Fully Automated CT System for the Inspection and Measurement of Castings

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Abstract. Even though Computed Tomography (CT) is a well-established method for NDT and geometrical evaluation, systems are not yet used for fast inline quality control but built for part-by-part inspection. By increasing the speed of the scan process, efficient evaluation of the huge amount of images is the bottleneck to guarantee reproducible inspection results. Once this is solved, manual charging significantly narrows throughput, so automation has to take place there as well.

The Y.CT customized system as shown is fully integrated into an existing production line of castings, including loading, identification, test, evaluation and sorting the objects.

1. Inspection task

Typical final customer's requirements like reduction of weight or increased performance as a general rule lead to more complexity of products. For castings this means usually thinner walls and more structure elements. By exhausting the capability of the moulding process and material properties the fault tolerance is reduced and so the need for improved testing increases.

Referring to X-ray testing this means the move from radiography to computed tomography: in many cases radiographic images are not clearly evaluable due to heavily overlaying structures. Residual wall thickness measurements are at least critical if based on projective radiographic images only. The volumetric or slice-wise visualisation of internal structures as generated with CT allows for accurate geometry determination. Internal defects are detected but also can be classified regarding size and position.

Most of the industrial Computed Tomography systems are designed for the inspection of individual parts, usually expecting a broad range of various sizes and materials. Therefore these systems are built to be flexible with many parameters to be set. A compromise is made regarding throughput as automation does not take place neither in image evaluation nor in handling.

This limitation was dissolved by combining YXLON's well-known expertise in building fully automated X-ray inspection systems with latest CT technology. In this particular case known types of statistically distributed faults may occur during a production process which in other respects is stable. As the parts are safety-relevant a 100% inspection has to take place, expedient before value adding but costly steps are made.

2. Object handling

Starting at the loading station, where the parts are placed in a carrier, the process starts with identifying each individual, linking this information to a production database where the test parameters for this type are taken from.

A robot, equipped with an automated gripper-exchanging system, picks up each individual part and places it into a positive fixation on the CT-turntable. Few minutes later, after the scan is finished, the part is taken off and placed either back on its original position on the pallet or rejected, depending on the result of the investigation. In this case, due to its size, more than one part can be scanned at a time.

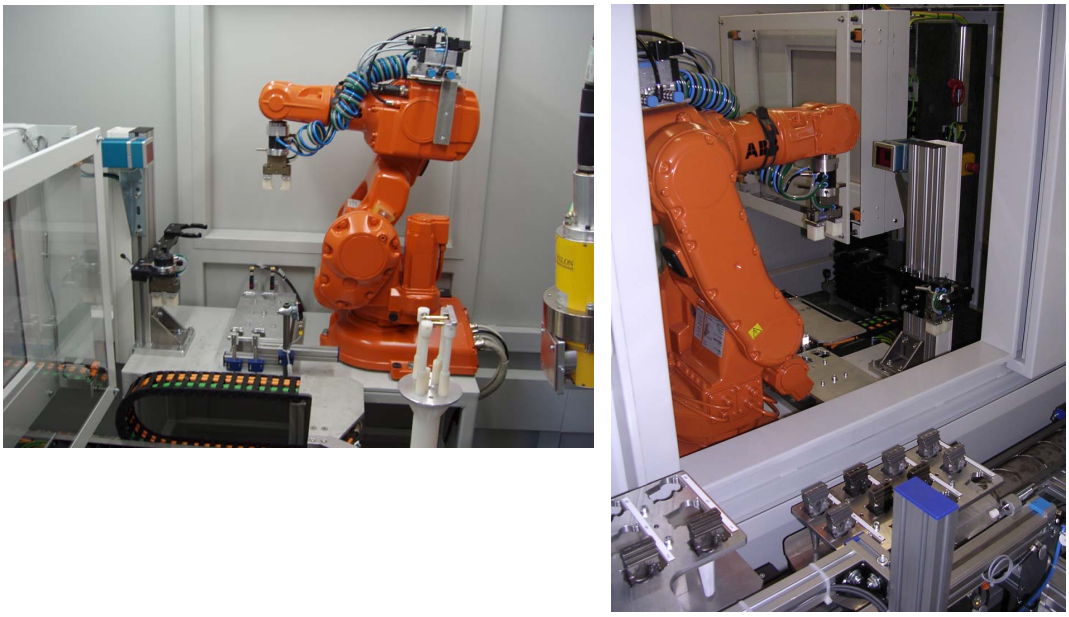

Fig. 1: Conveying and robot system

3. Image Evaluation

As soon as a major number of well-known objects has to be investigated, software-tools for image evaluation are profitable and provide a reliable basis for reproducible results and decisions. In serial production the parts as well as the occurring defects are known. So image evaluation can be trained to detect these faults without any manual assistance.

