Automatic X-Ray Anomaly Detection of Turbine Blades

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Introduction

Our group had the privilege of working with Howmet, an aerospace company that seeks to transform the future of flying and driving with high-performance engineered solutions that are paired with advanced manufacturing expertise. We were asked to develop an image processing model that directly works on X-ray images of these turbine parts to detect the presence of shrinkage defects/anomalies.

This project was approached with two methodologies:
1. A statistical approach which calculated the variance of n-nearest pixels holistically to distinguish between anomalous and normal images.
2. A machine learning approach that employs a neural network which is trained on normal and anomalous images.

Methodology – Data Cleaning

After applying a Sobel filter to the image, we dynamically locate the corners, rotate the image slightly, crop it, filter/fbin further if needed, then do anomaly identification.

Data Visualization Results

Before applying Sobel filter

After applying Sobel filter

Heat map applied to the x-ray of the turbine blade, to see the interior density

Results – Variance Arrays

This took the variance of n nearest pixels and compared that across images to detect significant differences in pixel contrast. Below is the distribution of variances retrieved from all normal images using a 19*19 matrix.

Results – CNN based classifier

A binary image classifier based on convolutional neural network (MobileNet).

Results – Location Detection

Locate where the defect is. However, the result is not consistent due to different property of the image. Sometimes it will pick up very small changes in image.

Conclusion

Although the variance array approach did not work, the CNN approach did. There was some trouble in identifying precisely where the defect was located, despite the fact we could identify which blades were anomalous with decent accuracy.

Future Goals

After determining if a blade is anomalous with a false negative rate of 0. Identify where on the blade is anomalous. A revamped variance array approach could work, as well as blob detection.

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References - Tools Used:

- Sobel Operator / Filter

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