Horizon Scanning Series

The Effective and Ethical Development of Artificial Intelligence: An Opportunity to Improve Our Wellbeing

Agriculture

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The potential impact of AI on agriculture

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The term AI can be used loosely to cover any application that is heavily dependent on computing power, but the impact on agriculture should also include the influence of communication.

A development that is already taking place is the design of autonomous machines. Once farming machinery becomes autonomous, there are fundamental changes in the optimum strategy for its use.

In an Australian context, a major limitation of farming has been the availability of manpower. For tasks including harvesting, many farmers must rely on holidaying backpackers and other temporary visa holders. Autonomous farming machines liberate the farmer from that constraint.

Over the years, agricultural vehicles have become large, spreading the influence of a human driver over as many rows as possible. With low-cost guidance ‘intelligence’, multiple small machines can each operate on a single row at a time. They do not have to work as a ‘swarm’; each can have its own task.

Autonomous machines can work throughout the night. Indeed, the ability to control illumination gives night-time vision an advantage over the variable light of sunshine. With the communication provided by mobile telephony, by satellite broadband or by proprietary wireless networks, an autonomous vehicle can collaborate with its peers or call for help if a condition arises that has not been pre-programmed. Most often, some human remote control can be used to resolve the situation.

The great attribute of computer control is its ability to amass sensory data and employ it. With digital storage costing a faction of a dollar per gigabyte, great quantities of ‘experience’ can be stored as the machine performs its task. It can be analysed in real time or passed offline to enable the process to be adapted and optimised.

Computing power is no longer at a premium. The power of an Android mobile phone can analyse a live stream of video data and use it for steering, for weed detection, or for crop health and progress evaluation. Communication can enable a small, autonomous mobile crop monitor to control selective watering, or to call in a slightly larger sprayer to deal with an infestation of weeds or pests.

Machine vision can give precision guidance relative to the actual location of a growing crop. This is superior to GPS guidance which locates the vehicle relative to where the crop was thought to have been planted. Vision can assess the yield of fruit-bearing trees and in the not-too-distant future can lead to efficient selective harvesting. With slight enhancement, a webcam can be given hyperspectral resolution of colours, extending its acuity well beyond that of the human eye. Shots taken from day to day, either from the ground or from flying probes, can be compared precisely to give objective analysis far beyond the quality of human subjectivity.

The addition of a diffraction grating and a slit to a webcam transforms it from a two-dimension viewer to a linescan device. For each pixel along the line, the second image dimension gives a rainbow spectrum of wavelengths. Thus, as it scans a field by moving forward, a two dimensional image is built up with a fine-resolution spectrum for each point.

Attention can be given to each individual plant in the view. If numerous small autonomous machines are integrated into the system, horticulture can be performed with all the diligence of the amateur gardener.

Thus, aspects worthy of research attention include:

- Vision acquisition and analysis
- Integration of multi-camera views
- Analysis across a sequence of images to deduce time variations of crop development
- Analysis across a sequence of frames of a moving video to give precise depth control and obstruction identification
- Multi- or hyperspectral analysis of crops and weeds.
- Multispectral analysis of crop health, heat and drought stress and response to additives
- Drone overview and satellite data, perhaps hyperspectral, to estimate yield and time to harvest.
- Integration of the farming processes with the actions of transportation, storage and marketing, 'seed to table'
- Automation of the animal husbandry processes, going beyond automatic milking and feeding
- Automatic monitoring and mustering of free-ranging herds.

At present, most agricultural machines are large capital items. Their manufacturers will perhaps be reluctant to introduce innovations in a way that would reduce their cost. In contrast, the 'smarts' required for intelligent computer control and autonomy can be embedded in the hardware of a mobile phone that can be purchased for well under a hundred dollars. Such a device can use Bluetooth to command a steering module, built into a machine that is perhaps no more massive than a quad-bike. Many farming tasks can be performed, though not those needing large carrying capacity such as broadacre harvesting.

Here is surely an opportunity for Australia to break its dependence on imported machinery. Indeed, such machines would have a worldwide market in poorer countries where large machines are uncommon. There, shortage of labour is not such a great pressure towards autonomous operation, but the increased efficiency of 'smart' machines would make them desirable.

An industry producing intelligent small machines both for home consumption and for export could make a great impact.