Editorial

Computer Vision Problems in Plant Phenotyping, CVPPP 2018

Tony Pridmore
Tony.Pridmore@nottingham.ac.uk

Sotirios Tsaftaris
S.Tsaftaris@ed.ac.uk

Hanno Scharr
H.Scharr@fz-juelich.de

School of Computer Science
University of Nottingham, UK

School of Engineering
University of Edinburgh, Edinburgh, UK

Institute of Bio- and Geosciences (IBG)
IBG-2: Plant Sciences
Forschungszentrum Jülich, Germany

Plant phenotyping is the identification of effects on the phenotype (i.e., the plant appearance and behavior) as a result of genotype differences (i.e., differences in the genetic code) and the environment. Previously, the process of taking phenotypic measurements has been laborious, costly, and time consuming. In recent years, non-invasive, image-based methods have become more common. These images are recorded by a range of capture devices, from small embedded camera systems to multi-million Euro smart-greenhouses, at scales ranging from microscopic images of cells, to entire fields captured by UAV imaging. These images need to be analyzed in a high throughput, robust, and accurate manner.

UN-FAO statistics show that according to current population predictions we will need to achieve a 70% increase in food productivity by 2050, simply to maintain current global agricultural demands. Phenomics – large-scale measurement of plant traits – is a key bottleneck in the knowledge-based bioeconomy, and machine vision is ideally placed to help [12]. However, the challenges arising differ the from usual tasks addressed by the computer vision community, due to the requirements posed by this application scenario.

Dealing with these new problems has spawned specialized workshops such as Computer Vision Problems in Plant Phenotyping (CVPPP) and the stand-alone workshop IAMPS (Image Analysis Methods for the Plant Sciences) now in its fifth year. CVPPP is regularly held in conjunction with top CV conferences (ECCV 2014, BMVC 2015, ICCV 2017). This year CVPPP returns to BMVC.

The goal of this workshop is to not only present interesting computer vision solutions, but also to introduce challenging computer vision problems in the increasingly important plant phenotyping domain, accompanied with benchmark datasets and suitable performance evaluation methods.

Together with the workshop, permanently open challenges are addressed: the leaf counting (LCC) and leaf segmentation challenges (LSC) (see https://competitions.codalab. org/competitions/18405 and https://www.plant-phenotyping.org/datas

In the following we briefly describe the papers received in the main call. Papers and extended abstracts can be downloaded from the workshop website (https://www.plant-phen org/CVPPP2018-programme).

1 Regular call

Of the 10 full papers presented in CVPPP 2018, seven [2, 4, 10, 11, 15, 20, 21] responded to our open call's computer vision for plant phenotyping topics and three [9, 23, 25] address one or both of the challenges. All submissions, including short papers and extended abstracts, were double-blind peer reviewed by at least two external reviewers. The committee then ranked papers and rejected those that did not receive sufficient scores of quality and priority as suggested by the reviewers. Overall, at present the program includes 7 full papers [2, 4, 9, 15, 21, 23, 25] that are presented as orals and 3 full papers [10, 11, 20] presented as posters. In addition, 14 short papers and extended abstracts [1, 3, 5, 6, 7, 8, 13, 14, 16, 17, 18, 19, 22, 24] are presented as posters. The full schedule and links to papers are available at: https://www.plant-phenotyping.org/CVPPP2018-programme.

This year, there has been particular interest in deep learning [2, 4, 9, 11, 20, 23, 25], affordable or low-cost approaches to plant phenotyping [2, 6, 15, 18] and specialized imaging techniques [3, 8, 15, 16, 21, 24].

