Quality Assessment and Organization for High-Throughout Crop Aerial Image Analysis

CAPSTONE DESIGN 2019

Agricultural & Biological ENGINEERING

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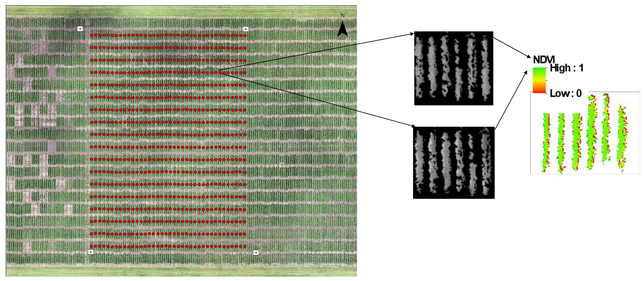
1. Background

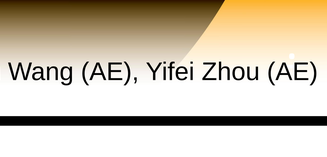
- Traditionally, farmers and plant breeders use ground measurements to manually evaluate plant phenotypic traits to monitor crop health and predict yield, which is inefficient.
- By using aerial images captured by UAV, researchers have built an efficient 3-step data processing pipeline to automate crop plot extraction, vegetation index computation, and data mining.



- Analysis suffers from poor-quality crop images, which deteriorate the accuracy of vegetation indices.
- Inefficient organization of the millions of extracted crop plot images makes the vegetation index computation process very time consuming.

2. Problem Definition

- Identify and remove poor-quality images to improve future analysis accuracy



- Organize massive number of images to derive crop indices from different sources
  - Crop planting time, location, row, range, etc.

3. Sustainability & Impacts

- Improve efficiency to compute vegetation index and phenotypic traits from millions of crop images
- Automate the process for plant breeders to select the crop seeds with the best genotype

4. Alternative Solutions

1. Image Quality Assessment

	Compatibility	Robustness	Optimization	Scalability	Final choice
MATLAB Script Assemble	**5**	**5**	**5**	**3**	**24**
MATLAB ML Toolbox	3	3	5	4	23
Pillow Python Library	4	4	3	4	20

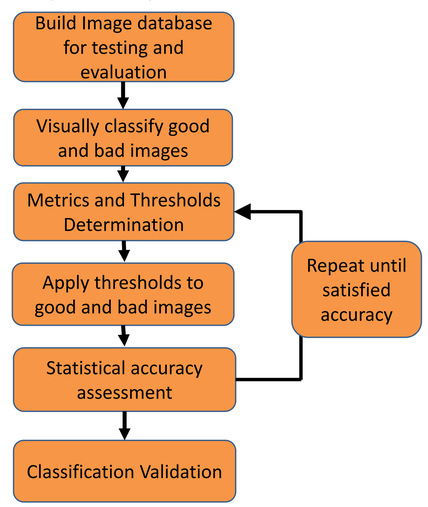
2. Image Organization

	Compatibility	Robustness	Optimization	Scalability	Final choice
2d table	4	5	1	3	20
Tree/graph	**3**	**5**	**4**	**5**	**24**
In-place search	3	1	1	1	15

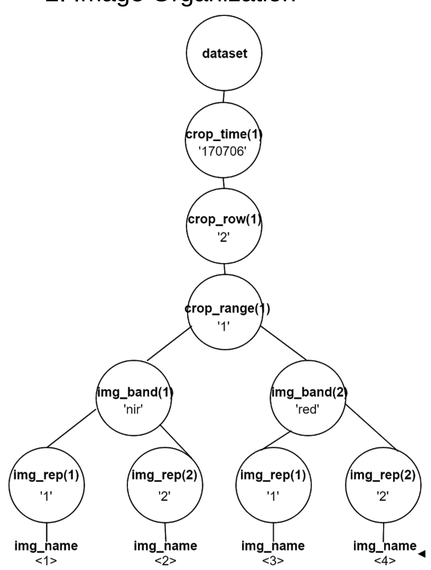
*Each cell is scored from 1-5. Higher score is preferred.

5. Final Solutions

1. Image Quality Assessment



2. Image Organization



6. Image Quality Assessment Result

1. Blurred Images

Precision = 29/35 = 83%

Code \ Human Eye	Blurred	Clear
Blurred	29	6
Clear	5	35

2. Mal-position **Images**

Precision = 30/38 = 79%

Code \ Human Eye	Mal-pos	Good
Mal-pos	30	8
Good	5	32

7. Image Organization Sample Output

- NDVI change for an experiment with 22*18 plots
- Computed from ~5000 crop images in 3 mins

8. Economic Analysis

Item	Unit price	Quantity	Sum price
Brown cluster computing node	$ 4,479	2	$ 8,958
Data storage per Terabyte	$ 75	15	$ 1,125
UAV	$ 17,000	1	$ 17,000
Total Budget			$ 27,083

*All items were purchased before Senior Design Project

9. Recommendations

- We may validate the efficiency of the tree data structure via comparison with previous methods in literature.
- We may elaborate the third step of data mining to utilize the full potential of large-scale vegetation indices and crop images.

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