Paper No:

Smartphone-based High Throughput Phenotyping on Wheat Field

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Abstract:

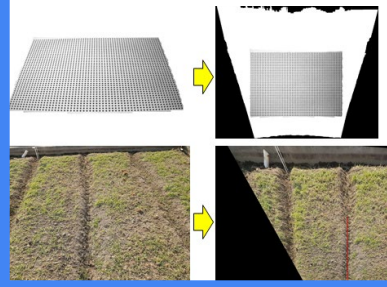
The field is not always easy for plant phenotyping using conventional phenotyping platforms due to the limited accessibility and regulated aviation area. Smartphone-triggered ground images were collected on wheat field that has a limited access to monitor growth conditions of four wheat varieties, Shinyoung (SY), Joseong (JS), Taewoo (TW), and Cheongwoo (CW). For field mapping during the growing season, six sets of the raw RGB images were acquired by a smartphone camera in an oblique view angle and processed to transform into nadir view images. A series of algorithms were developed to process the skewed tile images to straighten into the nadir images, align the deskewed images, and stitch them into a field image by detecting crop rows using Hough Transformation. Open-source software, iStitch, was developed to automate the algorithms in a batch process. Plot-level metrics were extracted to analyze plant growth of the wheat varieties using a gridding method for vegetation and leaf area indexes. The processed images resulted in the successful transformation and consistency of algorithms on image alignment and stitching. Plot-level analysis indicated that SY variety performed superior to the other varieties in plant quality and quantity and significantly different from TW variety in canopy coverage. The proposed approach of the stitching and gridding was applied on the skewed images acquired by a smartphone camera but can be directly used for other applications of plant phenotyping on images acquired by a camera on a mobile platform or a grid of stationary cameras in greenhouse or outdoor fields.

Keywords: Calibration, image processing, phenotyping, Python, software, stitching.

