TOOLS FOR ENHANCED DATA-ANALYSIS

Machine learning for analysis of tomography-based images for modeling of fiber material

THE INDUSTRIAL CHALLENGE

The mechanical properties for the majority of the materials are defined by the features of the microstructure. The 3D tomography imaging offers new insights and possibilities for material design through providing volumetric information about the microstructure. The material in focus of this project is paper packaging and, in particular, a new generation of packaging material designed for 3D forming operations thanks to its extreme extensibility, which is achieved through changes in the network structures. The extent of such changes and their distribution between fibre deformations at different length-scales defines the balance between extensibility, strength and bending properties, all of which are important to the product performance.

WHY USING A LARGE SCALE FACILITY

The required fibre-level data can only be extracted from 3D tomography images since the surface measurements are limited relatively few fibres forming a lower number of bonds with other fibres. The use of synchrotron facilities enables us with fast image acquisition (minutes instead of hours with lab-scale tomographs) therefore with a possibility to perform in-situ testing. Combined with the information from the micromechanical modelling, the imaging technique can be a valuable complement to the material design strategies.

NEED TO IMPROVE ANALYTICAL TOOL

The image processing of wood fibre networks tomographs acquired during in-plane compression of natural fibre materials at the P05 imaging beamline at the German synchrotron PETRA III, Hamburg, is challenging. The manual segmentation of thousands of pictures requires many resources and needs to be optimized. Machine learning offers the potential of speeding up this process if it can be trained.

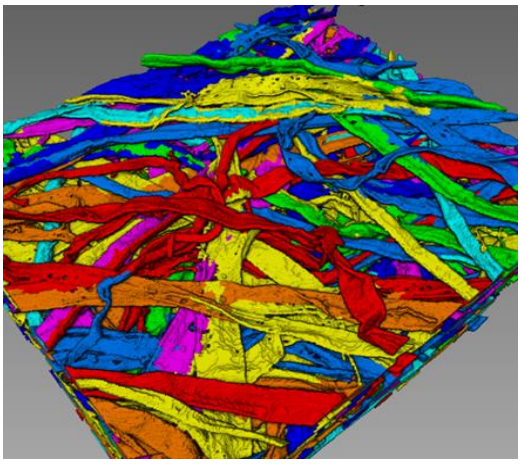
THE RESULTS AND EXPECTED IMPACT

Two methods to generate training data (i.e. segmented fibres) were investigated:

The manual segmentation method (with operator tracking fibres) was significantly improved, and a process description was created. Despite that, further speed and accuracy improvements are likely necessary before manual segmentation is a viable option for segmentation of volumes of relevant size. The method development can be used by stakeholders in academia or industry to manually segment natural fiber networks.

The automatic segmentation method works as intended but the data generated is not similar enough to real data to be useful at the current stage

The results have contributed to two scientific publications under consideration by the journals *Experimental Mechanics* and *Cellulose* and to new guidelines for using an open source software ITK-SNAP for a semi-automated segmentation available at KTH-Solid Mechanics. The work continues in cooperation with DESY in Hamburg



"The verification of different mechanisms with direct methods like 3D tomography is finally at reach"

/Micael Ragnarsson, BillerudKorsnäs AB

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