Catheterisation Robot for X-ray data collection

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

The main goal of this project is to develop a small, Arduino-based "catheterization robot". We want to allow a user to remotely push, pull and rotate a medical device (a catheter) in an x-ray suite while the user is sitting outside of the radiation-proof room, keeping them safe from the radiation. The Arduino will be used to control a set of motors, which then move the device as desired by the user. This will allow to record x-ray data of the controlled medical instruments in different poses and positions, without exposing physicians or students to unnecessary radiation.

Background and Motivation

Catheters are medical instruments used during endovascular procedures, to treat diseases like arterial stenosis. They are navigated through the human body by the surgeon under continuous x-ray monitoring. Automatic tracking of catheters on X-ray images allows for navigation during a surgery, optimal view selection, or even reducing the amount of radiation delivered during the procedure. As clinical datasets are scarcely available, recording data from human-like phantoms is an option. But to generate these datasets, catheters have to be navigated during continuous x-ray image acquisition, exposing the navigating person to radiation.

Therefore, we would like to automatically record catheter tracking sequences while having the catheter moved by a set of motors, controlled by a person sitting outside the radiation-proof room. This would allow for unlimited number of experiments, that could be conducted to test different tracking algorithms. Compared to sophisticated, but also complex and costly prior works (e.g. [1], we will explore a simpler setup that is still appropriate for the motion of a catheter through our phantoms.

Student's Tasks Description

The student will design and implement a system for pulling a catheter through a 3D vascular phantom.

This will would include 3D printing a model of vasculature and a component to attach the catheter to the motors. An Arduino microcontroller will be used, together with connecting components, to control the motors and thereby move the catheter based on the commands a user gives from an outside point of control (e.g. keyboard/joystick/scripted).
During this project, the student will learn how to use an Arduino based system to control motors in a medical-like catheterization setup. They will also learn about common robotic catheterization setups and design their own, simplified version, making this a small and self-contained project

containing both software- and hardware-components.

Technical Prerequisites

Prior experience with Arduino or similar micro-controllers is recommended. Beneficial are experience with small electrical circuit designs, e.g. on breadboards. Familiarity with 3D printing is also beneficial. Recommended programming languages are C++ and Python.

References

[1] D. Kundrat *et al.*, "An MR-Safe Endovascular Robotic Platform: Design, Control, and Ex-Vivo Evaluation," in *IEEE Transactions on Biomedical Engineering*, vol. 68, no. 10, pp. 3110-3121, Oct. 2021, doi: 10.1109/TBME.2021.3065146.

Please send the completed proposal to tianyu.song@tum.de, shervin.dehghani@tum.de and felix.tristram@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.