Computed Tomography Image Processing - Automated Analysis on GFRP Helicopter Rotor Blades

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Abstract. Eurocopter has the most comprehensive range of helicopter in the world and is currently the world´s leading manufacturer in the civil and parapublic market. The company is offering operators state of the art products and the best proximity service, anywhere, anytime.

Therefore very lightweight and stress optimised integral components, made of fibre reinforced materials, are necessary.
To ensure a high level of safety and durability it is essential to perform a high sophisticated quality assurance. Ultrasonic Testing is the most common procedure in aerospace, but newer techniques like Computed Tomography, Thermography or Shearography become more and more important. In 1993 Eurocopter invested in it's first medical CT scanner. Since then the Computed Tomography is established into serial production of rotor blades and some other parts. Today up to 3000 parts per year are inspected by Computed Tomography.

In order to make the quality assurance process more efficient and more reliable, Volume Graphics and Eurocopter launched an image processing project in the year 2003. The main objective was to develop an intelligent image processing based software to analyse composite components semi automatically or even automatically. In addition several measurement and segmentation tools were developed.

This paper presents some results of this project and it will show a few details of the analysis of composite materials. Furthermore there will be an outlook on possible future applications in the field of computed tomography data analysis.

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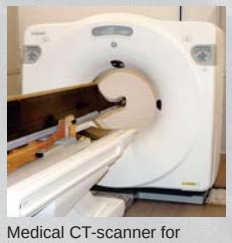
thinking without limits



Medical CT-scanner for serial inspection of rotor blades

Motivation for computerized analysis of CT Data in serial production:

- Traceable analyses and results
- Better description of the defect sizes
- Increase of the inspection capacity – up to 3000 parts/a are inspected today
- Simpler inspection specifications
- Support for the test staff

Nowadays composite structures are highly integrated, lightweight and its stiffness is function oriented. This orthotropic design leads to different local physical characteristics and fiber orientations. Furthermore some small undulations, little porosity and minimal variations in the fiber volume content are normal and acceptable. The challenge is to identify only the unusual variations.

Therefore a “Volumetric nominal/actual comparison” has been invented. In short: After registration, a representative “good part reference volume” out of several “good parts” will be created. This “nominal volume” contains the results (mean/tolerance) of different image processing operators. Depending on the operator the automatism will be able identify changes in orientation, fiber volume content or will find porosity.

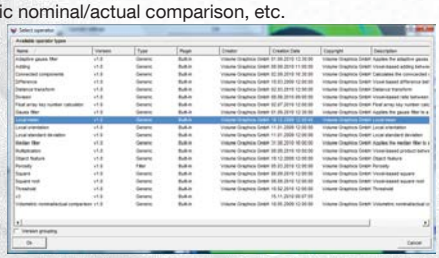
Basic software tools

Part registration:

For automated analysis it is necessary to register all parts at the same position. Therefore a registration tool was implemented, which allows to register against another part or against a reference.

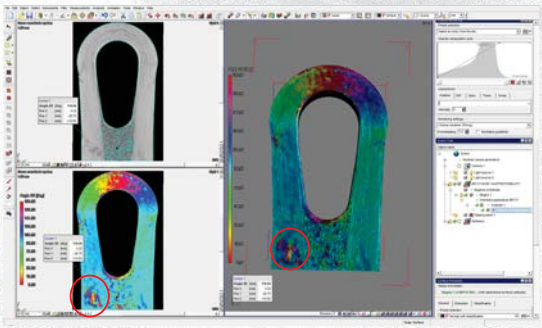
Image processing operators:

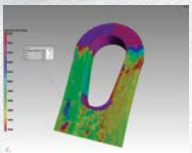
Local Mean, local deviation, local orientation, connected components, porosity, Volumetric nominal/actual comparison, etc.



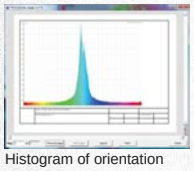
Visualization of results (color-coded orientation):

The undulation (red circle) is clearly identified.





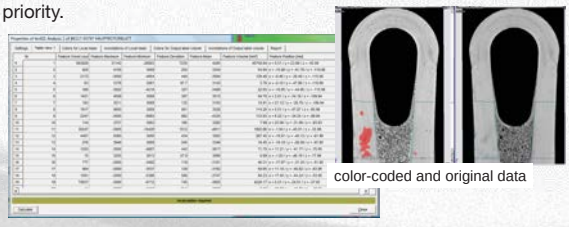
3D view of orientation



Histogram of orientation

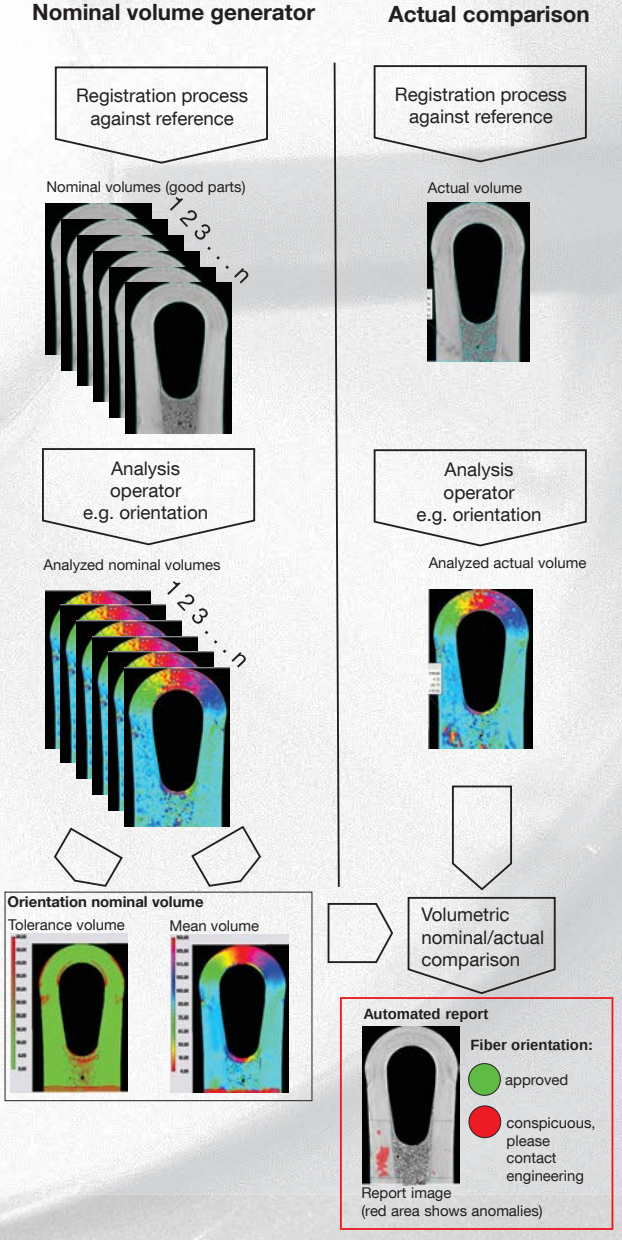
Reporting of analysis results:

The analysis results can be reported automatically. Therefore it is possible to report images of the flaws and tables with position, size and priority.



color-coded and original data

Workflow for volumetric nominal/actual comparison



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VOLUME GRAPHICS SOLUTIONS ABOUT VOXELS

EUROCOPTER AN EADS COMPANY