MNR Lab
Medical Micro & Nano Robotics

GUC
German University in Cairo
الجامعة الألمانية بالقاهرة

Drug Delivery using Electromagnetic System and MIPs

This work addresses the motion control of a cluster of molecularly-imprinted polymers in the three-dimensional space. Paramagnetic microparticles are coated with drugs and localized with in a reference position under the influence of the magnetic field gradients. These localization is done using an electromagnetic system and is used to release drugs within the vicinity of a soft-tissue simulant. Concentration of the drugs throughout the simulant is tested to verify the proposed targeted drug delivery. The proposed approach allows for localization of drugs within a diseased region. This localization could mitigate negative-side effects of cancer treatment.

Objective

In this work, we investigate the motion control of a cluster of molecularly-imprinted polymers in the three-dimensional (3D) space. An electromagnetic system is developed to control the motion of the cluster under the influence of the controlled magnetic field gradients. Moreover, we investigate the drug incorporation and release using molecularly-imprinted polymers. A soft-tissue simulant is placed inside a water container. The drug carriers are controlled towards the tissue simulant to release the drugs within the vicinity of a reference position. Concentration of the drugs throughout the Gelatine is measured to verify this drug delivery approach.

Tasks

- Development of an electromagnetic system;
- Motion control of a cluster of molecularly-imprinted polymers in 3D space;
- Experimental investigation of an efficient drug release mechanism;
- Magnetic-based localization of drug carriers within the vicinity of a reference position in the tissue-simulant.

Materials

- Paramagnetic microparticles, molecularly-imprinted polymers, and nanoparticles;
- An electromagnetic system;

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.

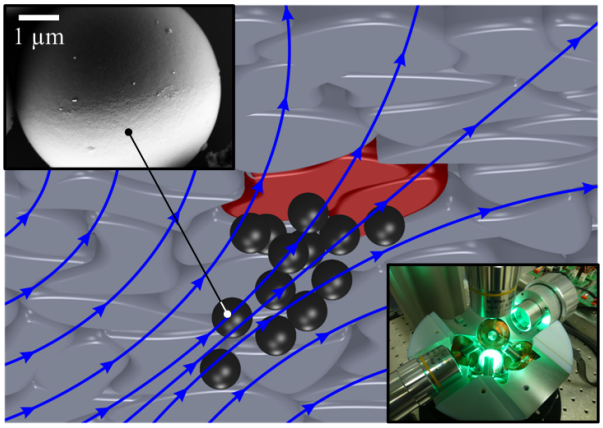

Figure 1. Schematic representation of the autonomous motion of the microparticles towards cancer cells under the influence of the controlled magnetic field gradients.

1. References

[1] Q. A. Pankhurst, J. Connolly, S. K. Jones, and J. Dobson, "Applications of magnetic nanoparticles in biomedicine," *Journal of Physics*, Vol. 36, no. 13, pp.167-181, July 2003.

[2] 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.

[3] H. Abbass, M. S. Shoukry, S. Misra, and I. S. M. Khalil, "Robust motion control of paramagnetic micro-particles against time-varying flow rates", in *Proceedings of the IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob)*, pp. 67-72, Singapore, June 2016.

[4] I. S. M. Khalil, B. E. Wissa, B. G. Salama, and S. Stramigioli, "Wireless motion control of paramagnetic microparticles using a magnetic-based robotic system with an open-configuration," *In Proceedings of the International Conference on Manipulation,*

Manufacturing and Measurement on the Nanoscale (3M Nano), pp. 190-196, Changchun, China, October 2015.