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Benchmarking Conventional and Machine Learning Segmentation Techniques for Analysis of Digital Rock Physics Properties

Thursday, 3 June 2021 19:30 (15 minutes)

Image segmentation remains the most critical step in Digital Rock Physics (DRP) workflows, affecting modelling results and the analysis of physical rock properties. Conventional segmentation techniques struggle with numerous image artefacts and user bias, which lead to considerable uncertainty. This study evaluates the advantages of the machine learning algorithm of the Ilastik code to DRP problems. Images of porous and fractured samples were acquired by X-ray computer tomography and segmented by both conventional methods (thresholding, watershed), and a machine learning approach. Porosity, permeability, flow fields, and preferred flow paths were computed. For each fracture segmentation, two skeletonized 3D images were calculated providing information about the true aperture distribution and orientation variation. Mean mechanical aperture and roughness were obtained from these aperture data. Additionally, the uncertainty of the pixel classification segmentation was calculated. A comparison with conventional segmentation methods highlight the superior capabilities of the machine learning approach, which does not even need excessive amounts of training data. Instead, these data can be provided by the user directly on the images, where a constant feedback with the output of Ilastik minimizes user bias. The program is easy to use, resource saving, and provides for high quality segmentations and uncertainty calculations as a quantitative measure for evaluating the output. For our rock samples, the machine learning segmentation was able to handle all artefacts and complexities without prior filtering. A comparison of the described methods highlights the importance of a high-quality segmentation if considerable variations in physical rock properties are to be considered.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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