Trajectory Planning and Control of Magnetotactic Bacteria

Magnetotactic bacteria have the potential to execute nontrivial tasks, such as microactuation, micromanipulation, and microassembly, under the influence of the controlled magnetic fields. Closed-loop control characteristics of these magnetic microorganisms depend on their self-propulsion forces (motility) and magnetic dipole moments. These properties can be controlled through the growth conditions of magnetotactic bacteria. We provide a comparison between two species of magnetotactic bacteria, i.e., *Magnetospirillum magnetotacticum* strain MS-1 and *Magnetospirillum magneticum* strain AMB-1. This comparison includes the characterization of their morphologies, magnetic dipole moments, and closed-loop control characteristics in the transient and steady states.

**Objective**

In this project, we will focus on the motion control of magnetotactic bacteria inside fluidic chips with several bifurcations and channels. The ultimate goal of this project is to demonstrate the ability of the directional control using magnetic fields to move the bacteria towards a reference position along a pre-specified path.

**Tasks**

- Control of magnetotactic bacteria in a stationary medium;
- Path planning and trajectory generation;
- Demonstration of closed-loop control along a path inside a chip with several bifurcations.

**Materials**

- Capillary tubes have to be ordered (VitroCom, VitroTubes 3520-050, Mountain Lakes, USA);
- An electromagnetic system is available;

**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

