An Automated CT Scanner System for Quality Control

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Abstract
An automated CT scanner system is presented which has been developed for quality control in the production of sugar beet seeds. The scanner is able to process more than 300 control samples per day with up to 400 seeds per sample. For each single seed about twenty features are determined by automated image processing.
Although the automated scanner has been developed for the analysis of seeds, it can be used as well for the rapid analysis of other goods. For instance pore and grain size distribution can be determined for bulk materials and material samples. Large amounts of small components can be checked for wholeness and completeness or for dimensional accuracy.

Keywords: X-ray, computed tomography, automated system, quality assurance, image processing

1. Introduction

X-ray computed tomography (CT) is a well-established non-destructive inspection method in industrial applications. Recent improvements speed up the CT scanning and image reconstruction process. Scanning times from few minutes to less than a minute allow for the inspection of hundreds of samples per day. To take full advantage of this opportunity for series analysis an automated sample changer is required and the interpretation and assessment of the CT reconstruction has to be automated by digital image processing and analysis.
In this paper we present a fully automated CT scanner system which has been developed for quality control in the production of sugar beet seeds [1, 2]. The scanner is able to process more than 300 control samples per day with up to 400 seeds per sample. For each single seed about twenty features are determined by automated image processing.
Although the automated scanner has been developed for the analysis of seeds, it can be used as well for the analysis of other goods. For example material samples and bulk materials can be fully automated analyzed for pore size or grain size distribution. Even so the control of wholeness and completeness or the dimensions of large amount of small parts is possible.

2. Description of the system

The automated CT scanner system has three working stations: a sample preparation station, the actual CT scanner and a visualization station. The stations are interconnected by local area network (LAN).

At the sample preparation station the samples are filled in small round boxes (Fig. 2). Bulk materials or small parts can be just filled in. Larger parts can be placed each one in a separate box. The round boxes are placed on a tray. The individual samples are registered either by bar code reader or by keyboard input. In the case of seeds a tray can take up to 60 samples. The samples of one tray form a batch.

Fig. 1: The sample preparation station of the automated CT scanner

The CT-scanner is equipped with a micro-focus X-ray tube and a digital flat panel detector. The housing of the scanner (cf. Fig. 2) contains all the control electronics and computers for the CT scan process but also the computers for image reconstruction and image analysis as well as a computer which holds the database with the outcomes of the analyzes.

When a tray is loaded it can be placed into the CT-scanner and the scan for that batch can be started. The scan process is fully automated and self-monitored. Conditioning of the X-ray tube and calibration of the detector are performed independently by the system without any user intervention. The integrated Cartesian robot takes the samples one by one and places them on the turn table of the scanner. During the scan of a sample the outcome of the previous scan is evaluated by automated image processing. In the case of sugar beet seeds each sample consists of up to 400 seed grains. For each single grain 20 dimensional parameters are determined; so, a total of 8,000 parameters are determined from a scan which takes a few minutes only.

Quality control is assured by periodical measurement of reference samples. If the outcome for the reference sample deviates from the expected value a warning is given or the scan process is stopped, depending on the magnitude of the deviation.

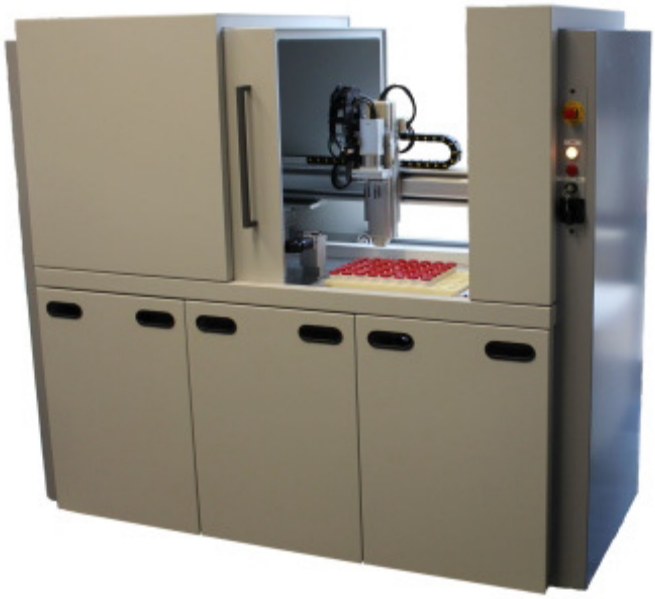

Figure 1: The automated CT scanner with sample changer

The result of the analysis can be reviewed at the visualization station. The result consists of all the parameter for all the individual items of a sample; but also statistical representations are given. An export functions allows the transfer of the result to an external database system. If required also the original CT reconstruction of the sample can be inspected.

By now, several automated CT-scanner are installed for industrial application. The system is ready for adaption to other applications. Possible applications are for example material analysis (porous and grain size distribution, structure, composition, material distribution) and the inspection of large amounts of small pieces (counting, wholeness, completeness, dimension control).

References

1. U Hassler, M Maisl, S Oeckl, M Rehak, A Wolff, ‚Computertomographie zur automatischen Volumenauswertung von Rübensamen‘, in ‚Handbuch zur industriellen Bildverarbeitung - Qualitätssicherung in der Praxis‘, Hrsg. Norbert Bauer, Fraunhofer IRB Verlag, Stuttgart 2007 (ISBN = 978-3-8167-7386-3)
2. A Gelz, F Porsch, M Rehak, ‚Computertomographieautomat SeedInspector zur Automatischen Bewertung von Saatgut‘, ZfP-Zeitung, Vol 139, pp 50–53, April 2014.