APPLICATIONS OF UAS TO LAND AND RESOURCE MANAGEMENT

workshop group discussion notes

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for

Argonne NATIONAL LABORATORY

16,17 July 2014

BUILDING A UAV FLEET

In the Beginning…

When we first explored unmanned aircraft for reconnaissance applications in the mid-1980's, we located and experienced R/C pilot, ductaped* a battery-powered 35 mm camera with a built-in timer to a make-shift stryrofoam pod beneath its wing and launched it into the air by hand. Guiding the operator were 4 ground-crewpersons stationed at corners of the target zone (land-fills, gas pipelines) holding walkie-talkies and serving as smart-waypoints ("*go left, a bit right, you're heading right at me, now execute a standard-rate right turn, passing control to #3…*"

This worked, and provided aerial photography that helped greatly with site analysis and planning. 30 years later, the technology is a bit more sophisticated…

NEW OPTIONS

During the 2010's, new materials, miniature autopilots, and better communications all provide some attractive options.

* Surplused (or new) military sUAS's (still $$, near-zero sources)
* Specialized commmercial sUAS's ($, few sources)
* R/C hobby components for purpose-building your own sUAS (¢,plentiful).

But each of these has its advantages and disadvantages.

PROS VS. CONS

* Military sUAVs were proven systems, they were very difficult to obtain, aged, lacking in offerings for upgrade and were clearly designed for a different role.
* Commercial systems advertised the same rugged [carbon fiber and fiberglass] materials as mil-drones, but lacked support and were unproven in populated areas.
* The R/C hobby industry had fallen in love with EPO foam aircraft, in no small way because of the inherent safety provided by the ‘soft’ materials. But the components were not validated for reliability and use near vulnerable (populated) areas.

MILITARY GRADE UAS BEYOND BUDGET OF MOST ORGANIZATIONS…

… BUT *EARLIER* MILITARY UAVS FOLLOWED A MORE DUPLICABLE PATH

PROTECTIVE DESIGN FOR CIVILIAN sUAS'S

A demonstrated safe and effective approach to taking advantage of *existing* R/C industry components was to…

* reinforce popular and available airframe components,
* reduce take-off weight to slow operating speeds,
* crash-proof the UAVs, (anticipate worst case scenarios***), and
* introduce multiple redundant control strategies and fail-safes.

This is the design approach taken by North American Robotics (NAR), and introduced the extensive use of fire-proof matrix-free carbon-fiber and fire-retardant [EVA] cushioning foam throughout the airframe (pat pending) to enclose vulnerable batteries, avionics, and instrument payloads.

