MNR Lab
Medical Micro & Nano Robotics

GUC
German University in Cairo
الجامعة الألمانية بالقاهرة

Targeted Drug Delivery using MIPs *In Vitro*

This project addresses the motion control of molecularly-imprinted polymers in two dimensional-space with applications towards targeted therapy. An electromagnetic system is developed to allow for the manipulation of the Molecularly-imprinted polymers under the influence of the controlled magnetic field gradients. These particles are used to release drugs and achieve targeted therapy.

Objective

In this work, we investigate the motion control of a cluster of molecularly-imprinted polymers in the two-dimensional (2D) space. An electromagnetic system is developed to control the motion of the cluster under the influence of the controlled magnetic field gradients [1]. Moreover, we investigate the drug release as shown in the Figure using a fluidic chip with several chambers that contains molecularly-imprinted polymers.

Tasks

- Development of an electromagnetic system (Fig. 1);
- Precise motion control of a cluster of Molecularly-imprinted polymers in 2D space;
- Manipulation of Molecularly-imprinted polymers in 2D;
- Characterization of the drug release using the magnetic system and the fluidic chip;

Materials

- Paramagnetic microparticles (Micromod Partikeltechnologie GmbH, Rostock-Warnemuende, Germany);
- An electromagnetic system;
- 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] M. P. Kummer, J. J. Abbott, B. E. Kartochvil, R. Borer, A. Sengul, and B. J. Nelson, "OctoMag: an electromagnetic system for 5-DOF wireless micromanipulation," *IEEE Transactions on Robotics*, vol. 26, no. 6, pp. 1006-1017, December 2010.

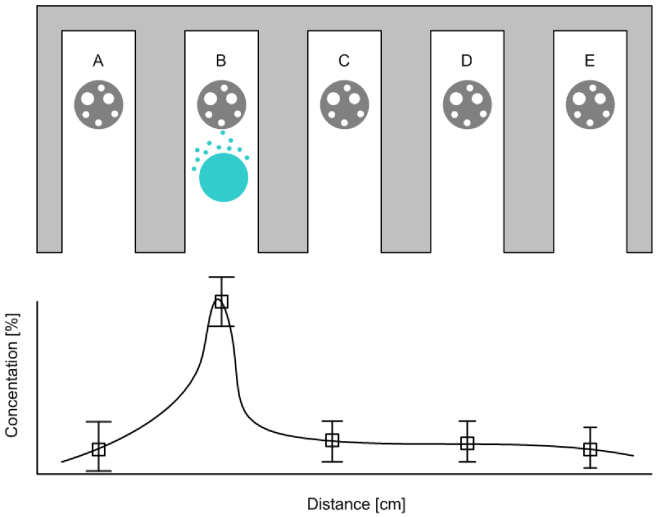

Figure 1. Motion control of molecularly-imprinted polymers will enable drugs to be localized within the vicinity of the reference position. First, the molecularly-imprinted polymers will be pulled towards the reference position inside one of the chambers and then drug release will be achieved. Measurements will be taken to validate the drug release within all chambers.

[2] I. S. M. Khalil, R. M. P. Metz, L. Abelmann, and S. Misra, "Interaction force estimation during manipulation of microparticles," in *Proceedings of the IEEE International Conference of Robotics and Systems (IROS)*, pp. 950-956, Vilamoura, Portugal, October 2012.

[3] I. S. M. Khalil, F. van den Brink, O. S. Sukas, and S. Misra, "Microassembly using a cluster of paramagnetic microparticles," in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 5507–5512, Karlsruhe, Germany, May 2013.

[4] M. Elfar, M. Ayoub, A. Sameh, H. Abass, R. M. Abdel-Kader, I. Gomaa, and I. S. M. Khalil, "Targeted penetration of MCF-7 cells using iron-oxide nanoparticles *in vitro*," in *Proceedings of the IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob)*, pp. 260-265, Singapore, June 2016.