

New Developments in Machining Simulation Using a Unified Material Model and Machining Monitoring Using Machine Learning Techniques

Dr. Rui Liu

Kate Gleason College of Engineering
Rochester Institute of Technology
Faculty Host—Juan Ren

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Abstract

To realize the unmanned operation, which is one of the major components of Industry 4.0, the machining process needs to be planned properly beforehand and monitored accurately in real time. Finite element simulation offers a cost-effective method to optimize the cutting conditions and to select the right cutting tool material and geometry before operating the actual cutting process. A key input to such simulations is a constitutive model that describes material behavior during severe plastic deformation. My theoretical/computational work seeks to develop a unified material model that explicitly incorporates microstructure evolution into the constitutive law to simulate the chip formation and predict the microstructure evaluation in the chip and on the machined surface during cutting. On the other hand, due to the complexity of the cutting process, the cutting tool degradation and failure always happen unexpectedly. Tool Condition Monitoring (TCM) system offers a good solution to monitor the cutting tool state during machining, which is essential to improve the production quality, optimize the labor and maintenance costs, and minimize the manufacturing losses with the increase in productivity. My current research work mainly focuses on developing an audio-based TCM system to thoroughly monitor the cutting tool conditions. Advanced machine learning techniques, Support Vector Machines (SVMs) and Convolutional Neural Networks (CNNs), have been adopted in my studies for decision making. The developed TCM system is expected to be easily incorporated into cyber-physical systems to realize the multifunctional tool condition monitoring in process and in real time.

Biography

Dr. Rui Liu is currently an Assistant Professor in the Mechanical Engineering Department at Rochester Institute of Technology. He received his B.S. degree in Jet Propulsion at Beijing University of Aeronautics and Astronautics, China, in 2005. In 2010, he received his M.S. in Mechanical Engineering at Northeastern University. In 2014, he completed his Ph.D. in Mechanical Engineering at Georgia Institute of Technology. Dr. Rui Liu's research areas cover a wide range of topics in advanced manufacturing, including tool condition monitoring, machining process optimization, and process simulation for various kinds of machining processes.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.