Ulysses Research Group's thematic focus

Research Problem: Intelligent Cognitive Manufacturing

Research Topic: Autonomous Robots

Vision holder – TUKE IH: Prof. Jozef Svetlík

Main area of research: Research focused on the application of autonomous and collaborative robotic systems to the industrial environment, resulting in new possibilities leading to increased productivity and production automation using virtual and simulation tools, which require a deep degree of adaptation of basic and applied research. At the same time, attention will be paid to the research of the application of the mentioned systems, supported by artificial intelligence from the point of view of system security and the impact on the surrounding environment in accordance with Industry 5.0, which is focused on smart materials, real-time simulations, virtualization of processes using a digital twin, and the security of cyber data transmission. The excellence of the application of collaborative robotic systems, autonomous robots using AI, virtual reality and smart materials is in the full implementation of the Industry 4.0 system and the preparation for the new Industry 5.0 system, which is oriented towards full collaboration between robots and humans, sustainability and resistance.

Existence of living lab:

- **Applied Robotics and Mechatronics Laboratory** (ARM-Lab) at Technical University of Kosice, Faculty of Mechanical Engineering, Slovakia is dedicated to make significant contributions to the advancement of robotics technology and bring real-world solutions to industrial and societal problems through its innovative research and development activities. Whether it's developing new and more flexible robots such as snake robots or continuum robots for minimally invasive surgeries, soft robotic grippers, or improving the dexterity of robotic manipulators. The ARM-Lab works closely with many local companies to provide innovative solutions to real-world problems. For more information see on website: https://www.arm-lab.sk/

- **The Modular Adaptive Reconfigurable Manufacturing Laboratory** (MARM-Lab) at the Technical University of Košice, Faculty of Engineering, Slovakia is determined to contribute significantly to the development of mobile robots, manipulators and devices with a special focus on reconfiguration and modularity adaptively according to the current changed task. These are mainly industrial applications intended for production and service purposes. Activities include the design, adjustment, testing and diagnosis of used production systems containing mechanical, electromechanical, pneumatic and hydraulic devices that are controlled by PLC and embedded systems with the application of artificial intelligence methods.

Specific research problems & objectives:
- Automated systems for industry and other areas using AI and IIoT devices
- Robotic manipulators, industrial robots, collaborative robots
- Continuum robots, soft robotics, snake robots
- Sensor systems and vision systems
- Control systems with the application of machine learning methods
- Production systems, design, adjustment, control and diagnosis of production systems
- And many more 😊

Expertise requested:
- Expertise in automation, mechatronic and robotic systems in commercial or public sector for joint scientific publishing
- Exchange and preparation of project proposals for international and national funding
- Development of special methodologies for design, optimization, simulation and control of systems
- Expertise in building European transactional data living lab

Selected research projects of the TUKE team related to the research topic:

- H2020-DT-2018-1 RIMA - Robotics for Infrastructure Inspection and Maintenance
- OPVaV-2009/2.2/05-SORO ITMS: 26220220141 Research of modules for intelligent robotic systems EU fund project
- DESCA-2020 MIDIH - Manufacturing Industry Digital Innovation Hubs
- APVV-18-0413 Modular architecture of structural elements of production machinery

Selected recent scientific publications of the TUKE team related to the research topic:

- DEMEČ, P. - SVETLÍK, J.: Virtual prototyping of machine tools/ 1st ed. Lüdenscheid: RAM-Verlag - 2017. 156 p. ISBN 978-3-942303-61-3.
- SVETLÍK, Jozef - DEMEČ, Peter: Flexible and modular production systems/ 1st ed. Lüdenscheid: RAM-Verlag - 2019. - 150 p. [print]. ISBN 978-3-942303-93-4.
- ONDOČKO, Š. et al.: Inverse kinematics data adaptation to non-standard modular robotic arm consisting of unique rotational modules. In: Applied Sciences. Vol. 11, No. 3 (2021), p. 1-15. https://doi.org/10.3390/app11031203
- SVETLÍK, J. et al.: Application of continuous carbon fiber reinforced composites in a modular system. In: 26th International Slovak-Polish Scientific Conference on Machine Modelling and Simulations. Bristol (GB): IOP Publishing. p. 1-8.
- SVETLÍK, J. et al.: Verification of the usefulness of the virtual reality application for URM assembly. In: 2023 the 15th International Conference on Computer and Automation Engineering. Danvers (USA): IEEE. p. 87-92. ISBN 979-8-3503-9623-2; ISSN 2154-4352.
- STEJSKAL, T. et al.: Mapping robot singularities through the Monte Carlo method. In: Applied sciences. Vol. 12, No. 16 (2022), p. [1-15]. https://doi.org/10.3390/app12168330
- KELEMEN, M. et al.: A novel approach for a inverse kinematics solution of a redundant manipulator. Applied Sciences. Vol. 8, No. 11 (2018), p. 1-20. https://doi.org/10.3390/app8112229
- VIRGALA, I. et al.: Investigation of snake robot locomotion possibilities in a pipe. In: Symmetry. Vol. 12, No. 6 (2020), p. 1-25. https://doi.org/10.3390/sym12060939
- VIRGALA, I. et al.: A snake robot for locomotion in a pipe using trapezium-like travelling wave. In: Mechanism and machine theory. New York (USA) : Elsevier Science No. 158 (2021), p. [1-21]. https://doi.org/10.1016/j.mechmachtheory.2020.104221

In the case of interest, we would like to arrange some meeting with more detailed presentation and discussion how to create domain specific research groups and how to manage cooperation and high impact R&I results.

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