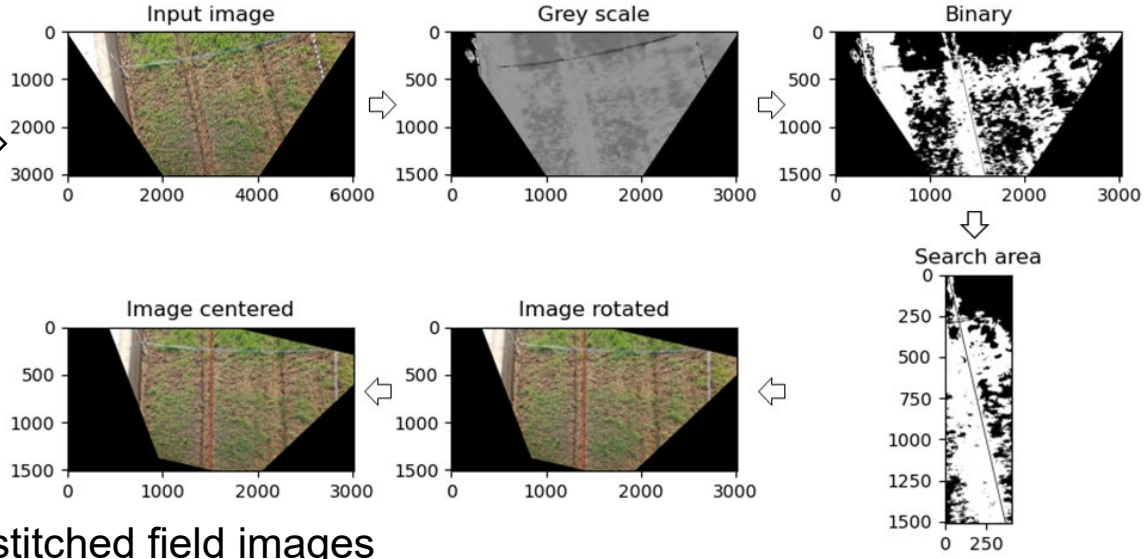
Image Acquisition & Processing

Mapping

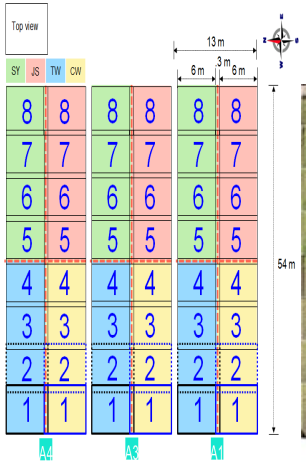
Raw → Deskewed image



Hough Transformation

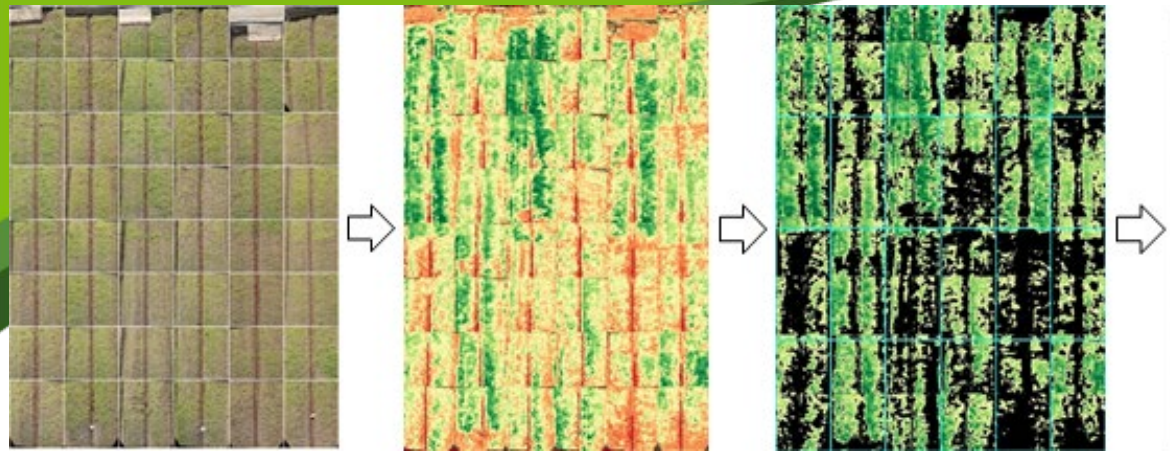


Field Layout

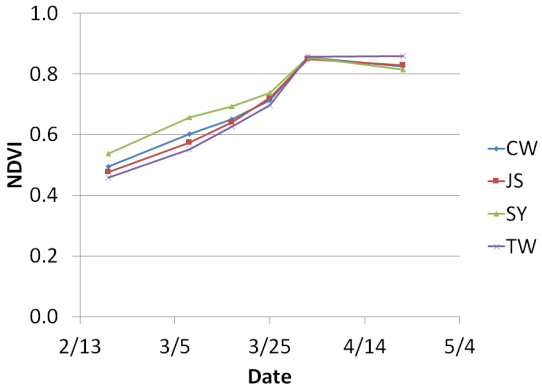


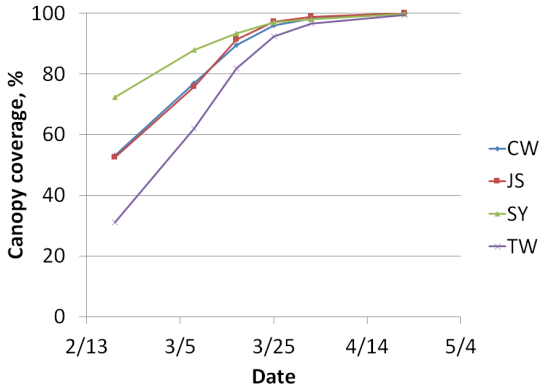
Seasonal sequence of stitched field images

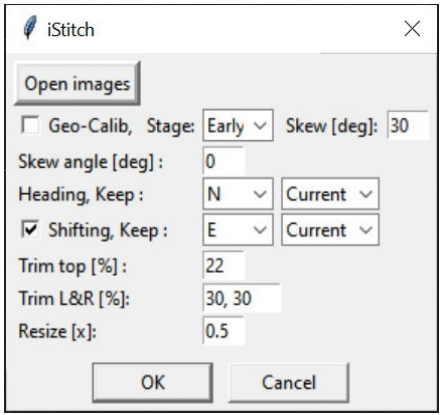
Software for Plot-Level Phenotyping



Row	Col	%Canopy	R [%]	G [%]	B [%]	H	S	V	NDVI
1	1	77.3	58.5	58.7	39.0	42.6	91.3	152.5	0.53
1	2	51.9	62.2	59.7	39.0	37.8	98.7	158.9	0.47
1	3	78.1	58.0	59.1	38.9	44.3	92.4	152.7	0.55
1	4	49.7	59.6	57.5	37.8	38.3	98.5	152.3	0.48
1	5	61.5	55.9	55.6	36.2	41.9	95.5	144.8	0.52
1	6	55.7	61.6	59.3	38.0	38.3	100.6	157.5	0.48
2	1	37.2	63.7	60.9	42.9	36.8	86.3	162.5	0.46
2	2	64.7	59.1	58.6	38.3	41.2	95.2	153.0	0.51
2	3	35.9	61.1	58.9	42.5	37.3	81.0	156.4	0.47
2	4	50.7	60.4	58.6	40.1	38.7	89.5	154.9	0.48
2	5	20.2	57.3	54.2	36.8	36.1	94.1	146.2	0.45
2	6	44.1	60.4	58.6	38.0	39.0	98.2	155.3	0.49







Open-source Software: IMAP: https://doi.org/10.15482/USDA.ADC/1523140
iStitch: https://doi.org/10.15482/USDA.ADC/1524260