

Master's Thesis

Building an MRI with a Robot: Automated Magnet Assembly for Low-Field MRI

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Background

Low-field MRI (~50 mT) promises compact, low-cost, and portable scanners that bring MRI to the patient bed, emergency vehicles, and low-income countries. Our scanner, developed together with Fraunhofer MEVIS, gets its field from thousands of NdFeB cube magnets and every single one is currently pressed into its 3D-printed shell by hand.

This works well by hand but is time-consuming. Automating it is no plug-and-play task, though: the magnets snap together, repel each other, and push back when inserted, so standard grippers cannot simply pick and place them.

In this thesis, you will build an automated assembly cell in which a robot arm and custom-designed tools separate, orient, and insert each magnet alongside smart software that ensures every one ends up exactly where it belongs.

Your Tasks

- *Mechanical Design:* Develop tools to separate single magnets from a stack, orient them, and push them into their slots via a rail-and-pusher system.
- *Robot Control:* Integrate a collaborative robot arm (ROS 2, MoveIt 2) with tool and shell calibration and force-controlled insertion.
- *Perception & Quality Control:* Use a 3D depth camera, Hall sensors, and force/torque signals to verify picking, polarity, alignment, and full insertion.
- *Robustness & Evaluation:* Implement fault-tolerant task logic with error recovery and compare B_0 maps of robot- and hand-assembled shells.

Your Profile

- Bachelor's degree in Mechanical, Robotics, or Electrical Engineering, Physics, or a related field.
- Experience in CAD and programming (Python); ROS 2 or computer vision is a plus.
- Hands-on, self-driven, and passionate about robotics for medical imaging.

Our Offer

We offer a collaborative culture in a dynamic team of students, PhD candidates, and postdocs that values new ideas and lively discussion. A workstation can be provided in our student office, together with modern IT infrastructure that includes around 2000 CPU cores and 100 GPUs, including multiple NVIDIA RTX PRO 6000 class server GPUs. You will also have access to a workshop and rapid prototyping facilities, including 3D printers with multi toolhead capability, to support fast iteration from design to hardware.

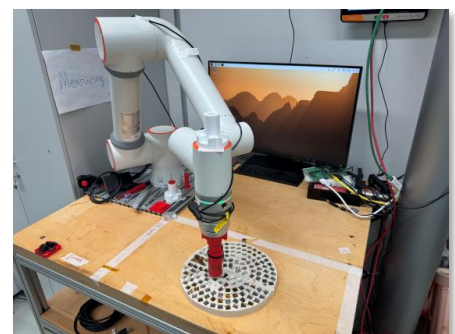
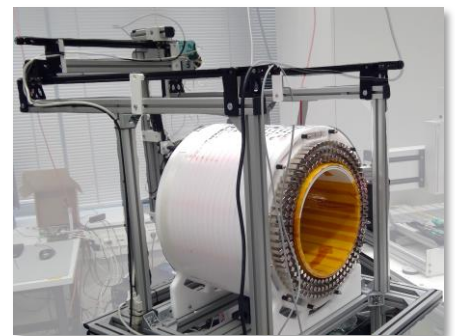


Figure 1: Top: Our Halbach-based low-field MRI scanner (50 mT) with around 3000 NdFeB magnet cubes ($12 \times 12 \times 12 \text{ mm}^3$). Bottom: Robot arm measuring the field of a single, manually assembled shell with the cubes inside using a Hall sensor.