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 : FERREIRA Given names : Antoine

Status (prof., assistant prof., …) : Professor

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

Institution : INSA Centre Val de Loire Website address : www.insa-cvl.fr

Scientific competence of the supervisor:

Antoine Ferreira (M'04) received the M.S. and Ph.D. degrees in electrical and electronics engineering in 1993 and 1996, respectively. In 1997, he was a Visiting Researcher with the ElectroTechnical Laboratory, Tsukuba, Japan. He is currently a Professor of robotics engineering with the Laboratoire PRISME, INSA Centre Val de Loire, Bourges, France. He is the author of three books on micro- and nanorobotics and more than 190 journal and conference papers and book contributions. His research interests include the design, modeling, and control of micro- and nanorobotic systems for medical applications and biological nanosystems.

Two major publications in the field proposed for the PhD :

1. L. Arcese, M. Fruchard, A. Ferreira, "Endovascular Magnetically Guided Robots: Navigation Modeling and Optimization", IEEE Transactions on Biomedical Engineering 04/2012; 59(4):977-987.
2. D. Folio, A. Ferreira, "Two-Dimensional Robust Magnetic Resonance Navigation of a Ferromagnetic Microrobot Using Pareto Optimality", IEEE Transactions on Robotics, Jun 2017, Volume: 33 , Issue: 3 , 583 -

Website address of the personal page : https://www.researchgate.net/profile/Antoine_Ferreira

Supervisor's email : antoine.ferreira@insa-cvl.fr

Description of the research work proposed for a PhD ***Topic # (see list) :*** VI.7

Title : Modeling and Control of Microrobots using Acoustic Propulsion for Medical Applications

Subject :

The aim of this PhD research project is to provide a theoretical investigation on modeling and control of acoustically propelled microrobots for targeted medical treatments. Recent experimental and theoretical studies demonstrate that microrobots can be remotely propelled acoustically which is safe to the human body. In particular, acoustically propelled microswimmers can achieve excellent motility (~1 mm/s) under sound pressure in the accessible range of therapeutic ultrasound. Our goal is to study theoretical mathematical models of acoustic propulsion for different types of acoustic propulsion methodologies (acoustophoresis propulsion, acoustic flagellum propulsion and bubble-based acoustic propulsion) to confirm that acoustic waves can control accurately the microswimmer steering in blood flow. The main research outcomes of the thesis work are: (i) to propose analytical dynamic models of acoustic propulsion methods: ; (ii) to develop nonlinear controllers for underactuated systems will be proposed for microrobot trajectory tracking ; (iii) to confirm feasibility of the proposed controlled acoustic steering strategies by verification with numerical simulations and experiments in microfluidic samples.

Keywords :

Dynamic modeling, acoustic propulsion, control of nonlinear systems, targeted therapy, medical microrobots.

Expected collaborations :

A specific collaboration with the Prof. Brad Nelson and Prof. Salvador Pané Vidal from ETH Zurich (Switzerland), Department of Multi-Scale Robotics will be established for this project.

Background required from the applicant :

The applicant should have a good background in theory in the domains of electrical engineering and control engineering. Mathematical modeling, simulation tools and control dedicated to mechatronics or robotics would be appreciated.

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

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