Research Grants for PhD students from the China Scholarship Council

Information Form (please read the guidelines carefully on the website www-csc.utt.fr)

Supervisor's name : FOLIO Given names : David

Status (prof., assistant prof., …) : associate professor

Laboratory : PRISME Website address : https://www.univ-orleans.fr/prisme

Institution : INSA Centre Val de Loire Website address : https://insa-centrevaldeloire.fr

Scientific competence of the supervisor:

David Folio is involved with PRISME Laboratory, Robotic Team on modeling, control, and navigation for micro/nano-robots, mainly devoted to health and biomedical applications. Its main scientific contributions lie in the study of magnetic microrobots evolving in the human body. This original topic is an expanding research field which is a very multidisciplinary, associating robotics, biomedical, fluid mechanics, electromagnetism, and microsystems.

Two major publications in the field proposed for the PhD :

1. Mellal L., Folio D., Belharet K., and Ferreira A.“Modeling of Optimal Targeted Therapies using Drug-Loaded Magnetic Nanoparticles for the Liver Cancer”, IEEE Transactions on Nano-Bioscience, vol. 15, no. 3, pp.
2. Belharet K., Folio D., and Ferreira A.“Simulation and Planning of a Magnetically Actuated Microrobot Navigating in Arteries”, IEEE Transactions on Biomedical Engineering, vol. 60, no. 4, pp. 994–1001, April 2013.

Website address of the personal page :

Supervisor's email : david.folio@insa-cvl.fr

Description of the research work proposed for a PhD ***Topic # (see list) :*** I-8

Title : Modeling and control of brain tumor treatment using therapeutic magnetic microrobots

Subject :

Glioblastoma multiform (GBM) is the most frequent and aggressive cancer of the nervous system. This thesis objective is to combine the modeling of such tumor with the use of magnetic microrobot as anti-tumor agent. Computational modeling offers interesting methodology that can give insights into a better understanding and control of these biomedical problems. Different approaches are used in the mathematical modeling of cancer and its control. A solution are based on reaction-diffusion models to describe the evolution of GBMs via proliferation of tumor cells and infiltration of the surrounding healthy tissue. Anyway, the model should take into account constraints from the therapeutic microrobot delivery rates and the evolution of the tumor, e.g. by solving an optimization problem. This research work aims to fill this gap by extending conventional therapy models for the GBM treatment using magnetic microrobots. Moreover, the control of these microrobots on the targeted area by manipulating the external magnetic field has to be considered. This magnetic field is induced from an electromagnetic actuation (EMA) system by controlling the electric current flowing in a set of electromagnetic coils. It is then necessary to determine the proper magnetic field allowing the optimal targeting and treatment of the GBM. The integration of this aspect from the modeling step would allow to improve the effectiveness of the overall cancer therapy.

Keywords :

microrobotics, mathematical modeling, magnetic theory, control of nonlinear systems, tumor growth, cancer treatment.

Expected collaborations :

Mechanical and Automation Engineering (MAE) Department of Chinese University of Hong-Kong (CUHK), with the team of Prof. Li Zhang

Background required from the applicant :

The applicant should have background on modeling and control, and some skills on techniques of simulations and application.
Some good understanding on microbotics or magnetic field theory would be appreciated.

Existence of a PDF file detailing the proposal ("yes" or "no") : yes

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