VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF MECHANICAL ENGINEERING | DEPARTMENT OF ROBOTICS

Annual Report

2024

VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF MECHANICAL ENGINEERING | DEPARTMENT OF ROBOTICS

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https://www.instagram.com/katedra_robotiky/
https://www.youtube.com/user/robot354

CONTENT

1 DEPARTMENT PROFILE

Since its establishment (1989), the Department of Robotics has focused comprehensively on robotics issues, both at all levels of teaching, as well as in science and research and in professional activities for practice. In line with current trends, the department's staff develops the topics of industrial, collaborative and service robotics. This is reflected in research, teaching and publications. Grants, contract research and the topics of thesis and dissertation theses are based in this sense. In teaching, the department provides several disciplines – Robotics, a specialization within the Bachelor's degree program in Mechanical Engineering and subsequently also in the follow-up Master's degree program in Mechanical Engineering with three specializations at the Faculty of Mechanical Engineering. The Department also sponsors the doctoral study programme Robotics and the bachelor's study programme Mechatronics.

The areas of robotics problems solved by the department can be divided into: design, operation, construction, testing and diagnostics, simulation, measurement, control and sensing, dynamics, the use of computer support to solve problems and innovations in the field, mathematical modelling of mechanisms and their drives in terms of control, the design of technical and software means of control systems of positioning mechanisms and sensing subsystems, including image processing of the technological scene for various applications, tools and methods - including optimization - for the design of mechatronic systems. The department also profiles interested students in the design and deployment of control systems intended for process and visualization levels of control in mechatronic systems.

The Department actively offers study placements to foreign students within the Erasmus+, IAESTE, etc.

The department staff and students solve theoretical and application tasks corresponding to the mentioned focus. Teaching takes place in the Robotics Centre, on various types of industrial and collaborative robots and their subsystems. Robotics and mechatronics is characterized by a wide and comprehensive use of computer support for all areas of activity. The CAD systems classrooms are therefore equipped with the appropriate software tools.

2 STAFF

Department head:	prof. Dr. Ing. Petr Novák *(until September 2024)* prof. Ing. Zdenko Bobovský, PhD. *(since October 2024)*
Deputy head:	prof. Ing. Zdenko Bobovský, PhD. *(until September 2024)* doc. Ing. Milan Mihola, Ph.D. *(since October 2024)*
Secretary:	Ing. Ján Babjak, Ph.D.
Assistant:	Ing. Petra Pišťáčková
Academic staff:	prof. Ing. Zdenko Bobovský, PhD., prof. Dr. Ing. Petr Novák, doc. Ing. Róbert Huňady, Ph.D. *(since September 2024),* doc. Ing. Milan Mihola, Ph.D., doc. Ing. Aki Matti Mikkola, Ph.D. *(since August 2024),* doc. Ing. Aleš Vysocký, Ph.D., Ing. Dominik Heczko, Ph.D., Ing. Václav Krys, Ph.D., Ing. Jakub Mlotek, Ph.D., Ing. Petr Oščádal, Ph.D. *(until Septemberí 2024)*, Ing. Jiří Suder, Ph.D., Ing. Michal Vocetka, Ph.D., Ing. Zdeněk Zeman, Ph.D.,
Researchers:	doc. Ing. Tomáš Kot, Ph.D., Ing. Ján Babjak, Ph.D., Ing. Jan Bém, Ing. Adam Boleslavský, Ing. Jakub Chlebek, Ing. Jakub Krejčí, Ing. Jan Maslowski, Ing. Tomáš Poštulka, Ing. Tomáš Spurný, Ing. Rostislav Wierbica,
Professor emeritus:	prof. Dr. Ing. Vladimír Mostýn, prof. Ing. Jiří Skařupa, CSc., Doc. Ing. Zdeněk Konečný, Ph.D.

3 ADUCATION ACTIVITIES

3.1 Guaranteed Study Fields

Bachelor Studies

The **Engineering** programme includes a common core that lasts two years. After that, students choose a specialisation – in our case it is **Robotics**.

Study programme:	**Engineering**
Study branch:	**Robotics**
Code:	B0715A270011/S07 (Czech), B0715A270012/S04 (English)
Coordinator:	doc. Ing. Milan Mihola, Ph.D.

The **Mechatronics** study programme lasts the whole three years.

Study programme:	**Mechatronics**
Code:	B0714A270002
Coordinator:	prof. Ing. Zdenko Bobovský, PhD.

