

ARTIFICIAL INTELLIGENCE FOR TARGETED WEED CONTROL



PROJECT LEADER

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SYSTEM

MAGNUS AND ZEUS

TIME ALLOCATED

50,000 HOURS

AREA OF SCIENCE

PLANT PROTECTION,
NEUROCOGNITIVE PATTERNS
AND NEURAL NETWORKS

APPLICATIONS USED

CAFFE, OPENCV, PYTHON
LIBRARIES SCIKIT LEARN

Food security is one of the major global issues facing researchers and policymakers today, and crop infestation by weeds is one of the biggest threats to grain productivity. Weeds cost Australian grain growers \$3.3 billion per year, and cause annual yield losses of 2.7 million tonnes. Currently, the most efficient method of weed control available is to use a blanket application of herbicides, but this wastes resources and cultivates herbicide-resistant weeds.

Dr Selam Ahderom and his colleagues at Edith Cowan University's Electron Science Research Institute (ESRI), alongside industry partners at the Grains Research and Development Corporation (GRDC) and Photonic Detection Systems (PDS), are developing technology that will allow grain growers to apply herbicides more selectively and efficiently. Using reflected spectral data from lasers and spatial information from cameras mounted on tractor booms, their technology will use artificial intelligence to discriminate between the crop and weeds such as ryegrass, wild radish, and wild oats, and will spray herbicide only where it is cost-effective to do so.

2017

WEED SENSING AND IDENTIFICATION THROUGH COMPUTER VISION

Testbed facility built at ESRI for testing our algorithm performance

THE CHALLENGE

Weeds and grain crops may be easy for a trained human eye to discriminate between, but for a computer it is much more of a challenge. There are many variables that will affect the shape, colour and spectral properties of a plant, including its growth stage, the presence of disease, and water deficiency. Furthermore, environmental factors like lighting, the presence of water droplets, and camera angle can change the plant morphology as measured by the sensors and camera. The ESRI team, led by Professor Kamal Alameh, needed to create a program that would be flexible enough to recognise weeds in various conditions with a high level of accuracy, while processing the data quickly enough to match the moving speed of a tractor, up to 25 kilometres per hour.

THE SOLUTION

The ESRI team designed a system using neural networks and deep learning to distinguish between crops and weeds, but needed a high performance computing solution to realise their vision.

Just like a human brain, the neural networks require training, in order to calibrate the 'weights' of different filters, which the network uses like neurons in making the decision on whether an image is a weed or not.

"What each particular neuron does is not very important," said Dr Ahderom, "but when it has many different potential inputs, when it is trained by looking at the images in hundreds of thousands of different scenarios, a particular pattern emerges in the weight distribution in how each neuron should behave."

The ESRI team used the Zeus cluster at Pawsey, allowing them to train the networks in different configurations simultaneously using multiple GPUs, each of which runs at more than ten times faster than a PC.

"Being able to see different models simultaneously, and being able to compare them, allows us to work very fast in evolving the system," Dr Ahderom said.

OUTCOME

Using the power of Pawsey's world-class facilities, the ESRI team have made significant progress towards their goal of creating a commercially viable variable-rate herbicide applicator. They are currently in the process of optimising their system, with the hope that they will be able to test a fully functional prototype in the field in April 2018.

"If we are able to put this technology into farmers' hands, we could, in certain cases, reduce the amount of herbicide used in a field by up to 90%,"

Dr Ahderom said. This would significantly reduce the estimated \$113 per hectare that is spent on weed control by farmers each year.

Once the program has been optimised for wheat crops, the photonic weed control technology also has the potential to be adapted to other applications, including anywhere "an invasive weed is affecting either an industrial process or the natural ecosystem, whether in natural reserves, roadsides, or other areas," Dr Ahderom said.