

MAWATARI LAB.

[Intelligent Technology for Highly-Skilled Handwork]

Department of Mechanical and Biofunctional Systems

Intelligent Manufacturing System

Department of Mechanical Engineering

<https://www.cmi.iis.u-tokyo.ac.jp>

Mawatari Lab belongs to the Consortium for Manufacturing Innovation (CMI) established in April 2013. Through Industry, Academia, and Government Cooperation, CMI will proceed progressive and innovative R&D of manufacturing and contribute to rapid and high value manufacturing, environmentally conscious manufacturing, and manufacturing with minimum natural resources and less amount of rare metals.

Research activities in CMI

Skills of Manufacturing Technology → Manufacturing Science → Highly-efficient Manufacturing Technology → Rapid advance

Research topics

1. Proposal of algorithm for automatic generation of machining program for difficult-to-cut materials
2. Collection of residual stress data (material, machining) and development of residual stress reduction method
3. Basic development of 3D position measurement control technology (online control)
4. 6-axis control error prediction (offline control)
5. Metal Deposition
6. Development of Large Area Faying surface sealing Technology
7. Cutting tool competition (Comparison of tool performance) for composite materials and so on
8. Technical consultation

WHAT IS CMI? (CONSORTIUM FOR MANUFACTURING INNOVATION)

Research institutes (as organizations)

- The University of Tokyo (IIS)
- Tokyo University of Agriculture and Technology
- Tokyo Denki University
- Hiroshima University

Industry, Academia and Government Cooperation for aircraft manufacturing technology

Government (as organizations)

- Ministry of Economy, Trade and Industry
- New Energy and Industrial Technology Development Organization

Aerospace Industries (as companies) (As of July 2020)

- The Boeing Company
- Mitsubishi Heavy Industries, LTD.
- Kawasaki Heavy Industries, Ltd.
- SUBARU CORPORATION
- DMG Mori-Seiki Co., Ltd.
- Idemitsu Kosan Co., Ltd.
- FUKUDA Corporation
- YASHIMA Co., Ltd.
- Tokuda Industries Co., Ltd.
- FUKUDA CORPORATION
- AICM TECHNI CO., LTD.
- HEIWA SANGYO CO., LTD.
- MARIUTAMA INDUSTRIAL CO., LTD.
- NTS Co., Ltd.
- KSI Co., Ltd.
- TOKYO ROBOT TECHNO-SYSTEM LTD.
- SADO SEMITSU CO., LTD.
- Asayama seihou Inc.

In CMI, Mawatari Lab especially focuses on developing intelligent technologies for highly-skilled handwork in industry. There is an increasing need to automate handwork by skilled workers in industry. However, that handwork is usually difficult to express clearly in words. Furthermore, human's motion contains time and spatial perturbations, and this makes the automation even more difficult. Mawatari lab is constructing mathematical methodologies to quantitatively evaluate highly-skilled handwork, and to establish principles for automation by robots and for workers learning the handwork.

Waveform analysis of highly-skilled handwork

Mathematical model

$$\|\Omega\|^S = \sum_{i=1}^7 \omega_i \|\Omega_i\| + \sum_{i=1}^7 \omega_{i+7} \left\| \frac{d}{dt} \Omega_i \right\|$$

$\|\Omega\|^S$: Sobolev norm

$$\max_{1 \leq k < n} \|\Omega^k - \Omega^l\|^S = \min_{1 \leq j < m} \max_{1 \leq k < n} \|\Omega^k - \Omega^j\|^S$$

Ω^0 : Sobolev center

Training of next-generation technicians

Professional Standard bundle: $\|\Omega^P(t)\|$
 $\|\Omega\| = \|\Omega^P(t)\| + \|\Omega^N(t)\|$

Novice Examinee bundle: $\|\Omega^N(t)\|$
 $\|\Omega\| = \|\Omega^P(t)\| + \|\Omega^N(t)\|$

Scientific evaluation of proficiency

New, flexible and intelligent manufacturing system