Master's Studies

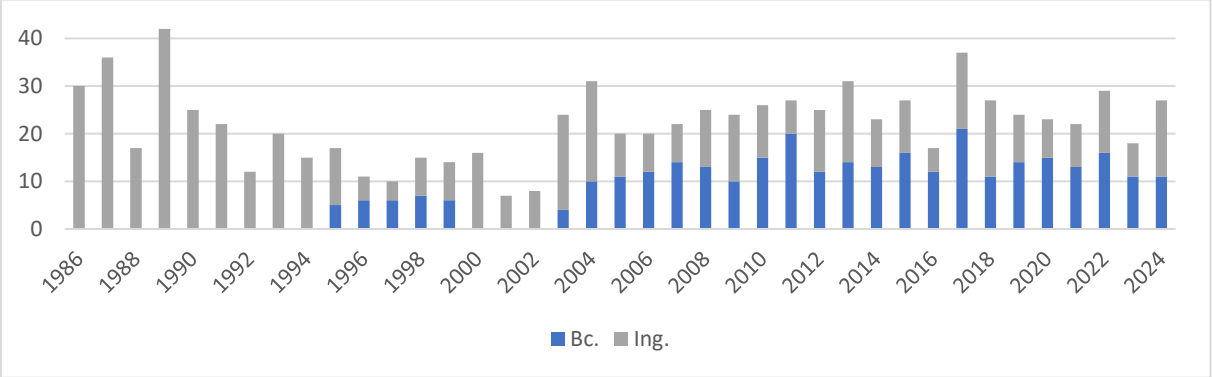
Study programme:	**Robotics**
Code:	N0719A270009 (Czech), N0719A270010 (English)
Specializations:	- Designing of Robotic Workcells - Service robotics
Coordinator:	prof. Dr. Ing. Petr Novák

Doctoral Studies

Study programme:	**Robotika**
Code:	P0714D270003 (Czech), P0714D270004 (English)
Coordinator:	prof. Dr. Ing. Petr Novák

3.2 Defended Final Theses

In 2024, **16** diploma theses and **11** bachelor theses were successfully defended.



Total number of graduates in the Department of Robotics

3.3 PhD Students

Student	Topic	Year	Supervisor
Ing. Jan Bém	Use of flexible materials in robotics	4.	doc. Mihola
Ing. Adam Boleslavský	Research and development of extruder for robotic printing of silicate materials	4.	doc. Mihola
Ing. Jakub Krejčí	The concept of IoRT (Internet of Robotic Things) and its application	4.	doc. Babiuch
Ing. Tomáš Spurný	Determining the safety space for human-robot cooperation using computer vision and AI	4.	doc. Vysocký
Ing. Rostislav Wierbica	Finding the optimal kinematic structure of a robotic manipulator for a given task	4.	doc. Kot
Ing. Jakub Chlebek	Optimization of a sensor system for obstacle detection around a collaborative robot	3.	doc. Kot
Ing. Jan Maslowski	Calibration of a multi-camera system sensing the workspace	3.	prof. Bobovský
Ing. Tomáš Poštulka	Robotic systems with closed kinematic chain	3.	prof. Bobovský
Ing. Amit Sain	Effect of the shape of the manipulator's variable bearing elements on its accuracy	1.	prof. Bobovský
Ing. Tomáš Drastik	Use of virtual reality in service robotics	1.	doc. Kot
Ing. Aleš Franc	Development of a print head with adjustable nozzle diameter for use in 3D printing	1.	doc. Mihola
Ing. Daniel Hartmann	Safe interaction between robot and human	1.	doc. Vysocký

3.4 Student Projects

This chapter provides a description of projects and activities carried out with significant involvement of students of the Master's degree programme and the PhD programme in Robotics.

SGS 2024

Programme:	MSM: SV_2010 – Specific research VŠB-TUO
Name:	**Research and development of means of perception of robotic systems**
Code:	SP2024/082
Keywords:	Perception, sensory subsystem, industrial robotics, service robotics, digital twin, virtual model, industry 4.0, internet of things.
Principal Investigator:	Ing. Václav Krys, Ph.D.

The project focuses on increasing the degree of adaptability of robotic systems in their dynamic environment using digitalization in the design and operation of robotic systems in line with the latest trends of Industry 4.0 and IoT. This will be achieved by creating HW and SW tools for collecting, evaluating and interpreting data about the dynamic environment of robotic systems. Robotic systems will thus be able to adapt to the current situation. This is essential for service robotic systems performing their service activities in spaces shared with humans. For collaborative industrial robot applications, this approach also proves to be essential for effective human-robot collaboration and interaction. Thus, the robot, knowing the surrounding environment, can re-plan its trajectory to accomplish the desired task without colliding with the operator and thus without interrupting the task (service or production).

