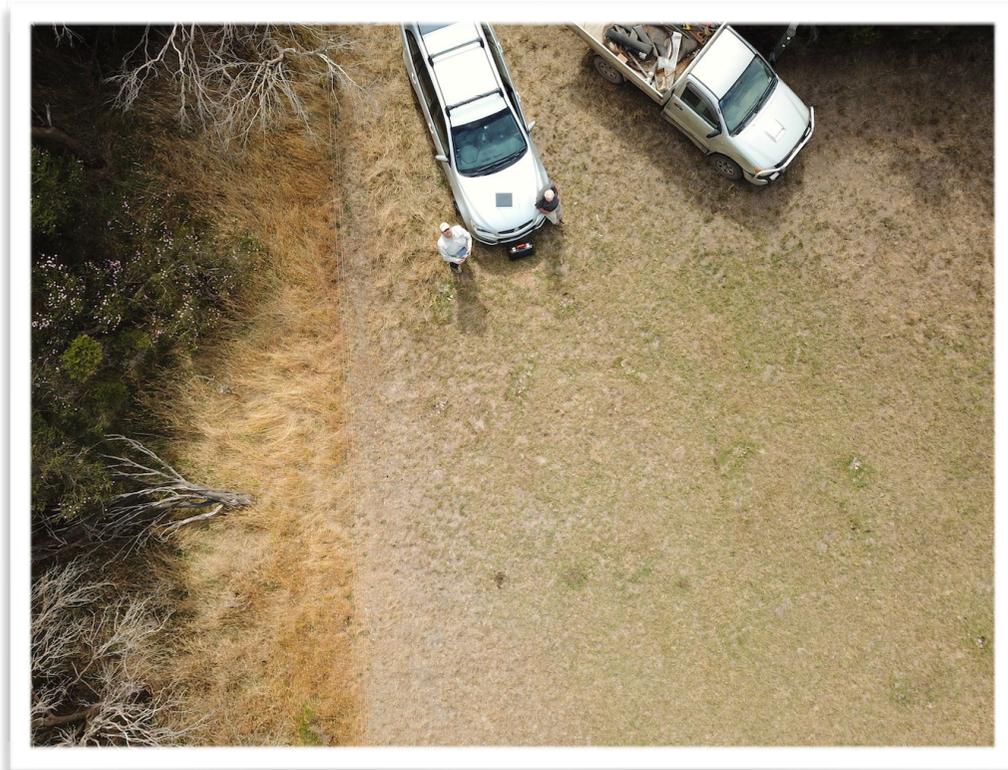


Paddock Mapping by Drone

is there a way we can replicate the expensive flight control software using low/ no cost software?
Is there a way to cheaply generate plant health data from RGB images?



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Paddock Mapping by Drone

BIMBADEEN PHILLIP ISLAND

Initial Rationale:

As part of the Carbon Capture project, we used a drone to capture high resolution imagery of several paddocks at Bimbadeen.

The Mavic Pro drone flew over each paddock taking an image every second. These images were then stitched together to create one ultra high definition image. The resolution on this image was incredible, we can clearly see individual plants, irrigation pipes and even cow pool!

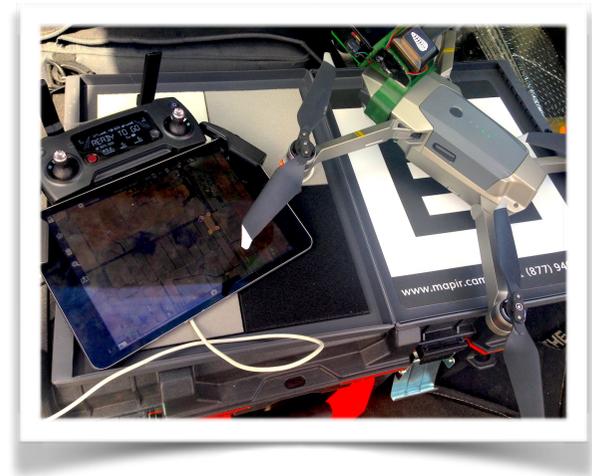
The idea was to offer our farmers a birds eye view of their paddocks to assist them in making decisions.

The drone was also modified to capture normal (RGB) images as well as Near Infra Red (NIR) images at the same time. To do this, we added a second camera- a Mapir Survey 3 OCN.