PROTECTIVE DESIGN FOR CIVILIAN sUAS'S

NAR ® QF-160 Prairie Hawk

NAR *Prairie Hawk**

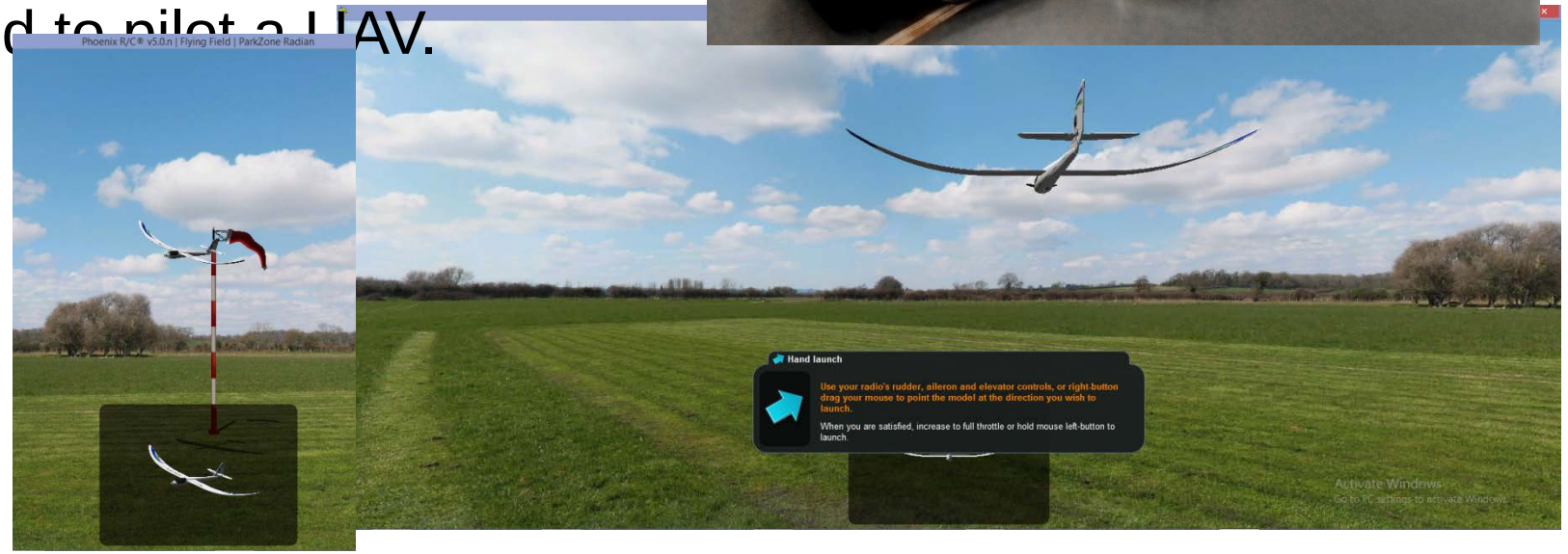
NAR® PRAIRIE HAWK™

NAR® PRAIRIE GULL PRO™

NAR ® QF-150 Prairie Gull Pro carries a variety of quick-change "mission pods", this one is side-looking for oblique inspections. Take off weight is 1.5 kg, operating ceiling of 1000 m AGL, and typical airspeeds of 30 km/hr for a range of approximately 20 km.

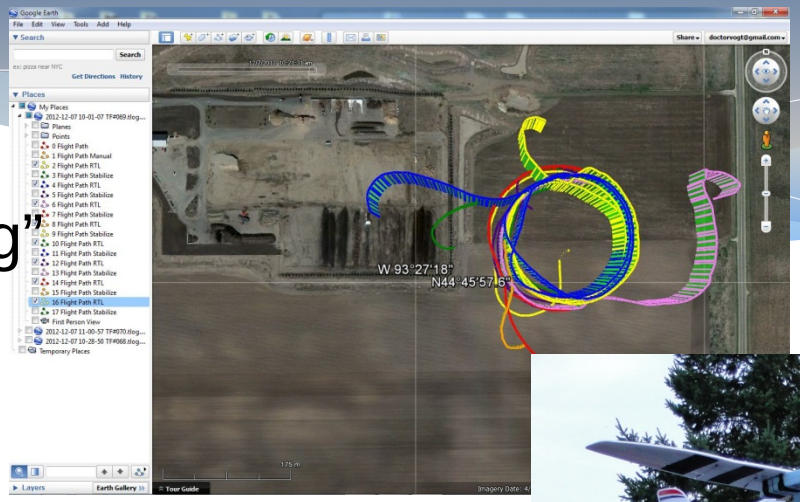
UAV SIMULATION TRAINING

Proper *flight training* is accomplished using an accurate UAV simulator with matching physical controller to introduce the novice pilot to the human-operated skills needed to pilot a UAV.



AVAILABLE UAS SAFETY FEATURES

* Hardware [ESC] “Arming”
* Automated Take-Off
* Flight Stabilization
* Automated Landing
* Fail Safes***
  * Return to Launch (RTL)
  * Power-Off Modes (LOITER)
  * Mechanical Over-rides



OPTIONAL EQUIPMENT

First-Person Viewpoint (FPV) Wireless Camera

Purpose

- Pilot-assistant
- Virtual Flying – beyond visible-line-of-sight
- Real-time Inspection

