Using synthetic data to boost automated image-based plant phenotyping

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Extended Abstract: Automated segmentation of individual leaves of a plant in an image is a prerequisite to measure complex phenotypic traits in high-throughput phenotyping. Despite substantial progress in automated techniques, leaf instance segmentation remains extremely challenging owing to the variability in leaf shapes and appearance over the life-cycle of the plant [1]. Leading deep learning instance segmentation require huge amounts of manually annotated training data. Currently, the benchmark datasets for leaf segmentation contain only a few hundred labeled training images (Arabidopsis and tobacco plants).

In this work, we propose a framework for leaf instance segmentation by augmenting real plant datasets with generated synthetic images of plants inspired by domain randomisation [2]. Our synthetic Arabidopsis generation pipeline begins with defining of geometric properties of an inspiration leaf. To model leaves of different shape and size, every leaf is randomly scaled along each axis independently. Then texture variation is added with random image exposures. Uniform distributions are used to provide a wide variety in leaf positions and repeated multiple times according to a normal distribution of leaves per plant to generate a 3D plant model. A top down view of the 3D plant model is then rendered to simulate 2D color image. Finally, we train a deep learning segmentation architecture (Mask-RCNN) with a combination of real and synthetic images of Arabidopsis plants. Our proposed approach achieves 90% leaf segmentation score on the benchmark test set outperforming the-state- of-the-art approaches for the Leaf Segmentation Challenge (LSC) [3]. Our approach also achieves 81% mean performance over all five test datasets.

Reference:

[1] Moghadam, P., Ward, D., Goan, E., Jayawardena, S., Sikka, P., Hernandez, E., 2017. Plant disease detection using hyperspectral imaging, in: International Conference on Digital Image Computing: Techniques and Applications (DICTA), pp. 1–8.

[2] Ward, D., Moghadam, P., Hudson, N., 2018. Deep leaf segmentation using synthetic data, in: British Machine Vision Conference (BMVC) workshop on Computer Vision Problems in Plant Pheonotyping (CVPPP2018).

[3] CVPPP Leaf Segmentation Challenge, https://competitions.codalab.org/competitions/18405