Drones in Earth Science ESIP Cluster:

Introductions

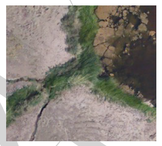
In response to apparent growing interest in the use of drones or unmanned aerial systems (UAS) in the earth sciences, a ESIP cluster focused on their use was formed this year. While there are currently various challenges around using UAS the existing and anticipated advantages mean that firstly the domain is swelling with innovation, and secondly that UASs are expected to become a standard piece of field equipment for scientists.

As a new cluster we are welcoming participants and input as to how we can best operate within ESIP.

UAS advantages over traditional approaches:

- Content on demand/currency of data
- Cost savings (10% of traditional methods)
- High resolutions possible (2.5cm)
- Turn around time (hours not months or years)
- Improved Safety
- Lowered impact on the environment being monitored
- All of the above mean an increased ease of observation repeatability

UAS at 400ft (5cm)



UAS at 200ft (2.5cm)

Challenges

- Steep learning curve
- Need for more reduced weight instrumentation
- Need for new data management and processing techniques (particularly open source options)
- Regulation (in the USA)

Landsat8 (30m)

NAIP 2010 (1m)

Images and Diagram from the USGS Unmanned Aircraft Systems National Project Office October 2014 presentation http://rmgsc.cr.usgs.gov/UAS/publications.shtml

System examples

Fixed-wing:

- Flight time 1 - 2hrs+ (10hrs at the extreme)
- Heavier payloads (up to around 10kg)
- Much harder to operate
- Cannot hover

Multi-rotors (3-8+ props):

- Flight times 20-30m
- Typically smaller payloads (1- 5kg)
- Relatively easy to operate utilising autopilots for stability
- Capable of vertical profiling and more wind resistant

NASA images.

Left: The remote sensing and gas sampling SIERRA fixed wing.

Right: Cliff face image analysis using a hexacopter

Examples:

As a very limited set of example:

- Wildlife population monitoring
- Volcanic plume monitoring
- Invasive plant species monitoring
- Fence monitoring for wildlife control
- Environmental impact of industry monitoring
- Pleistocene trackway mapping
- Comparative erosion mapping
- Pollutant spread and migration monitoring
- Tree modelling
- Environmental disaster damage assessment
- Willife migration tracking and population monitoring
- Real-time hurrican development monitoring

Aerostats provide a cheaper avenue

Data product examples

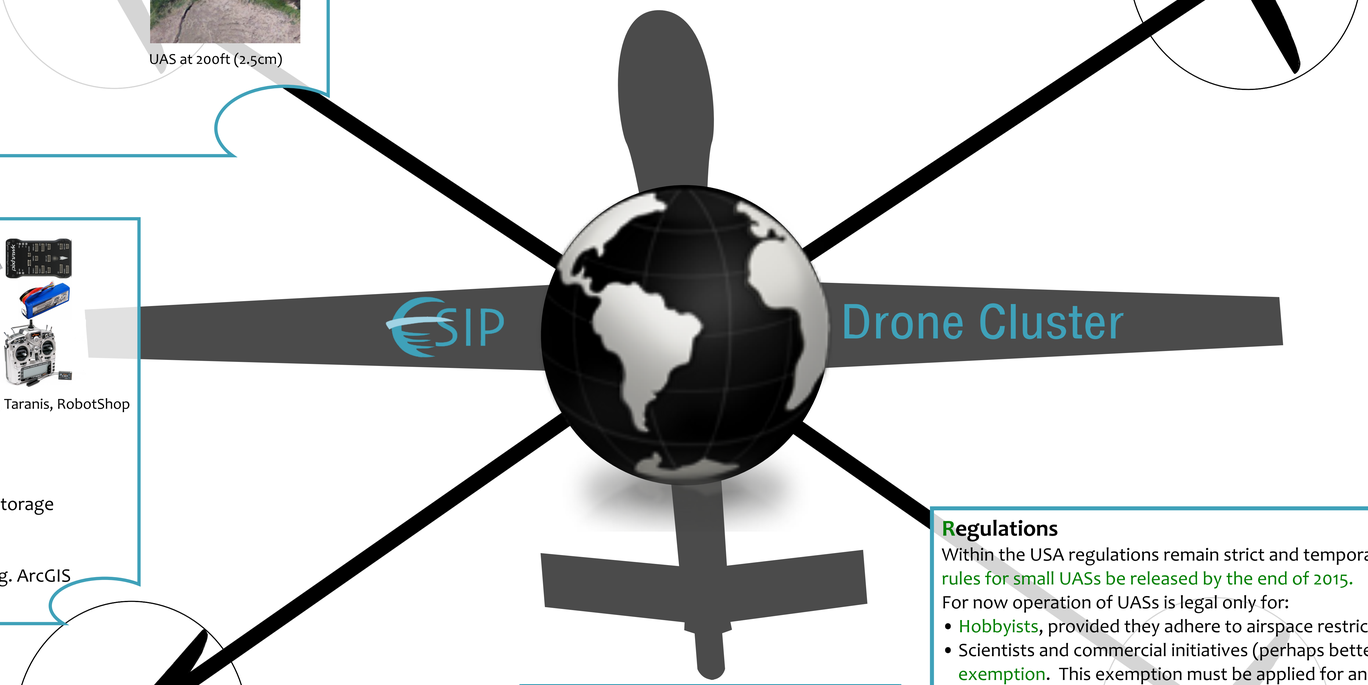
- Colour Infrared - NDVI and other vegetative index extraction
- GIS: Contour maps, digital terrain models, digital surface model
- Feature detection
- KML-3D modelling
- Orthophotography
- Volumetric Measurement
- Mass spectrometer
- Close range Photogrammetry
- TDLAS gas sampling
- LiDAR equivalent 3D Point Clouds (added ability to see underneath some features)