Extra Equipment

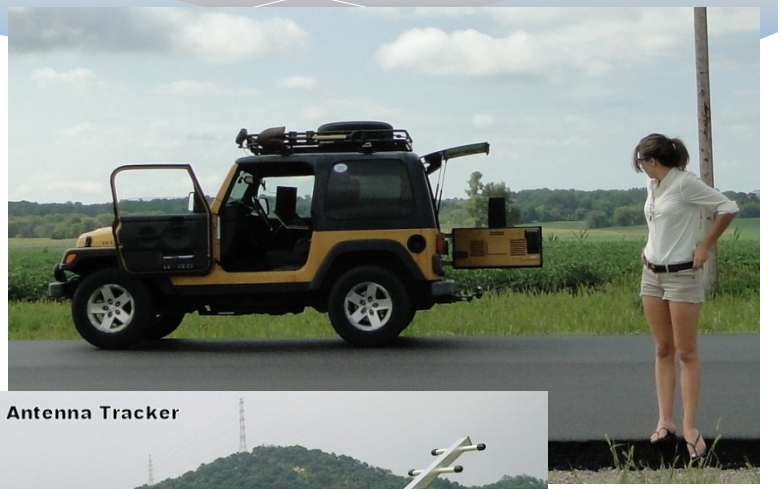
- On-board camera
- Transmitter/Receiver
- Display/FPV Goggles

UAS DEPLOYMENT STRATEGY

Only small "*chase vehicle*" needed

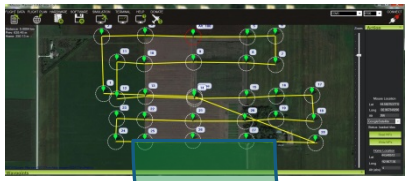
Field support equipment includes:

* Ground Control Station (GCS)
* Work Bench and Seat(s)
* Antennas for control and telemetr
* Meteorology Station
* Infra-red Ground Targets
* Mobile-phone-based WiFi Hot-spo



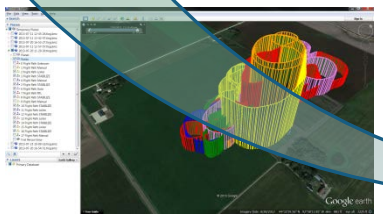
UAV Mission Stages

A complete mission requires several stages of pre-flight planning and significant post-flight analysis and interpretation. The flight itself requires reasonable weather and workable ground condition



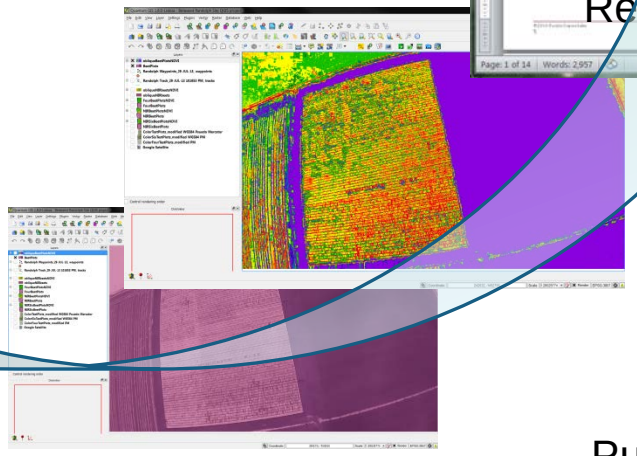
Site Recon and Flight Planning

Flight Execution



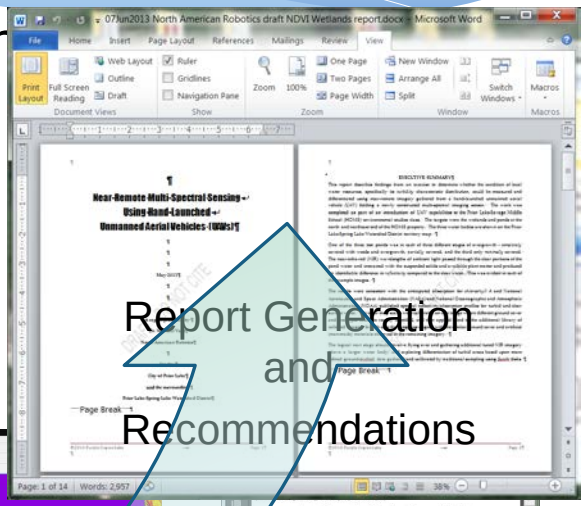
Post-flight Performance Analysis

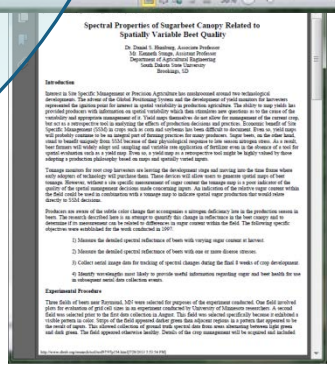
GIS Analysis, Interpretation, Photogrammetry