Near Infra Red images are used to create a NDVI image of the paddocks. The normalized difference vegetation index (NDVI) is a simple graphical indicator that can be used to assess relative “health” of the vegetation in the target area. It compares reflected red and near infrared (NIR) light and the level of absorption and reflection. Generally, plants which are reflecting more NIR light will be performing more photosynthesis and thus are healthier (and vice versa)

Our idea was to fly over these paddocks on a regular basis and capture data on the affects of carbon on plant health.

Complimenting this process, we also looked at how drones might assist our farming practice in the future...



In the second year of the trial, the paddocks had received treatments and practices which would not make a “fair” comparison. This therefore made the use of NDVI imagery as comparative data obsolete.

In continuing the main aims of the drone component, we decided to explore the ways utilise low cost drones to assist our farming practice. In this instance we explored the use of standard RGB cameras and the VARI index.

VARI INDEX

$$VARI = \frac{Green - Red}{Green + Red - Blue}$$

VARI is designed to work with RGB data rather than near-infrared (NIR) data.

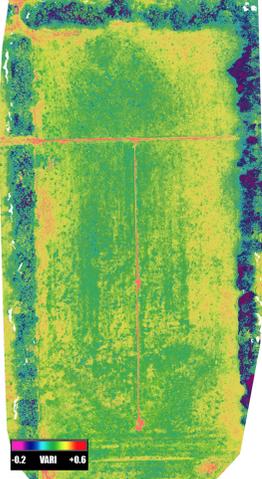
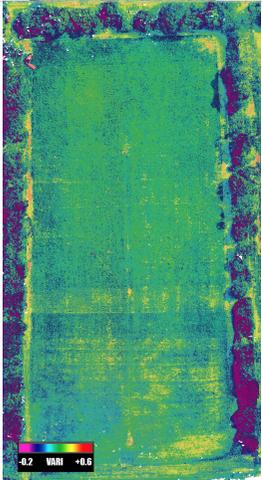
It is a measure of "how green" an image is and is not intended as a substitute for a NIR camera. It is not far beyond our visual reference which means it can be more relatable to our practice. VARI also measures the reflectance of vegetation versus soil.



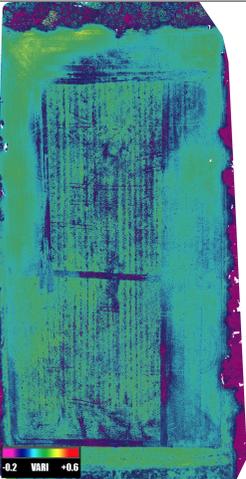
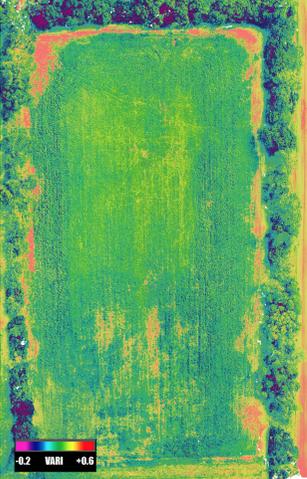
Purple/ Blue represents Dark Green (High Growth) and Yellow-Red represents No Green (Low Growth)
Patches of bare soil may appear at the Red end of visual spectrum.

BIMBADEEN- RESULTS

M14

	RGB	VARI
JAN 2019		
FEB 2020		

M16

	RGB	VARI
JAN 2019		
FEB 2020		

Observations:

- The VARI index offers a slight enhancement on “normal” RGB imagery, and could be used to pin point areas of the paddock requiring further attention. However, given the process, there may not be enough benefit to justify the time and cost.
- The most important aspect to come out of this trial was the ability of this imagery to tell an overarching “story” of the paddock. In both the m14 and m16 paddock examples, we can see the growth and changes to pasture.
- The Results images are scaled down versions. The master files are Geo Tagged Hi Resolution images which allow us to see the detail (eg we are able to observe the irrigation set ups such as pipes, pumps etc) and ask questions (eg is our irrigation covering the whole paddock?)

Notes on the VARI Index

Why Use RGB Sensors and the VARI Algorithm?

Many farmers are only seeking to understand the relative plant health of their fields. RGB imagery with the VARI algorithm provides useful information related to variance at a single point in time, and can be a valuable tool to help farmers identify stress and generate variable rate prescriptions. Some farmers may find that RGB imagery is more than enough to identify variability and gain actionable insights about their crops.

Benefits of RGB Sensors

- RGB imagery is cheaper, accessible and can be captured with the average camera
- RGB cameras capture images similar to what is seen with the human eye, meaning it is more familiar and easier to interpret — even without the use of plant health algorithms.
- RGB cameras are also multipurpose, meaning they are able to take pictures for making detailed orthomosaic drone maps; they are also capable of capturing high quality videos.

