Correlation between UAV-Based Remote Ground-Truth Data for Strawberry Plants

Luke Esperiquette, Graduate Student Mentor Vikram Sriram, Stanley Ossyra, Dr. Subodh Bhandari

Abstract

- Can the UAV (Unmanned Aerial Vehicle) NDVI (Normalized Difference Vegetation Index) data be correlated with the Ground leaf count data?
- Studying the correlation between UAV sensors and ground data collection equipment.
- NDVI - Normalized Difference Vegetation Index
- NDVI is a method of remote sensing for relative levels of greenness. Due to this, some believe it can be correlated with Chlorophyll levels.
- NDVI compares reflectivity of NIR and Red wavelength bands.
- NDVI = (NIR - Red) / (NIR + Red)
- When plants are healthy they reflect green, which means that the chlorophyll absorbs most of the red and blue light to make food. When unhealthy they reflect more red and blue which means the chlorophyll is not making food.
- Green leaves reflect NIR (0.7 to 1.1 um)
- On the other hand, Chlorophyll in plants absorbs NIR (0.4 to 0.7um)

Hypothesis:

- **The NDVI data will be able to correlate with the ground data, leaf count.**

Fig. 1. Map of the different test Regions

Acknowledgment

This project has been supported by California State Polytechnic University, Pomona

Unmanned and Ground Data Instrument

DJI Phantom 4 Multispectral Drone

Methods

1. The DJI P4 Multispectral Drone helped to collect the NDVI data and the ruler helped to collect the Data Sheet

a. Species included:

8-Apr																
R1	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	
	N0			N25			N50			N75			N100			
IR100	8	8	0.8	10	15	0.78	12.5	5	0.77	15	6	0.78	11	21	0.8	
	10	14	0.79	7.5	11	0.78	14	16	0.81	16.5	4	0.71	7.5	13	0.8	
	9	19	0.79	9	6	0.78	14	14	0.82	10	6	0.82	10	14	0.79	
IR75	10	6	0.8	10	10	0.83	11.5	17	0.78	12	11	0.78	14	12	0.82	
	10	9	0.8	11.5	9	0.8	14	12	0.82	12.5	11	0.74	9.5	15	0.83	
	10.5	11	0.8	10.5	13	0.8	12.5	10	0.81	9	8	0.81	12.5	18	0.84	
IR50	10	6	0.81	7.5	6	0.78	12.5	12	0.78	10	17	0.8	7.5	7	0.8	
	9.5	9	0.8	9.5	9	0.83	10	12	0.83	12	13	0.79	7.5	10	0.82	
	9	13	0.81	9.5	8	0.82	7	7	0.78	12	12	0.81	6.5	5	0.84	
IR25	11.5	7	0.84	7.5	7	0.79	9	15	0.78	9.5	9	0.82	12.5	10	0.82	
	10	5	0.83	9	12	0.8	6.5	6	0.81	10	14	0.77	11.5	8	0.79	
	9	9	0.79	9	7	0.81	9	13	0.83	9	11	0.83	9	11	0.83	
