Master's Thesis Opportunity:
Robotic Infrastructure for Magnetic Field Modulation in Productive Biofilms

A Master's thesis is available in the field of biofilm engineering, bioprocess engineering, and laboratory automation at the Institute of Technical Microbiology, Hamburg University of Technology. The project is embedded in the DFG Priority Program SPP 2494 "Productive Biofilm Systems" and contributes to a larger interdisciplinary effort to build and analyze productive biofilm architectures on magnetic particles.

The goal of your thesis will be to expand an existing robotic biofilm analysis platform by integrating a programmable robotic arm that can precisely reposition permanent magnets around microfluidic biofilm reactors in order to modulate biofilm architecture in a controlled way. The project builds on preliminary results showing that *Shewanella oneidensis* cells can be attached to magnetic conductive nanoparticles and that these biofilm structures can, in principle, be moved by magnetic fields.

Project background

Productive biofilms are promising biocatalyst systems, but their performance strongly depends on biofilm architecture, mass transfer, and the ability to control these properties reproducibly. In the present SPP project, magnetic nanoparticles are used as structural building blocks of biofilms, with the long-term aim of steering biofilm morphology, reducing mass transfer limitations, and linking spatial structure to productivity. Your thesis specifically addresses the engineering challenge of turning an existing partly automated setup into a programmable and robust infrastructure for magnetic field modulation and microscopic positioning.

Your task

The thesis will focus on the conception, implementation, and testing of robotic and process-engineering solutions for this platform. Depending on your profile and interests, the work may include:

- Integration of a programmable robotic arm into an existing biofilm handling platform.
- Development of routines for reproducible placement and movement of permanent magnets around microfluidic reactors.
- Calibration and validation of positioning accuracy, with the project aiming for sub-millimeter precision for the robotic setup.
- Development of automated movement sequences for controlled restructuring of magnetic biofilm micropillars.
- Support in coupling robotic positioning with OCT and fluorescence microscopy workflows.

- Experimental evaluation of how magnet movement affects reactor operation, oxygen transfer, and biofilm accessibility for downstream analysis.

The exact scope can be adapted, but the thesis is intended for someone who enjoys solving open technical problems rather than following a fully predefined recipe.

Who should apply?

This project is especially suited for students in process engineering, biochemical engineering, bioengineering, automation engineering, mechatronics, or related fields. A strong interest in experimental systems, technical development, and interdisciplinary research is more important than prior experience in all methods. Experience with one or more of the following is helpful: automation, CAD, sensor integration, microfluidics, control concepts, Python, LabVIEW, image-based workflows, or experimental design.

What to expect

This thesis offers the opportunity to work on a highly interdisciplinary research topic at the interface of biotechnology and engineering. You will contribute to a live DFG-funded project with direct relevance for the development of scalable productive biofilm systems and collaborate in an environment that combines microbiology, bioengineering, imaging, and data-driven analysis. The project is designed for students who want to take ownership, develop their own ideas, and actively shape technical solutions instead of only executing predefined tasks.

What is offered

- A challenging thesis project with high practical relevance in a current DFG-funded priority research program.
- Access to an existing robotic biofilm imaging and handling platform with automated sampling and OCT analysis.
- Close integration into an interdisciplinary team working on microbial engineering, robotics, imaging, and process development.
- Room for initiative, independent thinking, and development of your own technical concepts.

Application

Please send a short motivation statement, your CV, and a current transcript of records to Dr. René Wurst, who will supervise this Master's thesis (rene.wurst@tuhh.de). In your application, it is welcome if you briefly indicate which technical aspects of the project interest you most and where you would like to take the lead.