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INDEPENDENT STRATEGIC ANALYSIS OF AUSTRALIA'S GLOBAL INTERESTS

Associate Paper

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Australian Drone Technology Assisting a Significant Step in Crop Tolerance to Heat and Drought Stress

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Key Points

- Early identification of plant stresses is essential to ensuring maximum crop yield.
- Unmanned aerial survey drones equipped with sensors are increasingly being used by corporate farmers, agronomists, biologists, and environmental ecologists to make important production decisions.
- Aerial survey tools such as NDVI, thermal and multispectral imagery are now available to farmers and have the potential to boost crop yield and reduce production costs.
- Researchers have been working to discover ways to make Australian farms more capable of coping with a range of biological and non-biological stresses using unmanned aerial vehicles or drones.
- In the future automated systems will become a routine part of agricultural production as a tool for promoting productivity and efficiency.

Summary

Early identification of plant stress is essential to ensuring maximum crop yield. A detailed and timely visualisation of a cultivated crops can identify many plant stresses and can be vital to informed quality decision making. Research now being undertaken at Murdoch University in Western Australia and conducted with technical assistance from aerial imagery by Perth based company, Scientific Aerospace, is providing a precise new tool in the farmers' toolbox for increasing profits.

Analysis

Researchers have been working to discover ways to make Australian farms, both irrigated (market garden, viticulture, dairy), and non-irrigated (broadacre grain and livestock) more able to cope with a

range of biological and non-biological stresses such as heat, frosts, drought and pests events using unmanned aerial vehicles (UAVs) or drones.

Figure 1. Western Australian Wheatbelt Crop at Katanning. *Source: the author.*

UAV based technologies can provide an increasingly wide range of sophisticated data. Farmers can now access survey quality contour and three-dimensional mapping, digital surface and terrain models, plant counts, plant height, or geotagged vegetation index maps. The processed data is made visible in various 'layers' so that farmers get very graphic answers to specific questions about, for example, soil temp, soil moisture, crop nutrient status, biomass prediction, grain yield prediction, and other traits. Data processing beyond the capacity of a home computer can now be professionally provided on site via a datalink.

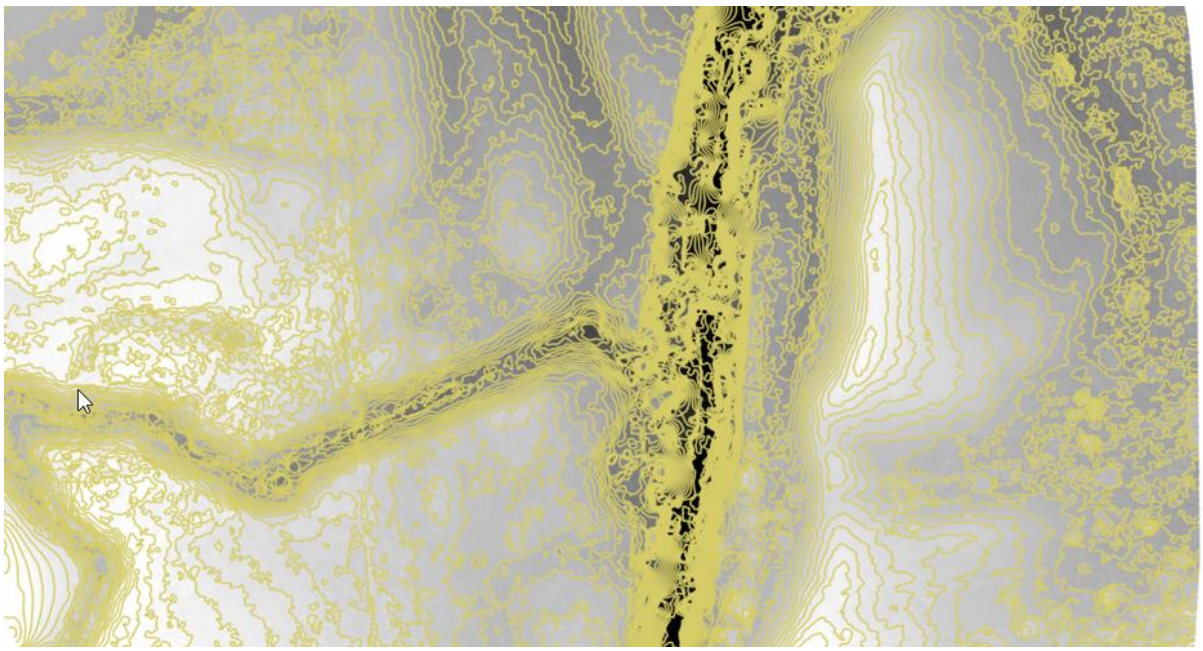

Figure 2. Aerial Survey processed to show 20cm Contour Intervals. *Source: the author.*

The integrated system technologies needed to provide information of this fidelity have been locally developed for precision, targeted, agricultural surveying. Data sources include NDVI, thermal, multispectral and a new miniature spectrometer recently developed by the University of Western Australia's microelectronics laboratories. The acquired raw data images are processed and enhanced

using third party software, such as Pix4D and Context Capture. Sophisticated scientific analysis is required to make use of the information contained within the raw data packages. The analytical service has been developed in collaboration with Murdoch University.

