Micro Scale 3D printing of Micro-Robots MagnetoSperms by near field electro-spinning (MCTR)

Introduction

Targeted therapy using MagnetoSperms have the potential to mitigate the negative side-effects associated with conventional treatment. We fabricate MagnetoSperms by an electrospinning technique using polystyrene, dimethylformamide and iron oxide nanoparticles. An empirical model of the size of the magnetic microparticles and the parameters (electric potential, concentration of the solutions and nanoparticles, and dynamic viscosity of the fluid) of the electrospinning technique is developed.

The magnetic dipole moment of the microparticles is characterized using an electromagnetic system and a force sensor at the microscale. In addition, we experimentally demonstrate closed-loop motion control of the microparticles under the influence of the controlled magnetic field gradient in three-dimensional space.

Objective

This work aims at fabrication of a Micro scale 3D printer to control the shape and form of the printed micro robots referred to as MagnetoSperm
Currently, the fabrication is done using the electro-spinning workstation of MNRLab, whereas the locomotion is achieved under the influence of oscillating magnetic fields. These fields are produced using an Electromagnetic system.
Controlling the shape and size of the printed micro robot will take the applications into a higher and wider scope.

Tasks

- Fabrication of MagnetoSperms using micro 3D printing
- Characterization of the fabricated micro robots
- Comparing the functionality and electromagnetic properties of 3D printed robots with electro spinned robots
- Simulating the motion behavior of the micro-robot

Materials

- The electrospinning workstation in MNRLab;
- 3D printer
- Motion stage
- Polystyrene, dimethylformamide and iron oxide nanoparticles.

PREREQUISITES

- Students are expected to have 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.

References

[1] I. S. M. Khalil, A. F. Tabak, A. Klingner, and M. Sitti, “Magnetic propulsion of robotic sperms at low-Reynolds number," Applied Physics Letters, vol. 109 (033701), July 2016.

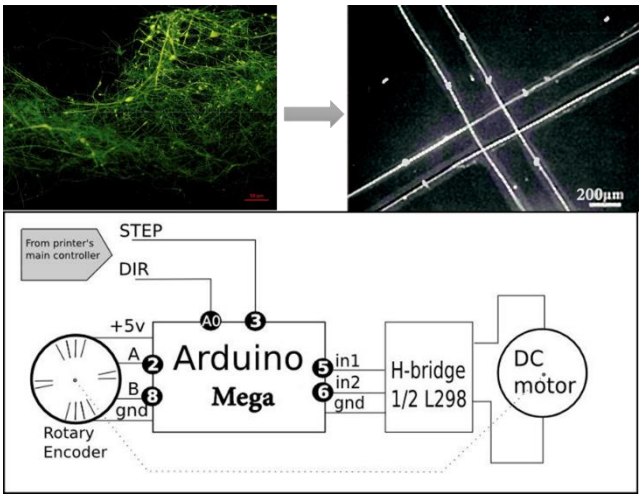

Figure 1. Sperm-shaped microrobots are conventionally fabricated as a mesh of fibers through electrospinning (top left) that are later on cut to have individual microrobots. Through controlled micro 3D printing, it possible to have individual fibers rather than a mesh (top right). Using a control system (bottom) and adjusting the process parameters, it is possible to control the size and shape of the magnetosperms.