

Editorial

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Special issue: Minimal-invasive robotics

Schwerpunktheft: Minimalinvasive Robotik

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Minimal-invasive robotics is a subtopic of medical robotics that has been constantly gaining importance over the years. Demographic ageing, the constant increase of the average life expectancy, and the importance of high-quality, accessible health care has led to constant investment in research and development for improving available treatment standards and technologies. While only a few years ago open surgery was considered the state of the art for many surgical treatments, interventions with miniaturized instruments that enter the patient through a keyhole (minimal-invasive surgery) has become the desired form of surgical treatment for many reasons. While minimal-invasive surgery mainly relies on rigid, straight tools that are manually guided, the advancement of robotics, teleoperation, material sciences, real-time control, and real-time data analysis, including applications from machine learning and AI, gave rise to continuous improvement of surgical technologies that constantly push limits for the benefit of patients. Nowadays, minimal-invasive surgery has become a highly interdisciplinary field. This field involves scientists with various backgrounds, industry, and healthcare professionals who work together in order to enable new treatments, improve patient recovery, and safety.

This special issue is dedicated to methods and applications that are directly from the field of minimal-invasive robotics or closely related fields. The different papers included in the special issue should contribute to a better understanding of health care challenges or the implications of diseases for the individual patient as well as technological advancements. The peer-reviewed papers were collected

from labs that are close to the editors' work environment. Overall, the papers provide comprehensive insight into current state of research in the field that will pave the way for new minimal-invasive robotic treatments and future trends.

1 Articles related to methods

Jeremy Genter, Georg Rauter, Annegret Mündermann, Daniel Baumgartner

“Muscular-driven control strategy of an over-actuated glenohumeral experimental simulator for assessing rotator cuff tears”

Murali Karnam, Marek Zelechowski, Georg Rauter, Philippe Cattin, Nicolas Gerig

“Qualitative and Quantitative Assessment of Admittance Controllers for Hand-guiding Surgical Robots”

Christian Marzi, Felix Buck, Franziska Mathis-Ullrich

“Antagonistic Tendon-driven Continuum Robot for minimally-invasive Surgery”

Ramy Zeineldin, Franziska Mathis-Ullrich, Oliver Burgert

“Development of a Multimodality AI-Driven System for Brain Tumor Surgery: A Step towards Minimal Invasive Robotics”

Nikola Fischer, Franziska Mathis-Ullrich

“Compact Flexible Actuator based on a Shape Memory Alloy for Shaping Surgical Instruments”

Nikola Fischer, Johannes Knapp, Franziska Mathis-Ullrich

“Shape-Sensing by Self-Sensing of Shape Memory Alloy Instruments for Minimal Invasive Surgery”

Yukiko Tomooka, Dominic Sporthelfer, Georg Rauter, Manuela Eugster

“Minimal-invasive *in-situ* 3D printing”

2 Articles related to applications

Lars Wagner, Sven Kolb, Patrick Leuchtenberger, Lukas Bernhard, Alissa Jell, and Dirk Wilhelm

“Deep learning-assisted intraoperative instrument cleaning station for robotic scrub nurse systems”

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We thank the journal at-Automatisierungstechnik for the opportunity to host this special issue. To all readers, we wish an enjoyable reading of the interesting contributions related to automation, control, and robotics in the medical field.

Best regards,
Georg Rauter, Franziska Mathis-Ullrich

Bionotes



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Georg Rauter studied mechanical engineering at TU-Graz and mathematical and mechanical modeling at MATMECA, Bordeaux. In 2014, he received his PhD in robotics from ETH Zurich. From 2014 to 2016 he was postdoc in rehabilitation robotics at ETH Zurich, University of Southern California (USC), and University of Zurich. In parallel, he worked as CTO for the first CYBATHLON (ETH Zurich) in 2015 before commercializing the gait rehabilitation robot the FLOAT in collaboration with the company Lutz Medical Engineering and the Spinal Cord Injury Center at the Balgrist, Zurich. In 2016, he founded the BIROMED-Lab as Assistant Prof. for Medical Robotics and Mechatronics at the DBE, University of Basel. Since March 2016, Georg Rauter has held a structural professorship as Associate Professor in Surgical Robotics, at the DBE, University of Basel. Georg Rauter has been a IEEE member since 2011, chair for IFToMM Switzerland since 2019, and member of the CURAC society since 2021. His research interests focus on development of medical robots from ideas to functional prototypes.



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Franziska Mathis-Ullrich is professor for surgical robotics at the Friedrich-Alexander-University Erlangen-Nürnberg (FAU) at the Dep. Artificial Intelligence in Biomedical Engineering. Before joining FAU in 2023, she has been assistant professor at the Karlsruhe Institute of Technology (KIT) since 2019. Her primary research focus is on minimally invasive and cognition controlled robotic systems and embedded machine learning with emphasis on applications in surgery. She received her BSc and MSc degrees in mechanical engineering and robotics in 2009 and 2012 and obtained her PhD in 2017 in Microrobotics from ETH Zurich, respectively. Prof. Mathis-Ullrich is vice-president of the German Society for Computer- and Robot-assisted Surgery (CURAC) and has received numerous international awards, such as the IEEE ICRA Best Paper Award in Medical Robotics (2014), the IEEE BioRob Best Student Paper Award (2016) and she won twice with her team the first prize of the ICRA Microassembly Challenge (2014 & 2015). Furthermore, she made it onto the prestigious Forbes “30 under 30” list (2017).