2 Acknowledgements

References

[1] Pablo Amador, Mark Müller-Linow, and Hanno Scharr. Measuring ground truth for 3d reconstruction of plants. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[2] John Atanbori, Feng Chen, Andrew French, and Tony Pridmore. Towards low-cost image-based plant phenotyping using reduced-parameter cnn. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[3] Gytis Bernotas, Livia Scorza, Mark Hansen, Lyndon Smith, Karen Halliday, Alistair McCormick, and Melvyn Smith. Photometric stereo data for leaf segmentation and plant phenotyping. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[4] Hao Chen, Mario Valerio Giuffrida, Peter Doerner, and Sotirios Tsaftaris. Root gap correction with a deep inpainting model. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[5] Anwesa Choudhuri and Girish Chowdhary. Crop stem width estimation in highly cluttered field environment. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[6] Mario Valerio Giuffrida, Thibaut Bontpart, Cristobal Concha-Vidal, Ingrid Robertson, Sotirios Tsaftaris, and Peter Doerner. An affordable system to phenotype the root system architecture of the chickpea. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[7] Mario Valerio Giuffrida, Peter Doerner, and Sotirios Tsaftaris. Pheno-deep counter: the universal and versatile deep learning architecture for leaf count. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[8] Evgeny Gladilin. Flu/vis registration approach to automated segmentation of vis plant images. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[9] Yotam Itzhaky, Guy Farjon, Faina Khoroshevsky, Alon Shpigler, and Aharon Bar-Hillel. Leaf counting: Multiple scale regression and detection using deep cnns. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[10] Kevin Keller, Raghav Khanna, Norbert Kirchgessner, and Helge Aasen. Soybean leaf coverage estimation for field-phenotyping. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[11] Jonas Krause, Gavin Sugita, Kyungim Baek, and Lipyeow Lim. What's that plant? WTPlant is a deep learning system to identify plants in natural images. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[12] M. Minervini, H. Scharr, and S. A. Tsaftaris. Image analysis: The new bottleneck in plant phenotyping [applications corner]. *Signal Processing Magazine, IEEE*, 32(4): 126–131, July 2015.

[13] Marcio Nicolau. High-throughput phenotyping of tan spot disease on wheat using iot and deep learning: A proposal workflow. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[14] Nicolas Pasisse, Aurélien Gourrier, Rachel Genthial, Delphine Debarre, Andrea Bassi, and David Rousseau. Graph encoding of multiscale structural networks from binary images with application to bioimaging. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[15] Pejman Rasti, Didier Demilly, Landry Benoit, Etienne Belin, Sylvie Ducournau, Francois Chapeau-Blondeau, and David Rousseau. Low-cost vision machine for high-throughput automated monitoring of heterotrophic seedling growth on wet paper support. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[16] Semion Rozov, Raghav Khanna, Norbert Kirchgessner, and Helge Aasen. RGB - thermal sensor fusion for leaf temperature estimation in field-phenotyping. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[17] Shunsuke Sakurai, Hideaki Uchiyama, Atsushi Shimada, and Rin ichiro Taniguchi. Deep plant growth prediction. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[18] Salma Samiei, Ali Ahmad, Pejman Rasti, Etienne Belin, and David Rousseau. Low-cost image annotation for supervised machine learning. application to the detection of weeds in dense culture. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[19] Hanno Scharr, Patrick Schwehn, Max Riedel, Katrin Heinz, and Kerstin Nagel. Deep neural networks for root system analysis. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[20] Dmitrii Shadrin. Instance segmentation for plant growth dynamics assessment in artificial soilless conditions. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[21] Ali Shafiekhani, Felix B. Fritschi, and Guilherme DeSouza. A new 4d-RGB mapping technique for field-based high-throughput phenotyping. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[22] Weinan Shi, Gert Kootstra, and Huanyu Jiang. Semantic segmentation on 3d tomato seedling point cloud using deep learning. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[23] Daniel Ward, Peyman Moghadam, and Nicolas Hudson. Deep leaf segmentation using synthetic data. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[24] Timothée Wintz, David Colliaux, and Peter Hanappe. Automated extraction of phyllotactic traits from arabidopsis thaliana. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.

[25] Yezi Zhu, Marc Aoun, Marcel Krijn, and Joaquin Vanschoren. Data augmentation using conditional generative adversarial networks for leaf counting in arabidopsis plants. In *CVPPP 2018*, Newcastle, UK, Sept. 2018.