Research Group in Interaction Design

Contact details.

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Areas of expertise

We conduct interdisciplinary research into products, services, processes, and environments to ensure they meet the needs of their users. We investigate various topics on ***human-machine interaction, industrial robotics and automation, servitization, robotic exoskeletons for cardiac rehabilitation, industrial software design, and aesthetics and usability***. We're also interested in ***operations research*** and ***technical project management***.

Our projects are mainly focused towards industrial and healthcare environments.

Human-Machine Interaction refers to the communication and interaction between a human and a machine via a user interface. When interacting with a system, be it an industrial application or a rehabilitation device, users play different roles (for example operators and maintainers, or patients and physiotherapists), use a variety of interface types (graphic, voice, gesture-based, or even brain-computer interfaces), and - maybe most importantly - face different cognitive loads and cognitive barriers while performing their tasks. Within our research group, we explore each of these dimensions of human interaction with systems.

Industrial robotics and automation refer to integrating in smart ways the latest achievements in artificial intelligence, IoT, mechanics and control. Beyond this, integration of robots with other smart systems to meet the challenges of smart factories leads to the consideration of new communication protocols, standardization and remote monitoring and control. Within our research group, we explore each of the challenges associated with industrial robotics and automation systems.

Robotic exoskeletons for cardiac rehabilitation refer especially to that type of robots, mainly exoskeletons, that can deliver structured physical exercise, education, and risk reduction to the cardiac patients in a cost-effective manner. The exoskeleton for cardiac rehabilitation is to support motor recovery of patients following a cardiac surgery or a major cardiac event to ensure a normal - active and independent - life. The main challenge in the design and development of such a robotic exoskeleton will be to allow the natural movements of the upper arms and body of the patients; to achieve this goal the focus should be on design the shoulder girdle and forearm mechanism, on kinematic design, design the actuation and controlling system, defining the dynamics of the exoskeleton, etc. Within our research group, we explore each of these dimensions of the design and development of a rehabilitation robotic system.

Servitization refers to industries using their products to sell "outcome as a service" rather than a traditional sale. Known in the academia as Product-Service System, it's a business model potentially generating, for its supplier, stronger customer relationships, constant or recurring income streams, or

value creation via new services. Customers of a PSS get access to higher quality products, avoid initial investment costs, and pay for a service better aligned to their needs. There are, however, a lot of challenges in implementing PSSs, both technical and managerial, emerging as the customer *interacts* with the product in a completely new way. Within our research group, we explore the adaptations of the product *and* the business model required for a PSS to stand out.

Industrial software design denotes a process to transform user requirements, in an industrial context, into a form which helps software developers in coding and implementation. In our research group, we focus on those particularities driven by the industrial context that influence how users interact with the software.

Aesthetics and usability are essential ingredients of an effective and efficient interaction of a user with a system. Learning curve, visceral reactions, motivation, productivity, brand loyalty, all are influenced by the usability and aesthetics of a system. Within our research group, we explore how to build systems with an increased level of usability.

Team and key skills

The Research **Group in Interaction Design** is a multi-disciplinary research unit that explores the possibilities of integrating the new technologies into practice through development of industrial robotic systems, rehabilitation robots, mechatronic and software products that focus on aesthetics, usability, and user experience.

The Research Group is composed of academics – **prof. Bogdan MOCAN**, **PhD. habil.; assoc.prof. Mircea FULEA, PhD. habil.; lecturer Mircea MURAR, PhD** – with a strong practice-oriented approach, an industrial research and development expert – **eng. Cosmin IOANES, Phd** – and research students: **eng. Raluca Mutu**, **eng. Dominic Schreiner**, **eng. Ionuț Andreca** - with a high interest in theory and practice of human-machine interaction, industrial robotics, cardiac rehabilitation robots, servitization, and aesthetics and usability. These areas of expertise are combined harmoniously in collaborative research projects. Within the research group, the synergy operates at all levels, fostering a flexible, dynamic, and adaptive approach to user interaction design.

