Towards an operational processing workflow of UAS imagery for environmental monitoring

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The Supervising Scientist undertakes independent scientific research and monitoring into the impact of uranium mining of the environment of the Alligator Rivers Region.

Who we are

The main roles of the Supervising Scientist are:

• Working to protect the environment through environmental research and monitoring, environmental supervision, audit and inspection.
• Ensuring the protection of the Alligator Rivers Region from the effects of uranium mining and encouraging best practice in wetland conservation and management.

As part of our environmental research and monitoring role, we use state of the art techniques, such as unmanned aerial systems (UAS), to collect and analyse data at scales that are appropriate to our area of investigation (e.g uranium mine sites). UAS allow for flexible, cost effective data collection at high spatial and temporal scales.

Operational requirements

Spatial:
• suitable for mine site analysis
• sub-metre Ground Sampling Distance (GSD)

Temporal flexibility:
• monthly to annual frequency for monitoring and comparative purposes;
• deployment at short notice for quick response to emergencies;
• ability to coordinate missions to suit other project schedules or satellite acquisition;
• avoid adverse climate conditions (such as smoke and cloud cover).

Spectral:
• colour (RGB)
• near infrared (NIR)
• multispectral (MS)
• hyperspectral (HS) in future

Typical UAS projects

Since beginning UAS operations, Supervising Science has collected imagery for over 60 missions, in RGB, NIR, and multispectral. The majority of UAS data collection to date has been using a fixed-wing UAV with an RGB and NIR sensor combination. Most datasets are processed using Pix4Dmapper Pro photogrammetry software, though trials continue with Caretaker3D.

Features and challenges

<table>
<thead>
<tr>
<th>No buildings</th>
<th>More difficult to find fixed landmarks for control points</th>
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<tbody>
<tr>
<td>Maturity vegetation</td>
<td>Open canopies, exfoliating leaves, tree shadows, artefacts due to blind spots beneath canopy</td>
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<tr>
<td>Sporadic cloud cover</td>
<td>Variability across imagery, particularly affects multispectral data</td>
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<tr>
<td>Water bodies</td>
<td>No reliable tie points, sun glint, cloud reflection, floating vegetation</td>
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<tr>
<td>Floating vegetation</td>
<td>Unevaluable tie points</td>
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<tr>
<td>Wildlife</td>
<td>Moving cattle and birds may be mistaken for suitable tie points between adjacent imagery</td>
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Step 1: Pre-flight and in-field data considerations

• Minimum planning (overlap, wind, terrain, take off and landing)
• Other air traffic
• Set out radiometric calibration targets
• Mark out Ground Control Points (GCPs) with a differential GPS

Step 2: UAV data pre-processing

Data collated will usually need to be pre-processed to suit the photogrammetry software requirements.

• Flight log needs to be corrected and formatted to suit the processing software.
• Post-processing of GCP data.
• RAW images need to be corrected and converted to high quality TIFF or JPEG format.

There are many RAW image converters available to handle image conversions, and some of them also allow batch processing to address other issues at the same time. Personalised camera calibration files may address issues of in-sensor variability (Dark Frame Corrections) and lens distortion (Flat-Field Corrections or Lens Correction Profiles). This treatment removes vignetting, helps with colour balancing and blending, and will assist photogrammetry software with image matching.

Step 3: Photogrammetric processing

Photogrammetric software use similar types of processes, in semi-automated linear project-based workflows. Once all of the input data is in optimal format, typical workflows include: aerial triangulation, bundle adjustment, 3D point clouds, elevation models, georeferenced orthomosaics, and other 3D products.

Challenges such as water and canopy artefacts in the mosaics may be improved by manually checking and editing the point cloud and the orthomosaic, although this requires an operator with a more in-depth understanding of the software and may become quite time-consuming, and will may not remove all unwanted artefacts.

Actual processing time depends on CPU specifications, such as memory and graphics cards.

For operational purposes, other necessary considerations include storage requirements, naming conventions for consistency, and metadata.

Other derived products

The aim of processing is usually to achieve a georeferenced orthomosaic for further analysis in GIS and remote sensing software. However, other by-products are often available, including digital 3D models for visual representation, intermediate products developed during the process, such as Point Clouds and Digital Elevation Models (DEMs), are useful and can be exported and used in other software.