Are drones the answer for detecting green weeds in green crops?

Peter Newman, Planfarm

Key messages

No, I don't think drones are the answer.

It may be possible to use drones to detect weeds in crop enabling later patch spraying with a conventional boom spray, but it is unlikely to be economically viable due to the cost of image capture by drone to achieve the required image quality.

There have been exciting international developments in the ground based see and spray technology such as Blue River technologies. I believe that this is where the detection and patch spraying of green weeds in green crops is likely to come from.

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Aims

To evaluate image capture with a fixed wing drone to detect green wild radish in an early tillering wheat crop to enable patch spraying with a conventional self-propelled boom spray.

To reduce the cost and improve the efficacy of the control of herbicide resistant wild radish in cereal crops for Australian grain growers.

Method & Results

We teamed up with a local surveyor in Geraldton, Peter Chaplyn from Quantum surveys. Peter owns an ebee Sensefly fixed wing drone carrying a Sony compact 18 megapixel camera. We chose the fixed wing drone as we believe that it will be necessary to fly in the order of 200ha / hour or more to make this approach economically viable. With the cost of travel, the cost of the drone, two staff (one drone operator and one full time eagle spotter), and the fact that images must be captured during cloudless days between 10am and 3pm, it is necessary to cover a lot of ground in one day for spot spraying to be cheaper than bulk spraying.

We also teamed up with researchers Steve Rees and Cheryl McCarthy from the University of Southern Queensland, Toowoomba. Steve has over twenty years of experience in weed detection and identification. Steve's advice, based on this vast experience, was to capture RGB images at the highest image quality possible and he advised against using multi-spectral images. Steve and Cheryl believed that if we could capture sub 12mm pixel resolution we should be able to distinguish between wheat and wild radish. Cheryl is running a similar research project in Queensland using a fixed wing drone to capture images, but at this stage is primarily focused on summer fallow spaying.

Test flight one: Chapman Valley, May 2016. Early sown wheat with large volunteer canola that had survived the knockdown herbicide. These weeds are larger than the weeds that we would typically like to target with this project and thus are considered an easy target. If we can't find these weed in a small wheat crop then the project is a failure.

The drone was flown at 78m altitude capturing images of 2.4cm pixel size. This image quality is deemed as adequate to identify broadleaf weeds in cereal crops, however, better image quality is preferable. Images were captured and mosaicked together by Peter Chaplyn and sent to researchers at the University of Southern Queensland, Toowoomba (USQ) who we have partnered with for image analysis. In short, the images were not of high enough quality for image analysis to differentiate between broadleaf weeds and cereal crop, despite the large size of the weeds (canola) in the small (3 – 4 leaf) wheat crop.

Test flight 2: Northampton – July 2016

Once again we flew the drone over a cereal crop (5 leaf wheat) this time with wild radish (10-20cm diameter). We flew the drone at 50m, 75m and 100m altitude with two cameras, a Sony and a Cannon compact camera. At 50m altitude the cameras captured 1.7cm pixel resolution images. Despite this improvement in image quality, once again, the images were deemed as being too low quality to differentiate between weeds and crop using an image analysis algorithm.

How to capture high quality images?