Bogdan Mocan is specialized in mechatronics applications. He has led a PNIII grant, managed two PNII and CEEX grants, and participated in six CEEX, PNII, FP6, FP7, H2020 projects. With 46 peer-reviewed publications in high-impact journals, two patents in 2021 and 2023, and authorship of 11 books or chapters on robotics and innovation, he has received 20 international IP awards. His work is well-cited in ISI Web of Science, with 136 citations and an H-index of 7.

Mircea Fulea is specialized in Human-Machine Interaction, Usability, Product-Service Systems, and Operational Research. He has 36 ISI-indexed publications with 117 citations, contributed to 18 peer reviews for ISI journals, and has an H-index of 5. He has led a PCCA grant and one international R&D project in robotic palletizing with an industrial partner (CSi Industries Netherlands). He was a key member (software architect & developer) in 2 FP7 research projects, one CEEX, one PNII, and one H2020 project. He coordinates the Technical Project Management master program at the Technical University, run in strategic partnership with Emerson.

Mircea Murar is specialized in industrial process integration for Industry X.0, connected workers, and process control, has contributed to a research project and a bridge grant. With 23 ISI-indexed papers, 100 citations, an H-index of 6, a patent application, and several book chapters, he has extensive experience in Siemens automation technology through over 150 projects.

Infrastructure

A broad variety of Siemens Automation Technology:

- Logo8! – Micro PLCs with integrated display
- S7-12xx - Programmable Logic Controllers and KTP Basic Human Machine Interfaces
- S7-ET200SP – Fails-Safe Programmable Logic Controllers with IOs and TP Comfort Human Machine Interfaces
- S7-15xx T – Technological Programmable Logic Controllers and Fail-Safe Mobile Human Machine Interface.
- SIMATIC ET 200SP Open Controller PC2 with Software PLC
- V90 PN & S120 PN – ServoDrives
- V20 & G120 – Variable Speed Drives
- RFID and Machine Vision Identification systems.

WAGO fieldbus couplers and distributed IOs
Single-board computers (Raspberry Pi, Arduino), touchscreens & sensors
3D Printer
Desktop robotic arms for developing and testing industrial application concepts
Maxon Plate Motors for Cardiac Rehabilitation Exoskeleton
Notebook PC systems
Open access to industrial equipment via our partner InnoRobotics

Development strategy

Our mission is to explore the why's, what's and hows' of interaction design, to shape products and services that provide meaningful and relevant experiences to their users.

Our development strategy is to contribute with both theoretical knowledge and applied research in the areas of human-machine interaction, cardiac rehabilitation robotics, product-service systems, and operations research. We also aim to support our industrial partners to deliver impactful design solutions via servitization and superior user experience, and thus improve their customer retention. We also aim to expand the research group's infrastructure into a state-of-the-art laboratory of interaction design.

Representative projects

- **New Assistive VR-enhanced Robotic Exoskeleton for Cardiac Rehabilitation**, research project, PN-III-P2-2.1-PED-2019 -1057, nr. 535PED/2020.
  The aim of this project was to develop and validate an innovative, integrated system that combines robotic exoskeleton technology with virtual reality applications to support and enhance cardiac rehabilitation. This project aimed not only to improve rehabilitation outcomes by providing personalized, adaptive support that can significantly improve motor functions and overall cardiovascular health of patients recovering from cardiac events but also to increase patient engagement through immersive virtual reality environments that make rehabilitation exercises more engaging and motivating.
- **innDrive - Integrated Innovation Management System for SMEs,** research project, 2014-2017, PCCA2013 no. 341/2014
  The aim of this project was to develop a novel information system, based on a multi-layer innovation model, covering all key business processes, addressed to SMEs, for supporting them in implementing comprehensive, multi-dimensional innovation management systems. It provides a consistent set of models, procedures, rules, specialized tools for innovation, innovation roadmaps, and expert modules for creative problem-solving, knowledge management modules, (ontology-based) search engines on various structured and unstructured databases in order to lead the company towards setting up and implementing mature solutions to various crisis points (e.g. technical, economical or mixed) that might occur within any key business processes.
- **Intelligent human-robot interfaces for intuitive programming of industrial robots**, postdoctoral research program, POSDRU/159/1.5/S/137516 „Parteneriat interuniversitar pentru excelență în inginerie - PARTING"
  The aim of this project was to develop and implement innovative, user-friendly human-robot interfaces that enable intuitive programming and efficient interaction between humans and industrial robots. The project aimed to enhance the capabilities of industrial robots, making them more accessible and usable for a broader range of applications and users, ultimately leading to increased productivity, flexibility, and safety in manufacturing environments.

