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”DATA1#1 - Vibration based milling diagnostics using Artificial Intelligence”

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In industrial machining processes, tool failures may result in losses in surface and dimensional accuracy of a finished part, or possible damage to both the work piece and the machine. Consequently, tool condition monitoring has become essential to achieve high-quality machining as well as cost-effective production. Moreover, cutting tool degradation may vary considerably under different operation conditions and materials behaviour. Therefore real time identification of the tool state during machining, before it reaches its failure stage, is critical. In this study the vibrations of the cutting tool and of the workpiece material are online measured. Features are then calculated in time domain from the raw signals. Transient zones, when the cutting tool enters or exits the material, can be considered or not. All the calculated features are normalized and stored in a table. It is then necessary to make a dimensional reduction of that feature table in order to avoid overfitting and to reduce the computing time of the learning algorithm. In this study, 54 milling experiments were conducted from which features were calculated and then split into two groups: 80% for the machine learning model training, 20% for the test phase. The first part of this study proposes an analysis on the impact of the features on the robustness of the models, and a second part focuses on a real-time data driven prognostics and health management (PHM) approach for tool condition monitoring, based on supervised machine learning techniques (i.e. the model training needs labelled data). The fusion of decision coming from several machine learning algorithms (kNN, decision trees (DT) and random forest (RF)) is then used to predict the tool quality in real time. All parameters and configurations of the algorithms are optimized in order to maximize the real time diagnosis accuracy. The experimental results show that our proposed approach achieves good accuracy and real time performances in dry milling operations. Results of our study are implemented in real tool wear diagnosis, and thus give new opportunities toward realizing Industry 4.0

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