Drawbacks of RGB Sensors

- RGB cameras are all purpose and not specifically designed for agriculture.
- They can only be used to determine relative plant health within the same map. This means that if you fly half of your field one day and the other half the next, you won't get a useful reading of crop stress. The amount of sunlight and cloud cover needs to remain constant throughout the duration of the drone flight to attribute the relative data analysis.

PROCESS and PROCEDURE
FIRST PASS- JANUARY 2019

PROCESSES

BEFORE THE FLIGHT

RGB Imagery

1. Maps are created by Drones Made Easy App (Map Pilot) . They are saved as 'Missions" within the App
2. The user defines an area to survey as well as the resolution of the survey (defined by height of flight/ number of images).
3. Target resolution is >1.5 pixels per cm. Ideal target is between 1 and 1,2 pixel/cm
4. Overlap should be between 70% and 80% depending on the vegetation
5. Mission are saved via the left menu
6. App controls onboard camera.
7. Format is high res jpg.
8. Be mindful of exposure

OCN Imagery

1. Camera is stand alone
2. Preset Capture to 1 sec interval
3. Format is JPG and RAW (RAW cant be processed by Maps Made Easy)
4. Make sure to take a shot of Calibration Target before mission.

THE FLIGHT

Flying the Mission

1. The Mavic Pro is a sub 2kg drone and complies with regulation relation to Landholders and drones. (Excluded category)
2. Conduct a visual inspection of the site- any obstructions?
3. Farm operations?
Power lines?
Stock?
Wildlife?
4. Identify a safe fly off zone
5. The mission is an automated flight which means that the operator is not flying the aircraft. The aircraft is flying to a set of GPS co ordinates.
6. To resume control off the aircraft at any time, the operator must switch from P to S mode on the controller.
7. Caution: Drones Made Easy (Map Pilot) mapping app can crash during a mission. The drone continues to fly the waypoints but camera is disabled. Other options are to use Litchi Mission with camera options set to interval recording of 2 sec, gimbal angle -90'. This doesn't affect the OCN camera as it it triggered internally.

AFTER FLIGHT

Processing RGB

1. Create a folder for the farm project (eg Bimbadeen)
2. Put all RGB images in a folder called RGB
3. Go through folder and delete any images which aren't part of the mission
4. Log on to Maps Made Easy
5. Create New Map and follow the steps to create an orthomosaic image. You can elect to have processing occur quicker by paying with points. You will get an email once the processing is complete.
6. Download the completed file in ALL of the formats supplied.

Processing OCN

1. Go to folder for the farm project (eg Bimbadeen)
2. Put all OCN images in a folder called OCN. Note: there will be RAW and jpg files. You need both.
3. Go through folder and move your calibration image to a folder called Calibration . Delete any images which aren't part of the mission.
4. Log on to Maps Made Easy
5. Create New Map and follow the steps to create an orthomosaic image. You can elect to have processing occur quicker by paying with points. You will get an email once the processing is complete.
6. Download the completed file in the TIFF and jpg format supplied.

Creating a NDVI Image

1. Open the processed OCN tiff file in Mapir Camera Control app (Windows Only)
2. Click on "Calculate Index".
3. The OCN camera uses the Red and Blue channels to calculate NDVI
Settings
4. X Filename @Band1(Red Channel)

5. Y Filename @Band3(Blue Channel)
6. Select Apply (the process will take a while)
7. The app will generate a BW image with NDVI values.
8. Click “OK” and Close the Calculate Index Tab.
9. Click on “Configure LUT”. LUT is a colour representation of the NDVI index.
10. Generally the RED colour represents lower NDVI values (a lower number on the index indicates more absorption of Near Infra Red light which points to poor plant health). The GREEN value indicates more reflection of Near Infra Red light which points to healthier vegetation.
11. You can select how many colours in th LUT and the values for Red and Green,
12. Select “Apply”.
13. Once the LUT has been applied hit “OK”. Then “Close”
14. In the top Left hand corner of the app, select “Save”
15. File will be saved as Filename_LUT.tif

Creating an Image Compile in Photoshop

1. Open the RGB Orthomosaic tif file in photoshop
2. Create a second layer called “NDVI_date” where date is the date of the flight
3. Open the processed OCN_LUT.tif file
4. Select All and Copy.
5. Go back to the RGB Orthomosaic, select the NDVI layer and Paste the OCN_LUT content into the layer
6. Go to Edit- Transform-Scale and make the X and Y values 145%. Click “Accept”.
7. You should now have a multi layer image with the high resolution RGB (Normal) view as the bottom layer and the NDVI layer over the top.
8. Use the test tool to label the paddock/details in top right of image

