precision ag news

Winter 2013 Volume 9 Issue 3

SPAA Precision Agriculture AUSTRALIA

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New frontiers for aerial sensing

Collecting on-the-go canopy data, including temperature could improve variable rate nitrogen application. Photo: David Lamb

David Lamb

Thermal imaging and on-the-go nitrogen zoning are two firsts for aircraft mounted sensors in Australia.

Satellite, aircraft, unmanned aerial vehicle (UAV) and ground based vehicles are all platforms able to carry sensors that gather data about a crop. Most commonly these sensors pick up wavelengths beyond the visible spectrum in the near infrared (NIR) wavelengths and provide an indication of plant vigour. However, other so-called thermal infrared (TIR) sensors can measure canopy temperature.

Which combinations of platforms and sensors provide the most useful information for production decisions continues to excite and challenge the research community.

At the University of New England, and as part of a large Cooperative Research Centre for Spatial Information "Biomass Business" project, we have been assessing the use of low flying aircraft as a platform for optical and thermal sensors.

In 2008, we successfully demonstrated that an 'active' NIR/red sensor (CropCircle™) mounted beneath a crop dusting aircraft could map crop vigour on-the-go.

These flights were done at an altitude of three to five metres. The key science in play here is that the sensor was 'active', i.e. the sensor contained its own light source. This means the sensor can be used any time, daytime, cloudy or clear sky, or even nighttime.

Aerial thermal mapping

In late 2012, a thermal sensor was added to the aerial platform so that in one pass we could gather data on canopy temperature as well as the optical measure of crop vigour.

Canopy temperature relates to the level of evapotranspiration (water use) by the plant. This allows canopy temperature to be used as a surrogate measurement of plant available water. Plants under water stress are hotter and those plants often tend to be less vigorous.

Measurements of crop vigour and canopy temperature were taken across a 230 hectare, irrigated cotton field at an altitude of 35m. Conducted during February 2013, the cotton was at six nodes above white flower corresponding to a fully-closed canopy of approximately 1.3m height above the soil.

Across the canopy, temperature ranged from 25 to 30°C (Figure 1) but rose to over 40°C on bare soil.

These measurements are the starting point. We now want to establish how this information could be used to improve management.

The new combined optical and thermal sensor unit is more powerful than the original used in 2008, so now we are hoping to deploy it on an unmanned aerial vehicle (UAV). UAVs offer the potential for higher resolution data capture as they can fly even closer to the canopy and can be deployed at less cost, so can be flown more frequently, if desired.

As applications of nutrients and desiccants to cotton are often carried out aerially, we also wanted to establish if on-the-go canopy data could be used to vary the rate of input applications.

Low flying aircraft versus ground based vehicles

Mounting a crop sensor on a low flying aircraft rather than a vehicle that has to enter a crop offers several advantages:

- large areas can be covered rapidly;
- all areas of a paddock or landscape can be mapped irrespective of access;
- flights can occur under cloud (even at night) and are not affected by the angle of the sun;
- disease transfer is eliminated as is wheel damage in established crops; and
- data could be collected at the same time as other aerial operations, e.g. crop dusting.

On-the-go aerial nitrogen zones

Ground based biomass/vigour data has been used to predict and control variable rate nitrogen applications on-the-go but this had not been achieved with an aerial platform.

Dr Greg Falzon, UNE has developed an algorithm that can predict and control nitrogen rates on-the-go for aerial nitrogen applications.

Currently, aerial applications of fertiliser are a uniform rate across the field so there is no data on the response time of rate controllers. However, work in New Zealand has shown that when aerially seeding, the actuators can change rates after about 20m.

The plane we used flies 20m transects. Based on the NZ data, we have calculated that when flying at 185km/hr (100 knots), rates could be adjusted on a 20m by 20m footprint.

Known variation suggests a larger management unit is appropriate and we have decided to work on a 100m by 100m footprint.

