ABSTRACT

Digital sensors are used in every modern assembly line to monitor the individual processing steps. Using this kind of data is essential for controlling the quality of such assembled products and to automatically detect defective ones. In addition, statistics about process variations can be calculated to identify possible systematic errors during production. The goal of this master thesis is the creation of a robust and modular system that is capable of detecting and classifying process variations.
This work is a pilot project to investigate the effectiveness of such a system on a newly created assembly line with the long term goal of deploying it on critical production steps that may affect the quality of the product drastically. Process variations represent in this case known anomaly types previously tested in lab tests. The problem of identifying the process variations is split up into a anomaly detection component and a time series classification component. While the system performs the detection on data from the production site, data from lab tests are used for the classification task. This increases the complexity of the problem, since only a limited amount of data is available for each anomaly case but also makes it possible to train models on anomaly types that haven't yet occurred in the production data.
For the anomaly detection component and the classification component, three different models each were investigated and evaluated. The experiments conducted have shown that the use of an AutoEncoder has given the best results in detecting process variations, achieving a F_1 score of 0.96. For the anomaly classification component, a special Random Forest model called Timeseries Forest Classifier provides the best results in classifying all 48 different process variations with an macro F_1 score of 0.94. These models combined form a robust model that can be used to reliably detect and classify process variations. In addition, both models offer the possibility of use in another production lines.

Keywords: Anomaly Detection, Time Series Classification, Machine Learning, Convolutional Neural Network, Autoencoder, Time Series Forest, Fewshot learning, Siamese Network