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 : https://www.insa-centrevaldeloire.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 - 593.

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 : Control of Magnetic Continuum Catheters using Cosserat Rod Theory

Subject :

The aim of this PhD research project is to provide a theoretical investigation on modeling and control of magnetically guided soft microcatheters. Robotic-assisted interventions facilitate minimally invasive procedures by reducing invasiveness and enhancing accuracy and dexterity. One procedure in which magnetically guided catheters are used is in the treatment of atrial fibrillation by controlling and steering the catheter into the vessels to reach the heart. Closed-loop catheter control is a challenging research topic that will enable the clinician to perform safely manipulation tasks. Our goal is to apply apply Cosserat rod theory to catheters with permanent magnetic components that are subject to spatially varying magnetic fields. For the first time, the Cosserat rod theory will be applied to the control of magnetically tipped catheters. The model will be general, covering cases with different catheter geometries, multiple magnetic components, and various boundary constraints. The main research outcomes of the thesis work are: (i) To propose a dynamic modeling approach dedicated to soft continuum catheters; (ii) to develop a Jacobian-based inverse kinematics method for control of the steerable catheter based on estimation methods (nonlinear reduced-order observers); (iii) -To extend of the proposed modeling and control methodology to the multi-segment magnetic catheter configurations.

Keywords :

Dynamic modeling, magnetic theory, closed-loop control, nonlinear observers, medical microrobotics.

Expected collaborations :

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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