IR0	10	10	0.83	5.5	7	0.82	5.5	6	0.81	6.5	9	0.86	7.5	8	0.86	
	7.5	5	0.82	7.5	7	0.85	7	7	0.85	9	6	0.83	6.5	6	0.82	
	10	10	0.84	6.5	5	0.86	6.5	5	0.87	7.5	6	0.86	7.5	8	0.84	
	r=	-0.4375		r=	-0.3813		r=	-0.234		r=	-0.0459		r=	-0.2141		
R2	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	
	N0			N25			N50			N75			N100			
IR100	7	7	0.79	11.5	13	0.81	9.5	7	0.82	11.5	16	0.81	9	9	0.81	
	12.5	10	0.8	9	8	0.84	15.5	5	0.84	18.5	3	0.79	12	7	0.79	
	8	10	0.82	12	11	0.83	12	7	0.8	16	6	0.81	13.5	11	0.78	
IR75	11	10	0.83	9	5	0.81	19	6	0.78	9.5	17	0.82	8.5	7	0.83	
	7	15	0.82	9	12	0.81	11.5	13	0.8	11.5	18	0.8	10.5	15	0.85	
	10.5	6	0.82	8.5	10	0.84	8	8	0.79	10.5	10	0.83	13	8	0.84	
IR50	7.5	4	0.78	7	5	0.82	9.5	6	0.8	10	7	0.82	12.5	8	0.79	
	8	4	0.81	9	9	0.82	11	4	0.82	12.5	6	0.81	8.5	11	0.8	
	6	5	0.8	8.5	10	0.83	12	5	0.81	11.5	6	0.78	9	11	0.82	
IR25	8	8	0.84	6.5	4	0.82	8	9	0.82	10	9	0.85	7.5	19	0.84	
	7.5	5	0.84	8.5	6	0.85	8.5	6	0.84	8.5	5	0.81	8	12	0.85	
	7.5	10	0.81	8	12	0.84	10.5	10	0.84	9	8	0.84	7	5	0.85	
IR0	11	5	0.83	8	12	0.82	10	5	0.85	12.5	7	0.84	9.5	11	0.83	
	8	9	0.86	7	8	0.85	12	5	0.8	12	6	0.81	6.5	10	0.83	
	7.5	8	0.81	8	10	0.86	11.5	5	0.85	9	11	0.85	8.5	7	0.79	
	r=	0.2136		r=	-0.0307		r=	-0.212		r=	0.1166		r=	0.3017		
R3	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	Height(cm)	# Leaves	NDVI Values	
	N0			N25			N50			N75			N100			
IR100	12.5	13	0.79	14	16	0.72	14	6	0.77	9.5	10	0.79	14	7	0.77	
	12	17	0.8	7.5	15	0.73	14	9	0.75	13.5	11	0.75	14.5	6	0.8	
	18.5	29	0.79	14	14	0.8	14.5	16	0.75	12.5	6	0.78	9	6	0.76	
IR75	12	6	0.8	13	9	0.73	12.5	6	0.8	12	5	0.81	9	14	0.8	
	14	5	0.84	13.5	4	0.81	16	6	0.78	9.5	12	0.78	11	9	0.81	
	13	13	0.81	13	6	0.82	10.5	6	0.83	8.5	4	0.8	11.5	6	0.77	
IR50	8	9	0.85	15	17	0.79	10	10	0.76	12.5	6	0.82	8	7	0.73	
	8.5	5	0.84	8.5	10	0.84	10.5	9	0.83	13.5	6	0.76	9.5	9	0.77	
	11.5	10	0.81	14	7	0.82	8.5	12	0.79	9.5	5	0.79	12.5	5	0.78	
IR25	12	13	0.82	11	8	0.81	11.5	3	0.83	11.5	5	0.79	8	11	0.78	
	14	12	0.85	13.5	6	0.83	8	3	0.76	9	6	0.81	10	15	0.79	
	9	8	0.84	12	6	0.82	9	3	0.83	10.5	7	0.83	10.5	6	0.8	
IR0	11	4	0.79	6.5	5	0.81	11	5	0.79	4.5	5	0.82	9.5	7	0.82	
	5.5	11	0.81	13.5	5	0.86	12	5	0.81	5.5	6	0.82	5.5	12	0.82	
	9	15	0.82	10.5	6	0.85	13.5	14	0.85	7	6	0.8	7	6	0.82	
	r=	-0.3849		r=	-0.656		r=	-0.1766		r=	-0.4676		r=	0.2116		

