Analysis of Materials and Structures Using Computed Tomography in Combination with fast Automated Defect Recognition and Finite-Element-Methods

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Abstract. The automatic detection of defects with the aid of computed tomography is combined with finite elements methods (FEM). With this combination of high resolution µ-CT and FEM the simulation of any stress or load on real components is available. By the aid of special developed field programmable gate arrays (FPGAs) a considerable reduction of inspection time is realized.

Defect detection methods with the aid of computed tomography, used in industry and research with high resolution results, are often quite slow and don't have the possibility to give a qualified decision whether a component under technical load will fail or not.

State of the art FEM Analysis is a reliable tool for the simulation of strain, stress, tension and so caused deformations in components. But these calculations are based on perfect construction elements with no faults or defects.

With the combination of high resolution µ-CT and FEM one can simulate any stress or load on real components with flaws, porosities or holes.

An equipment for the analysis of materials with a fast acquisition, segmentation, defect analysis and classification, in combination with a FEM simulation on real components or materials, is now available at the Research Centre Jülich.

Our development of special field programmable gate arrays (FPGAs) is the main reason for the rapid reduction of inspection time. This progress gives the performance of a supercomputer for the cost of a PC. It accelerates the system performance to:

- Computed Tomography: ~ x 30 faster than PC
- Segmentation: ~ x 50 faster than PC
- Classification: ~ x 30 faster than PC
- FEM: ~ x 30 faster than PC
The radioscopic data are acquired by a high performance CT–system including x-ray-tubes with focal diameters less than 1 micron or tubes up to 225 kV in combination with flat-panel-detectors.

The results obtained are here showed with the aid of an example, which is representative for the measurements performed to date.
Fig. 2 shows the photograph of an automotive part moulded from AlSi12. In Fig. 3 the CT-Reconstruction acquired with the cone-beam-method is presented.

In the figures above some results of the automated defect recognition (ADR) are displayed.

After the ADR a surface mesh of the examined part is generated and transformed into a volume mesh as input for the finite element analysis (FEM).