MNR Lab
Medical Micro & Nano Robotics

GUC
German University in Cairo
الجامعة الألمانية بالقاهرة

Control of Helical Microrobots using Helmholtz coils

3-axis Helmholtz coils provide uniform magnetic fields that can be used to steer and drive helical microrobots and robotic sperms in low Reynolds numbers. The ultimate goal of this project is to utlilize a 3-axis Helmholtz coils system to control the motion of helical microrobots and robotic sperms in 3D space.

Objective

Generating uniform magnetic fields in a region is essential to actuate (steer and drive) microrobots. Here, we focus on the development of 3-axis Helmholtz coils and the integration of 2 cameras to provide visual feedback. The feedback will be provided at the common centers of the coils and used to design closed-loop control system.

Tasks

- Development of the system shown in Fig. 1;
- Modeling and control of the 3-axis Helmholtz coils;
- Control of the magnetic field that is generated using the 3-axis Helmholtz coils;
- Synchronization of the magnetic fields generated using the two 3-axis Helmholtz coils.

Materials

- Electromagnetic coils;
- Electric drivers;
- Digital cameras;
- A magnetic field sensor and a finite element model;
- A feature tracking algorithm.

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] A. J. Petruska and J. J. Abbott, “Omnimagnet: An Omnidirectional Electromagnet for Controlled Dipole-Field Generation ," *IEEE Transactions on Magnetics*, vol. 50, no. 7, 8400810, July 2014.

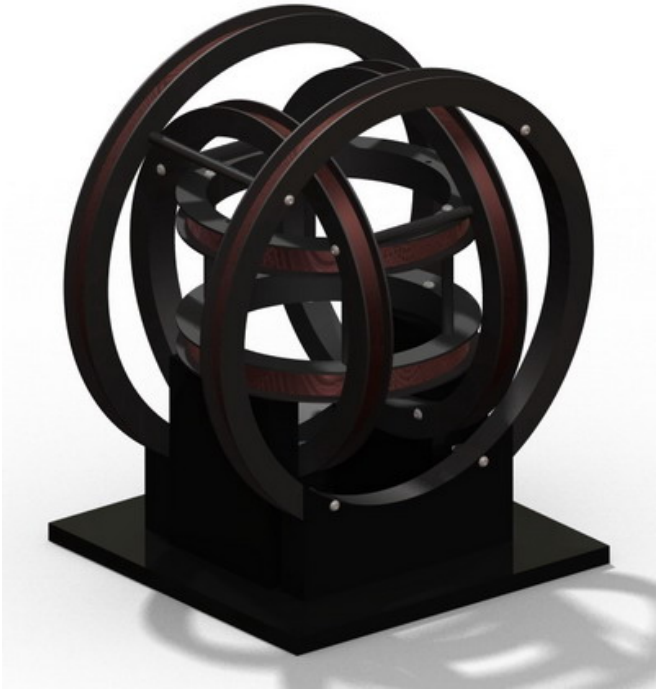

Figure 1. 3-axis Helmholtz coils.

[2] N. D. Nelson and J. J. Abbott, “Generating two independent rotating magnetic fields with a single magnetic dipole for the propulsion of untethered magnetic devices," in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 4056–4061, Seattle, Washington, USA, May 2005.

[3] M. E. Alshafeei, A. Hosney, A. Klingner, S. Misra, and I. S. M. Khalil, “Magnetic-Based motion control of a helical robot using two synchronized rotating dipole fields," in *Proceedings of the IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob)*, pp. 151-156, São Paulo, Brazil, August 2014.