YXLON's PXV 5000 is used for total system control, operator interface, and automated defect recognition (ADR). In excess of conventional functions, CT-specific modules were designed e.g. to analyse combined CT-scans as a whole. Wall thickness measurements, in particular scrutinising residual wall thickness, are performed throughout the entire objects or in predefined areas. Depending on the individual results of determination a good/bad-decision is made, initiating the sorting process which is then executed by the robot.

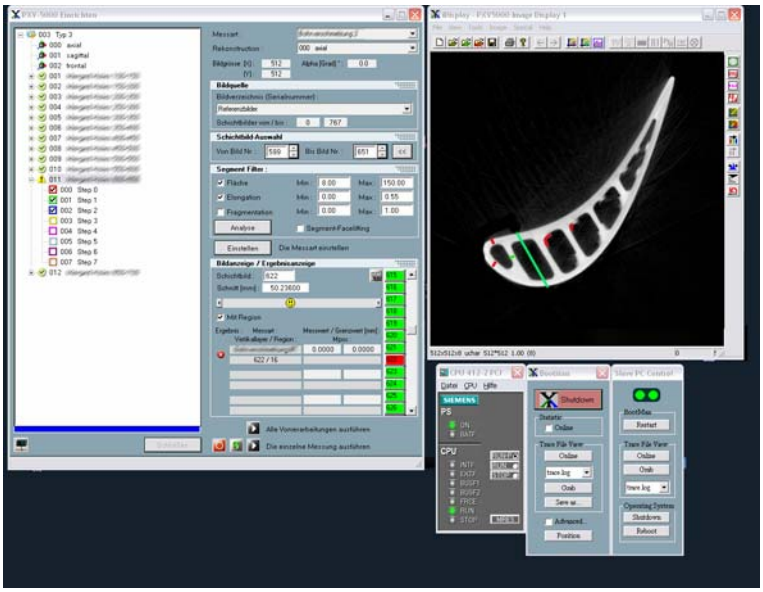

Fig.2 Automatic evaluation of structural and geometrical object features with PXV5000

For optimum performance in quality and time, the test sequence is performed tailored to each type of parts. New classes may be defined by customer or as a service.

An automated test sample recognition module may be used to relieve from sorting of different styles of test samples. This allows the system to be fed with all production samples from production lines in random order.

The entire system is self-monitoring to guarantee steady high performance during three-shift-operation.

4. CT-technology

The virtual CT-scanner is mounted in the radiation shielded cabinet. The high accuracy 4-axes manipulator is granite-based. The radiation from a 225 kV minifocus X-ray tube penetrates the sample and irradiates a 16” Amorphous Silicon Detector: 3D-CT.

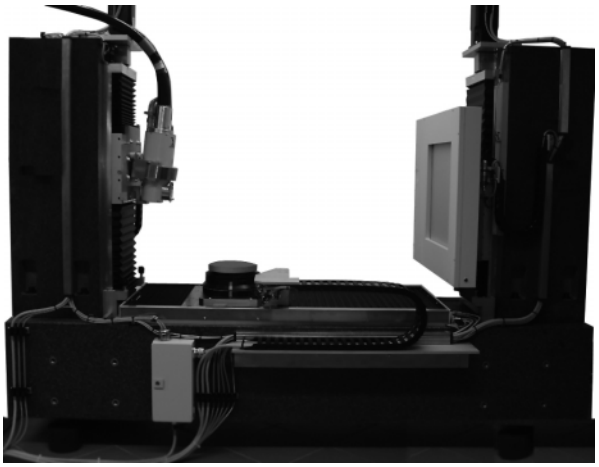

Fig. 3 CT-System (high precision manipulator, 400 mm x 400 mm detector array, “mini-focus” XRay system)

5. Perspectives

With the installation of a fully automated CT-system for inline-inspection YXLON took the next step for CT-applications.

The CT-system as shown was built for small castings, however, it is basically capable for almost any other material and size, depending on the imaging components used therein. Even though any combination of X-ray sources and detectors is basically usable, at high energies best results are achieved with LineDetectorArrays (LDA) for measuring tasks and ASDs for NDT purposes.