9. Export 2 versions of this file- one with 25% opacity on the NDVI layer and one with 50% opacity. You may need to reduce the overall size of the image to be exported (25%-33% of actual size recommended)
10. Save file as PSD file with layers. As you complete more passes of the same location, you will add extra NDVI layers

SECOND PASS FEB 2020

FIELD TRIAL

1. Capture Ortho of M16 and m14
2. Link RGB imagery to soil data sets with GoogleEarth
3. Trial VARI algorithm for RGB capture via Litchi

SECOND PASS

PROCESSES BEFORE THE FLIGHT

RGB Imagery

1. Maps are created by Litchi (App Store- \$39) . They are saved as ‘Missions’ within the App
2. The user defines an area to survey. We followed the edges of the paddock and then flew straight lines north/ south with 15 metre gaps between each line. For defining the resolution, we referred to the original flight data captured in the Drones Made Easy app.

	HEIGHT	RESOLUTION	SPEED
ORIGINAL DATA (DRONES MADE EASY)	35m AGL	1.2 cm/ px	4.2 m/s 15.1 kmh
LITCHI DATA	35m AGL	1.2 cm/px	3.47 m/s 12.5 kmh

3. Target resolution is >1.5 pixels per cm. Ideal target is between 1 and 1.2 pixel/cm
4. Overlap should be between 70% and 80% depending on the vegetation
5. The App controls flight (height, speed, orientation). The onboard camera is then set to capture at a set interval (every 3 seconds). Gimbal is set to -90° (0 nadir)
6. Format is high res jpg.
7. Be mindful of exposure

THE FLIGHT

Flying the Mission

1. The Mavic Pro is a sub 2kg drone and complies with regulation relation to Landholders and drones. (Excluded category)
2. Conduct a visual inspection of the site- any obstructions?
3. Farm operations?
Power lines?
Stock?
Wildlife?
4. Identify a safe fly off zone
5. The mission is an automated flight which means that the operator is not flying the aircraft. The aircraft is flying to a set of GPS co ordinates.
6. To resume control of the aircraft at any time, the operator must switch from P to S mode on the controller.
7. Litchi provided greater functionality with the ability to switch between Mission and Camera Modes during flight. This allowed the constant monitoring of exposure.

AFTER FLIGHT

Processing RGB

1. Create a folder for the farm project (eg Bimbadeen)
2. Put all RGB images in a folder called RGB
3. Go through folder and delete any images which aren't part of the mission
4. Log on to WebODM
5. Create New Map and follow the steps to create an orthomosaic image. You can elect to have processing occur quicker by paying with points. You will get an email once the processing is complete. This will take some time (+/- 150 images approx 90 minutes)
6. Download the completed file in ALL of the formats supplied.
7. In the Map heading, you can select Plant Health Index.
8. Select VARI from the drop down box
9. Values should be set to between -0.2 to 0.6

Creating an Image Compile in Photoshop

1. Open the RGB odm_orthophoto.tif file in photoshop
2. Create a second layer called "VARI_date" where date is the date of the flight
3. Open the processed odm_orthophoto_vari.tif file
4. Select All and Copy.
5. Go back to the RGB Orthomosaic, select the VARI layer and Paste the ortho_vari content into the layer
6. Select all in the VARI layer. Image Mode: Adjust to 8bit or 16 bit
7. Go to the Adjustment tab and select Gradient Map
8. From the Colour Swatch, Select Transparent Rainbow (You can also use Spectrum or Red/Green Colour Swatch depending on what you are looking for)

9. Select Dither. You should now have a modified colour image where Purple/ Blue represent Dark Green (High Growth) and Yellow-Red represents No Green (Low Growth)
10. Reduce the Opacity on this layer to 50% so you can see the RGB image underneath.
11. You should now have a multi layer image with the high resolution RGB (Normal) view as the bottom layer and the VARI layer over the top.
12. Use the text tool to label the paddock/details in top right of image. We also added a VARI reference scale
13. Export a JPG version of this file- one with 50% opacity layer showing. You may need to reduce the overall size of the image to be exported (25%-33% of actual size recommended)
14. Save file as PSD file with layers. As you complete more passes of the same location, you will add extra NDVI layers