- GIS
- GPS
- CAD
- REMOTE SENSING
- PHOTOGRAMMETRY
- SURVEYING
- CARTOGRAPHY
- IMAGE PROCESSING
- BUSINESS GEOGRAPHICS

May/June 2018 | Volume 17 | Issue 4

Geo:

GeoConnexion International Magazine

GEO:INTERNATIONAL

UAV LIDAR V PHOTOGRAMMETRY
ALL AT SEA WITH PLASTIC WASTE
SURVEYING 15KM² IN A DAY

GEO:UK

CENTRAL GOVERNMENT
HEALTHCARE
GEOBIM

This month incorporating May/June 2018

GEOconnexion UK

SERVING THE GEOINFORMATION COMMUNITY IN THE BRITISH ISLES

The latest geoinformation serving the World

FLYING THE SPECTRUM

MANY PEOPLE THINK THEY CAN INTEGRATE SPECTRAL IMAGING DEVICES WITH UAVS BUT END UP MISSING CRITICAL DEPLOYMENT TIMELINES BECAUSE THEIR WHOLE ASSEMBLY IS STILL ON THE BENCH RATHER THAN IN THE AIR. CHRISTOPHER VAN VEEN LOOKS AT THE DOS – AND DON'TS – OF HYPERSPECTRAL UAV IMAGING MISSIONS

The UAV has evolved into a very dependable and tactical platform for remote sensing missions ranging from crop disease detection and environmental monitoring to infrastructure inspection and mining. Remote sensing was originally the domain of military/defence applications using high-flying aircraft and satellites. But commercial missions depend on cost-effective, low-altitude data-on-demand capabilities that today's range of UAVs and imaging sensors provide.

While this pairing has become increasingly popular on a global basis, the reality is that much integration work needs to occur before the first mission is flown. The type of UAV, field of view, spectral resolution requirements, frame rates, power consumption, and flight duration are considerations that must be addressed.

UAVs come in two general formats: fixed-wing and multi-rotor. Fixed-wing UAVs require some space to land and take off, which is something not every mission can provide. Fixed-wing craft tend to have somewhat better stability characteristics while aloft, which can directly translate into higher quality image data. Depending on the model chosen, they can also carry more payload (more instruments) than multi-rotor UAVs and can often stay aloft longer. However, multi-rotor UAVs are themselves very capable today, and offer the advantage of vertical take-off and land. Since many remote sensing missions occur in heavily vegetative locations, this is a decided plus. Also, a multi-rotor UAV has no stall speed. It can hover or fly very slowly, which can match the data-collection frame rates of the imaging sensors.

Spectral imaging sensors basically collect and interpret reflected light in the visible-near-infrared (VNIR) range from 400-1,000nm, and also in the shortwave-infrared (SWIR) range from 950-2,500nm.

For crop disease detection and other precision agriculture applications, the VNIR range is typically going to collect the necessary image data to answer important questions such as where to fertilise, where to irrigate, and where plant stress levels are high. A number of vegetative indices (VIs) exist to help users understand complex relationships and spectral imaging sensors collect the data these VIs use. The shortwave-infrared range from 950-2,500nm is where true chemical imaging occurs. Geological exploration and infrastructure inspection of pipelines, bridges, and dams are good examples.

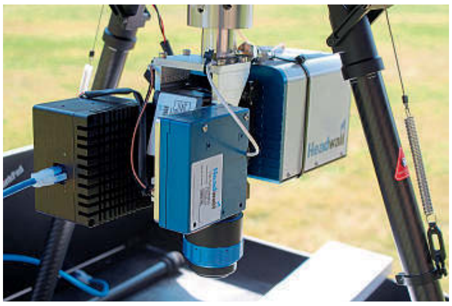
In both cases, the ability to accurately characterise the materials seen within the field of view is largely a factor of the number of spectral bands. Multispectral imaging sensors typically provide a small number of wide bands (6-10, for example) with gaps between those bands. This means that spectral classification of similar-

looking but meaningfully different materials is somewhat limited.

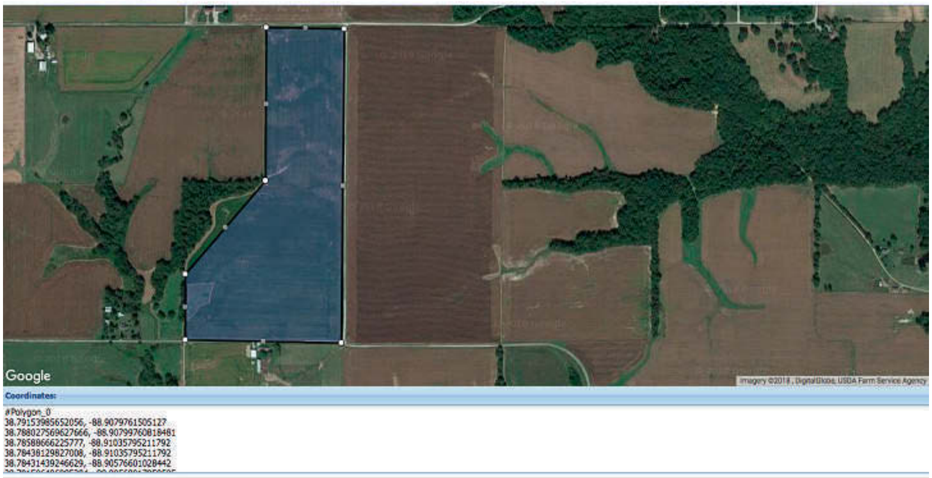
By comparison, hyperspectral imaging sensors provide hundreds of narrow spectral bands that are nearly contiguous. This means that material classification is precise, essentially a full spectrum for every pixel collected. In situations where the spectral ranges of interest are precisely known, a multispectral sensor might be adequate. But more common are situations where these regions are not understood or known, or where missions might change over time. The ability of a hyperspectral imaging sensor to collect all the spectral data between a certain range (say, between 400-1000nm) is beneficial.