2. Remote sensing data was collected around midday for best lighting conditions.

3. After data collection: the data is inputted into an image analysis software. The software utilized is known as **Pix4DFields.** Individual images collected by the UAV are inputted and processed

4. There are **75 regions** within the test field.

5. The software automatically stitches together the collected imagery and turns It into **1** cohesive file.

6. After retrieving the NDVI values, the data is joined with the Ground Leaf Count Data.

7. Once the data is inputted on one excel file, graphs are created to help visualise the correlations.

NDVI vs. Leaf Count Correlation Graphs

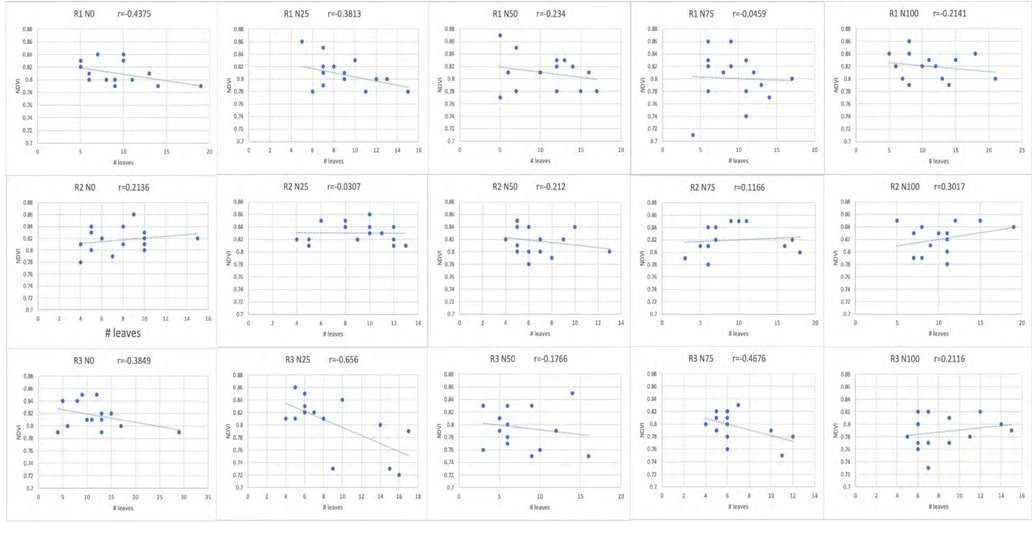
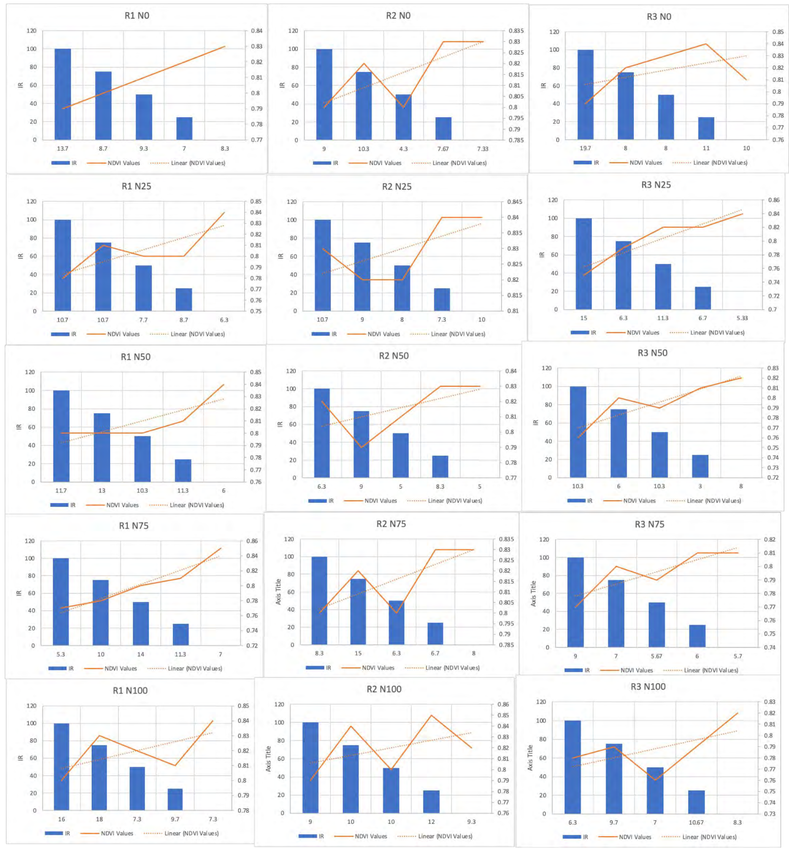


Fig. 2. Ground view of the Strawberry field

Fig. 6. R1 N100 Strawberry Plant

NDVI vs. Leaf Count vs. Irrigation Correlation Graphs



Results and Conclusion:

- The UAV NDVI data does correlate with the Ground Leaf Count data.
- The NDVI data also correlates with the Irrigation levels at an interesting rate. This can be seen in the graph above.

Importance and Future Studies:

- **Areas of further study** include:
  1. Determine how to better correlate the ground nitrogen data with the NDVI data.
  2. Bring in, ground collected, Chlorophyll data to determine the correlation between the chlorophyll readings and the NDVI values.
- This can aid in the process of optimizing the process of collecting data regarding the health of the plant. It will automate the process in a way where the drone can **collect the data by itself**, without the need for another individual to go out and utilize a ground data analyzer.

Alternate Text

Luke Esperiquette

Cal Poly Pomona- STARS

'Correlation between UAV-Based Remote Ground-Truth Data for Strawberry Plants'

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Hypothesis: The NDVI data will be able to correlate with the ground data, leaf count.

Fig. 1. Map of the different test Regions.

Unmanned and Ground Data Instrument Picture of DJI Phantom 4 Multispectral Drone.

Methods:

1. The DJI P4 Multispectral Drone helped to collect the NDVI data and the ruler helped to collect the Data Sheet.

Picture of how strawberry plants appear with drone camera and a data sheet.

2. Remote sensing data was collected around midday for best lighting conditions.
3. After data collection: the data is inputted into an image analysis software. The software utilized is known as Pix4DFields. Individual images collected by the UAV are inputted and processed.
4. There are 75 regions within the test field.
5. The software automatically stitches together the collected imagery and turns It into 1 cohesive file.
6. After retrieving the NDVI values, the data is joined with the Ground Leaf Count Data.
7. Once the data is inputted on one excel file, graphs are created to help visualize the correlations.

NDVI vs. Leaf Count Correlation Graphs

Fig. 6. R1 N100 Strawberry Plant.

Fig. 2. Ground view of the Strawberry field.

NDVI vs. Leaf Count vs. Irrigation Correlation Graphs.

Results and Conclusion: The UAV NDVI data does correlate with the Ground Leaf Count data. The NDVI data also correlates with the Irrigation levels at an interesting rate. This can be seen in the graph above.

Importance and Future Study: Areas of further study include: 1. Determine how to better correlate the ground nitrogen data with the NDVI data. 2. Bring in, ground collected, Chlorophyll data to determine the correlation between the chlorophyll readings and the NDVI values. ● This can aid in the process of optimizing the process of collecting data regarding the health of the plant. It will automate the process in a way where the drone can collect the data by itself, without the need for another individual to go out and utilize a ground data analyzer.

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