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Abstract

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Orientation maps from gray-level images using oriented granulometry

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Natural fibres are now widely used as reinforcements for semi-structural and structural composite applications. The mechanical properties of the resulting composites highly depend on the morphology and on the organisation of the fibres, in particular their orientation. A first approach to describe morphology of composite fibres is to segment each fibre individually and quantifying its morphology, resulting in a distribution of morphometric features such as length or thickness values. However, the imaging of large collections of fibres makes their identification often problematic.

Texture analysis is an alternative to object-based analysis that allows describing local variations of gray levels. We propose a novel method based on gray level granulometry by mathematical morphology that allows describing preferred orientation of fibres from gray level images [1,2]. We use a family of linear structuring elements with variable size and orientation that allows applying morphological opening and closing of increasing sizes. Granulometric curves and gray level mean sizes can be computed for each orientation around pixel of the image. An estimate of the preferred orientation for each pixel is computed, that allows to build an orientation map from the input image, and to generate a histogram of orientations.

The methodology was applied to electron microscopy images of fibres (synthetic and natural) used for composite reinforcement. Orientation histogram computed on images of glass fibre unidirectional preform validates the method. Similar analyses performed on images of a flax nonwoven could reveal a preferred orientation of fibres that could be related to the manufacturing process. This new method raises interesting perspectives for determination of fibres and bundles diameters, estimation of the orientation in the three dimensions or finally numerical modelling of biocomposite properties.

References

[1] P. Soille, *Morphological Image Analysis*. Springer, 2003.

[2] M. F. Devaux, B. Bouchet, D. Legland, F. Guillon, and M. Lahaye, "Macro-vision and grey level granulometry for quantification of tomato pericarp structure," *Postharvest-Biol. Technol.*, vol. 47, no. 2, pp. 199–209, 2008.