BAT optimized CNN model identifies Water Stress in Chickpea Plant Shoot Images

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Overview

Plant Phenotyping

- Plant phenotyping is an area of plant science that deals with the measurement of phenomes as they change in reaction to genetic and environmental changes [1].
- Manual plant phenotyping approaches are costly, time consuming, destructive, low throughput and cumbersome [2]
- In recent years, high-throughput image-based plant phenotyping has emerged as an important field of computer vision research [3]

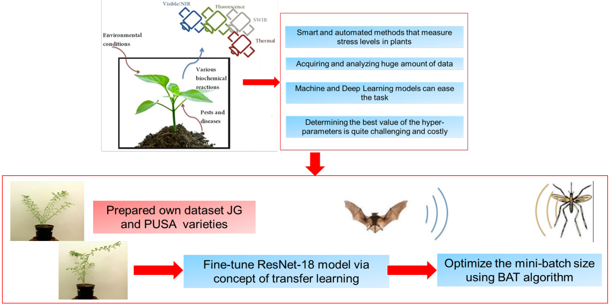

Figure: Image-based plant phenotyping

Dataset

- Dataset collected from National Institute of Plant Genome Research (NIPGR) (chickpea images under water stress condition).
- Two varieties of chickpea strains are used, drought tolerant chickpea (Pusa 372) and sensitive variety (JG 62).
- 15 plants are grown for every variety in an individual pot in control chamber room.
- Measurements are taken under three different conditions of water deficiency; control (no stress), young seedling stage, and before flowering stage.

(a) Pusa 372

(b) GJ 62

Data collection

- We use Canon 60D EOS camera for capturing images.
- The camera is fixed on the tripod at a fixed distance from the plant and plant is placed on the turntable inside a chamber.
- Images are taken in 8 different views (45 degrees apart) every 3rd day. We capture 240 images per day.
- Capturing images is started when the plant is 1 week old and continued till fruiting stage.
- We captured a total of 8600 images in 36 sessions.

Water Stress Identification using proposed BAT optimized CNN model

- We quantify the moisture stress levels in chickpea plant shoot images using BAT optimized ResNet-18 model.
- We have proposed a BAT optimized ResNet-18 model that automatically identifies the best value of the mini-batch size to be used for training.
- The proposed BAT Optimized ResNet-18 model compared with the other state of art CNN algorithms.

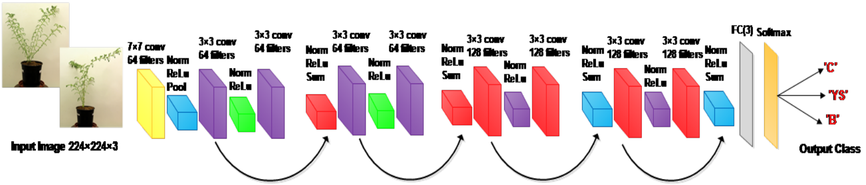

Figure: ResNet-18 architecture used in this work

CNN model	Variety	Mini Batch size
BAT Optimized ResNet-18 model	*Pusa*	49
	JG	28

Table: Value of the mini-batch size optimized by the BAT algorithm

Classifier	Variety	Acc	Se	Sp	Pre
ResNet-18	*Pusa*	0.87	0.87	0.93	0.88
	JG	0.92	0.92	0.96	0.92
BAT Optimized ResNet-18	*Pusa*	0.91	0.91	0.95	0.91
	JG	0.96	0.96	0.98	0.96

Table: Classification performance of the proposed optimized ResNet-18 model

Results

Classifier	Variety	Acc	Se	Sp	Pre
AlexNet	*Pusa*	0.80	0.80	0.90	0.81
	JG	0.80	0.80	0.90	0.80
GoogleNet	*Pusa*	0.66	0.66	0.83	0.67
	JG	0.68	0.68	0.84	0.69
ResNet-50	*Pusa*	0.83	0.83	0.91	0.83
	JG	0.89	0.89	0.94	0.89
BAT Optimized ResNet-18	*Pusa*	0.91	0.91	0.95	0.91
	JG	0.96	0.96	0.98	0.96

Table: Classification performance of optimized ResNet-18 model with state of the art CNN architectures

Conclusion and future work

- We have focused on classifying water stress conditions for chickpeas plants.
- We created our own chickpea shoot images dataset under three different water stress conditions.
- We proposed a BAT optimized ResNet-18 model for identifying water stress in plants.
- With optimizing hyper-parameters, the classification performance improves 4%. Also, the proposed optimized model outperforms the state of art pre-trained CNN models.
- We will consider water stress using chickpea shoot images by using area and distances.

References

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- [2] Challinor, Andrew J., J. Watson, David B. Lobell, S. M. Howden, D. R. Smith, and Netra Chhetri. "A meta-analysis of crop yield under climate change and adaptation." Nature Climate Change 4, no. 4 (2014): 287.
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The End

Thank You