Universität Rostock
Traditio et Innovatio

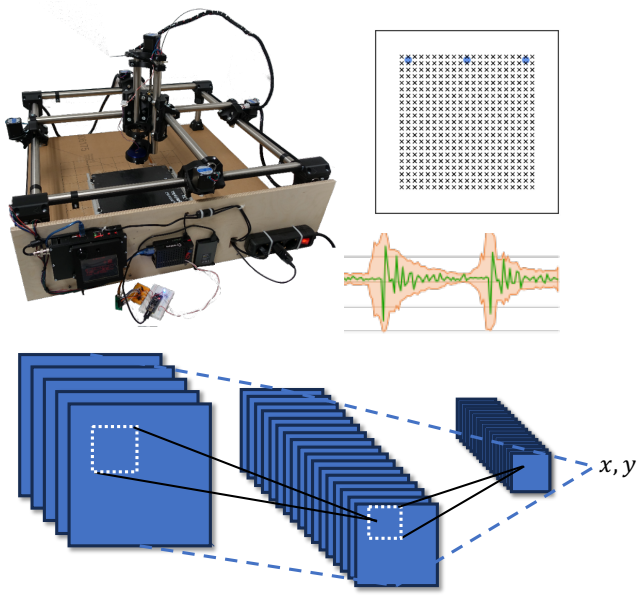
CHAIR OF LIGHTWEIGHT DESIGN
Lehrstuhl für Leichtbau

Explainable AI and Transfer Learning for Impact Detection in Smart Composites

Erklärbare KI und Transfer Learning für Impact Erkennung in Smart Composites

(Master thesis)

Sensor and actuator integration is currently an important research topic in lightweight design. One area of interest are smart structures or smart composites that are able to interact with their environment, act as an interface to the user, or monitor their loading or structural health. The integration of sensors into composite structures is facilitated by digital MEMS (microelectromechanical systems) sensors, which are widely used in many fields of technology. However, compared to other sensors, such as piezoelectric sensors for acceleration measurements, they have much lower signal and time resolution. Therefore, novel signal analysis approaches are required to enable their use in practical applications. Artificial neural networks have proven to be very useful to analyze and process sensor data in such situations. To develop and train such models, a large number of data points is required, so automation of experiments has to be considered.



The goal of this work is to establish an artificial neural network for the impact detection of sensor-equipped smart composites. Using an automated testbed for smart composites, datasets of different specimens and boundary conditions are to be obtained and used for training of the machine learning model. To allow for the necessary variety of different boundary conditions, modifications to the automated testbed should be extended and modified as required. By systematic manipulation of the physical experimental setup or of the obtained sensor data the robustness of the model shall be examined. Using basic concepts of transfer learning a transfer of a trained model to another specimen configuration should be studied to identify the achievable reduction of training data. By application of methods for explainable AI the training process should be examined in detail to, e.g., understand the feature extraction from the sensor data, positional effects on model accuracy or the role of individual physical mechanisms for the model training.

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