Imagery Processing and Correction

Report Generation and Recommendations



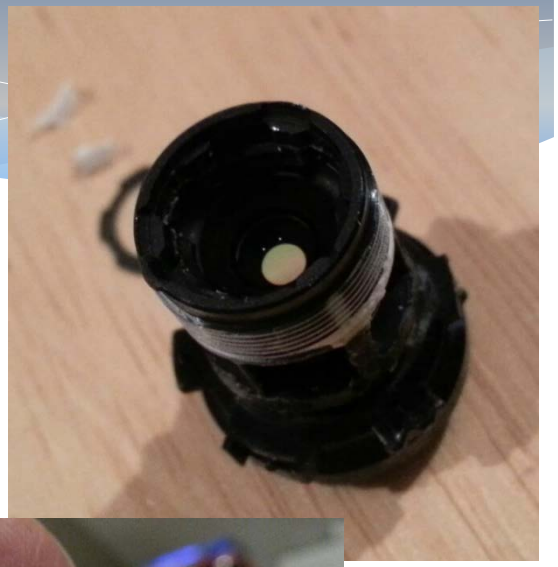


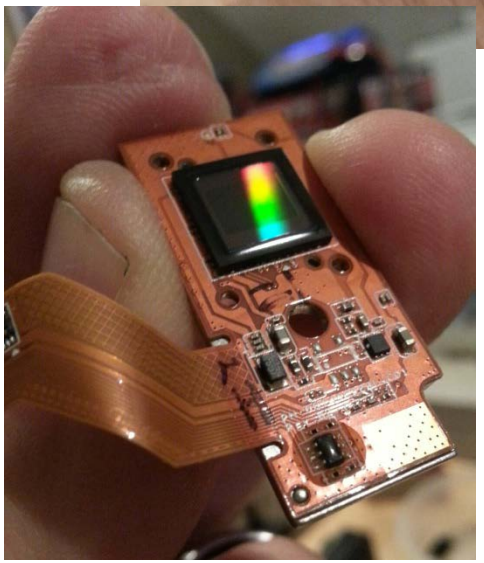
Publishing and Peer-Review

NAR® MODIFICATIONS EXTEND TO COMMERCIAL *SENSORS* AS WELL

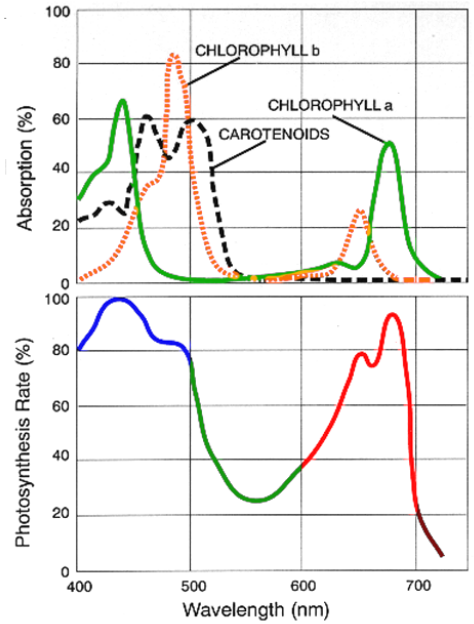
Commercial products modified for research applications

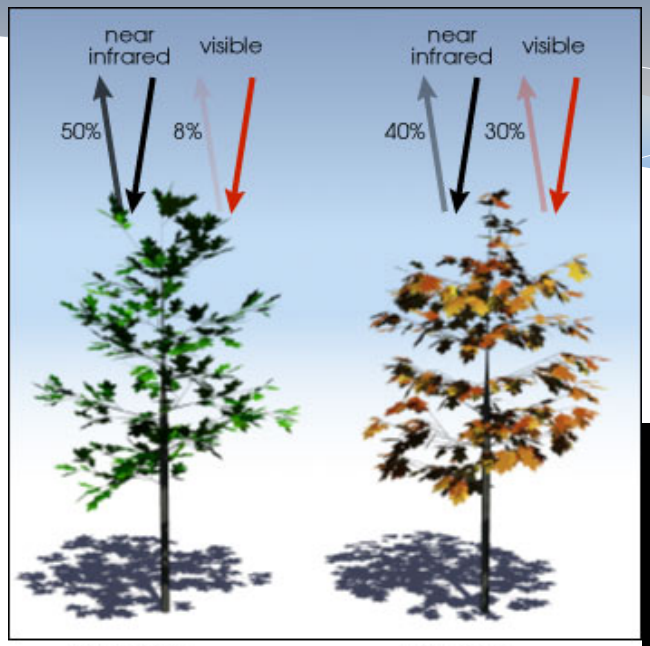
* Tailored lenses
* Customized filters for selective bands



