Master Thesis: Virtual Generation and Detection of Welding Defects in Cross-Sections Using AI-Based Algorithms

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Introduction:

The aim of the work is the detection of defects that occur in welded steel components using an AI-supported evaluation based on micrographs of the weld seams. Since the targeted and reproducible production of weld seams with defined defect patterns is extremely difficult. Both in research and in industry, a method is to be developed within the scope of the work to introduce different defect types into cross-sectional images specifically. Based on the images developed from this methodology, an AI-supported analysis tool is to be developed to recognize and evaluate weld seam defects in these images. The enormous advantage of such software for the industry is the significantly reduced scope of real tests to generate data sets and the difficulty of specifically introducing certain types of defects. As a result, development times and costs can be significantly reduced.

Methodology:

1) Knowledge Acquisition: Understanding and selecting welding errors according to European Standard DIN EN ISO 5817
2) Data Collection: Gather data with web scrapping for error generation. Later, train and validate the application
3) Data Pre-Processing Pipeline: Involve two datasets and multiple steps like Image enhancement, normalisation of images, Annotation, and Data Augmentation.
4) Model Selection: Choose an adequate deep learning model and algorithm, considering computational efficiency, accuracy, and availability.
5) Performance Matrix: Carry out evaluation process, based upon baseline criteria >= 75 mAP 0.5 0.95. And leveraging the company's industrial environment for real-world implementation.

Significance:

This research holds significant relevance by creating a dataset without contributing to resource wastage in the real world like metal and energy. Later, welding error detection helps in cost reduction by early error detection. It also holds significance to the company by positioning itself as the welding leader of tomorrow.

Expected Outcomes:

We envision establishing a successful implementation of deep learning practices in industrial settings. Deep learning practices are proven to be beneficial in minimizing and early detection of errors and in our case welding errors; thus supporting optimal utilization of resources such as steel, time, and energy.