Basic system components required:

- Transmitter
- Autopilot
- Batteries
- Battery charger
- AIrFrame
- Motors/servers and controllers
- Receiver
- Transmitter
- GPS and other telemetry sensors and transmitter
- Ground station:
  - -- FPV gear, receivers (for telemetry), data processing and storage
- Sensor
- Post processing and data transport:
  - -- Harddrives, 3G, cloud services, servers, web streaming (e.g. ArcGIS online), processing software pipelines

Components from: 3DR, Taranis, RobotShop

NOAA whale tracking hexacopter



DIY Electrohub from FliteTest

Regulations

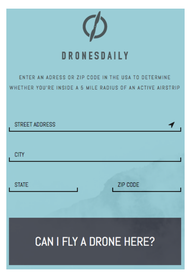
Within the USA regulations remain strict and temporary for now, but congress has required that a full set of finalised rules for small UASs be released by the end of 2015.

For now operation of UASs is legal only for:

- Hobbyists, provided they adhere to airspace restrictions and safety law, and provided they do not violate state privacy laws.
- Scientists and commercial initiatives (perhaps better understood as any "professional" activity) with a FAA Section 333 exemption. This exemption must be applied for and comes with the following restrictions:
  - A licensed pilot must be on site
  - Flights are limited to line of sight (1-2mi, daylight)
  - State privacy laws
  - Is only valid for the specific area, time period, and vehicle applied for.
  - Is very difficult to obtain for populated areas.
  - May entail ITAR issues if overseas operation is involved

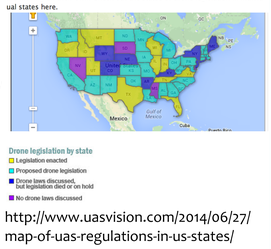
6 test sites have been established, some of which are at universities. These may be of assistance in carrying out UAS activities.

- University of Alaska
- State of Nevada
- New York Griffiss International Airport
- North Dakota Department of Commerce
- Texas A&M University- Corpus Christi
- Virginia Polytechnic Institute and State University (Virginia Tech)



http://www.caniflyadrone.com/

Interactive Map of UAS Regulations in US States



http://www.uasvision.com/2014/06/27/map-of-uas-regulations-in-us-states/

Contacts

As mentioned this cluster is very new and seeking input on what is desired by the ESIP community. Curent goal ides include - providing a collective source of knowledge and experience, collaboratively taking on specific challenges, organising relevant speakers...

Please feel free to get in contact, join our mailing list, and visit our wiki.

- MailingList: esip-drone@lists.esipfed.org
- Wiki: http://wiki.esipfed.org/index.php/Drone_Cluster
- Other:
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NASA Volcanic plume monitoring

Founders: JPL Data Systems and Technology Group, University of Vermont Rubenstein School of Environment and Natural Resources