3D TRACKING OF CELLULOSE FIBRES IN VOLUME IMAGES

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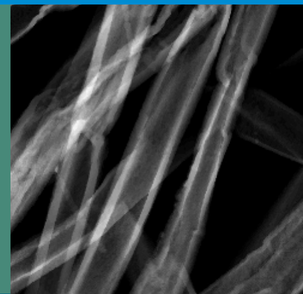
- Tracking and segmentation of individual fibres is an important step in 3D structure characterisation of paper and fibre based composite materials.
- Measurements on individually segmented fibres give access to important fibre properties like connectivity, orientation, length and shape and the possibility to model fibre network properties like strength, optical properties and transport properties and to *engineer* paper sheets and fibre reinforced composite materials.
- Previous tracking methods, which all use cross sectional images (right), have problems with cracked and collapsed fibres.

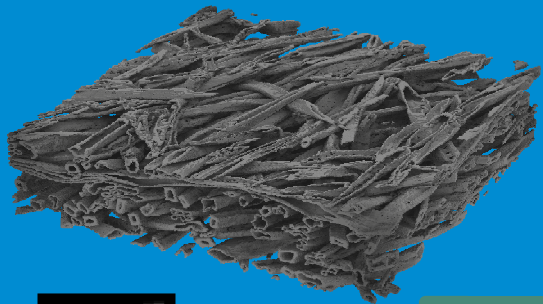
Idea

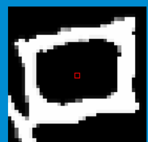
- ✓ All fibre walls occur as brighter edges in sum projections perpendicular to the fibre cross sections (right). This can be used to track fibres in sum projected images where problems with cracked or collapsed fibres are handled implicitly.



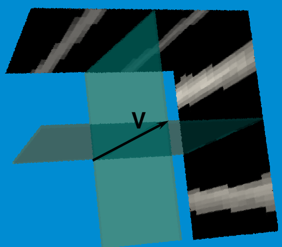
Method

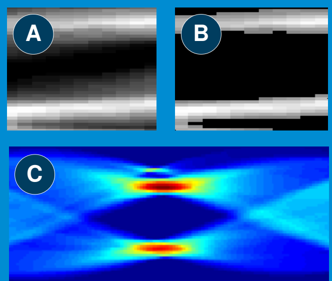
1. Calculate *N* evenly spaced local sum projections (**A**) of the fibre perpendicular to the fibre direction **V**. Remove the lowest values (**B**).
2. Radon transform the sum projected images to identify the two fibre walls as local maxima in the transformed images (**C**) .
3. Calculate the positions and angles of the local maxima in the radon transformed images. The two maxima pairs with the strongest peaks in the *N* images are used to estimate the new parameters **m** and **V**.
4. Correct the fibre centre point **m** in the plane perpendicular to the fibre direction using the middle point between the two fibre walls in two sum projected images.
5. Calculate a new estimate of the local fibre direction **V** using the positions and mean orientation of the two fibre walls in two images.
6. Take a step L from the corrected fibre centre point **m** in the updated direction **V**.
7. Continue the tracking (from step 1) if at least two maxima pairs are identified among the *N* sum projection images. If not enough maxima pairs are visible or if the border of the volume is hit, the tracking ends.

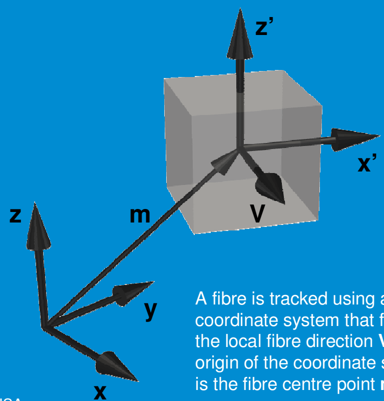




A fibre is seeded by marking the fibre centre point **m** in a slice approximately perpendicular to the local fibre direction **V**.







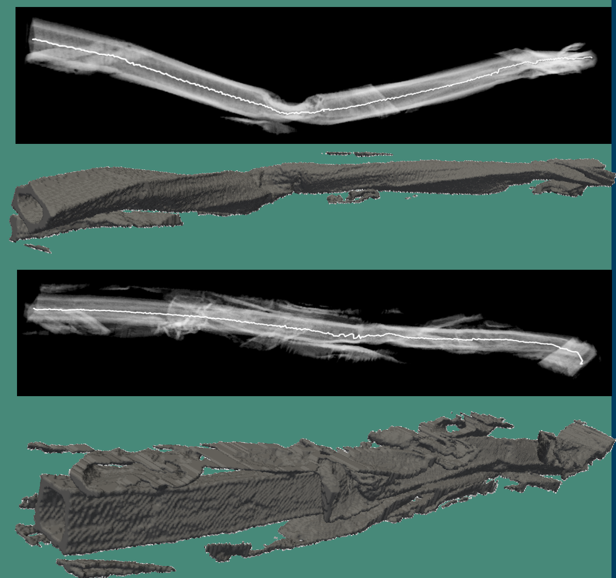
A fibre is tracked using a coordinate system that follows the local fibre direction **V**. The origin of the coordinate system is the fibre centre point **m**.

Features

- ✓ The fibre centreline is approximated.
- ✓ The fibre orientation and the fibre dimensions in each point are available for further segmentation steps or for estimation of the fibre orientation in the material.
- ✓ The sum projections are automaticly adjusted to be approximately perpendicular to the local fibre direction.
- ✓ Problems with holes, cracks or partial collapse are handled implicitly.

Experiments and results

- Good results are obtained for fibres with holes, cracks, irregular shape and partial collapse.
- All fibres which fit the tubular fibre model can be tracked.
- Completely collapsed fibres in binary images do not fit the model since no edges are visible.
- The method can be used on binary data and on grey level data with good contrast.
- The method is adaptable to other tubular structures.



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