

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. Machining Technology for Aluminum Alloy
2. Machining Technology for Al-Li Alloy
3. Drillings of CFRP
4. Additive Metal Processing
5. Robotic Milling Technology
6. Robotic Sealing Technology
7. Hot Stretch Forming
8. NDI for CFRP

New 1. Orbital Drilling

WHAT IS CMI? (CONSORTIUM FOR MANUFACTURING INNOVATION)

Research institutes (6 organizations)

- * The University of Tokyo (IIS)
- * Tokyo University of Agriculture and Technology
- * Tokyo Denki University
- * Industrial Research Institute of Niigata Prefecture
- * Tohoku University
- * Hiroshima University

Government (2 organizations)

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

Aerospace Industries (21 companies)

- * The Boeing Company
- * Mitsubishi Heavy Industries, LTD.
- * Kawasaki Heavy Industries, Ltd.
- * SUBARU CORPORATION
- * DMG Mori Seiki CO., LTD.
- * Idemitsu Kosan Co., Ltd.
- * Nachi-Fujikoshi Corp.
- * KYOCERA Corporation
- * Tokuda Industries Co., Ltd.
- * Iwado Industry Co., Ltd.
- * YASHIMA, Co., Ltd.
- * MIZUNO METAL WORKS. CO., LTD.
- * ACM TOCHIGI CO.,LTD.
- * HEIWA SANGYO CO., LTD.
- * MARUTAKA INDUSTRIAL CO., LTD.
- * NTS Co., Ltd.
- * KSI Co., Ltd.
- * FUKUDA CORPORATION
- * SADO SEIMITSU CO., LTD.
- * Aoyama seikou Inc
- * TOKYO BOEKI TECHNO-SYSTEM LTD.

Industry, Academia and Government Cooperation for aircraft manufacturing technology

先進ものづくりシステム連携研究センター

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

$$\max_{1 \leq k \leq n} \|\Omega^k - \Omega^0\|^S = \min_{1 \leq j \leq n} \max_{1 \leq k \leq n} \|\Omega^k - \Omega^j\|^S$$

Ω^0 : Sobolev center

Training of next-generation technicians

Professional: Standard bundle : $\Omega^k(t)$
 $\mathfrak{R}(n) = \{\Omega^k(t) \in C^1[t_s, t_e] : 1 \leq k \leq n\}$

Novice: Examinee bundle : $\Psi^k(t)$
 $\mathfrak{N}(n) = \{\Psi^k(t) \in C^1[t_s, t_e] : 1 \leq k \leq n\}$

Scientific evaluation of proficiency

New, flexible and intelligent manufacturing system