Segmentation of Pores in Carbon Fibre Reinforced Polymers Using the U-Net Convolutional Neural Network

Miroslav Yosifov[1], Patrick Weinberger[2], Bernhard Plank[1], Markus Höglinger[2], Bernhard Froehler[1], Johann Kastner[1], Christoph Heinzl[1]

[1]Research Group Computed Tomography, University of Applied Sciences Upper Austria, Austria,
[1]Research Group Computed Tomography , University of Applied Sciences Upper Austria, Austria

This work illustrates the use of deep learning methods applied to X-ray computed tomography (XCT) datasets to segment pores in carbon fibre reinforced polymers (CFRP) by binary semantic segmentation. The proposed workflow is designed to generate efficient segmentation models with reasonable execution time, applicable even for unskilled users using consumer-grade GPU systems. First, U-Net [1], a convolutional neural network, is modified to handle the segmentation of XCT datasets. In the second step, suitable hyperparameters are determined through a parameter analysis (hyperparameter tuning), and the parameter set with the best result was used for the final training. In the final step, we report on our efforts of implementing the testing stage in open_iA [2], which allows users to segment datasets with the fully trained model within reasonable time. The model performs well on datasets with both high and low resolution, and even works reasonably for barely visible pores. It also offers an efficient segmentation of pores with different shapes and size. We demonstrate our findings on different real-world CT datasets of carbon fibre reinforced composites. In our experiments, we could show that U-Net is suitable for pore segmentation. Even when trained only with a low number of datasets, it returns a reasonable prediction accuracy.