Thesis subject:

Capsules in flow in a complex capillary network

PhD Advisor:

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Context of the thesis :

The thesis is part of the project activities of the Laboratory of Excellence (LABEX) at the Université de Technologie de Compiègne (UTC) in France on the Control of Technological Systems of Systems (MS2T) (www.utc.fr/labexms2t).

The PhD student will be part of the Biomechanics & Bioengineering Laboratory. He/she will work in collaboration with Roberval Laboratory.The 2 teams offer pluridisciplinary fields of expertise, which are complementary. They will be both needed for the PhD project, which is centered on a biofluids problem

- The team Biological Fluid-Structure Interactions from the BMBI Laboratory has a double expertise that is unique at the international level in the field of modeling of capsule flows: it combines a numerical approach (based on fluid-structure interaction codes that offer a very good accuracy and numerical stability) and an experimental approach (microfluidic experiments in complex microchannels)
- The team Numerical Mechanics from Roberval Laboratory is specialized in the development of new numerical tools to model problem in mechanical engineering. It works mainly on the optimization of large-scale problems with a multi-scale approach, using various strategies of model reduction.

PhD thesis description:

A micro-capsule is a fluid droplet enclosed in a thin membrane with hyperelastic properties. When in suspension in a confined carrying fluid, it experiences large deformation under the hydrodynamic constraints of the internal and external fluids. The objective of the project is to study the flow of a dilute suspension of capsules in a capillary network composed of multiple bifurcations. One application is the use of suspensions of microcapsules containing drugs for drug targeting.
The aim is to determine the capsule repartition in the system. The parameters of the study are the geometric properties of the network (diameter and length of the branches, bifurcation angles) and the geometrical and mechanical properties of the capsules. The capsule distribution will be studied both numerically and experimentally. A fluid-structure interaction numerical code will be developed based on reduced models. The numerical predictions will be compared with experimental results obtained in microfluidic networks.

Keywords: capsules in suspension, model reduction, fluid-structure interaction, microcirculation in capillary network, drug targeting