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Evaluation of Methods for the Detection of Acoustic Transients Emitted by Plug-In Connections in Automotive Assembly Processes Employing Convolutional Neural Networks.

ABSTRACT - Masterthesis

In the context of this work a transient detection and classification system is developed and evaluated with respect to an automotive application scenario. The motivation originates from the detection of the success of plug-in connections that are performed in the automotive assembly process. The plug-in connections emit an acoustic “click” that is considered to be characteristic for a successful connection. Thus the “click” of a successful connection appears as a transient in a continuously recorded signal and is desired to be detected accordingly. For the detection and classification of the transients, a convolutional neural network is employed due to the recent popularity and promising results without the necessity of in-depth investigations of the process.

A measurement system was developed that enables the recording of the acoustic signal of connections close their location. This measurement system incorporates a microphone and the potential extension with a force and motion sensor system. The investigations are performed with respect to the influence of different aspects introduced by the application environment and connection process. Thus the environmental noise of the assembly environment as well as different perturbations caused by the handling of the connectors are investigated.

The transients of multiple connector types were examined for the time and frequency domain representation of the “clicks”. It revealed that different connectors provide characteristic frequency contributions to the transients. From human perception the time domain transients provide a certain similarity, whereas one can find common characteristics of the frequency domain representation that are more or less distinct for the particular connectors.

For the employment of a convolutional neural network as binary classifier, the network was trained with data sets introducing different aspects of possible application scenarios. It can be concluded that training the model benefits from undisturbed data with the least noise contribution. Nevertheless the presence of noise can be compensated with an increased complexity of the model. Further the classifier is able to discriminate the connection transients from background noise in the assembly environment and from most acoustic perturbations. Whereas it revealed that particular

perturbation transients introduce false- positive classifications. It can be assumed that these perturbation transients are not sufficiently represented in the training data with respect to the variety of candidates and the dimensionality of the data.

The discrimination of different connectors was also investigated with a correspondingly trained neural network and revealed certain limitations. The discrimination of connection transients performed with the presence of environmental noise from the assembly line, leads to many confusions of the different connectors. Whereas the discrimination of connections from none-connections provides results similar to the binary classification problem.