ROBOTIC ARM BASED AUTOMATED DIGITAL X-RAY INSPECTION SYSTEM FOR ALUMINUM CASTINGS WITH AUTOMATIC DEFECT RECOGNITION (ADR)

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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 can fail in the predicted life in the long run. Manufacturing defect-free components are very crucial in maintaining the integrity of the automobile.

As the components are manufactured in mass production, fast and accurate testing methods should be incorporated. An automated digital X-ray inspection system with Automatic Defect Recognition (ADR) is designed for this application. The designed system uses an articulate six-accesses robot for material handling.

This system is exclusively developed for radiographic inspection of a continuous production component made from aluminum pressure die casting. This is a completely automated system including the defect identification, characterization, and sizing, and all the hardware components are controlled from the single user interface. The main components are:

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

2. Robotic arm for material handling inside the X-ray cabinet.

3. Control panel for the system.

4. Integrated software with ADR

The complete system is shown as mentioned below:

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1. Lead Shielded X-ray cabinet

The X-Ray cabin is where the X-Ray source and detector along with the component handling robot are placed. The cabinet is made of sandwiched lead sheets in between mild steel sheets enclosed in an outer cabinet made of mild steel. The thickness of the lead sheet can be altered based on the capacity of the x-ray used inside manufacturing.

2. Robotic Arm for material handling

A robot is used for the handling of the component. The robot will come out through the programmed path pick the component from the loading tray and move it between the source and detector for the planned X-ray shots. Once the inspection is complete the component is moved out and placed in the unloading tray. The robot is completely controlled by the computer and waits for the commands.
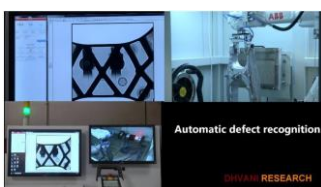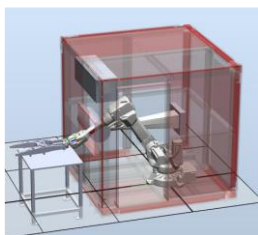

3. Control Panel

The control panel is a centralized control system that operates the following:

- Induction motor drives
- PLC
- Computers
- X-Ray control device
- Vision systems
- Robotic control

4. 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.
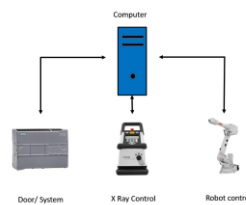
The screenshot of the software used is shown below:
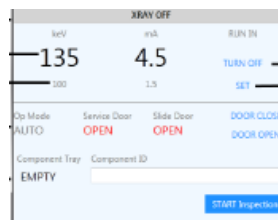
Salient features of the system:

- Fully automated testing process
- Robotic arm-based material handling of the test sample.

- Automatic adjustment of X-Ray Source parameters for each shot according to presets.
- Automatic detection of defects using the ADR algorithm.

The Automatic Defect Recognition software is developed for the automatic defect identification and sizing of the defects without human interference. The ADR software is developed using artificial intelligence and is customized to detect the casting defects in the X-ray images in this application. Following are the images with defects identified using ADR. The image on left shows the defect detected using ADR and the right is the normal image.
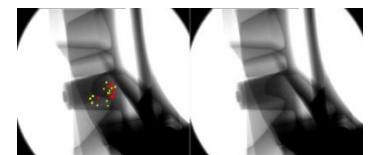

ADR algorithm will compare the defect size with the quality standard references mentioned in the ASTM E2422 standard (defect types L1 to L8) for gas holes, gas porosities, and shrinkage. Based on the response from the ADR engine about the quality of the sample, the robot will place the sample in the respective accept or reject tray outside the cabin.

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Robotic ARM based Automated Digital X-Ray inspection system – Application Note

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Chennai, INDIA
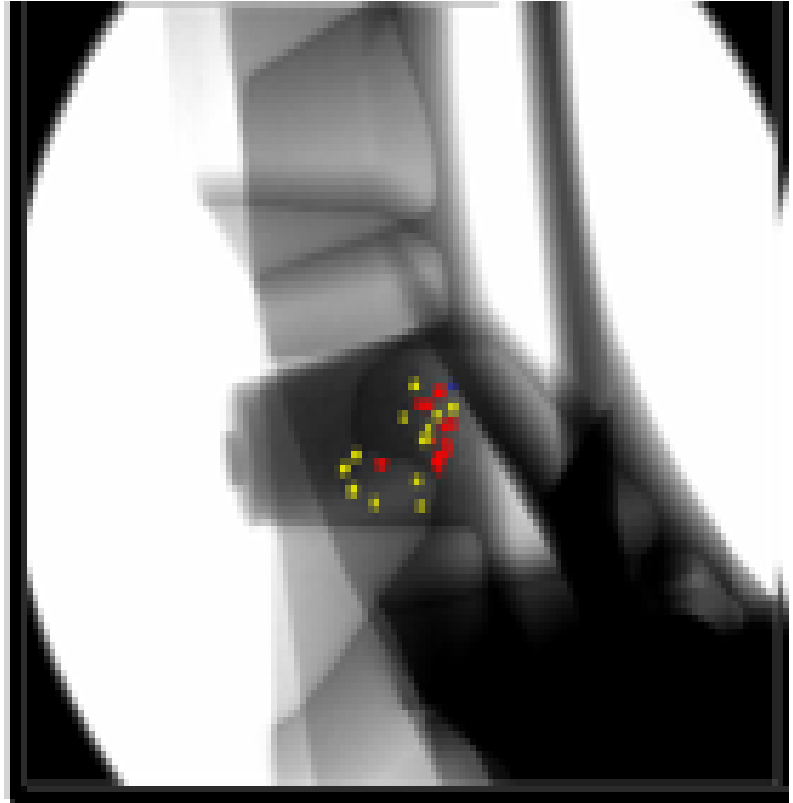
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