Project title:	KIQS - AI based quality control system to classify draping defects
Partner:	MABRI.VISION GmbH Gesellschaft zur Förderung angewandter Informatik e.V. (GFaI)
Duration:	01/2021 – 12/2022
Funding Agency:	BMBF: KMU innovativ (DLR, Berlin)

Univ.-Prof.
Prof. h.c. (MGU)
Dr.-Ing. Dipl.-Wirt. Ing.
Thomas Gries
Director

Florian Brillowski
Research Associate

21.01.2021

Mission Statement

Lightweight construction technologies have already been successfully used and further developed for many years in the fields of aerospace technology, the energy sector and automotive engineering. In the course of the German government's high-tech strategy, they are considered key technologies of the future due to their relevance to the issues of resource efficiency, sustainability and climate change. Fibre-reinforced plastics (FRPs) are a particularly promising group of materials in this context.

During the production of FRP components, various defects can occur, especially in the three-dimensional shaping (draping), which make the component unusable in later applications due to poor mechanical properties or aesthetic defects. In order to be able to avoid the resulting material and component scrap, extensive and robust in-process quality assurance (QA) is of particular importance.

However, currently commercially available quality assurance systems are limited to recording the fibre orientations of the outer layers by means of a 2D image analysis of the visible edges. In the course of a grey value analysis, the textile information is determined from individual images and output in histograms (Fig. 1, right).

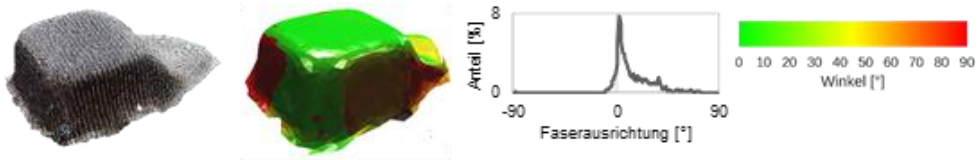

Fig. 1: Exemplary evaluation of a preform

If fibre orientations deviate in a certain area, this indicates the occurrence of a defect (Fig. 1, centre, red). However, it cannot be deduced from this which

specific defect (e.g. fold, alley, ondulation) is present and whether this is critical for the component properties. Therefore, a manual, subjective visual inspection based on internal company guidelines must also be carried out. A generally acknowledged basis for decision-making or standards for defect evaluation do not exist.
Machine learning (ML) approaches offer a promising possibility to classify occurring defects directly and reliably. With the help of this, it is possible to determine different defect classes despite varying defect characteristics. In preliminary tests at the Institute of Textile Technology at RWTH Aachen University, the general applicability of ML approaches for the classification of drape faults was proven. However, with classical ML approaches, the faults have to be relearned for each material-textile variation (e.g. glass/fabric/twill/245 g/m² or carbon/fabric/fringe/400 g/m²) with a manually classified, large data set (1,000 - 5,000 images per fault type).

The **goal of the KIQS research project** is to develop an inspection system for the automated detection and classification of drape defects in different fibre materials. For this purpose, transfer and curriculum learning approaches are being applied for the first time and are newly developed in an application-oriented manner.

Approach

Based on preliminary investigations and empirical values, a prototypical quality assurance system for automated defect detection and classification of fibre composite components will be developed. The defect classes are defined using a previously non-existent, objective methodology to be developed in the project, which for the first time allows a distinction to be made between relevant drape defects and non-critical features. For this purpose, the size, type and location of the defect are included in the decision and a limit pattern catalogue is developed that differentiates the individual defect types from each other.
In addition, automated fault detection is carried out using machine learning approaches. A reduction of the required data through transfer and curriculum learning is being investigated in order to counteract the problem of data sets that are often incomplete or too small in production environments. The novel interaction of ML approaches and objective evaluation methodology forms the essential innovative character of the project.

Acknowledgement

The authors gratefully acknowledge the support of the Federal Ministry of Education and Research within the scope of the research project “KIQS” (Ref: 01IS20089C)

SPONSORED BY THE
Federal Ministry of Education and Research

Contact

Florian Brillowski, M. Sc.

florian.brillowski@ita.rwth-aachen.de

+49 (0) 241 / 80 27662