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November 1, 2022

NAPPN Annual Conference Abstract: Weakly-supervised Plant Root Segmentation with Graph Convolutional Networks

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Keywords: Root segmentation, weakly-supervised learning, graph convolutional networks

ABSTRACT

Most current phenotype plant research focuses primarily on above-ground traits, like leaves and flowers. Roots often get comparatively less attention because they are challenging to examine and image. Minirhizotron (MR) systems are one of the imaging approaches to studying plant roots underground. In MR systems, a tube is inserted into the ground to allow a camera to be inserted to capture the images of root systems. Unlike minirhizotron imaging, X-ray computed tomography (CT) captures the three-dimensional (3D) information of soil cores extracted from the soil. For a better analysis of roots, the first step is always to segment the roots from the background in the images or image sequences. The results of root segmentation play an essential role in further analysis like root diameter and length estimation. Current fully-supervised segmentation methods mainly use pixel/point-level annotated labels, which require much manual effort and time. In this work, we propose a weakly supervised root segmentation approach with graph convolutional networks. Our model only requires image-level annotations to segment roots from the images or image sequences. In detail, our model first constructs graphs for the neighboring pixels/points and then learns the distinguishable features used as hints for segmentation by training a classifier based on the image-level annotations. Finally, post-processing procedures like principal component analysis (PCA) are applied to refine the final segmentation results. We conduct experiments on the challenging 2D PRMI minirhizotron benchmark and 3D switchgrass root X-ray CT datasets for evaluation.