Machine Learning Based Classification of Lay-Up Quality in Composites Manufacturing

Nowadays, the primary structure of modern commercial aircraft consists of up to 50% of carbon fiber reinforced plastic (CFRP). Most of the structural elements are manufactured using the so-called Automated Fiber Placement Process (AFP). In this manufacturing process, pre-impregnated fiber tapes (prepreg tapes) are automatically placed on a mold (see Figure 1). The quality assurance of the components and the evaluation of defects is a bottleneck in the production, since the inspection of the individual layers is done manually. One approach to automation is the optical measurement of the laminates by laser sensors. The result is a digital 3D image of the component surface. Afterwards defects and placement errors (see Figure 2) can be detected automatically.

The project work consists in analysing and combining different Object Detection and Classification Algorithms for the assessment of the part quality after lay-up (see Figure 2). Based on grayscale image data from the component surface, a suitable algorithm will be implemented combining means of Computer Vision and Machine Learning. The method will be validated on surface scans from composite specimen manufactured with the AFP machine from the Chair of Carbon Composites.

Research focus of the thesis

- Literature research on Object Detection with Neural Networks and strategies for implementation in PyTorch
- Definition of requirements for possible classifiers regarding quality tolerances
- Manufacturing and scanning of AFP laminate specimens to enlarge the training data set
- Implementation of a suitable algorithm for the assessment of the lay-up quality (OK-NOK), can be extended to Defect Classification (Multiple Output Types)
- Optimization of parameters to improve the performance of the classifier
- Detailed documentation and discussion of the results

Requirements

- Curious, proactive and accurately working student
- Ideally first experience with Python and PyTorch
- Interested in process technologies, digitization, programming
- Remote work from home possible, thesis can be written in German or English

Starting date: August 2020

For more details please contact:
Fabian Diemar, M.Sc., Room 5504, 1.407, Tel. +49 89 / 289 – 15786, fabian.diemar@tum.de