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 :
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 :
- 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.
-L. Mellal, K. Belharet, D. Folio, A. Ferreira, "Optimal structure of particles-based superparamagnetic microrobots: application to MRI guided targeted drug therapy", Journal of Nanoparticle Research, Jan. 2015, 17:64, pp.1-18

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) :*** III.7

Title : Modeling, Closed-loop Control and Ultrasound Imaging of a Medical Magnetic Microrobotic System.

Subject :
The aim of this PhD research project is to control 5 degree of freedom magnetic microrobotic platform which provides a minimally invasive means for targeted therapeutic interventions in specific brain areas in vivo. The goal is to stabilize the microrobots along a pre-planned reference trajectory, from the robot release point to the medical target. Real-time tracking of the microrobots is essential for the magnetic navigation in blood vessels. Our preliminary results indicate that real-time tracking of the microrobot using ultrasound and the magnetic actuation using an electromagnetic system is feasible. i) Dynamic modeling of multi-dof magnetic-field-generation robotic system based on orthogonal arrangement of electromagnetic coils for microrobot propulsion . ii) Nonlinear microrobot position control taking into account model uncertainties, sensing noise and external perturbations in biological fluids (blood vessels). iii) Closed-loop navigation control using two-dimensional ultrasound imaging. iV) Experimentation and validation of prototype for safe, controlled and robust propulsion of magnetic microrobots. Small animal tests will be conducted in an hospital.

Keywords :
Dynamic modeling, nonlinear control, magnetic theory, medical robotics.

Expected collaborations :
A specific collaboration with the Chinese University of Hong-Kong (CUHK), Prof. Li ZHANG, Department of Mechanical and Automation Engineering, CUHK and Prof. Wai-sang POON, Department of Surgery, Prince of Wales Hospital, CUHK will be established for this project. The collaboration will focus on the development of microrobotic magnetic agents for drug delivery as well as the medical tests in animals for stem cell delivery in specific areas.

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

Existence of a PDF file detailing the proposal ("yes" or "no") : YES
(see guidelines on the website www-csc.utt.fr)