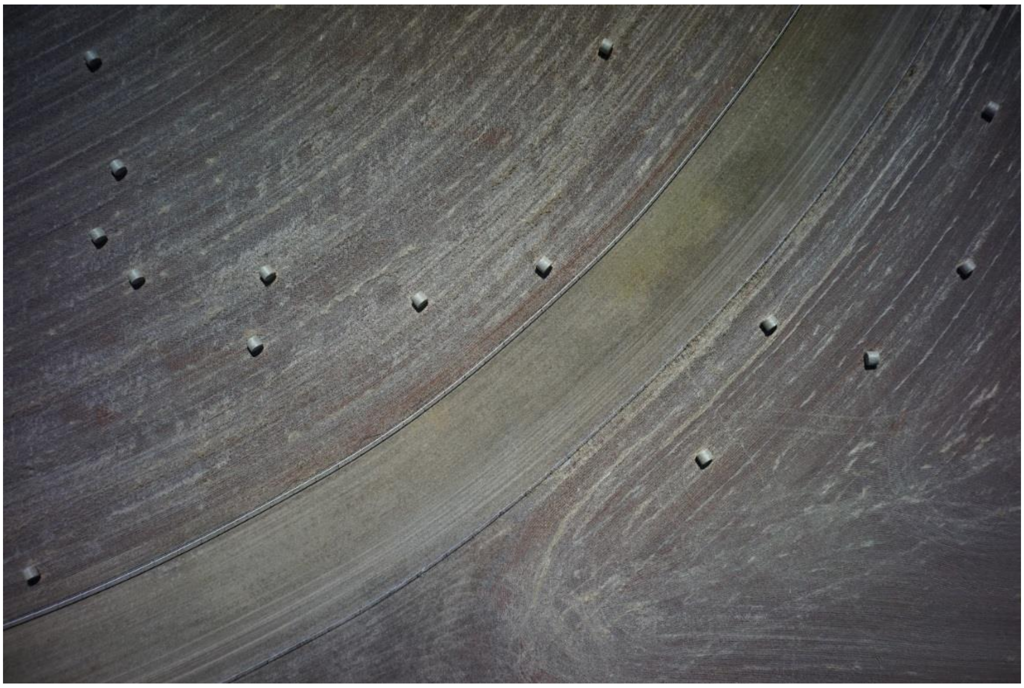
After these test flights further discussion was held with USQ researchers Steve Rees, Cheryl McCarthy and Craig Baillie. Given the pixel resolution that we captured, Steve and Cheryl were hopeful that we would be able to capture adequate images with the ebee drone but as it turns out there is more to image quality than pixel size. The size of the image sensor in the camera is critical. A compact camera has an image sensor approximately 8mm x 5mm. Also, the lens on a compact camera is generally of low quality. What is required for this job is a higher quality camera.

Enter the Trimble UX5 HP

This drone can carry a full frame sensor (35mm lens) 36 megapixel mirrorless SLR camera – Sony alpha 7r. Fitted with a high quality lens, this drone is capable of capturing 1cm pixel resolution images from 80m altitude while travelling at 90 kph. The great news is that Peter Chaplyn from Quantum purchased this drone at a cost of $80K. Not only does it capture great images, it has 5cm accuracy geo-referencing capability when used with a base station.

Test flight 3: Trimble UX5 HP flown over Dongara race course

The image below from this test flight was forwarded to the USQ researchers and passed with flying colours.



Test flight 4: Trimble UX5 HP, Chapman Valley, June 2017

This flight had two objectives.

1. To once again attempt to capture images of the resolution required to detect green weeds in green crops
2. To capture geo-referenced images of pegs placed on the ground to develop a 'dummy' prescription map with the John Deere boom spray.

Results

1. The images were once again deemed to be of inferior quality to be able to identify green weeds in green crops despite achieving 13mm pixel resolution. Flying at 4pm is likely to have influenced this, although this was the time of the day when the wind had dropped.
2. The geo-referencing equipment that the drone was fitted with was found to be faulty and was sent back to the manufacturer for replacement. However, we also shot the location of the pegs using ground based surveying equipment and developed a prescription map to spray these points. This was a success and demonstrated the ability to develop simple prescription maps to patch spray a paddock. This private YouTube video shows patch spraying in action. https://youtu.be/_sLjeai58T4

Conclusion

Through this project we have identified that it is definitely possible to patch spray weeds in crops and there is a demand for this technology from farmers to save time and money as well as target weeds for which there is no selective herbicide option. We have also determined that drones are challenging pieces of equipment for a number of reasons, and it is difficult to achieve adequate image quality from a drone. This is likely to change in the future as technology improves, however at this point in time, I believe, that image capture with a drone for later patch spraying is not feasible both in terms of cost and time efficiency.

Unfortunately the option to pursue a ground based image capturing system is not possible as it is tightly held IP and we are not able to work in this space. I believe that it would be possible to capture images with a ground based system, enabling sub 3mm pixel resolutions, accurate geo-referencing, lights to enable image capture in a range of light conditions, all at low cost. This would be a three stage process of image collection, image analysis, and spot spraying. However, it could be cost effective if the image analysis was successful.

The problems with drones

- They fly. Much more temperamental than ground based machines.
- Eagles.
- Multi-rotors capture better images but they are too slow and their flight time is generally shorter than fixed wings.
- Fixed wing drones are fast and have acceptable flight time (an hour or so), but are harder to launch, and have a minimum altitude (they fly fast and the camera can't keep up), therefore image quality is limited to about 10mm pixel resolution or greater.
- Geo-referencing accuracy. The world is not flat so images are stretched over undulations, restricting accuracy.
- Flights must be overlapped by 70% for image mosaicking software to work. This means that the drone must fly approximately three times as much compared to nil overlap. New software is being developed to overcome this which may reduce overlap to 5%. This would be a major step forward.

Key words

Drone, UAV, wild radish, wheat

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