More than just spectral

Most often, a commercial UAV remote sensing solution includes more than just a spectral imaging instruments. Very often LiDAR instruments are used to provide 'point cloud' analytics and general elevation data. Similarly, a thermal or RGB camera might also be used aboard the UAV to provide complementary information. The data streams from all these instruments needs to be synthesised, which is largely the role of the GPS/IMU (internal measurement unit) as well as a data hub (such as Headwall's HyperCore) collecting the outputs from each instrument on a solid-state drive. The best rule of advice is to choose the GPS/IMU with the highest accuracy, since crop data often needs to be interpreted on a per-plant or per-tree basis. Overall, the proper fitting of each instrument aboard the UAV is crucial for aerodynamic purposes. Additionally, the payload capacity of the UAV not only needs to factor the weight of every instrument and the requisite cabling, but also



Data fusion is key in any remote sensing mission, where hyperspectral images combine with LiDAR and GPS/IMU data to yield a more complete view of crops, minerals, environmental indices, and more



Controlling the imaging sensor while aloft makes for a more efficient mission while optimising data management. The Polygon tool defines the geographical coordinates within which the sensor will collect data

the weight of the batteries themselves.

Combining all the necessary instrumentation and then connecting it all is a robust exercise that takes time. Often, commercial users don't have the in-house expertise to manage and balance all the necessary factors mentioned earlier and need to rely on systems integrators such as Headwall. Factors such as desired flight altitude, speed, sensor frame rate, field of view, spectral range of interest, and power consumption (itself a determinant of flight duration) all are understood before the ultimate solution is crafted. But an integrated solutions provider allows users to get in the air sooner than they otherwise might, hitting important crop cycles or geological milestones.

The objective of a remote sensing airborne solution is to collect data that can be accurately interpreted and then turned into straightforward answers for the user. This is the role of software, which is just as important as the instruments themselves. Before the flight, it's crucial to define the parameters within which data will be collected. This is the role of web-based apps. With Headwall's Polygon Tool, for example, the user simply points and clicks on Google Map coordinates to define the precise area within which the sensor will collect data. Then, as the UAV flies its mission, data will only be collected within that 'polygon'. Data efficiency is assured, and power consumption is optimised. Overall, the most crucial thing a commercial user can do is put considerable thought into flight planning: what altitude will he need to fly? What spectral resolution does he need? Is the speed of the UAV matched to the frame rate of the sensor? In the end, a well-articulated flight plan will result in well-articulated image data.

The back end

On the back end, software plays a role in interpreting and managing the collected data. A hyperspectral imaging sensor can accumulate several gigabytes of meaningful data per flight. Software that stitches together (batch processes) the data cubes into a 'mosaic' while also handling orthorectification is a powerful pair of capabilities that users should seek. Orthorectification is the means by which any unintended anomalies due to roll, pitch or yaw are basically 'straightened out' with respect to their GPS coordinates. This is a key task, and a powerful one, but it can often be combined with or replaced by a stabilising gimbal in cases where a multi-rotor UAV is used.

Stabilising gimbals such as the Ronin aboard the DJI Matrice 600 are outstanding in carrying out their mission, which is to maintain sensor perpendicularity no matter what the UAV does. There is of course additional weight and some power consumption when a stabilising gimbal is used, but a solutions integrator can communicate the relative benefits of using one based on factors such the type of sensor being used. Sometimes hard-mounting the sensor to the UAV is sufficient, provided that orthorectifcation during data processing is available.

The cost of a UAV is falling rapidly, and numerous 'hobbyist' craft are available. However, these are not suited for commercial remote sensing missions. It should be noted that the cost of the UAV is often less than 10 per cent of the cost of the entire solution, so a commercial-grade craft (fixed-wing or multi-rotor) is vital. DJI is one such vendor, with a range of craft suited to missions where payloads and battery life are high and airborne stability is excellent. Commercial users see the lure of acquiring a UAV and complementary instruments piecemeal, but often the entire assembly sits on a workbench for months because key integration tasks weren't properly understood beforehand. For these users, where time is crucial, putting these tasks into the hands of solution integrators is often a shrewd and ultimately a cost-effective decision.

Christopher Van Veen is marketing communications manager at Headwall Photonics (www.headwallphotonics.com)