Alithya

CASE STUDY

ARTIFICIAL INTELLIGENCE FOR ULTRASONIC PIPE INSPECTION

This solution was developed as a proof of concept for a large nuclear operator in Ontario to automate the detection of fuel channel defects.

Introduction

Pipe-inspection is a critical aspect of the operation of plants. Over the years, pipes can get damaged from scratches, rusting, cracking, corrosion and sagging.

A large nuclear operator in Ontario approached Alithya to build a tool that can automatically detect wear-induced flaws in the plant's fuel channels.

CHALLENGES

- The client's processes require multiple streams of highly skilled analysts to review the collected ultrasonic (UT) data.
- Identification and sizing of fuel channel defects is a manual, subjective process, which requires a significant time investment.
- Recent inspection tooling modifications have introduced mechanical noise (chatter) into the collected data (Figure 1).

SOLUTION

- A deep learning model was developed to automate the subjective human analysis portions of fuel channel inspection.
- The developed model was able to detect 100% of fuel channel defects.
- The model does not make use of any programmed rules, which makes it adaptable to new anomalies and other generating stations/units.

Results

Alithya's prototype was able to automate the detection of flaws in nuclear fuel channels **with an accuracy of 100%.**

Benefits Realized

The expansion of the presented prototype into a full product will lead to **significant cost savings in terms of time and human resources.**

The developed model is easily **adaptable to new anomalies and other generating stations/units** vs. traditional rule-based algorithms.

Opportunities

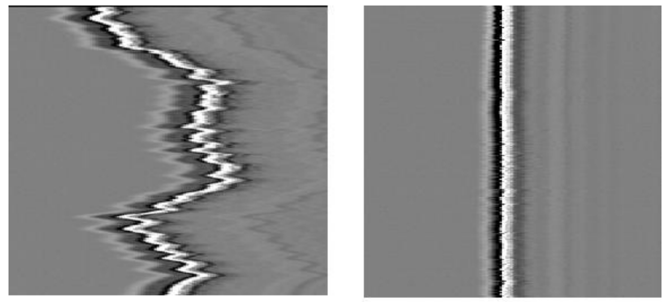
The solution can be expanded to **alternative pipe inspections** within nuclear or other industries.

Summary

Alithya's deep learning model was able to detect all fuel channel defects (flaws) with an accuracy of 100%. The prototype was tested using UT scans of different flaw types, from multiple reactors and operating years. In many instances, the prediction was perfect with zero false positives (FP) and zero false negatives (FN). However, for certain complicated UT scans the results contained a minimal amount of FPs.

Figures (2) and (3) demonstrate two visualized examples of the model's predictions. Note that in these figures, the objective of the prototype was to identify points within the flaw which have a significant depth. Therefore, at least one prediction point (blue) was expected per flaw (red).

Figure (2) demonstrates the prediction results applied to a common UT scan. These scans have limited number of flaws with the existence of mechanical chatter. As can be seen from the figure, all 3 flaws were detected with an accuracy of 100%. Also no FPs were identified. Figure (3) demonstrates one of the most complicated cases in the plant. This scan had 44 flaws with the data containing heavy chatter. Alithya's ML model was able to detect all 44 flaws correctly with a minimal number of FPs.



(a) (b)

Figure 1
UT Scan example
(a) with chatter (b) without chatter.

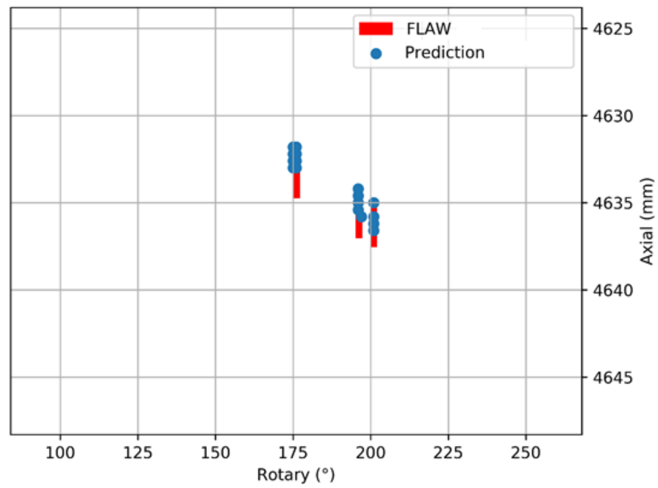


Figure 2
Prediction results for a regular scan with minor chatter

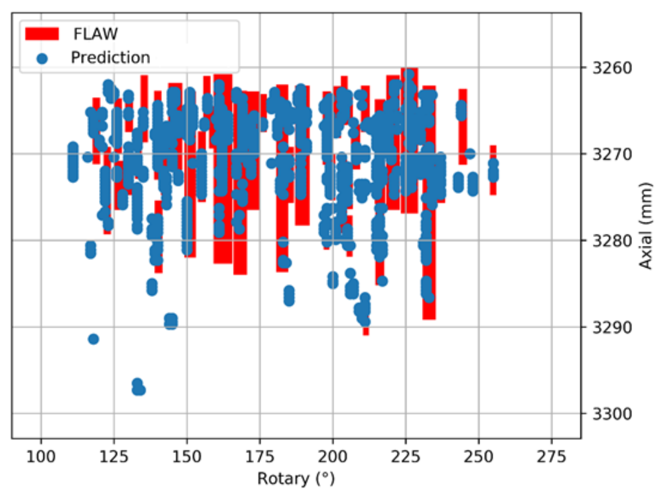


Figure 3
Prediction results for a complicated scan with severe chatter

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