ENHANCEMENTS OF AN INLINE QA SYSTEM FOR FIBER LAYUP PROCESSES

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1. ABSTRACT

The use of fibre-reinforced plastics for primary structures in current aircraft are increasing significantly due to the better specific properties compared to metallic designs. However, in order to be able to transfer the advantages from long range to short or medium range aircraft an increase in production efficiency and significant reduction of manufacturing costs is required. This paper therefore presents the errors encountered in fibre layup processes and a sensor system which enables automated detection of manufacturing deviations and drastically reduces times currently required for visual inspection. By detecting the geometric and optical properties of the laminate, potential defect areas are detected, classified, localized and measured in a cascading analysis. An exemplary setup that is directly mounted at an endeffector for fibre layup processes is shown in Figure 1.

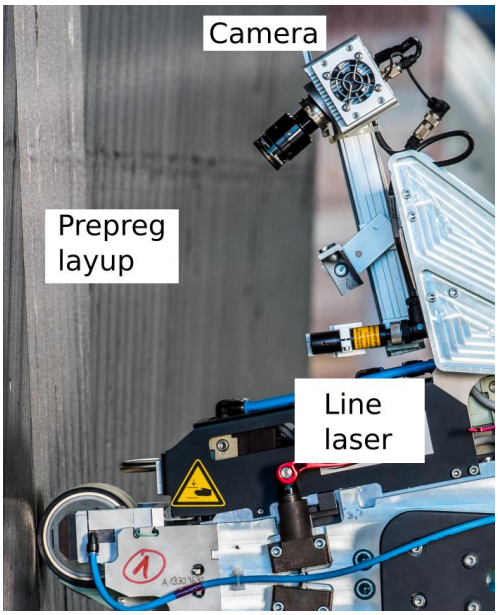

Figure 1: The figure shows a laser light section sensor mounted in back run to an Automated Fiber Placement (AFP) head.

The developed approach is highly adaptive for different and multiple sensor systems and multiple parallel and sequential working algorithms.
Especially the detection and classification behaviour is analysed in this paper, with respect to various applied algorithms.
For defect detection cascade, the method by Otsu and adaptive thresholding is considered. Evaluating the feature extraction step, Histogram of Oriented Gradients (HOG), Rotation

Invariant HOG (RIHOG), Local Binary Patterns (LBP), various texture based features and statistical moments are evaluated. For defect classification and defect class separation, a Support Vector Machine (SVM) is applied. An exemplarily detection and classification result is visualized in Figure 2.

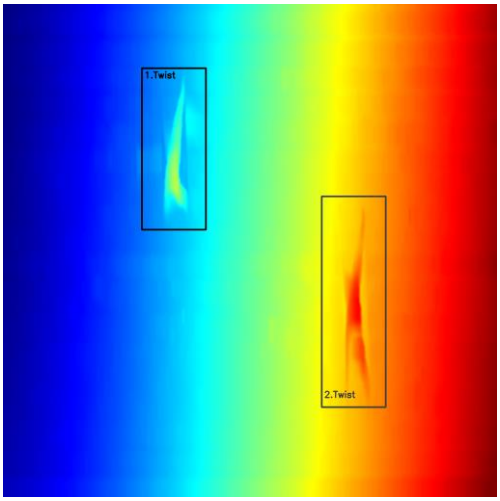

Figure 2: The figure shows exemplarily two automatically marked defects (twists). Different colors represent the standardized image depth.

The results show a significant increase in calculation speed and detection performance. The Method by Otsu performs better for poor quality or textured input data containing potentially more defects. Adaptive thresholding works best for high quality input data with less texture.
The feature extraction operates best with all algorithms combined. Obviously, this increases calculation time and slow down the classification process. Therefore, this paper suggests an algorithm selection as a compromise between calculation speed and classification performance.