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An improved method for the segmentation of roots from X-Ray computed tomography 3D images: Rootine v.2

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X-ray computed tomography (CT) is acknowledged as a powerful tool for the study of root system architecture (RSA) of plants grown in soil. The study of the root system properties is however only possible after performing root segmentation, i.e. the binarization of all root voxels. Root segmentation is often regarded as a tedious and difficult task as its success depends on several factors such as the image resolution, the signal to noise during image acquisition and the gray value contrast between the roots and all other surrounding features. Here, we present an improved method for the segmentation of roots from X-Ray computed tomography 3D images. The algorithm Rootine (Gao et al. 2019) does not detect roots by their gray values but by their characteristic tubular shape. This algorithm was further developed in order to improve the root recovery rate and to reduce the number of parameters involved during the segmentation process. This was achieved by adding two key steps: (1) an absolute difference transform and (2) an automatic calculation of the parameters used during the Gaussian smoothing. The first step allows for targeting specific features based on a gray value criteria contained within a user-defined gray value range in order to better distinguish roots from pores whereas the second step allows for targeting root segments of specific diameters. On the benchmark dataset of Gao et al. 2019, the newly called “Rootine v.2” was able to recover 34 % more roots as compared to its preceding version. Moreover, the number of parameters was reduced from 10 down to 5 which allows for a faster calibration and an overall better usability of the algorithm. The presented method also allows for a more reliable estimation of root diameter derived from X-Ray CT images. This work was carried out in the framework of the priority programme 2089 “Rhizosphere spatiotemporal organization - a key to rhizosphere functions” funded by DFG (project number 403640293).