2018-00993 - New methods for 3D animation in surgical assistance

Level of qualifications required: Bachelor's degree or equivalent
Function: Internship Research
Level of experience: From 3 to 5 years

Context

Research team

MIMESIS research team focuses on its global objective which is to create a synergy between clinicians and scientists in order to develop new technologies capable of redefining healthcare, with a strong emphasis on clinical translation. In our case we joined IHU institute for this purpose.

The scientific objectives of our team, MIMESIS, are related to this ambitious objective. Over the past years we have developed new approaches supporting advanced simulations in the context of simulations for training. We now propose to focus our research on the use of real-time simulations for per-operative guidance. The underlying objectives include numerical techniques for real-time computations and data-driven simulation dedicated to patient-specific modeling. This last topic is a transversal research theme and raises several open problems, ranging from non-rigid registration to augmented reality.

Although our team is attached to the Inria Nancy research center, our offices are located inside the IHU Strasbourg. For more information on the research team, do not hesitate to visit our website at http://mimesis.inria.fr.

Assignment

Project description

During her (his) internship, the candidate will be brought to develop a soft body simulation model. She (he) will have the opportunity to learn advanced animation techniques based on physical dynamics. Surrounded by a young team of dynamic researchers, her (his) work will be integrated into the team's multi-physics simulation software: SOFA Framework. At the end of the internship, the candidate will have learned the basics of physics-based animation of deformable objects. She (he) will also have been introduced to scientific publications reading in the field of computer animation and simulation in a surgical environment.

Available positions

This year, we have two internship positions available.

Position-based dynamics In this project, the field of animation based on position constraints, often call position-based dynamics, is explored. Given a cloud of points filling the interior of a simulated soft object, constraints are added to those points in order to force them to regain a steady state (the rest form of the object) after being deformed by some external forces (gravity, collisions, etc.). Those constraints need to be solved at each time step of the simulation. An equilibrium state should be reached after a set of solver iterations, resulting in a deformed object that exactly balances out the external force energy (which try to deform the object) against the internal elastic energy (which try to regain the undeformed state of the object).

Immersed boundary method In this project, a new method of 3D space integration is explored. Given a 3D surface of a simulated soft object (consisting of a set of triangles or quads), and given a set of regular cubes surrounding the object, we wish to compute the set of triangles or quads that intersect the cubes. If a triangle or quad intersects a cube, but isn't entirely contained inside that cube, this surface element must be split into smaller triangles or quads that will be entirely contained inside the cube. The implemented method must allow for non-convex surface, and must be fast enough for real-time applications (optimization with GPU and CPU vector operations can be used).

Skills

Required skills:
- Good or very good knowledge of c++ and python
- Master of science in applied mathematics and/or computer science
- Significant interest in numerical methods and medical simulation
- Significant interest in animation technique and 3D modeling
- Practical experience with research methods, and R&D.
- Collaborative skills, initiative, ability to accomplish complex tasks.
- Practical skills and ability to create and establish new projects in collaboration with colleagues.
Communication and integration skills

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

General Information
- Theme/Domain: Computational Neuroscience and Medicine
  - Scientific computing (BAP E)
- Town/city: strasbourg
- Inria Center: CRI Nancy - Grand Est
- Starting date: 2018-11-01
- Duration of contract: 4 months
- Deadline to apply: 2018-09-15

Contacts
- Inria Team: MIMESIS
- Recruiter: Brunet Jean-nicolas / jean-nicolas.brunet@inria.fr

About Inria
Inria, the French National Institute for computer science and applied mathematics, promotes “scientific excellence for technology transfer and society”. Graduates from the world’s top universities, Inria’s 2,700 employees rise to the challenges of digital sciences. With its open, agile model, Inria is able to explore original approaches with its partners in industry and academia and provide an efficient response to the multidisciplinary and application challenges of the digital transformation. Inria is the source of many innovations that add value and create jobs.

The keys to success

Qualifications for applicants
We are looking for a candidate with a particular interest in numerical simulation of physical phenomena and the development of real-time animation software. Since the trainee will have to use a variety of mathematical tools, we will prioritize candidates who already have experience in numerical computing, or demonstrate a distinctive curiosity for this area of research. The applicant must be self-taught and ready for scientific challenges.

Conditions for application

Defence Security:
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy:
As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.