FINAL REPORT 2015/055

Field ready, optimised precision weed identification sensor system

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PUBLIC ABSTRACT

Research was undertaken to develop a machine vision-based weed spot sprayer for the Australian sugar and cotton industries. Competition from weeds causes significant loss in production that is estimated at $70M annually to the Australian sugar industry. Commercially-available weed spot sprayers have ability to control weeds growing between the rows. However, weeds growing in the row cannot be easily controlled as the current technologies do not discriminate weeds from sugarcane. Machine vision-based weed detection has potential to reduce herbicide use and runoff by selectively spraying weeds.

This project aimed to integrate machine vision-based weed discrimination algorithms with commercial spray control systems from a spray equipment manufacturer, to develop a field-ready, optimised, precision weed detection system. The project followed from SRA project NCA011 (2010/011) in which proof-of-concept algorithms for discriminating Guinea Grass from sugarcane were developed.

The video data set of sugarcane and Guinea Grass was extended in the current project using a dedicated over-the-row data collection unit, consisting of colour and colour/depth cameras. The data collection device was sent to Cairns in 2016 where video imagery was recorded across nine field trials. Collected video was used to refine and optimise Guinea Grass detection under a range of conditions. Evaluations indicated that colour cameras were more robust and cost-effective than colour/depth cameras.

A commercialisation agreement was developed with the aim of making this technology commercially available to the sugar industry, and a generic sensor module compatible with the commercial partner was developed. An SRA sprayer instrumented with generic sensor modules was evaluated in field trials at Cairns in 2018. Agronomic field trials consisted of recording hit and miss rates during a real-time detect and spray operation using the machine vision-based weed spot sprayer. The machine vision-based spot sprayer achieved average hit rates of 96%, 88% and 67% with less than 1% false triggers on big, medium and small Guinea Grass, respectively, in agronomic field trials for large cane. The spot sprayer was inconsistent in agronomic trials for low cane; however, weed detection accuracy of 89% accuracy was achieved during post-processing analysis that involved image analysis parameter adjustment and recorded field images being replayed through the spot sprayer equipment in a desktop study.

Simultaneous to research in the sugar industry, development of the machine vision-based spot sprayer also occurred for application in the cotton industry. Volunteer cotton is an emerging weed problem in the Australian cotton industry, and there are currently six grasses and two broadleaf weeds with herbicide resistance in Australian cotton systems.

Initially, the project focussed on weed discrimination algorithms using a colour/depth camera, leading to development of novel algorithms. However, the colour/depth camera was limited in application given it required a shade hood and controlled lighting. Subsequently, algorithm development focussed on colour cameras that could operate in daylight and on a free-standing boom that was consistent with industry use cases. The algorithms were implemented on the generic sensor module and a ute-mounted spot spray boom was designed and manufactured for data collection using the generic sensor module to validate developed algorithms.

Video imagery of weeds was collected at six cotton field sites using the ute-mounted spot spray boom, a Phantom drone and a handheld phone/gimbal apparatus. Post-processing analysis was applied to video data collected at five of the cotton farm sites to evaluate weed management strategies using the machine vision-based weed spot sprayer.

Traditional practices of broadacre weed management and the use of the machine vision-based spot spray system were compared by calculating the volumes of herbicide used for both potential approaches. The volume of herbicide required was significantly reduced using the machine vision-based weed spot sprayer. Potential herbicide cost savings were calculated as up to $8 per hectare for a glyphosate-based strategy, and $30 to $40 per hectare for alternate modes of action.

Commercial trials will be required to continue during 2019 for extended field trials including spray efficacy, for both sugar and cotton industries.