

# Bachelor / Master Project

## Robotic Ultrasound Navigation

Chair for Computer Aided Medical Procedures, Technical University of Munich

### General Info

**Project Title:** Endovascular navigation using robotic Ultrasound  
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### Project Abstract

Robotic ultrasound systems provide the possible automation of various interventional procedures, and such systems can be used for both diagnostic and therapeutic imaging. By using an ultrasound probe attached to a robotic system, the position and orientation of different objects can be detected and followed automatically. This aim of this work is to explore the potential of a robotic ultrasound platform in combination with such techniques to allow for catheter tracking and navigation in an endovascular interventional setting.

### Background and Motivation

In healthcare, interventions become more and more minimally-invasive, with a strong trend towards endovascular procedures. In such procedures, medical implants (e.g. stents) can be placed within the vascular system by requiring only a small incision in the femoral or radial artery. The navigation is thereby allowed by endovascular catheters, which are used to guide and deploy the desired implant at the target site. One major drawback of today's endovascular procedures is, however, that X-Ray guidance by interventional C-Arm systems<sup>1</sup> is required to navigate the catheters

<sup>1</sup> <https://www.healthcare.siemens.de/angio/artis-interventional-angiography-systems/artis-zeego>

within the body. Those systems exhibit ionizing radiation to patient and staff, which is why alternative systems to provide guidance to physicians during these procedures could improve acceptance of these techniques also for other indications.

In this view, ultrasound (US) imaging has already become the first-line imaging modality for multiple medical indications, including diagnostic and on-site imaging in real-time. Due to recent advances in robotic imaging in our labs, an integrated robotic system with a dedicated probe navigation could allow for a direct catheter guidance and visualization similar to current interventional systems.

### Project Description

The goal of this work is to explore the viability of a robotic ultrasound system for endovascular catheter navigation. The work will be developed on the foundation of an existing robotic ultrasound platform developed by our chair (see Figure 1).

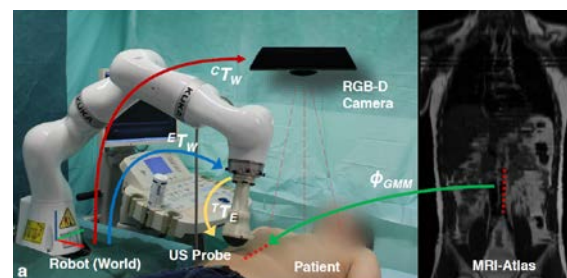


Figure 1 - Robotic ultrasound system developed at the Chair for Computer Aided Medical Procedures.

The project aims to integrate the following aspects:



- Tracking of catheters using 2D and 3D ultrasound imaging.
- Calibration of ultrasound probe images with respect to existing interventional images (patient registration).
- Navigation of ultrasound probe using a lightweight robotic arm to provide real-time feedback about the catheter position.

### Project environment

The project is located both in the interdisciplinary research laboratory at Klinikum rechts der Isar (<http://campar.in.tum.de/Chair/IFL>), as well as at the Chair for Computer Aided Medical Procedures in Garching.

Interested students will be immersed in our collaborative team working on robotic ultrasound imaging, and the focus of the work can be adjusted to the specific scientific interests of the student.

### Technical Prerequisites

Interested students should have good knowledge in C++. Basic knowledge about medical imaging (e.g. Ultrasound, CT, MRI) and robotic systems (e.g. the ROS<sup>2</sup> framework) is beneficial.

### If you're interested

Please get in touch with us, such that we can give you a more detailed overview of the project, and also show you our lab environment and running projects at our chair

[christoph.hennersperger@tum.de](mailto:christoph.hennersperger@tum.de)

### References

[1] Navab, Nassir, Christoph Hennersperger, Benjamin Frisch, Bernhard Fuerst. "Personalized, Relevance-based Multimodal Robotic Imaging and Augmented Reality for Computer Assisted Interventions." Medical Image Analysis (2016).

[2] Chatelain, Pierre, Alexandre Krupa, and Maud Marchal. "Real-time needle detection and tracking using a visually servoed 3D ultrasound probe." Robotics and Automation (ICRA), 2013 IEEE International Conference on. IEEE, 2013.

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<sup>2</sup> <http://www.ros.org>

