NAPPN Annual Conference Abstract: A Pipeline for Individual Root Feature Extraction in Minirhizotron Image

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ABSTRACT

The structures of roots play an essential role in plant growth, development, and stress responses. Minirhizotron imaging is one of the widely used approaches to capture and analyze root systems. After segmenting minirhizotron images, every individual root is separated from each other and the background. Root traits, like root lengths and diameter distributions, can provide information about the health of the plants. Current methods to analyze minirhizotron images usually rely on manually annotated labels and commercial software tools, which are time and labor-consuming. Unfortunately, these current methods usually generate a statistical analysis of the input image rather than the features of each root. In this work, we propose a pipeline to automatically use deep neural networks to segment roots from the background and then extract root features like lengths and diameter distributions from the individual segmented root. In detail, we first use a pre-trained U-Net to segment the roots in the minirhizotron images. Then, we separate each individual root with the help of connected component analysis. Finally, we extract the features like diameter distribution or root lengths of every individual root with morphological operations, like skeletonization. For evaluation, we conduct experiments on synthetic roots, which are made of strings and threads, and compare results against a benchmark root dataset (PRMI) of real switchgrass roots and compare the estimated results with the existing commercial software.