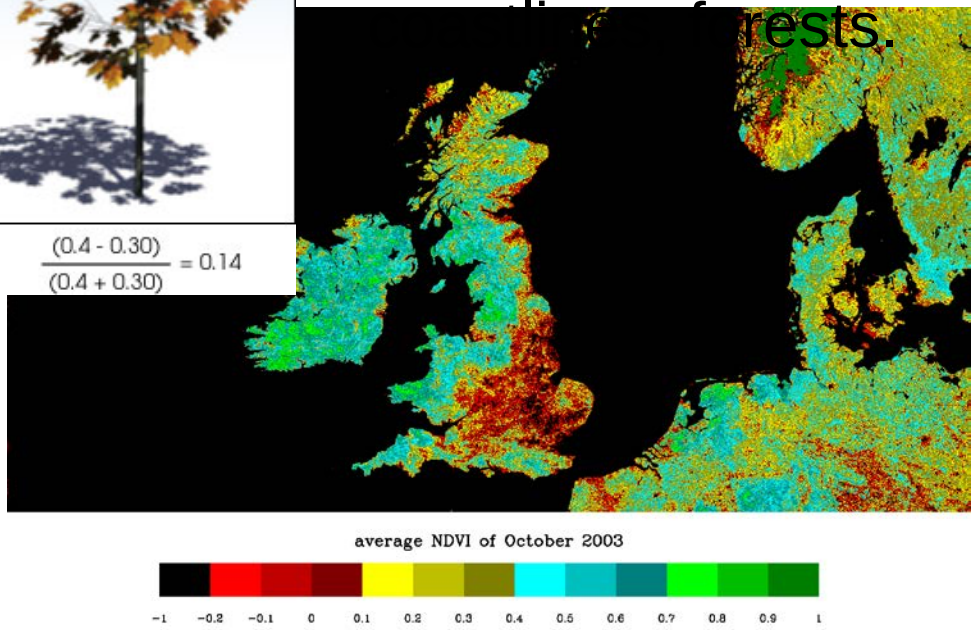


NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)



