Touchdown Detection for a Manufacturing Machine

Graduate

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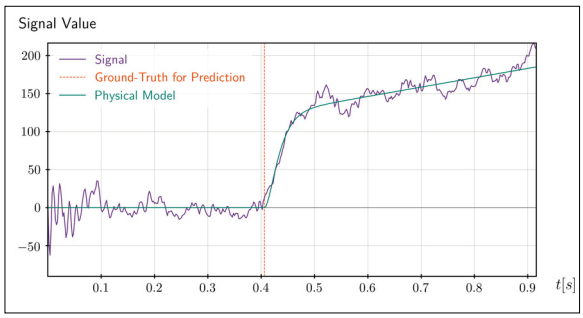
Introduction: This thesis was done in cooperation with a manufacturing company. Their machines record data from various sensors during the production process. The main objective of this thesis was to use this data, to predict the touchdown point. Due to unique conditions for every machine and work piece, the sensor signals often have very different characteristics from one another and a small signal-to-noise ratio. Therefore, giving a sophisticated estimation proves to be a rather difficult task for both humans and algorithms alike.

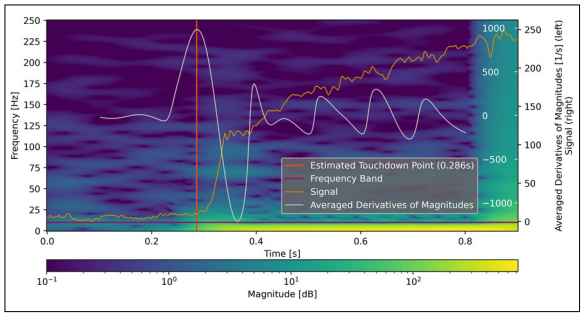
Approach: First, the authors analysed the data at hand. Once they got a good understanding of the situation, they developed a mathematical model of the physical process, to be able to generate an unlimited amount of artificial data. The main reason this is desirable, is that the generated data contains some known ground truth, which opens up the possibility for supervised learning. After establishing all this groundwork, the authors implemented several schemes, which are able to predict the touchdown point. Some of those detection methods are purely analytical, like the time-frequency analysis, which can not only be used to make a prediction but also to gain insights on the characteristics of the sensor signal. Other approaches are rooted in machine learning, where the authors explored classical and deep learning techniques, such as fully connected, recurrent, and convolutional neural networks. A whole framework was established to evaluate and compare the performance of all the developed detection methods.

Result: The authors developed a simulation that can describe the underlying physical process. With it, they are able to generate artificial data on a large scale. Several methods achieve promising results on this data and make reasonable predictions on the recorded machine data. Especially the convolutional neural network performs well with a mean absolute error of 9.63ms on the generated data, which corresponds to around 5 samples in time. Additionally, some interesting details about this specific manufacturing process were revealed, which might prove useful to the collaboration partner in the future.

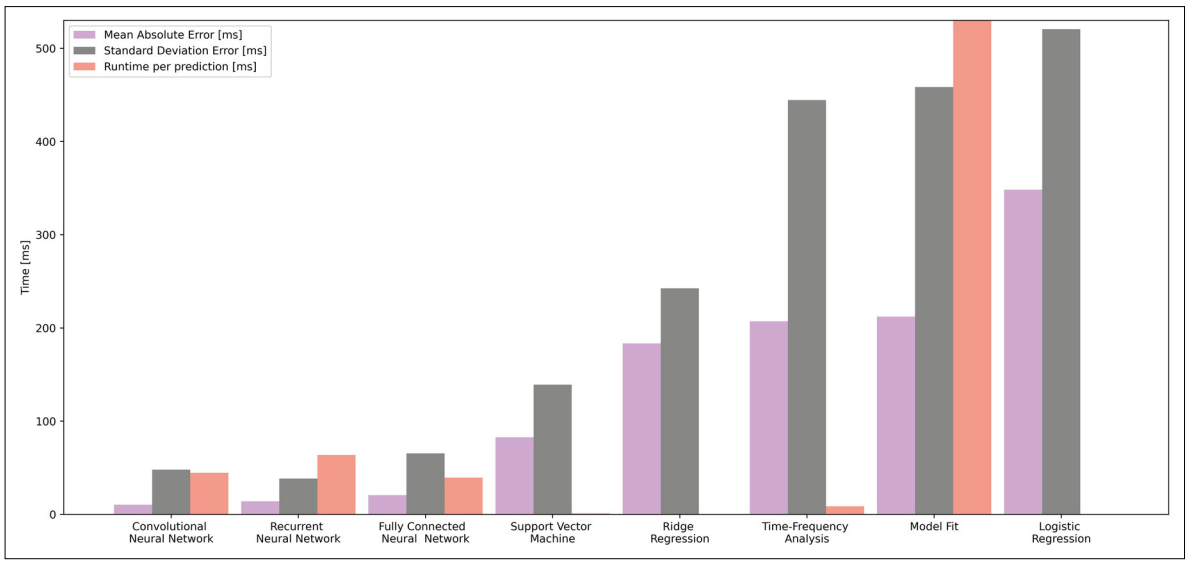
Recreation of a Real Signal by the Physical Model
Own presentment



Time-Frequency Analysis of a Signal
Own presentment



Performance Comparison Between Different Prediction Methods
Own presentment



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Subject Area
Artificial Intelligence, Digital Signal Processing