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Machine Learning Algorithm for Identifying Errors in Laser Material Processing.

ABSTRACT - Masterthesis

Laser material processing such as laser cutting, laser welding and laser drilling are rapidly becoming an important part of the manufacturing industrial world because of their advantages such as high efficiency and productivity over conventional material processing. In order to assess the efficiency and accuracy of laser material processing such as laser welding, one of the state-of-the-art solutions is based on machine learning approaches.

Deep learning, a sub-area of machine learning has gained a lot of attention for research in recent years in various technical and non-technical sectors due to the development of advanced hardware processing units such as tensor processing units and graphics processing units. Laser based material processing, e.g. Laser welding is one of the application fields with a rapidly growing interest in applying novel deep learning concepts for a fully automated assessment of the quality and productivity of the laser welding.

The main focus of this thesis is to evaluate the different deep learning networks for object detection in laser welding. In this object detection task, the different deep learning networks have to classify, locate and detect the laser welding qualities such as seam and no seam. For training, validation and testing of deep learning networks, the raw data consists of Gray-scale images of tailored blank laser welding which have collected from various industrial manufacturing companies. The experimental tasks related to hyperparameter optimization of deep learning networks are performed in order to get the best performance on the tailored welded blanks (TWB) test dataset. In order to check the robustness of the deep learning algorithms, the experimental tasks are performed and their performance are evaluated and analyzed in term of mean F1 score, mean intersection of union (IOU) and mean classification accuracy (mCA). In order to make deep learning networks more robust to image corruptions, optimization techniques are used so that they can become more robust in terms of the mean classification accuracy and the mean F1 score. In addition, the different deep learning models' performance are compared with each other in order to understand the concepts in depth at both micro and macro level.