

Estimation of Orientation Distribution of Fibers

Exposition of the problem

In the paper making process wood fibers, mineral fillers, and other additives, together form the basic structure of paper. The properties of paper depend essentially on how fibers are distributed. For example, orientation difference between surface and middle layers affects bending stiffness of the paper sheet, and the orientation difference between opposite surfaces causes curvature of the paper sheet. Because of this, companies like Metso are interested about methods to image and analyze fibres in paper.

Fibers in the paper can be imaged in many different ways. With proper placement of light sources, the normal reflectance images taken from paper surface can reveal information about fibers on the surface. Second approach is to illuminate the paper from one side and take image from the another side. This kind of transmittance images can give information not only about fibers on surface, but also a bit deeper inside the paper. If true 3D-image of fibers in the paper is needed, X-ray tomography devices can provide that.

If imaging of paper is made off-line, very high resolution can be used with all three method described above. If on-line solution for running paper web in paper mill is needed, then resolution is much lower, although imaging techniques are rapidly developing. However, question remains the same: how to estimate orientation of fibers from the images?

Scheme of the work to be done

1) Explore theoretical possibilities and limitations of different type of imaging techniques discussed above.

2) Describe a method(s) to estimate (planar) orientation distribution of fibres. Some references will be given, but students are encouraged also to develop their own method(s) and algorithm(s).

3) Compare time-complexity of method(s) described in 2).

4) Test algorithm(s) with i) simulated fibre network ii) transmittance images and iii) images taken by electron microscope. Data will be provided.