Title: "Practical Motion Control for Industrial Positioning Devices: Controller Implementation to Laser Processing Machines with World-Top Market Share"

Abstract: *"Motion Control"* is one of practical academic disciplines on the basis of control theories, and has been extensively applied to actual *"Mechatronic Systems"* in various industrial fields. For example, fast-response and high-precision motion control should be indispensable in a wide variety of high performance mechatronic systems including micro and/or nano scale motion, such as data storage devices, machine tools, manufacturing machines for electronics components, and industrial robots, from the standpoints of high productivity, high quality of products, and total cost reduction. In those applications, the required specifications in the motion performance, e.g. response/settling time, trajectory/settling accuracy, etc., should be sufficiently achieved. In addition, the robustness against disturbances and/or uncertainties, the mechanical vibration suppression, and the adaptation capability against variations in mechanisms should be essential properties to be provided in the performance.

The plenary lecture presents practical motion controller design approaches for industrial fast and precise positioning devices, specifically giving a research/development example of positioning controller design of Galvano Scanners in laser processing machines for printed circuit boards. An example of the required processing specifications is over 2,000 holes/s for 50-100 μm diameter hole with 10 μm accuracy in the laser hole drilling. The Galvano Scanners, however, inherently possess mechanical vibration modes and nonlinear properties with perturbations in resonant frequencies due to temperature and aged variations, which mainly deteriorate the precision motion performance in scanner positioning speed and accuracy. The lecture, therefore, focuses on the controller design techniques to improve the performance deteriorations in positioning accuracy and vibration suppression. In the compensator design, promising approaches have been introduced, such as, precise plant mathematical modeling with vibration modes, robust 2-degree-of-freedom controller design, model-based vibration suppression compensation, evolutionary algorithm-based autotuning and optimization, coordinate design between feedforward and feedback compensator, etc. The proposed approaches and techniques have been applied and implemented to actual motion controllers of the scanners, and verified through numerical simulations and experiments under the collaborative research/development activities with a Japanese machine company. These activities have been yielding the highest performance laser processing machines with the world's top market share.

Biography: Makoto Iwasaki received Dr. Eng. degrees in electrical and computer engineering from Nagoya Institute of Technology, Nagoya, Japan, in 1991. Since 1991, he has been with Nagoya Institute of Technology, where he is currently a Professor at the Department of Electrical and Mechanical Engineering.

As professional contributions of the IEEE, he has participated in various organizing services, such as, a Management Committee member of IEEE/ASME TMech (Secretary in 2016 and Treasurer in 2017), a Co-Editors-in-Chief for IEEE Transactions on Industrial Electronics since 2016, a Vice President for Planning and Development in term of 2018 to 2021, etc. He is IEEE fellow class 2015 for "contributions to fast and precise positioning in motion controller design".

He has received many academic, foundation, and government awards, like the Best Paper Award of Trans of IEE Japan in 2013, the Technical Development Award of IEE Japan in 2017, the Nagamori Awards in 2017, the Ichimura Prize in Industry for Excellent Achievement of Ichimura Foundation for New Technology in 2018, the Technology Award of the Japan Society for Precision Engineering in 2018, and the Commendation for Science and Technology by the Japanese Minister of Education in 2019, respectively. He is also a fellow of IEE Japan, and a member of Science Council of Japan.

His current research interests are the applications of control theories to linear/nonlinear modeling and precision positioning, through various collaborative research activities with industries.