# Surface Roughness Prediction in Ultra-precision Machining: A Conditional Generative Adversarial Network for Signal Data Augmentation Approach

S. Y. Shang [1], C. F. Cheung [1] and P. Zheng [1]

[1]State Key Laboratory of Ultra-Precision Machining Technology, Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hong Kong, China

benny.cheung@polyu.edu.hk

**Abstract**

Ultra-precision machining is a kind of subtractive technologies which is widely used for fabricating structure and freeform surfaces. Intelligent surface roughness prediction for ultra-precision machining is crucial to achieve real-time surface quality control. The dataset for training the ultra-precision machining prediction model is usually composed of signal data appearing in times series collected during the machining process in conjunction with machining parameters as model input and real-measured surface roughness as model output. However, such datasets are often small and time-consuming to collect and annotate, hindering the prediction ability of prediction models. To overcome this challenge, the conditional generative adversarial network for mechanical sensor data augmentation is first introduced, by taking real-measured surface roughness as the condition to increase the prediction accuracy of the ultra-precision machining surface roughness prediction model. The augmented results show a very high similarity between the generated signal and the real signal. Then, those generated signals are incorporated with machining parameters as new model input. To compare the prediction accuracy before and after signal data augmentation, a three-layer backpropagation neural network is utilized for ultra-precision milling surface roughness prediction. Results show that adding more generated samples in the training dataset can improve the prediction accuracy compared to taking the original 56 real samples as model input. In detail, adding 560 or more generated samples can reach the best prediction ability for this dataset with a mean absolute percentage error of around 9%, while the original 56 real samples only have a prediction accuracy of 27.2%.