FEATURE ARTICLE

Low Altitude Remote Sensing with UAS

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About one year ago TNO teamed up with HighEye B.V. (www.higheye.nl) with a goal of developing applications based on the UAS platforms of HighEye. TNO's interests are mainly in the fields of sytem engineering, sensors and image processing and less in the flying of UAS, so the choice of HighEye as an experienced partner was logic.
Numerous small problems were encountered on the way, but in the course of 2008 the first 2 or 3 services will be developed. These services will be subsequently transferred to commercial third parties. Only civilian applications will be discussed here.

State of the Art

Most UAS are equipped with a videocamera, often a standard consumer-grade model. Sometimes, infrared camera's are deployed. For professional services this is not sufficient. A professional service (e.g. monitoring a pipeline or dike) requires the total chain of technologies, UAS, autonomous flight system, instrument/sensors and image and dataprocessing to be engineered and optimized for the application at hand. This requires system engineering and integration capabilities.

The Market

There are many civilian UAS applications possible, but the market develops slowly. Much attention is given in the UAV communities on the flying aspects and insufficient funds are available for developing sensors and data processing.
A restricted amount of organisations would want to buy a UAS themselves (and do the maintenance, pilot, storage, transportation), a typical example is the police. Owner's of UAS are likely to be interested in new sensors and data processing in order to enhance the capabilities of their UAS. Most users will just want to order the service and get the result, with no worries about flying, intruments and data processing.
Focussing on this last market segment, we see that many of these service buyers need the service «on occasion»,

creating a diverse customer pool that need the service at irregular intervals. Such a product-market combination is a challenge for a business to serve on a continuous basis and requires technological flexibility. This is perhaps the major reason why the market develops slowly.
Examples of applications are

- Dike inspection
- Water monitoring and detection
- Traffic
- Air pollution
- Infrastructure
- Gas & oil pipes
- Agriculture
- Inspection HV lines

Economic, Legal and Technical Obstacles

In general there is no clarity in flying rules, at least in The Netherlands. Flying is allowed below 150 meters in an open area, with the UAS within visual line-of-sight. Flying above built-up/inhabitated areas seems not to be allowed. The cost of a UAS, including an autonomous flight unit, is fairly steep because it is not a mass market product.

Sensor Development

There are a variety of sensors available for use on a UAS, e.g. video camera, IR camera. The range of applications possible is only limited by sensor properties (weight, volume, resolution) and flying (range, weather, gasoline, memory storage).
Some sensors are still too heavy to be used on a UAS, e.g. Lidar. TNO started with RGB, B/W and IR camera's and is presently exploring a hyperspectral spectrometer. The spectrometer allows applications such as monitoring of algae bloom. In the coming years the range of sensors will be expanded, thereby 'borrowing' from the field of space technology.
One of the trends in space technology is miniaturisation of satellite instruments. This brings some of them in the weight and volume range suitable as payload on UAS. TNO has the attractive position to have both UAS technology and space technology in house.
The use of various sensors with UAS has led TNO to give

the name «Low Altitude Remote Sensing» to this technology. The typical operating height is 50-100 meters.

Data Processing and Domain knowledge

Key of the success of UAS applications lies in the data handling. To collect terabytes of data is not much of a challenge. Most customers will not be interested in harddisks full of data, but in decision-grade information. This requires a good knowledge of the professional domain of the customer and tailor made data processing.

Advantages and Disadvantages UAS

These have been mentioned on many occasions, such as accessing locations difficult or dangerous for humans, high resolution (vs satellite), below cloud cover (vs satellite & high-altitude UAS), mobile (transportable by car).
However, where satellites fly by at high altitude undisturbed by world activities, UAS fly directly above people, houses, air traffic, etc. This creates a number of safety problems, which are not yet fully addressed legally and technically.

Cases

Upwelling Salt Water

For a pilot study of sources of upwelling deep salty groundwater a HighEye helicopter UAS was used. The helicopter was equipped with a RGB, B/W and IR camera's and a PC104 computer. The deep groundwater differed from surface water by several degrees in temperature and hence was visible on IR imagery.

Tidal flats

For another study the UAS was equipped with a RGB videocamera and a spectrometer. The spectrometer is used for measuring the spectral reflectance of the tidal flats. The UAV made several runs over an island of 4 x 1,5 km and at the same time ground data were collected using a hand-held spectrometer. At the time of writing no results were yet available.

Conclusions

In order to develop a fruitful 'consumer' market for UAS services more effort is needed in developing services, including data handling, which answer questions at a reasonable price. Just flying around with a videocamera is not sufficient.
The micro and nano developments in electronics and other sectors will benefit the UAS sector: sensors will become smaller and lighter.
However, total cost of ownership, safety and legal issues still hamper a healthy development of the UAS market. These issues will have to be addressed by the community.