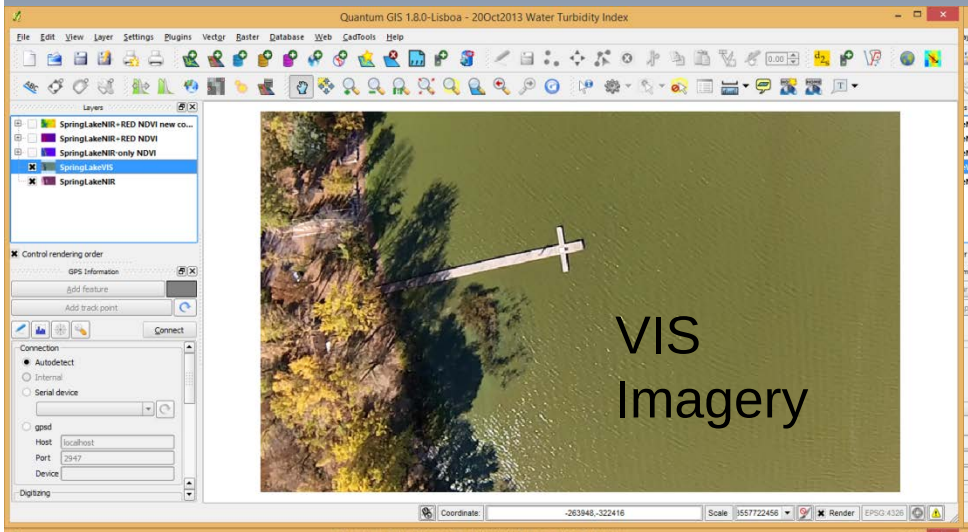


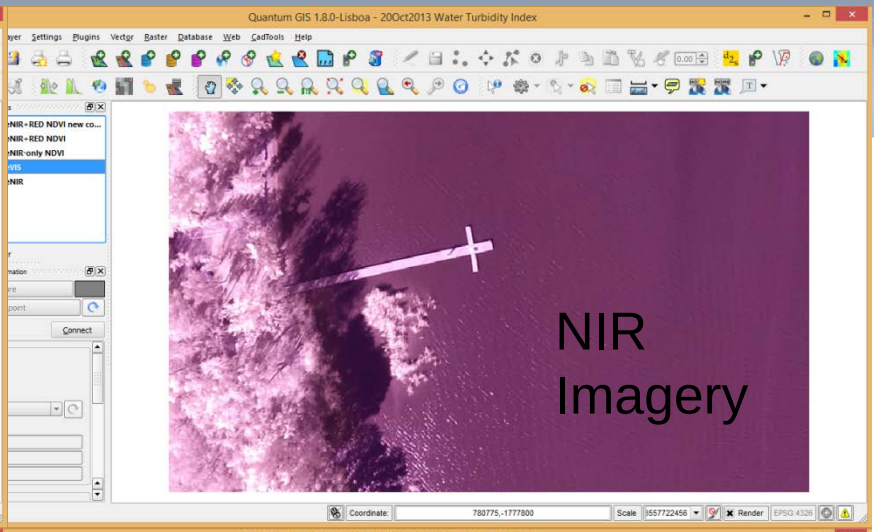
NDVI values are displayed in color maps to indicate ground cover over large areas - land, [illegible] forests.

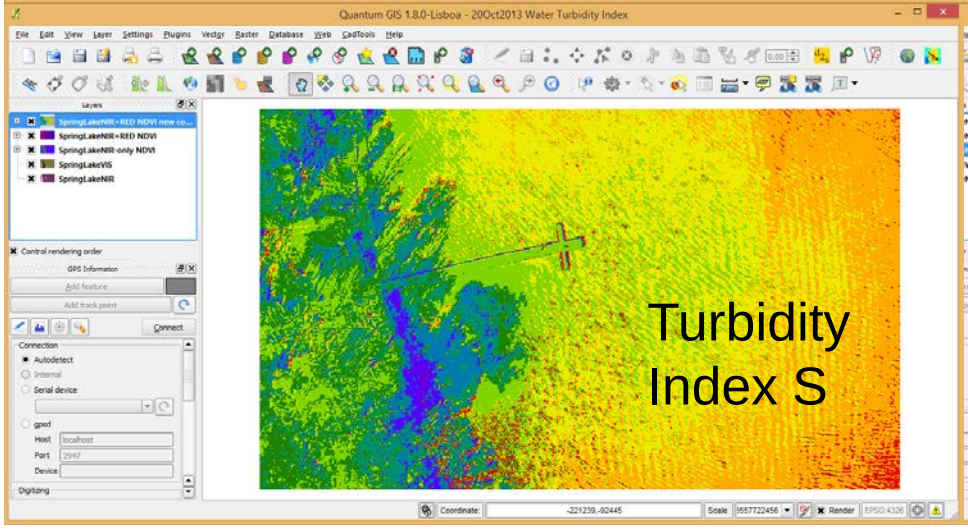


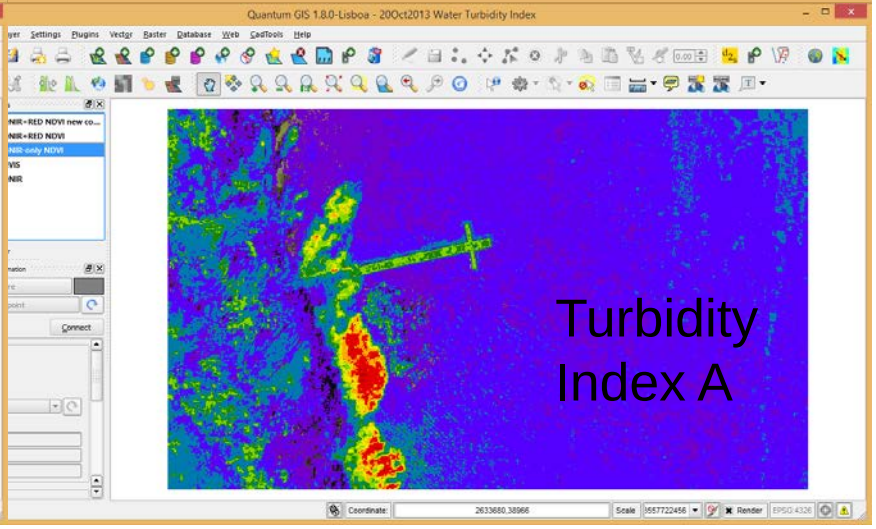
Chlorophyll content and leaf cell structure affect the absorption and reflectance of VIS and NIR light.

