Automated Defect Detection in Calandria Tubesheet Bores for CANDU Reactors

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Bruce Power launched its Major Component Replacement program in 2020, focusing on replacing critical parts within CANDU reactors. The program's scope includes replacing steam generators, pressure tubes, calandria tubes, and feeder tubes. The examination of Calandria Tubesheet Bores (CTSB) is a time-consuming activity, with engineers manually evaluating inspection footage to detect defects that might lead to leak test failures. High radiation levels in these videos create significant visual noise, posing challenges for correct defect identification.

Building on a successful first phase of this collaborative project between Bruce Power, the University of Strathclyde, Prolucid, and ATS Corporation, we have made substantial progress in automating the CTSB inspection process. Our focus has shifted to developing an explainable automated algorithm for detecting indications within CTSB videos. The anomaly detection process involves several steps: frame differencing to highlight changes, thresholding to identify potential anomalies, and noise removal using a morphological opening.

To ensure explainability, we developed a procedural image processing-based solution complemented by a knowledge base with specific rules. These rules filter out false positives based on criteria such as anomaly size, saturation levels, position relative to the CTSB surface, and appearance in successive frames. This approach significantly improves detection accuracy while maintaining transparency, crucial in the nuclear industry.

The new system will reduce inspection time while maintaining the same level of accuracy as human inspectors. It generates comprehensive reports with detailed analytics and visualizations, aiding engineers in their final assessments. This advancement streamlines Bruce Power's inspection procedures, ensuring a more efficient process without compromising on reliability. The potential applications extend across various aspects of nuclear power plant maintenance.