RoverOva

RoverOva's departmental student team is developing the K3P4 mobile robotic system for participation in robotic competitions simulating Mars conditions. The robot consists of a number of modules designed as part of undergraduate or thesis work - a mobile chassis, currently two robotic arms and several effectors. Specially developed modules are used for competitions, such as a laboratory for the evaluation of soil samples or camera modules for intuitive control and autonomous navigation in the field. The development of the system was also supported by the Faculty of Engineering, Excalibur Army, SGS and the City of Ostrava. In the past years, the team regularly participated in international competitions, but in 2024 it did not qualify for any.

LastLIGHT

In June, the robotics department formed a student team called LastLIGHT, whose goal was to build a drone for a competition in Vietnam. The drone was tasked with dropping balls into colored targets. Several versions of the drone were developed over the summer and final documentation and an instructional video were completed before the flight. Upon arrival in Vietnam, the team completed the final version of the drone and competed with it. Out of a group of three, the team recorded one win and one loss, not enough to advance, and finished fifth overall.

4 SCIENCE AND RESEARCH ACTIVITIES

The current scientific and research profile and experience of the Department of Robotics can be described as follows:

- Methodology and theory of conceptual design of robotic manipulators.
- Design and optimization of kinematic structures of robots and their parts with respect to environmental obstacles and desired trajectory.
- Synthesis of robot kinematic structure, automatic design of 3D models of robot arms according to specified parameters using a database of elements.
- Design and development of control systems.
- Elimination of the influence of temperature on the drift of the absolute position accuracy of the robot.
- Optimized design of distributed camera system for 3D sensing, 3D data preprocessing.
- 3D on-line workspace monitoring and analysis.
- Adaptive robotic measurement of 3D objects.
- Optimization of the number and placement of sensors with respect to the object of interest.
- Soft and bio-robotics.
- Kinematic and dynamic analysis of mechanical systems.
- Research on collision-free mechanisms with closed kinematic chains.
- Assisted assembly with collaborative robots, using deep neural networks.
- Human-robot interface (HRI) for more efficient collaboration.
- Development of mechatronic systems for explosive environments (spark safety).
- Robot-assisted 3D printing using a variable cross-section nozzle.

4.1 Current Projects

Name: **Infrastructural support of doctoral study programmes at VŠB - TUO**
Code: CZ.02.01.01/00/22_012/0008111

Name: **MATUR – Materials and technologies for sustainable development**
Code: CZ.02.01.01/00/22_008/0004631

Name: **National Recovery Plan for VŠB-TUO**
Code: NPO_VŠB-TUO_MSMT-16605/2022

Name: **National Centre of Competence in Mechatronics and Smart Technologies for Engineering**
Code: TN02000010

Name: **Refresh – Research Excellence for Region Sustainability and High-tech Industries**
Code: CZ.10.03.01/00/22_003/0000048

Name: **Research and development of means of perception of robotic systems**
Code: SP2024/082

5 ROBOTICS CENTRE

The Robotics Centre is a modernly equipped space designed for teaching students in study programmes guaranteed by the Department of Robotics and for scientific research activities of the Department's staff. Demonstrations are also held here for visitors from companies and educational institutions from the Czech Republic and abroad.

The Robotics Centre underwent a major reconstruction and expansion in 2023 and 2024. The reconstruction was financed by the project *Infrastructural support of doctoral study programmes of the VŠB-TUO, reg. no. CZ.02.01.01/00/22_012/0008111 (call OP Jan Amos Komenský, Development of infrastructural facilities of doctoral study programmes), OP-JAK MŠMT, EU*.

In connection with the reconstruction and expansion of the Robotics Centre, the Department of Robotics moved to these premises in the autumn of 2024.

5.1 Second Floor – Classrooms and Offices

The reconstruction mainly concerned the 2nd floor of Building T, where modern facilities for academic and research activities of the Department of Robotics were created:

- T201 to T217 – Consultation rooms and other spaces.
- T220 – Meeting room – capacity about 35 persons, multimedia system.
- T221 – Lecture room – capacity at least 20 seats, multimedia system.
- T222 and T223 – Computer classrooms – capacity of each room 20 + 1 computers.

Lecture room T221

5.2 First Floor - Laboratories

The laboratory space of the Robotics Centre (LCR, UCR - officially room T29) is gradually being transformed into six separate sections for individual laboratories according to their focus:

- Laboratory of Experimental Robotics.
- Laboratory of Collaborative Robotics.
- Laboratory of Design of Mechatronic Systems.
- Laboratory of Industrial Robotics.
- Laboratory of Sensor Systems, Vision and SW.
- Laboratory of Service Robotics.

Part of the Laboratory of Collaborative Robotics

The Laboratory of Sensor Systems, Vision and SW

Part of the Laboratory of Design of Mechatronics Systems