Evaluation of reconstruction and segmentation techniques on high temporal resolution µCT scans for geotechnical applications

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Abstract

Coupled hydro-thermal phenomena are often relevant to applications in energy geotechnics, such as nuclear waste disposal and ground heat storage or transfer. It is then necessary to obtain data for use in and validation of models. Micro-focus X-ray computed tomography (µCT) has the potential to investi-gate hydro-thermal phenomena, both qualitatively and quantitatively. Howev-er it is difficult to obtain representative CT scan data for dynamic processes as a compromise must be made between image quality and scan time. For exam-ple, in thermally-driven water flow, moisture migration in the pore space could occur rapidly and over the course of a single scan. Reducing the scan time to obtain representative temporal data leads to a different set of chal-lenges in terms of image quality and data processing. This paper investigates the potential of algebraic reconstruction techniques (ART) to improve the quality of reconstructed images from fast undersampled scans or noisy projec-tion data, with reference to a uniformly-graded dry sand specimen. Results us-ing ART are compared with those obtained using data reconstructed by the conventional filtered back-projection technique (FBP). In both cases, phase proportions are determined by Gaussian decomposition (GD) rather than tra-ditional thresholding methods. It is shown that there is no need to attempt to improve the image quality by altering the image reconstruction algorithm, be-cause GD is tolerant of undersampling and noisy data.