RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Biomedical Engineering / Life and Health Science and Technology

Subfield: Fluid mechanics, Biomechanics, Biofluidics

Title: Modeling the control parameters of pulsed flow through a Drug elucting stent

ParisTech School: Arts et Métiers Sciences et Technologies

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Short description of possible research topics for a PhD:

Controlling blood flow and the associated pathologies is an important health issue. The practitioners in the field of cardiovascular medicine have joined forces with researchers in the field of fluid mechanics since several decades, in order to better understand and especially anticipate certain pathologies. The emergence of bioengineering and new numerical technologies through additive manufacturing or connected objects is leading to an acceleration of innovations in this field. Despite of the considerable progress, the works carried out still give unsatisfactory results and require models that are more in conformity with the proposed solutions geometrically and physically. The endoprostheses considered as the arterial geometrical singularities have been widely studied in the context of pathologies relating to the blocked blood flow caused by the reduction of artery cross section. Instead of simplified geometrical model, the practical stent and artery geometries are required necessarily to be established. The considerations of a more realistic constitution of fluid as well as taking into account the elasticity of artery wall need to be added in the model. Regarding the active stent, physics existed in the tissue are necessary to be taken in account which can greatly relate to the drug transfer process. Validation works are still not enough which need to be achieved by the experiments.

In the thesis envisaged, both theoretical and experimental research works will be dedicated to the modeling of pulsed flow through arterial geometrical singularities, relatively closer to the practical case. The manufacture of the endoprosthesis will be carried out with additive manufacturing techniques, more precisely by deposition of materials by fusion (FDM). The geometrical model of the artery will be established from the real case of diseased patient through collaborations with hospital. Fluid-structure interaction will be achieved by considering the elasticity of artery wall. Moreover, the determinations by numerical simulations of the parietal flow behaviors and validated experimentally will make it possible to quantify the influence of the geometrical characteristics of the singularities.

Required background of the student:

Fluids Mechanics, Mechanical Engineering

A list of representative publications of the group:

1. J. Song , S. Kouidri, F. Bakir, Numerical study of hemodynamic and diagnostic parameters affected by stenosis in bifurcated artery, Computer methods in biomechanics and biomedical engineering, June 2020
2. N. Abbasnezhad, N. Zirak, M. Shirinbayan, S. Kouidri, E. Salahinejad A. Tcharkhtchi F. Bakir Controlled release from polyurethane films: drug release mechanisms, Journal of Applied Polymer Science, December 2020
3. J. Song , S. Kouidri, F. Bakir, Numerical study on flow topology and hemodynamics in tortuous coronary artery with symmetrical and asymmetrical stenosis, Biocybernetics and Biomedical Engineering, January 2021
4. F. Chabi, S. Champmartin, C. Sarraf, R. Noguera, Critical evaluation of three hemodynamic models for the numerical simulation of intra-stent flows, Journal of Biomechanics, June2015