



AUTOMATIC DIGITAL X-RAY INSPECTION SYSTEM WITH AUTOMATIC DEFECT RECOGNITION



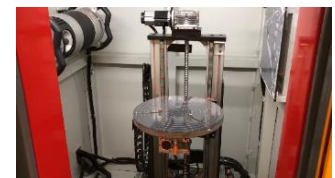
Aluminum is the most preferable material for the automobile sector due to the high strength-to-weight ratio, availability of raw materials, ease of manufacturing, etc. These parts may have inherent defects developed during the casting process like porosity, cracks, blisters, blowholes, shrinkages, etc. The presence of these defects will affect the design performance of the parts and fail to inform the predicted life in the long run. The manufacturing of defect-free components is very crucial in maintaining the integrity of the automobile. An automated digital X-ray inspection system with

Automatic Defect Recognition (ADR) is designed for this application. The system is designed by keeping the principle that the system should be used for a variety of components. The system can work in the automatic mode and also in the manual mode. The samples from various production lines in the factory are brought to the machine for evaluation. ADR plugins are available for automatic inspections on demand. The developed system has a control from the single user interface. The main components are:

1. Lead shielded X-ray cabinet which includes Source and FPD.

2. Integrated software with ADR

A robot material handling system can be integrated into this system for a faster and 100 % automation cycle. The system can be incorporated into the production line for a seamless inspection process.

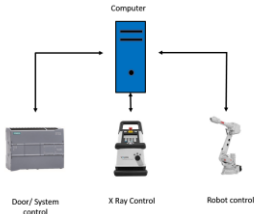


Lead Shielded X-ray cabinet

The X-Ray cabinet is where the X-Ray source and detector along with the component handling gantry is placed. The cabinet is made of sandwiched lead sheets in

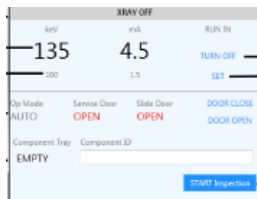


between mild steel sheets enclosed in an outer cabinet made of mild steel. The gantry system consists of vertical and horizontal axes along with the rotary table. This can be customized on demand. The rotary table has provision for templates.



Integrated Software:

The complete system is computer-controlled using an integrated single interface software. The software installed in the computer can communicate to all the devices and attain the required functionality. The screenshot of the software used is shown below:



Salient features of the system:

- Fully automated testing process
- A Robotic arm-based material handling system can be implemented.
- Automatic operation where a set of predefined movements and image save operations

will be implemented along with optional ADR integration

- Manual operation where a joystick can be used to control the gantry.
- Automatic adjustment of X-ray Source parameters for each shot.
- Automatic detection of defects using the ADR algorithm. An aluminum casting sample is given as an example in this application note.

Automated Defect Recognition

Algorithm: This is an algorithm developed for automatic defect identification and sizing of casting components without human interference. The algorithm needs to be trained for different components having known defects. For this various ADR, methodologies are used based on the application. This makes the software look for the expected defects in the material. This algorithm is a simulated assisted ADR that is not limited to defect detection but also with the following extra features:

Need for Simulated Assisted ADR



This minimizes the false alarms and also selects the region of interest (ROI).

- Evaluation of the translational and rotational error in the acquired images
- Identifies the features of the component that may be wrongly identified as a defect
- Optimization of the number of shots and their orientations to cover all the possible defect regions.
- Optimization of the robot-pick position on the object to minimize the impact of the robot arm on the image.

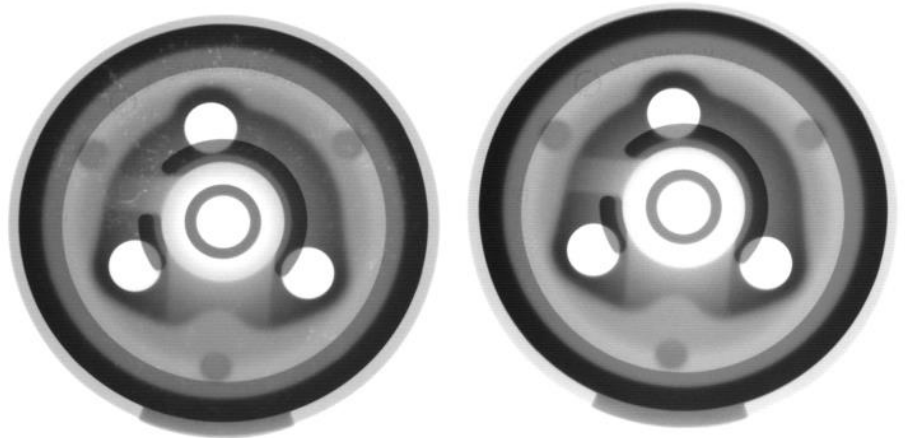
The ADR software is developed using Artificial Neural Networks and is customized to detect the aluminum casting defects in the X-ray images.

Following are the X-ray images with defects identified using ADR. The image on left shows the digital X-ray images of the diffuser plate and the right is defects detected using ADR. ADR algorithm will compare the defect size with the quality standard parameters. Based on the response from the ADR engine about the quality of the sample.

Digital X-ray inspection system with Automatic Defect Recognition (ADR) - Application Note

A Dhvani Research Application Note

Chennai, INDIA



No Tilt

Slight Backward Tilt

X-Ray images of Aluminum Casting component with and without a tilt while fixing on a manipulator. The angle of tilt and rotation can be evaluated using Assisted simulation software.

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