Qld Veg Automation News

June 2018

An update on the vegetable levy funded project VG15024: *Vision systems, sensing and sensor networks for managing risks and increasing productivity in vegetable crops.*

Rapid yield assessment with vision systems

QUT and DAF are developing tools that can automatically and quickly assess fruit quantity and quality in vegetable crops using robotic vision.

QUT researchers use inexpensive 2D and 3D sensors (cameras) to capture colour images of capsicum fruit in crop to 'train' and evaluate vision-based algorithms.

Field-grown capsicum at the Gatton Research Facility

After scanning, DAF staff label individual fruit while still on the plants, then the crop is filmed and this video footage is used to manually note fruit location and quality attributes on scanned images (see picture at right). Next, DAF staff pick and assess capsicum fruit for size, colour, weight and marketability to validate the machine generated data.

All data collection is now complete. QUT researchers use about 50% of fruit detections in camera imagery to 'train' the algorithms; the other 50% are used to test the accuracy of the algorithms. This work is on-going and researchers are using the image validations to improve their machine learning algorithms. These will be validated against actual yield data over the coming months.

Protected cropping trials at Giru

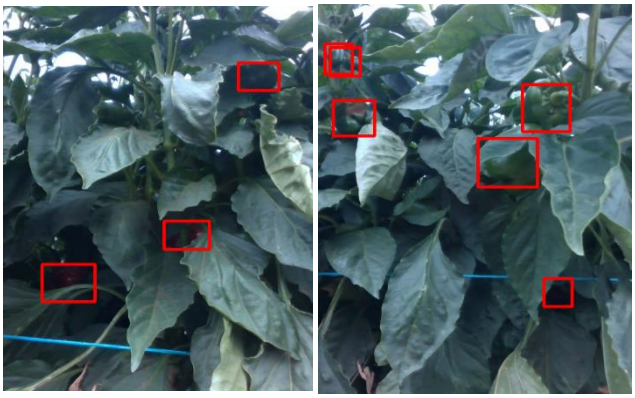
From July 2016 to September 2017, researchers acquired five sets of data with associated images and crop yield data at the protected cropping site at Giru in North Queensland. Initial algorithms are shown in the blue box.

Field trials at Gatton

Researchers completed ten trials (image runs and validations) in field-grown capsicum at DAF's Gatton Research Facility. Two commercial varieties (Warlock and SV6947) in both single and double row configurations were compared. Crops were planted on three separate occasions:

- On 1 September 2016 with three image runs in December to January 2017
- On 2 January 2017 with three image runs in May
- On 3 September 2017 with four image runs in December to January 2018

As expected, fruit is often obscured by leaves so estimating fruit numbers and colour in field-grown crops is proving more difficult than in protected-cropping capsicum.



Example detections shown by a red rectangle illustrate the challenge of accurately detecting fruit in the less structured field-grown crop environment.

Rapid yield assessment results to date:

For protected-cropping capsicum, QUT's initial algorithms can find about 80 out of 100 fruit in camera imagery. They correctly classify 94% green, 91% red and 70% mixed colour capsicum with an average accuracy of 90% across the three colour categories.

For field-grown crops, QUT's initial algorithms can find about 70 fruit out of 100 in camera imagery. They correctly classify 94.5% green, 93% red and 33.3% mixed colour fruit with an average accuracy of 91.5% across the three colour categories.

Results are still to be validated against actual yields.

Early problem detection with hyperspectral imaging

CSIRO and DAF are using Tomato Spotted Wilt Virus (TSWV) in capsicum as the 'proof of concept' problem/crop combination for this work.

Plants are grown in pots in the glasshouse complex at EcoSciences Precinct in Brisbane. A proportion of plants are inoculated with virus then leaves are scanned under controlled lighting conditions (dark room) with two sophisticated hyperspectral cameras to develop algorithms that detect changes in leaf reflectance.

The research team is now consolidating this work. Our first three trials were based on cutting leaves from plants before scanning. This sampling method has some obvious limitations however CSIRO's machine learning algorithms could discriminate between leaves with symptoms and healthy leaves at better than 80% accuracy which is very encouraging.

Whole plant imaging trials

CSIRO have now built an experimental set-up that can scan whole plants in pots. This allows tracking of symptom development over time as well as more frequent scanning so increasing the chance of picking up very early changes in leaf reflectance, potentially before symptoms can be seen with the naked eye.

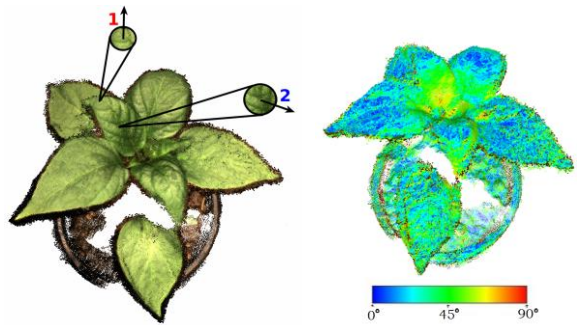
Eight week old capsicum plant with TSWV symptoms

A fourth pot trial is currently underway. DAF planted capsicum seeds in late March and inoculated plants with TSWV four weeks later. First visible symptoms appeared after a week and plants were scanned every Monday, Wednesday and Friday until the end of May.

While the current trial is nearing completion, a follow-on trial is being established.

CSIRO will process and analyse the data from the whole plant scanning trials over the coming months and results will be reported later this year.

Challenges of whole plant imaging. *To track symptom development over time, the CSIRO system needs to be calibrated so that it can lock in on the same leaf each time. It also needs to account for changes in leaf angle as that will impact on leaf reflectance.*



To illustrate, the plant on the left is a 3D model of a plant where pixel 1 has an incidence angle of 0 and pixel 2 an angle of 48. The plant on the right is a heatmap of a plant showing incidence of pixels.

November 2018 regional industry forums

The DAF/QUT/CSIRO project team is planning another round of 'Veg Automation' forums in Bowen, Bundaberg and Gatton later this year using the very successful 'virtual meeting' format from the last two years.

Researchers will link in via webinar and this is an excellent opportunity to speak with key people working in the field of automation, robotics and sensing directly.

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You might also be interested in an upcoming webinar hosted by the National Vegetable Extension Network:

FutureFocus – robotics and intelligent systems in Australian vegetable production systems

Thursday 23 August – 12:30 pm to 1:30 pm (AEST)

To register click here

Hort Innovation Strategic levy investment | VEGETABLE FUND

This project has been funded by Hort Innovation using the vegetable research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au