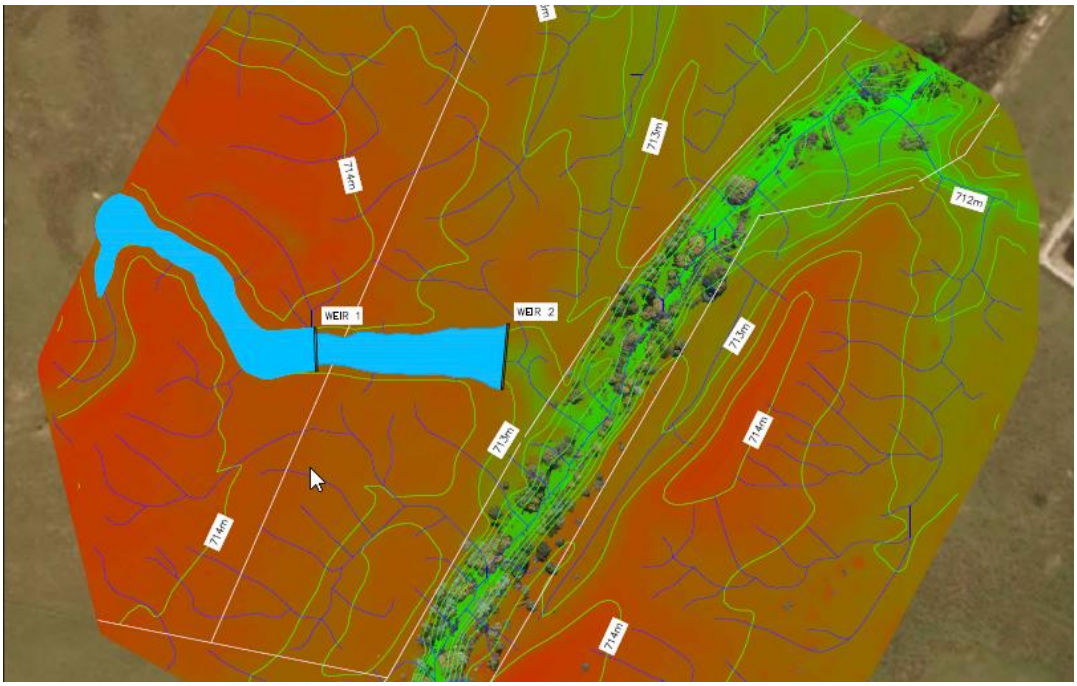

Figure 3. Further processing of the same area revealing optimal sites for installing Leaky Weirs. *Source: the author.*

Scientific Aerospace has made a significant research and development investment to integrate the optical output with the third party and drone software. This is achieved using Application Programming Interfaces (API's) developed and built in house. Scientific Aerospace also utilises a custom application for a computer tablet, tailored prior to each mission for a specific flight based on each client's requirements.

Figure 4. In-field assessment of aerial imagery and data processing. *Source: the author.*

Case Study in Collaboration - Assessing Heat Stress Resilience in Wheat and Barley Crops

With the aim of discovering which wheat and barley varieties and soil combinations provide the best resilience to a combination of non-biological stress (heat and drought), Scientific Aerospace teamed up with Murdoch University researcher and PhD candidate, Karl Svatos, to help develop a 'proof of concept' drone experiment. This was performed in the field at the Katanning Research Station.

The research is an extension of study in evaporation, transpiration and drought stress with ground based thermal remote sensing in agricultural cultivation. For simplicity, the algorithm for the internal energy status of plant systems is not shown here, but involves several temperature parameters, emissivity, heat transport and leaf resistance.

Data Capture

Two drones were equipped with either the NDVI multispectral and optical lenses or a thermal camera. Two flights were made at the coldest time of day (dawn) and later in the afternoon at the hottest time of the day.

Ground truth testing was also used to provide reference absorption, reflectance and saturation benchmarks, so that any deviation in the raw drone data could be corrected during data processing. The UAV was flown at altitudes to capture high resolution data specific to each flight requirement. The sensors looked vertically and sideways to capture three-dimensional imagery.

Figure 5. The UAV in flight over the Rye Wheat and Barley Test Field at Katanning. *Source: the author.*

Data Processing

The raw data was gathered and transferred to the on-board computer and saved for processing after the flight. Geographically tagged photos were extracted from the files and a grid map was overlain on data. These reference photos were then used to determine individual aspects of the traits in question specific to each plot in the trial. The aerial data may be further processed using index map solutions

such as SMS, AgPixel, ArcGIS, and other GIS systems to produce other data 'layers' that provide further, value-added insights.

The results from the various images (NDVI, thermal, RGB, multispectral) are then used to identify which wheat and barley varieties and soil combinations provide the best resilience to heat stress in the field. The researchers hope that this may then be used to produce better varieties suited to the environment where the cultivation is located.

Conclusion

Scientific Aerospace envisions a world where automated systems are a routine part of agricultural production as a tool for promoting productivity and efficiency. It is the vision of the project partners that the farmer, in the paddock, will be able to access sophisticated, real time, analysed data on the stress condition of a crop that will enable a timely response and thus, optimise production. This will be achieved by collaborating in the development of a systems engineered software suit that will autonomously incorporate and integrate climate records, rainfall, meteorological logs and real time drone acquired, crop data. Prescription maps will be generated which can then be uploaded to a Farm Management Information System (FMIS) system or directly to irrigation systems, seeders, spreaders, tractors, combine harvesters or headers for sowing, watering, fertilising, nitrogen optimisation, weed control yield monitoring and harvest timing management in real time.

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About the Author: Geoff Trowbridge is an internationally experienced program manager in the aviation, telecommunications, manufacturing and resources sectors. A former weapons system engineer in the RAAF, he subsequently held senior management roles and directorships with Optus, Siemens, Ernst & Young, Oracle and BHP Billiton. He has also worked in research and development facilities in London, Chicago and at Curtin University. He lives in Perth, WA and was appointed CEO of Scientific Aerospace in November 2016. Scientific Aerospace is the only designer and manufacturer of drones in Australia.

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