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A novel multi-channel segmentation algorithm for X-ray microtomography data

Steffen Schlüter
Helmholtz-Centre for Environmental Research - UFZ, Soil Physics, Germany (steffen.schlueter@ufz.de)

X-ray microtomography has evolved into a standard technique for non-invasive imaging of inherent heterogeneity in rock and soil samples. As a prerequisite for quantitative image analysis the gray scale data has to be segmented into objects and background or multiple classes if more than two materials or phases are present in the image. In almost all cases a single gray value image serves as a basis for image segmentation. However, complimentary information could be provided from an additional image in order to help identify different classes with low contrast in the first image. This multi-channel segmentation is a standard method for RGB color images with three channels, and is also frequently used in other disciplines like remote sensing.
This study explores the applicability of multi-channel segmentation for X-ray microtomography data. Instead of a single histogram, every phase evokes a cluster in the two- or multidimensional feature space. Fuzzy C-means clustering is used to assign combinations of gray values to certain phases. This can be combined with Markov random field segmentation to add neighborhood information to the class assignment.
We demonstrate the novel segmentation method by two standard applications of X-ray μ-CT. First, we use dual-energy scans to improve the identification of two fluids in homogeneous sand. Second, we use morphology information as a second image channel to distinguish root channels from inter-aggregate pores in a silty loam sample.