- **Smart command and control architectures for reconfigurable robotized manufacturing cells**, postdoctoral research program, 2014-2015, POSDRU/159/1.5/S/137516 „Parteneriat interuniversitar pentru excelență în inginerie – PARTING"
  The goal of this postdoc program was to research smart architecture frameworks that allow the effective implementation of the reconfigurability concept in manufacturing processes.
- **Non-invasive Intraoperative Detection of Small Endoluminal Digestive Tumors and their Margins using Magnetic and Proximity Sensors,** medical RD project, 2014-2015, Grant Agreement no. nr. 11740/09.07.2014
  The aim of the project was to develop a groundbreaking, non-invasive technology for the real-time, intraoperative identification and delineation of small endoluminal digestive tumours and their margins. This project aimed to harness the capabilities of advanced magnetic and proximity sensor technologies to accurately detect tumours within the digestive tract, thereby enabling precise surgical interventions. The ultimate goal was to improve surgical outcomes, reduce the risk of tumour recurrence, and enhance patient recovery by providing surgeons with precise, immediate information on tumour location and boundaries, facilitating the complete removal of cancerous tissue while preserving healthy surrounding structures.
- **Innovative design of the robotic security fences for fast assembly and installation**, industrial RD project, 2015-2017, CSi Industries B.V. Netherlands, Grant Agreement no. 28343/10.11.2015
  The aim of the project was to revolutionize the field of perimeter security by developing a novel robotic security fence system that is not only robust and effective in threat detection and deterrence but also designed for rapid, easy assembly and installation. This project aimed to integrate cutting-edge robotics, automation, and smart sensor technologies to create a modular, scalable fence system that can be quickly deployed in various environments.
- **Expert System for Smart Robots**, industrial RD project, 2013-2016, CSi Industries B.V. Netherlands, Grant Agreement no. 2013111901/2013
  The aim of this project was to develop a novel software tool to manage the palletization patterns (how boxes are arranged onto the pallet) in robotized applications. It allowed volume optimization, multiple boxes grabbing, custom box rotation, box layer flip and rotation, and an interactive 3D view of the resulting pallet.

Our offer to the economic environment

Research & development in core areas	R&D in User Experience Design R&D in Industrial Robotics and Automation R&D in Robot-Assisted Medicine
Research & development in applied fields	R&D in servitization, R&D in industrial software design, R&D in industrial automation; R&D in robotic cardiac rehabilitation, R&D in operations management
Consulting	Consulting in the field of: ▪ Design and development of industrial robotic systems. ▪ Design and development of industrial automation systems. ▪ Design and development of user control interfaces for smart robotized systems. ▪ Design and development of mechatronic products for medical use. ▪ Design and development of robotic exoskeletons for cardiac rehabilitation. ▪ Solving the Facility Layout Problem and developing the risk assessment analysis for industrial robotic systems.
Applied engineering services	Automation and commissioning the industrial robotic manufacturing systems. Design the user control interfaces for smart robotized systems. Optimising the industrial robotic manufacturing systems.
Training	Trainings in UxD, industrial software design, automation and robotisation of industrial processes, operations management.