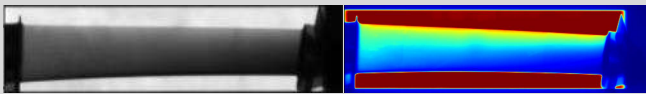


## Introduction

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:

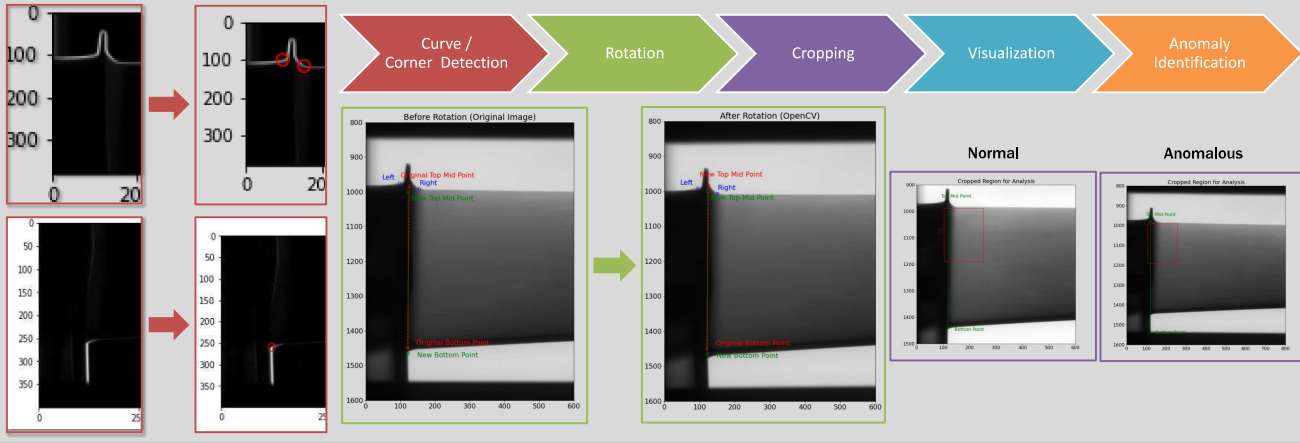
- 1) A statistical approach which calculated the variance of n-nearest pixels holistically to distinguish between anomalous and normal images
- 2) A machine learning approach that employs a neural network which is trained on normal and anomalous images.



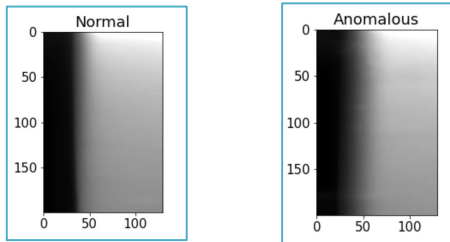
Heat map applied to the x-ray of the turbine blade, to see the interior density

## Methodology – Data Cleaning

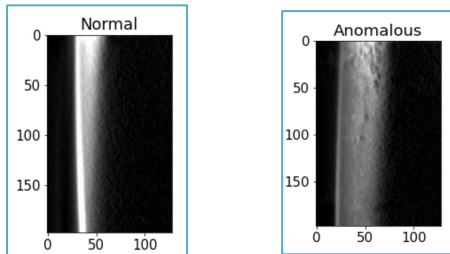
After applying a Sobel filter to the image, we dynamically locate the corners, rotate the image slightly, crop it, filter/trim further if needed, then do anomaly identification.



## Data Visualization Results Before applying Sobel filter

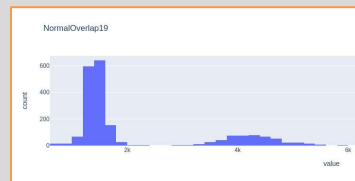


## After applying Sobel filter



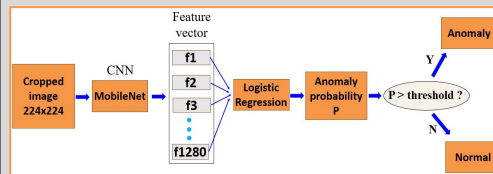
## Results – Variance Arrays

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.



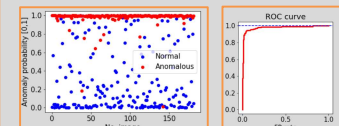
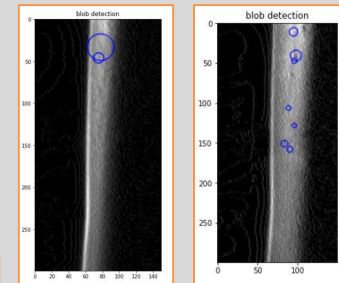
## Results – CNN based classifier

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



## Results – Location Detection

Locate where the defect is. However, the result is not consistence 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.

## Acknowledgments

Special thanks to:

- Teaching Assistant: Maxwell Low
- Howmet Mentors: Haydn Schroeder, Brian Griffin, Chad Hirsch, Patrick Tallquist
- Data Mine Staff: Gautam Choudhary, Dr. Ward, Jessica Jud, and more

## References - Tools Used:

- Sobel Operator / Filter
- Transfer Learning (MobileNet) - M. Sandler et. al. CVPR.2018.00474 (2018)

os	Pillow	scikit-learn
glob	OpenCV	pandas
Math	PyTorch	seaborn
plotly	NumPy	pydicom
	Numba	matplotlib