Punching Tool Wear monitoring at the Edge

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Abstract

As a fast and inexpensive machining method applicable for creating a wide range of shapes and producing large batches, sheet metal punching is widely used e.g., in automotive, aerospace, electronics, and construction industries. A significant downside of sheet metal punching is the punching tool wear in use. A worn punch tool may impact the quality of the end product by causing imperfections and reduce the efficiency of the manufacturing process through increased scrap and by slowing down the production. Effective monitoring of punching tool wear is therefore essential for an efficient and cost-effective production of high-quality parts. The monitoring can be based on acceleration measurement which produces large amounts of raw data, making edge processing ideal as only the indication of the tool condition needs to be sent forward for decision support. Classification models for tool wear identification were built and compared in this study. The models are based on measured acceleration data (Figure 1). Two different open-source methods for time series feature extraction, namely TSFEL and MiniRocket, were tested and the classification results based on them compared. All methods used for building the models are computationally light and therefore applicable for real-time data processing at the edge. According to the results the MiniRocket algorithm is suitable for the task and superior compared to the TSFEL method. The classification accuracies based on the MiniRocket features are at best over 96.5 % and at worst around 84 %, whereas the corresponding accuracies are between 35 and 56 % for TSFEL feature based models. The use of the MiniRocket algorithm in building a model for punch tool monitoring shows very promising results. However, the available dataset is very limited in size. Therefore, further investigation is required based on an ampler dataset. We will use finite element method for simulating the effect of the tool wear on the acceleration response. By simulations we are able to vary the state of the cutting tool in a wider scale and less effort and expenses compared to experimental methods and thus enrich the content oft he dataset efficiently.

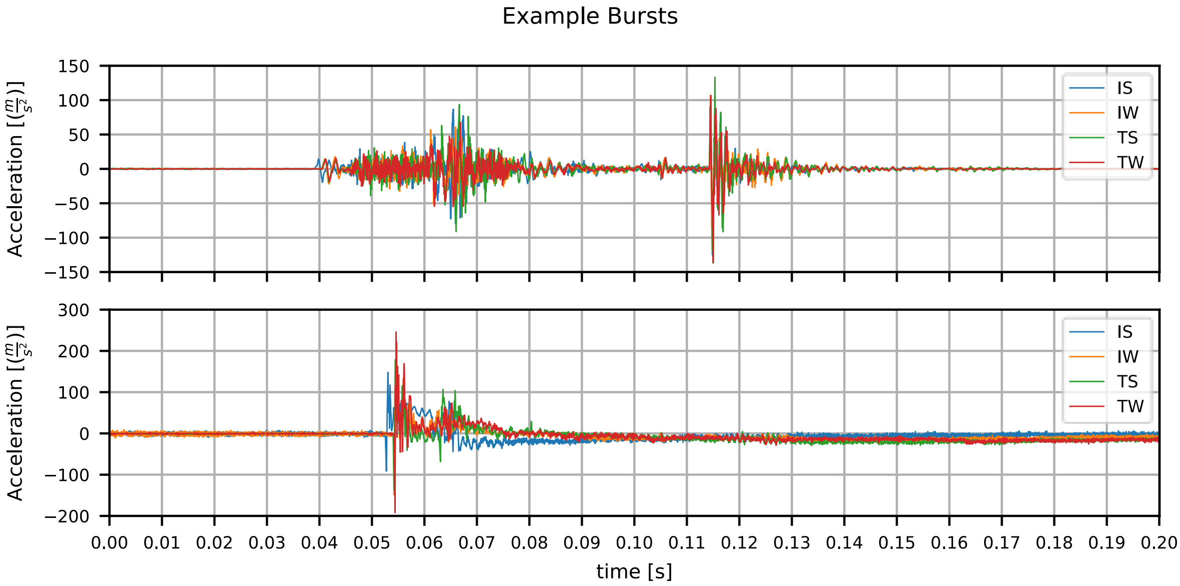

Figure 1: Example bursts, upper bursts measured at the punch and lower bursts at the die. Tool material and shape: IS = Inox sharp, IW = Inox worn, TS = Terninox sharp, TW = Terninox worn

References

[1] Junttila J., Raunio K., Kokkonen P., Saarela O.: " Feature Estimation for Punching Tool Wear at the Edge ", ESAAM 2023, Not published