NAR® EXPERIMENTAL WATER TURBIDITY INDEXES





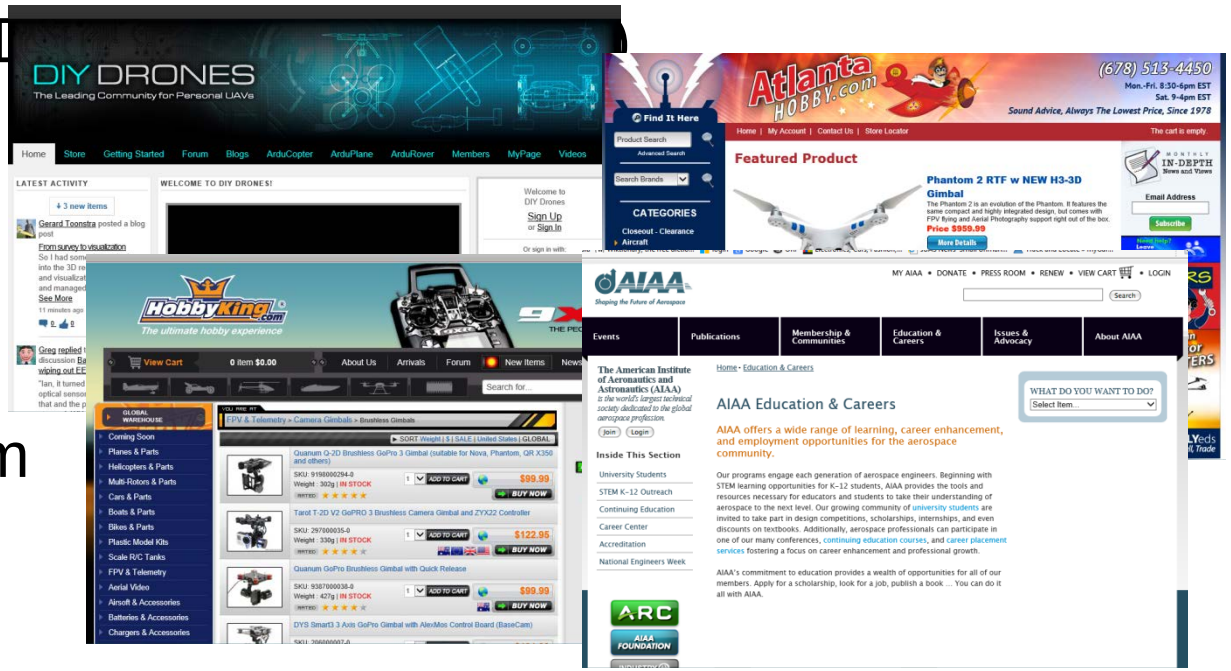




UAS/DRONE USERS GROUPS ABOUND

Enthusiastic and capable Users Groups and Open Source products are available… but with limited liability protection to go with them.

* DIYdrones.com (3D
* AIAA UAV Project
* Also professional resellers such as atlantahobby.com and hobbyking.com



Vast R/C Aircraft Industry Supports DIY sUAVs

While there are a large number of industries supporting the design and construction of specialty UAVs, there are caveats…

* *R/C parts were designed for hobby/recreation – never tested nor certified to be operated over populated areas nor near human presence.*
* *Few standards for integration exist – each system is significantly proprietary and that's not likely to change soon.*
* *Hobby industry is world-wide, so are the different options such as telecommunications, and the user must familiarize themselves with a whole new additional set of rules (FCC).*

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