A low-cost system to quantify root phenotypes resulting from root-root interactions

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Abstract

Root-root interactions significantly impact the formation of architectural root phenotypes, yet are poorly understood. Phenotype formation is impacted by sensing of soil resources and exudates of neighboring plants (Nord et al., 2011; Wang et al., 2021), which motivates the need to accurately quantify this phenomenon into its underlying causes. Currently, we are developing a complete experimental system for root-root interactions. A mesh frame has been designed to support the growth of two mature plant root systems. The frame is inserted into a large mesocosm, filled with a sand/soil mixture, and two plants are grown. To harvest, the mesocosm is disassembled and the sand/soil is gently washed away. Root systems are left suspended in the mesh and using a Canon EOS Rebel T5, ˜500 total photos are taken at 10 different angles ranging from below to above the roots, 360° around the frame. DIRT/3D is used to construct 3D models and extract data from individual root systems. We are in the process of improving our data extraction methods to include spatial traits relative to the two root systems. To do so, we dye the root systems right before harvesting. The difference in coloration allows the use of a deep learning model based on U-net architecture to perform image segmentation and separate roots in the 3D models. Our next step is to run a larger experiment with 10 mesh frames. This will provide statistical significance for trait identification and adaptation of DIRT/3D for root-root interaction data extraction and analysis.

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