

LOCAL FILTERING AND WAVELET TRANSFORM INTO WOVEN COMPOSITES

Jana Saláčova

Department of Textile Materials, Technical University of Liberec, Czech Republic
jana.salacova@vslib.cz

Woven composites are prepared by the use of prepreg technology under joint pressing and heat-treatment. Their physical properties are dependent on determination of their real structure. Actual composite structure has been examined on the image of surface of cross-section cuts, these images (*.jpg, *.bmp) were obtained from microphotograph in software LUCIA G, LIM, Ltd.cz. See Fig.1 for kind of original images. Structural analysis of real images is an important step, because quantitative parameters following from the structural analysis can be utilized for prediction of physical properties or for virtual reality. Quantitative parameters can be contours of pores, contours of cracks, contours of longitudinal fibres and contours of cross fibres. This paper provides comparison between local filtering and wavelet transform and demonstrates their use on the problem of contours setting. Contour setting is provided by converting into vector format (*.dxf, *.iges). Image converting is dependent on image de-noising and binary image setting.

There were suggested algorithms by the use of function of software Matlab [3] to be appropriated for software Femlab. Algorithms were opting to automatically processing without hand thresholding, only automatically by default adjusting. The great point in algorithms are local filtering or wavelet transform. There were tested following session: *local filter* – averaging, Laplacian of Gaussian, Gaussian, Laplacian, Sobel, Prewitt and *stationary wavelet transform* for de-noising or select wavelet coefficients by thresholding, for more information about theory see [1, 2]. Original input images were in grayscale, see Fig. 1., results are compared by statistical tool mean square error (MSE), by subjective visual notion and time aspects. Each algorithm has its advantages to recovery of specific image artifacts. For the best result see Fig. 2.

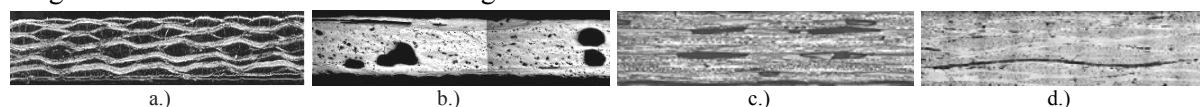


Fig.1 Image details of woven composite types – a.)carbon/carbon, b.)glass/epoxy, c.)carbon/plastic, d.)glass/pop

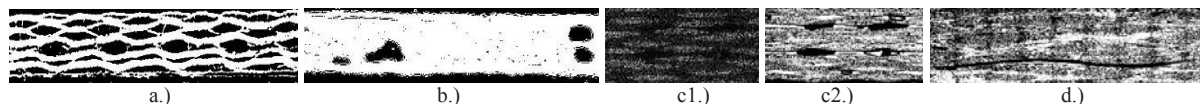


Fig. 2 Details of the best results of binary image setting - a.) carbon/carbon - filtering by averaging and thresholding by Otsu's method for longitudinal fibre contours, b.) glass/epoxy - stationary wavelet transform de-noising and thresholding by Otsu's method for pore's contours, c1.) carbon/plastic - horizontal details from stationary wavelet transform de-noising for cross fibre contours, c2.) carbon/plastic - filtering by Gaussian and thresholding by Otsu's method for pore's contours, d.) glass/pop - filtering by Gaussian and thresholding by Otsu's method for crack's contours

Each one image has been adjusted and equalized before filtering. Binary images have been obtained from filtered images or images after wavelet transform by Otsu's method. After filtering or wavelet transform [4] it was obtained the some results into carbon/carbon composite, bad acceptabler result was better after thresholding upon filtering. Images in the Fig. 2 are fit to morphological operations and contours setting [5]. Others contours, unentered above, could be plotted, f. e. by function `impixel`. Filtering is faster in the time measurement. Contours of real woven composite structure can be used in FEM calculation (Femlab) or virtual reality (VRML).

References

- [1] Hlaváč, V: *Computer image processing* <http://cmp.felk.cvut.cz>, FEL CVUT Praha, 2003
- [2] Vesely, V.: *Kernel and Wavelet smoothing*, Mathematics Subject Classification, 1996
- [3] *Matlab reference manual*, <http://www.humusoft.com>
- [4] Salacova, J.: *The signal windowing for image processing in woven composite structure*, ICCE 12, Tenerife, USA, 2005
- [5] Salacova, J.: *Cooperation of software Luciatm G, Matlab[®], Femlab into woven composite*, Matlab 2004, Praha CR, 2004

Keywords: woven composites, image processing, local filtering, binary image setting