

The **Laboratory for Surgical Planning and Robotic Cognition (SPARC)** offers a

Position as Research Assistant (m/f/d) with the perspective of a doctorate

for a research project with the tentative title

AI-Based Perception and Robotic Manipulation in Minimally Invasive Surgery

The Project:

The cooperation project AVATAR aims to develop a partially autonomous robotic retractor for robot-assisted laparoscopic surgery that can be used across various procedures and organ systems. Surgeons can teach the robot how to grasp and retract tissue using a force-sensitive instrument. The robot then performs this task autonomously, guided by force feedback and visual cues from the laparoscopic camera.

To achieve this, AVATAR is developing a force-sensing instrument and AI-based control software, integrating them with an existing laparoscopic manipulator arm to create a robotic assistant. This innovation enhances laparoscopic surgery with autonomous robotic functions, improving care quality while reducing personnel needs and operating costs.

The focus of this project is the development of AI-based methods for the autonomous perception and manipulation of soft tissue in minimally invasive surgery. The research includes 3D reconstruction of the surgical scene from stereo endoscopic data, semantic segmentation of anatomical structures using deep learning, and the determination of optimal grasp points for safe and effective tissue interaction. Furthermore, the work extends to the robotic execution of grasping and hand-over routines through reinforcement and imitation learning. The overall goal is to enable context-aware robotic assistance that enhances precision, safety, and efficiency in laparoscopic procedures.

Key Responsibilities:

- 3D Reconstruction:
 - Develop methods to reconstruct the surgical scene in 3D using stereo endoscopic image data.
 - Apply stereo-matching and deep learning approaches to generate accurate, metric 3D point clouds of the target tissue.
 - Enable precise representation of surface geometry and spatial depth within the surgical field.
- Semantic Segmentation:
 - Perform semantic segmentation of 3D point clouds and 2D endoscopic images to identify relevant anatomical structures.
 - Use and extend state-of-the-art AI-based techniques such as neural networks for tissue, vessel, and organ classification.
 - Support safe grasping and manipulation by distinguishing sensitive or unsuitable regions.
 - Combine 2D and 3D segmentation results to achieve a robust, context-aware understanding of the operative scene.
- Robotic Execution of Grasping and Hand-over:

- Determine optimal grasp points and orientations for safe, stable tissue manipulation by the robotic system.
- Integrate segmentation results to avoid fragile or sensitive tissue areas.
- Compute anatomically meaningful and clinically valid grasp points, ensuring feasible robotic execution.
- Robotic execution of handing over routines utilizing reinforcement/imitation learning.

Qualifications:

- Above-average university degree (Master's or Diploma) in Computer Science, Electrical Engineering, Mechanical Engineering, Mechatronics, or a related field
- Strong background in Machine Learning, Computer Vision, and Software Development
- Excellent knowledge of Reinforcement Learning and Imitation Learning; experience with Diffusion Models is an advantage
- Experience in development and implementation of algorithms and software in Python or C/C++
- Experience with machine learning frameworks, preferably PyTorch (TensorFlow is also acceptable)
- Solid understanding of Computer Vision, demonstrated through independently implemented projects
- Good knowledge of Robotics, including transformations, coordinate systems, and kinematics
- Ability and willingness to work both independently and collaboratively with a diverse team in a goal and solution-oriented manner
- Very good English language skills, both written and spoken; German language skills are advantageous
- High level of motivation, initiative, responsibility, and creativity, combined with strong communication and teamwork skills

Additional Descriptions:

- Aim for doctorate (Dr.-Ing.) at FAU
- A fully funded position (100%, TVL-E13) in a young, dedicated, and innovative team that addresses significant medical and technical challenges using scientific methods
- A creative and inspiring work environment where you collaborate with renowned partners from research, medicine, and industry to develop, implement, and analyze innovative projects
- Interdisciplinary project work and a top-tier national and international network
- An excellent starting position for an academic career or a career in leading industrial companies
- Development and experience in teaching, taking on leadership roles in student projects
- Possibility for (part-time) remote work (home office)

The SPARC Lab:

The laboratory for Surgical Planning and Robotic Cognition (SPARC) at FAU Erlangen-Nürnberg investigates cognition guided robots for surgical assistance in minimally invasive procedures, intelligent and flexible surgical instruments, and intuitive interfaces between humans and robots in the operating room. The SPARC laboratory conducts interdisciplinary research in close collaboration with national and international partners. We aim to contribute to building a healthcare system that enables optimal and personalized treatment of patients through targeted interactions between surgical experts and the next generation of minimally invasive surgical robots and assistance systems.

You can find more information about the lab and our research on our website: www.sparc.tf.fau.de

FAU promotes equal opportunities. Female candidates are specifically encouraged to apply. The position is open to start as soon as possible (presumably 1. March 2026). Please send your application (until 31.12.2025) including cover letter with interests and background (max. 1 page), plus full CV and transcripts, as one PDF document via e-mail to Prof. Dr. Franziska Mathis-Ullrich (franziska.mathis-ullrich@fau.de), chair of the Laboratory for Surgical Planning and Robotic Cognition at FAU Erlangen-Nürnberg.

Please note that the candidate evaluation involves one or more scientific-technical presentations and interview appointments to be held in person or via teleconferencing. Furthermore, please note that applications not complying with the above requirements may neither be confirmed nor considered. This includes generic AI-generated applications.