’s best mix of gain, shutter & aperture
- AE: Auto Expose lock keeps the settings fixed versus floating for best exposure
- M: Manual aka the operator knows what’s best, example shadowed or high glare
- EV: Exposure Value represents a combination of shutter speed and aperture that give the same exposure have the same result.
- A good tool is EV Bias in which you can set a trend or bracket exposures automatically
- A: Aperture is the opening in the lens that lets in the light
  - The f-stop or F/N indicates degree of aperture opening
  - F-stop is the focal length divided by the diameter of the lens
  - Depth of field and in some cases distortion
SCENARIOS FOR SUAS

Missing Persons
Natural Disasters
Man-made Disasters
Support for Fire and Police
Accident Reconstruction
Aerial Documentation and Surveying
Reach difficult areas
HOW TO INTEGRATE DRONES INTO EMERGENCY MANAGEMENT?

Using Geotagged images
Using Live video feeds
Search Patterns

Then

Processing data
Data storage and access
Policy and Procedures
SUAS WORK FLOW

First Responder
Drone Pilot
Incident Commander (Increased Situational Awareness to make better decisions)
CHALLENGES

Technical
- Dual Cameras (Zoom/Thermal)
- Battery Life
- Weather (Wind/Rain)
- Streaming/sharing data

Other
- Knowing how to best use the drone
- Getting everyone on board
- Keeping a positive public view on its use
TRAINING AND WHAT ARE THE RULES FOR FLYING?

COA’s vs Part 107
PUBLIC COA

Positives
  More flexibility in your operation
  Easier to get permission to fly in large controlled airspace (Kansas City class B)
  Self train your pilots

Negatives
  Monthly Reports
  Takes more time and paperwork to complete (90-120 days)
  Aircraft specific
September 2016, Part 107 - Rules for Commercial use of sUAS
PART 107

Remote Pilot Certificate allows you to operate sUAS commercially.

• Positives
  • Easy to obtain
  • Not specific to your department.
  • Easier to obtain insurance
  • Standardized training
  • Part 107 was designed to be flexible

• Negatives
  • Need authorization to fly in controlled airspace (2 – 4 weeks)
  • Need waiver for night flying (30 – 90 days)
HOW ABOUT FLIGHT TRAINING?

• None required
• Knowledge of the equipment and systems
  • Batteries
  • Cold/Hot weather flying
  • Limitations
• Easy to fly
WHICH DIRECTION IS SUAS MOVING?

- New technology
  - Drones designed for specific needs
  - Software to make your job easy
- New Rules
  - Less strict
- Lots of learning
  - Changing every day
- Many benefits
RECENT SUAS EVENTS
US military bases have been given permission to shoot down drones when appropriate.
a) April 2017 It became illegal to fly personal drones within 400ft (122m) of the US's 133 military facilities

b) August 2, 2017; Army Air Directorate's Deputy Chief of Staff Lt. General Joseph Anderson issued an Office Memorandum ordering the following:
1) Cease all use of DJI Drones on Army Installations
2) Uninstall all DJI applications
3) Remove all batteries/storage media from devices
4) Secure equipment for follow-on direction
5) The Pentagon has given US military bases permission to shoot down or otherwise destroy consumer drones flying overhead and nearby Military Bases
CURRENT PROJECTS
Marion County Kansas Emergency Management Agency (MN EMA) in partnership with the Property Drone Consortium (PDC) are working jointly with the Department of Homeland Security (DHS) on a Cooperative Research and Development Agreement (CRADA).

The Federal CRADA Partners will collaborate with PDC to leverage knowledge, assets and other resources toward joint conduct of research with the goal of advancing small unmanned aerial systems (sUAS) education for public safety. The evaluation will focus on beginning use of sUAS to support public safety missions, testing, evaluation and training.

The end result will be the development of a document that directs, educates and instructs the private sector on how to safely interact and work with public safety efforts for the benefit of all parties.
TARGET AUDIENCE

• Federal, State and Local Emergency Services in conjunction with private organizations and non-government organizations (NGOs) who respond to natural or manmade disasters within the United States or America and its Territories.
1. Working with the Federal Aviation Administration (FAA) using Small Unmanned Aircraft Systems (sUAS).
2. Fulfilling all laws and rules of the FAA.
3. Identify a structure that will be used for sUAS during a declared disaster which will ensure safety of manned aircraft, sUAS, hobbyist and the general public.
4. Provide structure for all aircraft to deploy while not limiting lifesaving and emergency response aircraft.
5. Provide an avenue for emergency responders to locate missing persons both during the day and at night.
6. Identifying the areas of disaster damage so that responders can focus their efforts.
7. Integrate the sUAS as a part of a Standard Operating Guidelines (SOG).
8. Identify types of training for sUAS pilots for disaster response.
9. Identify types and quantity of equipment needed for response.
CONCLUSIONS

• It is clear that the role of SUAS and the growing need in the emergency services sector with respects to future enhancements of technology in the near future will increase substantially. Technological challenges that will need to be overcome are longer flight times and the ability to sustain higher wind speeds.

• During the Full Scale Exercise we will be able to identify strengths and challenges in responding to a disaster while using sUAS.

• These aircraft are quickly becoming the symbol of disaster response as they are used for identifying areas of debris removal and locate survivors in the disaster area. The access to the images from the sUAS will assist response leadership teams with a more accurate situational awareness and which will uphold the Disaster Response Plan.
QUESTIONS?