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Polar ice core micro CT super resolution segmentation with deep learning

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Precise segmentation of 3D micro-CT scans is a crucial step in analyzing the microstructure of porous materials. The polar ice core (firn column) microstructure is of great importance in polar research. Detecting environmental effects on the firn column in polar ice core studies relies on accurately digitizing the microstructure. To study the evolving microstructure of the firn column, 150 meters of core sample should be scanned with a microCT machine. With current technology in hand, it is practically impossible to scan the whole column with high resolution (e.g. 30 µm), thus, it is only possible to scan the entire column with lower resolutions such as 120 µm. Consequently, the smaller bubbles and pore structures are missed or represented vaguely in low-resolution scans. To tackle this problem, a unique pipeline for generating a data set consisting of low-resolution images and their corresponding registered high-resolution images is developed. With this pipeline, the high-resolution data were registered to the low-resolution data with the rigid image registration method. Then the patch-wised low-resolution data were fed to deep neural networks having their corresponding patch-wised high-resolution data as the ground truth. Due to the 3D nature of the project utilizing HPC is necessary for performing image registration and training the deep learning models. Finally, different deep learning models were compared on pixel-wise metrics and microstructure parameters. The trained models will be used to enhance the resolution of archived ice cores in AWI.

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