Interventional Radiology is a branch of minimally invasive surgery (MIS), which uses X-ray image-guidance to navigate a catheter through the vasculature up to the diseased area to be treated. Minimizing the time spent on operating the patient is critical to a successful outcome. The ability for the surgeon to benefit from a preview of the surgical scene and the capacity for them to build a mental model of the operation have been recognized as key factors of performance in MIS [1]. To that aim, patient-specific computer-based simulation has already proven efficient to train practitioners, but relying on simulation for pre-operative planning and practice is still out of reach.

Interactivity and predictivity are paramount for the simulation to be trusted as a planning tool: the catheter must interact with the blood vessels in such a way that the interventionalist can test various scenarios in close-to-real conditions. This requires a predictive mechanical model for the catheter and appropriate collision information [2] - an accurate surface model for the blood vessels, fast and precise contact detection, and physically compliant collision response force. There exists a vast literature for each problem considered separately (see [3] for catheter models, [4] for blood vessel surface modeling, and [5] for contact handling), but they all still remain challenging. We have recently demonstrated that a more integrated approach had the potential to unlock decisive progress: in [6], an implicit blood vessel surface model was designed to both accurately model the surface of the vasculature and foster rapid and accurate contact computations. However, the predictivity of such interactive simulation cannot be ensured.

The objective of this thesis is to address this challenge of simulating accurate, numerous, and physically compliant contacts between vessels and catheters, while maintaining interactivity.

References

The candidate will rely on recent work published in the team concerning blood vessel modeling [6] and Cosserat modeling of interventional devices [7]. Three main objectives will be pursued:

- Improve and/or design procedural model for the surface of blood vessel
- Incorporate continuous contact handling from state-of-the-art mechanical rod models of deformable tubular structures for contact handling

Project description

Vessels and interventional devices, such as catheters, are deformable tubular structures. The scientific challenge behind this thesis is to design geometric models that facilitate contact handling between such structures. In particular, vessels will be considered as deformable and self-collisions will be within the scope of this work.

The candidate will have access to a PhD position: 2020-02500 - PhD Position F/M Implicit modeling of deformable tubular structures for contact handling [S]

Type de contrat : CDD
Niveau de diplôme exigé : Bac + 5 ou équivalent
Fonction : Doctorant

Contexte et atouts du poste

Team


Contacts

Erwan Kerrien (erwan.kerrien@inria.fr) and Pierre-Frédéric Villard (pierrefrédéric.villard@loria.fr).

This PhD position is funded by Inria.

Mission confiée

Contexte

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References

Principal activités

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References
Validate the approach in close connection with our long term clinical collaborators in Nancy University Hospital: this work will be clinically applied to planning interventional neuroradiology procedures.

**Compétences**

**Required qualifications**

MSc in applied mathematics or computer science.

**Language**

French or English. Intermediate to proficient language skill in English is required.

**Technical skills**

Candidates must have a solid background both in mathematics (modeling, optimization) and/or computer graphics (surface modeling, physical simulation). Good programming skills in C++, and some knowledge in mechanics will be appreciated, as well as some acquaintance with medical imaging techniques.

**Relational skills**

We are looking for a highly motivated student with very strong inclination for interdisciplinary research, and excellent communication skills.

**Avantages**

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

**Rémunération**


Monthly salary after taxes: around 1596,09€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).

In addition, one recommendation letter from the person who supervises(d) your Master thesis (or research project or internship) should be sent directly by his/her author to erwan.kerrien@inria.fr and pierrefrederic.villard@loria.fr.

Applications are to be sent as soon as possible.

**Consignes pour postuler**

**Sécurité défense**

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

**Politique de recrutement**

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.

**Attention**

Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.