UNIVERSITE D'ORLEANS

AVIS DE SOUTENANCE EN VUE DE L'HABILITATION A DIRIGER DES RECHERCHES

Discipline : Génie Electrique

FOLIO David – Maître de Conférences

présentera ses travaux en vue de l'habilitation à diriger des recherches

Le 3 décembre 2021 à 14 heures

Lieu : Grand amphithéatre - IUT de Bourges

devant le jury constitué par les personnalités suivantes :

- **Michaël Gauthier**	Directeur de Recherche, CNRS, FEMTO-ST, Besançon
- **Sylvain Martel**	Professeur, Polytechnique Montréal, Canada
- **Philippe Poignet**	Professeur des Universités, Univ. Montpellier
- Chantal Pichon	Professeur des Universités, Univ. Orléans
- Christine Prelle	Professeur des Universités, UTC
- Mohammed Samer	Professeur des Universités, Univ. Paris-Est Créteil
- Li Zhang	Professeur, dept. MAE, CUHK, Hong Kong
- Antoine Ferreira	Professeur des Universités, INSA Centre Val de Loire

Résumé des travaux :

This research work mainly focuses on the study of the modeling and control of microrobotic systems in a biomedical context. So far, the use of magnetic actuation has been regarded as the most convenient approach for such achievements. Besides, the cardiovascular system allows to reach most parts of the human body and is then chosen as the main navigation route. This original topic is a rapidly expanding field whose ambition is to modernize current therapies by trying to improve therapeutic targeting while improving patient comfort. To achieve this goal, a good understanding of how microrobots evolve in the human body is an important step. The theoretical foundations and the physical laws that make it possible to describe the various phenomena which act on magnetic microrobots in vascular-like environments have thus been deeply studied. Methodologies for dealing with multiphysics approaches combining different sources of hypotheses and uncertainties have been developed. Great care has been taken in their validations by experimentation when possible, otherwise by numerical analysis. This helps to better understand the dominant dynamics, as well as the predominant parameters in the description of magnetic microrobots in a vascular-like environment. This makes it possible to efficiently characterize and predict their behaviors in a viscous flow and their responses to magnetic fields. On this basis, advanced navigation strategies have been developed. The navigation process can be divided into two stages. First, safe and efficient navigation paths are planned (off-line) based on the fast marching method (FMM). With the proposed navigation planning framework, different constraints and objectives can then be taken into account to obtain a truly feasible reference path. Second, control schemes that drive the magnetic microrobots along the planned reference path to the targeted location are synthesized. To do so, predictive and optimal control laws have been implemented. All the proposed models and navigation strategies have been evaluated through various experiments under different conditions with the platforms developed at the PRISME Laboratory.