MNRLab
Medical Micro & Nano Robotics

GUC
German University in Cairo
الجامعة الألمانية بالقاهرة

Life of a Magnetotactic Bacterium

Magnetotactic bacteria have the potential to access deep regions within the human body. The motion control of this microorganism has been demonstrated using controlled electromagnetic fields. In this work, we will investigate the behaviour of a single bacterium throughout its lifetime. Single cell will be separated from the culture using fluidic microchip and controlled magnetic field.

Objective

In this project, we will separate a bacterium from its culture using magnetic control and a fluidic microchip. The magnetic control will enables the bacterium to move controllably towards a chamber. Once the bacterium is positioned in the chamber, we will track its motion throughout its lifetime. This study is essential as it provides quantitative information pertaining to the relation between time and motility of the cells. We observe that cell motility decreases with time.

Tasks

- Development of a magnetic-based control system to move single bacterium towards the chamber shown in Fig. 1;
- Tracking of the motion of the bacterium inside the chamber throughout its lifetime;
- Investigating the average speed of the bacterium throughout its lifetime.

Materials

- 4 electromagnetic coils are available in MNRLab;
- 4 electric drivers;
- Motion control systems;
- Magnetotactic bacteria and microfluidic chips;
- 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.

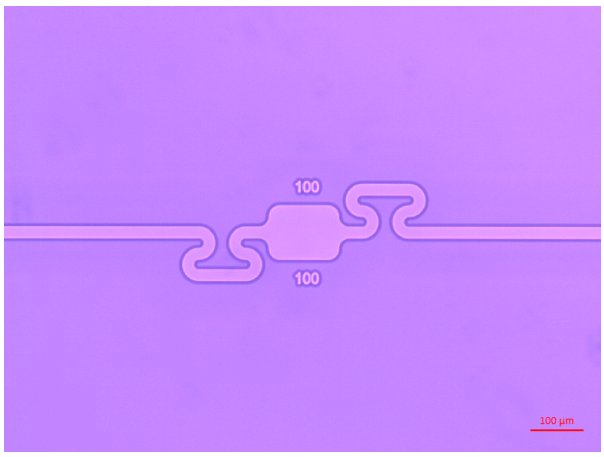

Figure 1. A microfluidic chip with depth of 5 μm is designed and fabricated to separate a single bacterium from the culture. Tracking of the bacterium is done within the chamber.

1. References

[1] R. Blackemore, *Magnetotactic bacteria*, *Science*, 190 (4212), pp. 377–379, October 1975.

[2] H. A. Hassan, M. Pichel, T. Hageman, L. Abelmann, and I. S. M. Khalil, "Influence of the magnetic field on the two-dimensional control of *magnetospirillum gryphiswaldense* strain MSR-1," in *Proceedings of the IEEE/RSJ International Conference of Robotics and Systems (IROS)*, pp. 5119–5124, Daejeon, Korea, October 2016.

[3] 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.