A novel structured light based sensing and probabilistic diagnostic technique for pipe internal corrosion detection and localization

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Main Objective

This project was awarded to MSU and ASU in order to develop a structured-light based inspection tool to detect and evaluate internal corrosion in metal gas pipelines. The tool will be integrated with a machine learning based model in order to enhance the probability of detection and enable system automation.

Figure 1. Corrosion on pipe inner surface

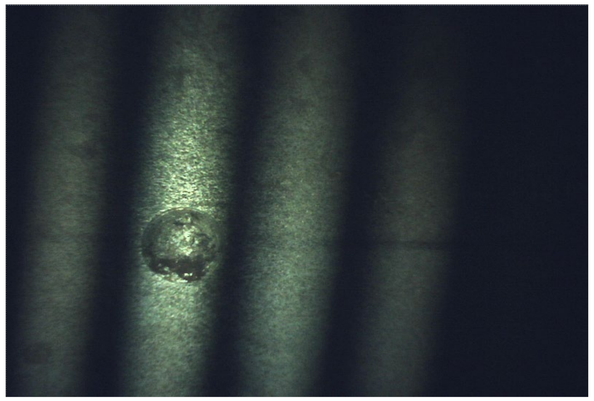

Figure 2. Corroded sample under inspection

Project Approach/Scope

The proposed structured light technology depends on exploiting the sensor movement inside the pipe to enhance the 3D reconstruction. The tool also combines stereo vision with digital fringe projection to improve the sensor robustness and simplify the calibration process . The machine learning method is a modification of the fully supervised R-CNN method to a weakly-supervised case. Initial cues for crack locations are obtained from edge maps, and each cue is serially classified by the trained neural network.

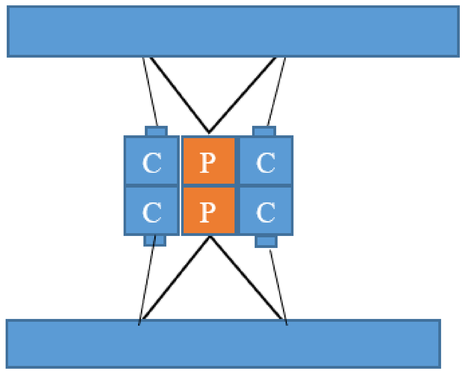

Figure 3. Schematic of the structured light setup inside the pipe

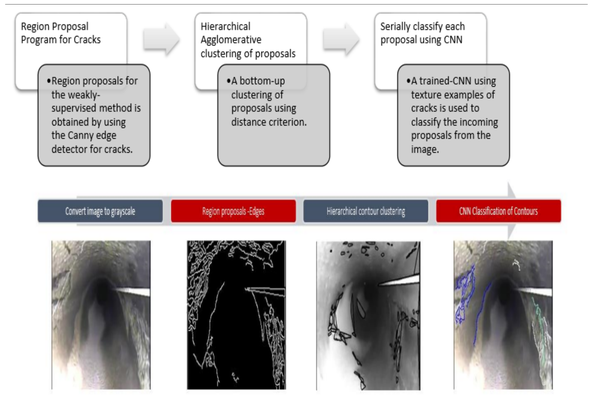

Figure 4. Block diagram of the automatic damage detection algorithm

Results

We have completed the design and fabrication of the structured light sensor, including system calibration. Reconstruction algorithm was also developed and tested by simulations and experimental work. Automatic damage detection algorithm worked well to detect cracks in diverse test images, with a false positive rate of ~ 5.65 contours per image and detection of 61.65% of crack pixels on a test set with 80 images.

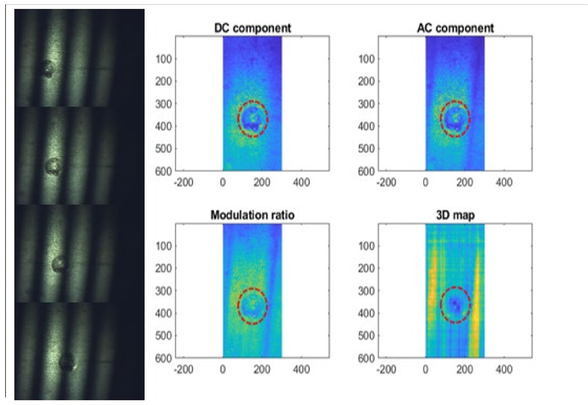

Figure 5. SL scanning sequence and reconstruction results of a corroded sample

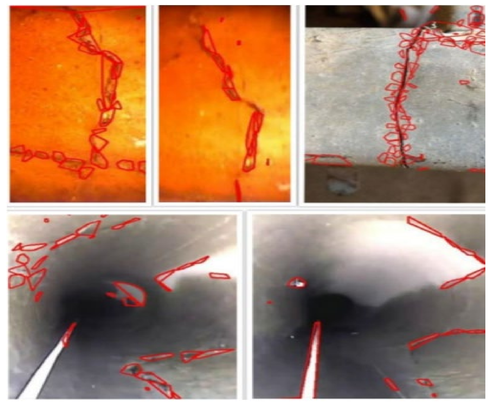

Figure 6. Demonstrative images of the Machine Learning detection algorithm

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References

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