BAT optimized CNN model identifies Water Stress in Chickpea Plant Shoot Images Presentation ID: 2324

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Abstract

Stress due to water deficiency in plants can significantly lower the agricultural yield. In the present work, we have built a dataset comprising of two varieties of chickpea plant shoot images under different moisture stress conditions.
Specifically, we propose a BAT optimized ResNet-18 model for classifying stress induced by water deficiency using chickpea shoot images. BAT algorithm identifies the optimal value of the mini-batch size to be used for training rather than employing the traditional manual approach of trial and error. Experimentation on two crop varieties (JG and Pusa) reveals that BAT optimized approach achieves an accuracy of 96% and 91% for JG and Pusa varieties that is better than the traditional method by 4%.

Introduction

Computer vision based methods offer automated alternatives that measure stress levels in plants in less time without disturbing the plant. However, imagery based plant phenomics does offer many challenges.
Machine Learning (ML) methods have been proven to be quite efficient in the analysis of big data resulting in different research areas such as health, agriculture, etc [2]. Of the various ML techniques Deep Learning (DL) methods where data hierarchically is presented in terms of different convolutions has been becoming increasingly popular [3].
The present paper deals with the classification of water stress in chickpea plants using the shoot images. The main contributions of the paper are:

- As no publicly available image dataset of chickpea plant shoots under different moisture stress conditions are available, we have prepared our dataset to run the experiments presented in this paper.
- 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 outperforms the other state of art CNN algorithms.

Fig. 1: JG variety

Fig. 2: Pusa variety

Material and methods

Dataset: We created our dataset containing chickpea plant shoots images under three different water treatment conditions. Two strains of chickpea plants: stress-tolerant (Pusa-372) and stress-sensitive (JG-62), were grown for the experiment.
Classification performance of the proposed optimized ResNet-18 model: The proposed method is an effective way to enhance the performance of the pre-trained model. The hyper-parameter, i.e., the mini-batch size has been optimized using the BAT algorithm.

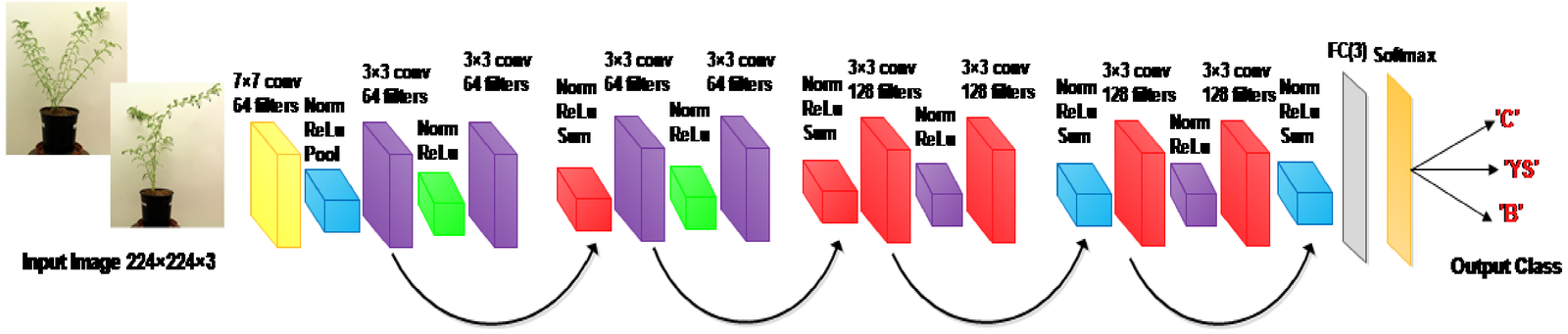

Fig. 3: ResNet-18 architecture used in this work

Results

- The hyper-parameter optimization has been carried out using the BAT algorithm.
- The classification performance achieved by the proposed BAT optimized ResNet-18 model is better than the conventional ResNet-18.
- The classification accuracy of JG variety is more than Pusa variety.
- The performance of the proposed optimized ResNet-18 model is compared with the state of the art pre-trained models like AlexNet, GoogleNet, and ResNet-50.
- Via adopting the optimization strategy the potential of the pre-trained ResNet-18 model is enhanced by nearly 4% for both the crop varieties.

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

Table 1: 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 2: Classification performance of the proposed optimized ResNet-18 model

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

Conclusion

- 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.

References

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