2.6 Gabor Kosa

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Talk Title

MRI Driven Swimmers for Capsule Endoscopy

Abstract

Magnetic microrobots are usually using permanent magnets for propulsion. Permanent magnets create a large artifact in the MRI especially if detailed scan is required and/or the magnets needs to drive a miniature device (characteristic size of a few mm-s). Our swimming method in the MRI is based on none ferromagnetic coils embedded into an elastic structure. In a sense our swimming method reverses the order of magnets, the internal coils create an alternating magnetic field which interacts with the external constant field of the MRI (B0) and creates propulsion. We developed a dynamic model for the robot based on the swimming model of Ekeberg and were able to show that the theoretical model matches the experiments. The micro swimmers were tested in a commercial 3 T MRI and in addition we did experiments in an MRI emulator that is able to provide a constant magnetic field of 0.2 T in a box of 8 × 8 × 8 cm. We tested the swimming actuators in different conditions and showed that the swimming is absolute viscosity dependent although the characteristic Re number (about 100) indicates a laminar flow. In addition we showed the ability of a tethered swimming tail to maneuver in water and even advance orthogonally to the magnetic field. We also demonstrated power autonomous swimming using internal batteries. Currently we are working on autonomous swimming using the B1 alternating magnetic field of the MRI as a power source, multiple swimming tail driving, and miniaturization of the swimmers.

References


Figure 6: Kósa et al.: (a) Schematic drawing of the capsule endoscope with three swimming flaps, and (b) illustration of the trajectory of the swimming tail in the MRI emulator applying an orthogonal advance gait.