Research topics for graduate students for 2023

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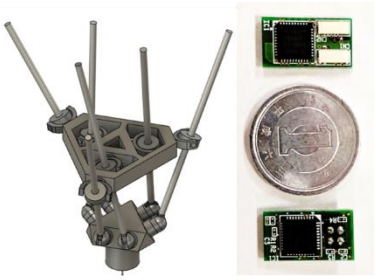
Acceptable course(s)

- Master's Degree
- Doctoral Degree

Research Topics



The main topic of research is intelligent and advanced manufacturing system. Especially we are focusing on precision machining system/process such as metal cutting, grinding and so on. The key concept is how to realize the precision machining by a machining system with low stiffness and low accuracy. We have developed various on-machine measuring sensors to enable the real-time feedback and compensation of machining errors. The machining robot is being developed for proof of concept. Followings are a few research topics.

1. Condition monitoring of machine tools by real-time identification of system dynamics

Dynamics of machine tools significantly affect the vibration state and eventually final accuracy of machined parts. We proposed an identification method of system dynamics with multiple vibration sensors on machine [1]. A novel vibration sensor was developed to realize the system identification by only using the vibration of machining process itself. It would be a breakthrough in the machine tool technology.

2. Highly precise thermal error compensation by means of large-scale temperature measurement

Thermal deformation of the machine tool structure dominates up to 75% of total machining error. Robust and real-time compensation method has been desired. We developed large-scale array of temperature sensors interconnected in series which enabled the temperature measurement at hundreds or thousands locations on a single machine tool [2]. The large amount of temperature information is revealed to be helpful to realize robust and accurate thermal error compensation.

3. In-process monitoring of machining phenomena by tool-integrated intelligent sensing system

Tool-workpiece interface is exposed to extreme temperature and pressure whose magnitude significantly influence the machining results and tool wear. We developed a robust sensing system of cutting temperature integrated in a tool that enabled deep analysis of process phenomena and feedback control to improve it [3].

Articles Related to Research Topics

[1] Liu, J., Kizaki, T., Ren, Z., Sugita, N., 2022, Mode shape database-based estimation for machine tool dynamics, Int. J. Mech. Sci., 236/September.

[2] Tanaka, S., Kizaki, T., Tomita, K., Tsujimura, S., Kobayashi, H., et al., 2023, Robust thermal error estimation for machine tools based on in-process multi-point temperature measurement of a single axis actuated by a ball screw feed drive system, J. Manuf. Process., 85/July 2022:262–271.

[3] Kizaki, T., Takahashi, K., Katsuma, T., Shu, L., Sugita, N., 2020, Prospects of dry continuous generating grinding based on specific energy requirement, J. Manuf. Process., 61/June 2020:190–207.

Lab. Web page: https://www.hnl.t.u-tokyo.ac.jp/