So, assuming we change rates every 100m, we want to combine the accepted approach of zoning paddocks into high, medium and low application zones based on full-field data collection, with the ability to collect instantaneous values based on the active optical and passive thermal sensor on-board the aircraft.

Summary

A new combined optical and thermal sensor unit is being tested

Thermal maps have been generated from aerial platforms and offer information on available soil moisture

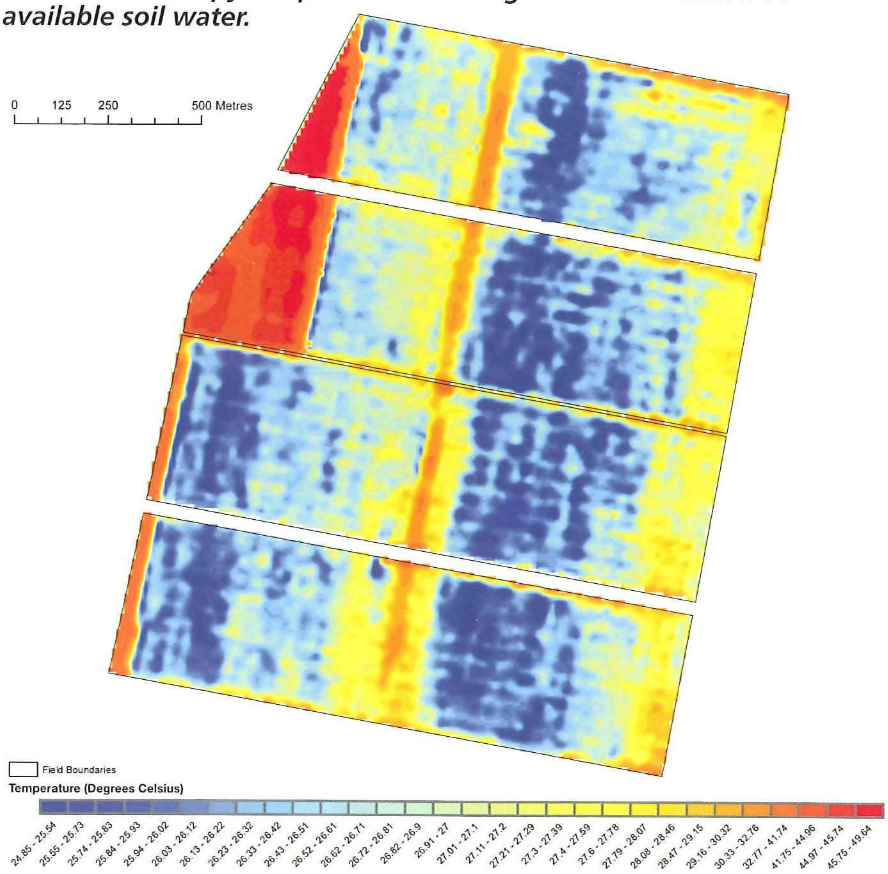
An algorithm has been developed to control on-the-go variable rate nitrogen from the air

To achieve this blended approach, statistician Dr Falzon established a Dynamic Aerial Survey (DAS) algorithm that can calculate the required nitrogen rate based on the area of crop over which the plane has just flown.

On entering the paddock, the pilot flies a transect and the sensor starts gathering crop reflectance data. This information is processed and used to predict the nitrogen requirement zones ahead of the plane rather than try to control nitrogen rates based on the very noisy instantaneous data. The more data that is gathered by the sensor, the greater the accuracy of the forecast application rate.

We are now at the proof of concept phase. We are currently looking at how we could combine another data layer such as yield, an electromagnetic soil map or terrain map to improve the accuracy of the early predictions.

Figure 1. Keytah L2-L4 Raptor thermal map of cotton showing the variation in canopy temperature that might be an indication of available soil water.



In time we hope to assess how the combination of on-the-go thermal and biomass data can be used to improve the on-the-go fertiliser rate predictions.

Both of these developments are firsts for aerial agricultural platforms and will eventually offer farmers another way to capitalise on precision management of their land.

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