2D AI Weld Defect Detection Project

AI Assisted NDE

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Background

Magna International is one of the largest automotive suppliers globally, designing and manufacturing components for major original equipment manufacturers such as Stellantis, Honda, and For Motor Company. The Magna Seating Lancaster facility specializes in the production of automotive seating components, many of which incorporate robotic gas metal arc welding processes. These welds must meet strict quality standards and undergo inspection and certification prior to being put into the final product assembly. To improve the inspection efficiency and accuracy, a 2D imaging-based AI was developed using a combination of software programs called Label Studio and AutoMetrics. Label studio is an open-source data platform that allows users to train machine learning models by manually labeling features of interest. Through this supervised approach, the AI model learns to recognize weld characteristics based on the annotated examples. Also, during the training, pixel-level image data is analyzed and correlated with real-world dimensions, allowing the system to quantify weld attributes such as surface defects, weld length, area, and spatial location. This approach supports automated, repeatable weld inspection and has the potential to enhance quality control processes within high-volume manufacturing environments.

Motivation

Magna relies on weld operators to certify their welds. Since these operators inspect thousands of welds every day there is potential to miss weld defects and put bad parts into production which could lead to catastrophic failures and potential lawsuits. These limitations costs Magna time and money, so other methods of inspection are desirable.

Objectives & Approach

- Create a large data set to be used as the “backbone” of the AI detection software.
- Receive training on the weld specification Magna uses to evaluate the success of the AI software.
- Improve the accuracy of the AI model when possible.
- Create an AI model that can attain a 99% defect detection rate with a <4% false positive rate.

- Utilize the software Label Studio to label 1000 weld images of parts in service to teach the AI how to recognize welds.
- Travel on-site to Magna Lancaster to receive training in General Motors Specification
- Manually analyze 600 parts in service and record their serial numbers to compare to the AI software’s weld analysis
- Evaluate the AI software’s successes and failures in analyzing defective welds in service.

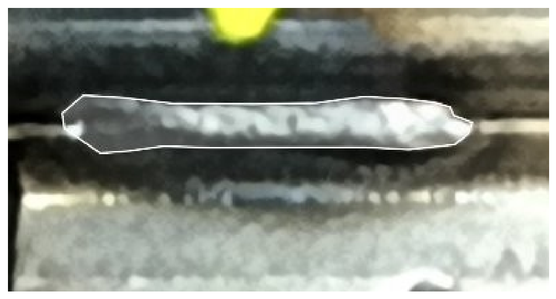
Conclusions

- The “backbone” data set was successfully developed after analyzing the 1000 weld images
- The team was able to learn the General Motors Specifications and manually analyze 600 parts in service
- The AI software was successfully able to reach a 99% defect detection rate as well as a <4% false positive detection rate.

Future Work

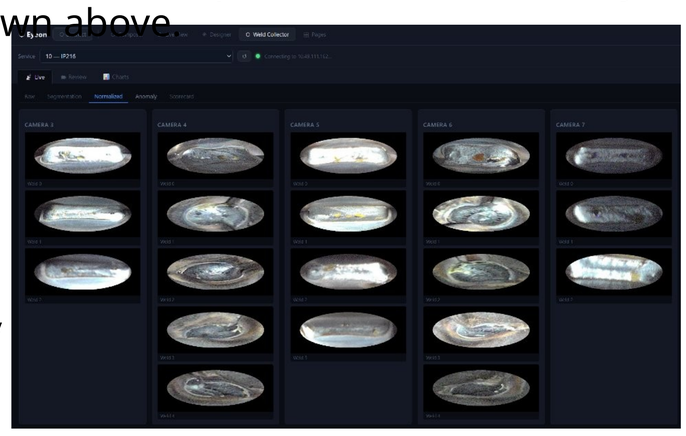
- Continue to monitor the AI’s performance of detecting defective welds in service.
- Enhance training data to improve detection of tack welds.
- Develop classification capabilities to identify specific types of weld defects.
- Expand model capability to analyze additional welding processes.

Results & Discussion

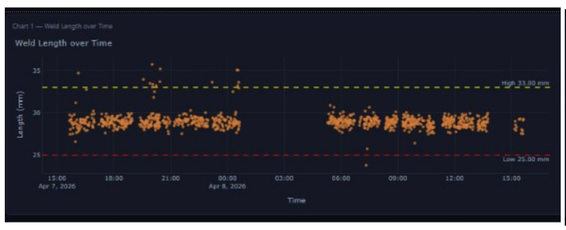


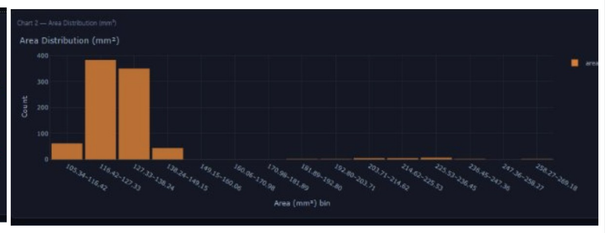
The AI model was developed using a supervised learning approach, where labeled data was used to train the system to recognize weld features. A dataset of about 1,000 images of welded parts was first compiled and annotated by using Label Studios. These annotations served as the base for the training model. Following the training, the AI model evaluated 400 different images to assess its performance. The AI successfully labeled welds within these images with a high degree of precision. Examples of welds labeled by the AI model are shown above.

After the AI was trained it was able to locate all the welds on whatever part was loaded into the machine and flag any visual discontinuities in the welds.



The image above shows an example of 20 welds on one of the parts that was run through the machine.





Using the pictures of the welds, the AI counts the pixels of the welds and then translates that to length. All the orange dots in the left picture represent individual calculated weld lengths. The red line shows the minimum acceptable length, and the yellow line shows the maximum length. The bar graph on the right shows the distribution of the surface areas of the welds that the AI inspected.