Real-time error detection in the Beckhoff XTS transport system

Development and integration of a machine learning model

Graduate

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Introduction: This work explores the implementation of machine learning modells in the Beckhoff TwinCAT control software. Utilizing a small dataset, synthetic data is generated to simulate phenomena that were not originally recorded in order to implement loss detection in the Beckhoff XTS transportation system.

Approach: The linear transport system Beckhoff XTS consists of magnetically driven movers that move along a route of fully integrated motor modules. Fig. 1 shows this structure.

One model is implemented to detect wether products are lost during the transport and another for determining the exact location of these losses. The data used consists of the current for various transported weights, which are combined to simulate product loss. The models are developed using Python with the Scikit-learn framework and are implemented in TwinCAT via Open Neural Network Exchange (ONNX) where they are evaluated for their effectiveness. Fig. 2 shows the confusion matrix for the trained location detection model. Which should reach a theoretical detection accuracy of more than 90%.

Result: The simpler model, focusing one the acceleration and deceleration phases demonstrates how machine learning can be effectivly applied even with limited training data. In contrast, the more complex model for location detection focusing on the the whole dataset struggles with accuracy due to the limited dataset and high noise levels, which obscure the true signal and hinder pattern recognition.

This study highlights the potential of using Beckhoff's tools to integrate machine learning models into TwinCAT with minimal development effort. It also underscores the feasibility of achieving valuable insights with a limited data foundation while recognizing the limitations faced with more complex models and data constraints.

Fig 1: Beckhoff XTS
Beckhoff Automation

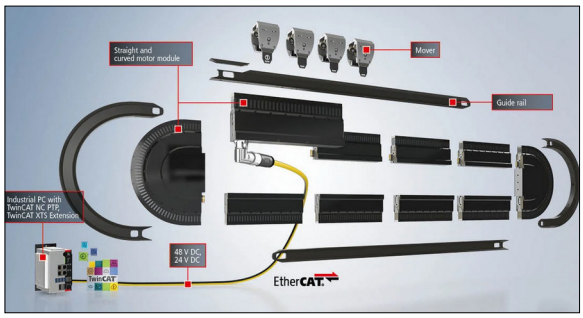
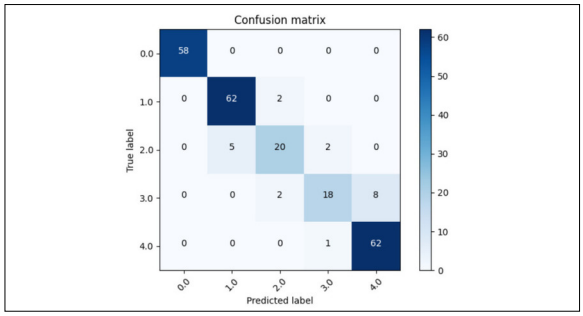


Fig 2: Confusion Matrix for prediction
Own presentment



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