MNRLab
Medical Micro & Nano Robotics

GUC
German University in Cairo
الجامعة الألمانية بالقاهرة

Fabrication of a Soft Robot for Targeted Therapy using Magnetic Fields

In this work, motion control of paramagnetic microparticles is achieved using a magnetic system with an open-configuration. This control is done using a permanent magnet and an electromagnetic coil under microscopic guidance. The permanent magnet and the electromagnetic coils are fixed to the end-effector of a soft robot to control the motion of the microparticles in three-dimensional (3D) space. A closed-loop control of the robotic arm is done at the joint-space to orient the magnetic field gradients of the permanent magnet and the electromagnetic coil towards a reference point in 3D space.

Objective

In this project we will fabricate a soft robot, as shown in Fig. 1. This robot will be integrated with a magnetic system to provide controlled magnetic fields in 3D space.

Tasks

- Development of the soft robotic arm, as shown in (Fig. 1);
- Precise motion control of a cluster of paramagnetic microparticles in 3D space;
- Motion control of microparticles using the robotic arm and the coils inside the vertebral column in MNRLab;

Materials

- Paramagnetic microparticles (Micromod Partikeltechnologie GmbH, Rostock-Warnemuende, Germany);
- An electromagnetic coil and the robotic arm shown in Fig. 1;

PREREQUISITES

Students are expected to have a working knowledge of control theory, differential equations, linear systems, statics, kinematic and dynamics. Familiarity with programming, especially with Matlab and C++.

OTHER NOTES

This project will involve a weekly meeting with the instructors and progress reports have to be prepared. All reports should be written in academic paper format.

1. References

[1] J. J. Abbott, K. E. Peyer, L. Dong, and B. Nelson, *"How should microrobots swim?" The International Journal of Robotics Research*, vol. 28, no. 11-12, pp. 1434-1447, January 2009.

[2] A. W. Mahoney, D. L. Cowan, K. M. Miller, and J. J. Abbott, "Control of untethered magnetically actuated tools using a rotating permanent magnet in any position," in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 3375-3380, Minnesota, USA, May 2012.

[3] A. W. Mahoney and J. J. Abbott, "Control of untethered magnetically actuated tools with localization uncertainty using a rotating permanent magnet," in *Proceedings of the IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob)*, pp. 1632-1637, Rome, Italy, June 2012.

[4] O. Abdellatif, "Bilateral Control of a Continuum Robot for Targeted Drug Delivery", Master's degree in Mechatronics Engineering, Faculty of Engineering and Material Science, Mechatronics Department, The German University in Cairo, Egypt, June 2015.

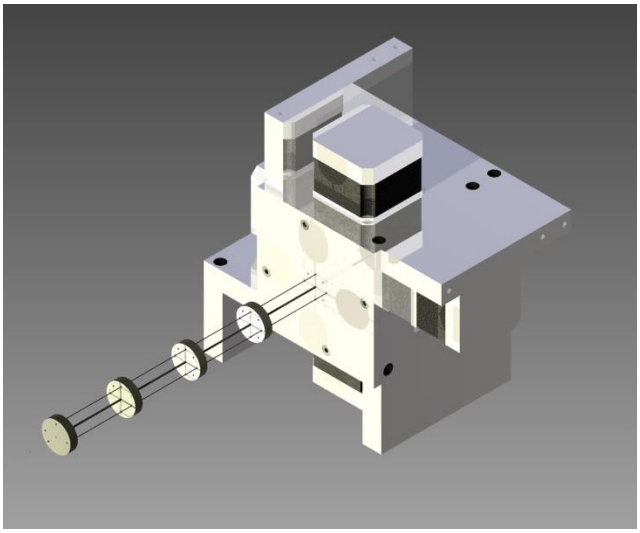

Figure 1. Design of a soft robotic arm is achieved and fabrication will be done in this project. The robotic arm will be adapted to integrate a magnetic system for high precision motion control of magnetic drug carriers.