Department of Industrial Production and Automation
Department Introduction, Testbed Involvement and Research Topics

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Department of Industrial Production and Automation

- Joint personal team with Faculty of Mechanical Engineering (FME CTU)
- Main research areas and topic leaders:

- **Advanced robotics**
  - Prof. Michael Valášek

- **Industrial automation**
  - Dr. Jiri Švéda

- **Smart machine tools**
  - Dr. Petr Kolar

- **Digital twin and production process virtualization**
  - Dr. Matej Sulitka

- **Machining and laser technologies**
  - Dr. Pavel Zeman

- **Hybrid manufacturing technology**
  - Dr. Jan Smolík
Department laboratories

- The IPA department operates two laboratories:
  - Laboratory of robotics and manufacturing technology (LRMT)
  - Laboratory of advanced robotics (LAdR)
- Both labs are part of CIIRRC Testbed for Industry 4.0
Advanced robotics

- The focus is on research of non-traditional structures and control methods of robots. Combination of both approaches has potential to significantly improve properties of the traditional robotic systems. The research results can be implemented in wide task spectra of industrial production.
- Non-traditional robotic structures: e.g. parallel kinematic structures, inflated structures, rope structures, structures with redundant drives.
- Non-traditional control approaches: general problems of are controllability and observability, model identification and control robustness, special control approaches (sliding-mode control, state observer control)
Industrial automation

- Industrial robots are the key instruments of the modern automated production.
- Industrial communication involves topic of monitoring of production machines and manufacturing processes and communication of production machines with the superior systems for production control.
- On the production system level, there is focus on horizontally and vertically integrated automated production systems. It includes industrial communication between various production machines combined with continuous monitoring of the production processes enable better effectivity, productivity and quality of the production.
Smart machine tools

- Our research goal is enhancing and maturing the concept of the smart machine tool.
- The smart machine tool is equipped by additional sources of inputs for feedback. The intelligence of the machine tool is based on predefined algorithms and current process data. Autonomous reaction to unexpected situations is a current research goal.
- Research areas involves:
  - Physical and also virtual sensorics integrated in the machine tools and production, development of auxiliary measurement systems.
  - Process characterization using machine and process signals.
  - In-process collaboration of real machine tools with their digital twins.

Sensorics and signal processing
Data fusion
Edge computing
Data analyze
Cloud computing
Digital twin and production process virtualization

- Machine tool Digital Twin is an effective instrument for predicting and optimizing the results of machining process. Workpiece Digital Twin is a result of the complex simulation of the machine tool – process interaction, including the dynamic behavior of the machine tool and the workpiece and detailed visualization of the manufactured part.

- Digital Twin eliminates the uncertainties of NC machining processes, serves as a tool to identify and to eliminate machining errors.

- Our research goal is enhancing and mastering this concept for every-day practical implementation in the industrial production.
Machining and laser technologies

- The research scope is on fundamentals of the machining and laser processes used for additive or subtractive manufacturing processes. The key goal is to understand tool/laser beam interaction with the workpiece material and ability to characterize it using measurable parameters. This is a cornerstone for further process optimization and process-machine interaction control.


- Laser micro processing using nano-, pico- and femtosecond laser.

- Machining of difficult-to-cut materials with using cryogenic and MQL cooling.
Hybrid manufacturing technology

- Hybrid manufacturing means combination of additive and subtractive production processes in one working space of the production machine. The research is focused on effective implementation of hybrid manufacturing.
- Applications include solution for production of new parts, partial material addition on the part and workpiece repair applications.
References
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