In-situ prediction of the spatial surface roughness profile during slot milling

Bernd Peukert, Adithya Rangaraju, Andreas Archenti

KTH Royal Institute of Technology, Stockholm 08544, Sweden
bpeuke@kth.se

Abstract. Quality inspection is traditionally considered non-productive. That is why the manufacturing industries aim to decrease inspection times to a bare minimum without sacrificing part quality. Alongside the implementation of the Industry 4.0 paradigm, data-driven in-situ quality control is a potential enabler for minimizing inspection times. In that, the surface roughness parameter prediction is the subject of a large body of research, but studies on the spatial surface roughness profile prediction are limited. This research contributes to this field by using vibration signals and physics-informed machine learning models for the in-situ prediction of the surface roughness profile. A tri-axial accelerometer mounted on the machine tool spindle is used to capture the vibrations during a slot milling process. For one tool revolution during a stable cut, the observed acceleration in the three axes and the surface roughness profile are periodic. A model is constructed to establish the correlation between the input signals and the spatial surface roughness profile by utilizing a physics-based model of the tool trajectory together with a two-layer feed-forward neural network. Furthermore, the feature engineering of denoised velocities and displacements derived by the numerical integration of the acceleration signals improves the prediction performance with overfitting. The results show a good correlation between the spatial surface roughness and the accelerometer signals.

Keywords: surface roughness, data-driven modeling, physics-informed machine learning.

The full paper is published in MATEC Web of Conferences, Volume 368 (2022):

DOI: https://doi.org/10.1051/matecconf/202236801019