Improving a turn process using piezoelectric actuators

Project description

This project focuses on the machining process of turning. A high bandwidth piezoelectric actuator with advanced control algorithms will be designed for studying the effects such a system can have on surface finish as well as on process stability behaviors such as chatter characteristics. Another technique we will employ in this project is ultrasonic assisted machining, which utilizes ultrasonic vibration to improve machined surface quality. Ultrasonic assisted machining is a non-conventional material removal process to promote the improvement of machining quality through the utilization of ultrasonic vibration in the cutting tool at a fixed amplitude and frequency. The approach is founded upon the principle of transforming a conventional turning process into a high frequency vibro-impact process which results in an increase in the dynamic stiffness of the lathe-tool-workpiece system and improves the accuracy of turning. It is intended that the design and evaluation of these technologies will expose project participants to a variety of concepts and techniques that are important in a modern, agile manufacturing environment, including model based design, in process monitoring, non contact metrology and advanced process control. Finally, the cutting condition performance of these systems will be evaluated in face cutting operations on aluminum, and the effects on surface finish are measured using non-contact profilometry. Based on the results from these experiments, the performance characteristics of the actuator are documented for future use in high precision machining operations.

Schedule

Weeks	Tasks
1	Orientation
2	Background research piezoelectric materials, fast-tool servo, ultrasonic-assisted machining
3	Study on adaptive positive position feedback filter
4-5	Experimental setup and characterization under the laboratory setting
6-8	Experimental setup and characterization under the manufacturing environment
9	Finish writing and presentation

Background Literature:

1. Park, G., Bement, M.T., Hartman, D.A., Smith, R., Farrar, C.R. 2007, "The Use of Active materials for Machining Processes: a Review," *International Journal of Machine Tool and Manufacture*, Vol. 47, No. 15, pp. 2189-2206.
2. Thoe, T.B., Aspinwall, D.K., Wise, M.L.H. (1997) "Review on Ultrasonic Machining," *International Journal of Machine Tools & Manufacture*, **38** (4) pp. 239-255.
3. Creasy, M.A., Leo, D.J., Farinholt, K.M., 2008, "Adaptive Positive Position Feedback for Actively Absorbing Energy in Acoustic Cavities", *Journal of Sound and Vibration*, V311, 1-2, pp. 461-472.