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Addresses

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Technical skills

C++	Unix familly	Compilation	Git	Virtualization
Modern C++17/20	Linux kernel	CMake	Rebase / merge	KVM/qemu
Template-based static polymorphism	GNU Tools	AST, re-engineering	Submodules/Subtrees	libvirt
Eigen3	Zsh, Bash	Compile time optimization	Blame :-)	PCI passthrough
SIMD instructions	Fedora, Debian, Arch	Cross compilation	Github (issues, PRs, workflows)	VM based continuous integration (CI)
OpenMP, CUDA, pthread	Embedded Linux	Shared library linkage		Podman/Docker

Simulation skills

Galerkin methods	ODE integration	Nonlinear system	Linear system	Biomechanics
Finite element methods	Explicit/Implicit Euler	Newton-Raphson	(Preconditioned) CG method	Tensor algebra
Meshless methods	Trapezoidal rule	Quasi Newton (BFGS)	LDLT / LLT/ LU solvers	Strain measures (small, Green, Cauchy)
Immersed-boundary methods	Leapfrog (central difference)	Line search optimization	Pardiso library	Stress measures (Cauchy, FPK, SPK)
Extended-FEM	Newmark	Gauss-Seidel iterative methods		Hyper-elastic materials
	Runge-Kutta			

Formations

Dec 2020 June 2017	9 trimester	Ph.D	*Doctorate in computer engineering* University of Strasbourg – Inria Nancy Strasbourg, France
April 2017 Sept 2015	5 trimester	M.Sc.A	*Master in computer engineering* École polytechnique of Montreal Montreal, Canada
Aug 2014 Sept 2010	7 trimester	B.Sc	*Bachelor in computer science* University of Montreal Montreal, Canada
May 2009 Sept 2006	6 trimester	T.Inf	*Technical degree in computer science* Cégep de Maisonneuve Montréal, Canada

Academic and research experience

2020 - 2017	Selected as part of 16 PhD students for the European High Perfomance Soft Tissue Navigation (HiPerNav) project funded by a Marie Skłodowska-Curie grant. My research focused on the development of new numerical methods for the simulation of soft tissue deformations in the context of augmented reality surgery assistance and was conducted under the supervision of Stéphane Cotin, Research Director at Inria and leader of the MIMESIS team. https://hipernav.eu	*Inria Nancy* Europeen projet HiPerNav Marie S.-Curie grant Oslo, Trondheim, Strasbourg, Bern, Delf, Cordoba, Paris
2017	Laboratory instructor of the course "Software re-engineering" (LOG6302) under the supervision of Professor Ettore Merlo.	*École poly. of Montreal* *Montreal, Canada*
2016	Joined the Inria MIMESIS team as a research internship. Main responsibilities included the analysis of meshless methods for real-time surgical simulation applications using the well-known SOFA Framework.	*École poly. de Montreal* *Mitacs-Globalink grant* *Strasbourg, France*

Industry experience

2021 2020	Member of the Inria MIMESIS research staff. Research activities focus on computer assisted medical training, planning and guidance. My responsibilities involve the development as well as the evolution of the real-time computation and data-driven simulation models available within the open-source SOFA framework. Patient-specific applications vary from augmented reality liver surgery assistance to surgical training.	**Inria Nancy** Research engineer C++, Git, cmake High performance computing, Finite element methods
2016 - 2014	Member of the ERFT (Engineering Research and Flow Technology for Composites) R&D team. The focus of ERFT is the development of complex composites products. I was responsible for the implementation of a computerized automaton solution embeddable on different industrial machines. Tasks varied from team lead, software design and low-level software code development.	**ERFT Composites** R&D dev. team leader C++, Git, cmake Embedded Linux, x86/ARM, Linux drivers
2014 - 2013	As a consultant-developer, my job was to develop software extensions and web services for PLM (Product Lifecycle Management) software, in particular in the aerospace industry. Customers came from all over the world. We had access to advanced formation in various areas of software development.	**Accenture** Aerospace dev. Java, J2EE, Oracle DB server, Apache Axis2, WSDL
2013 - 2012	As a backend developer, I had to develop the architecture of complex web software. LG2 is the first advertising firm in Quebec and develops web software for very large companies. I worked in collaboration with a frontend team (css and html) of ten employees and several graphic designers / artistic directors. My main mandate was PHP / MySQL /Javascript development of web softwares and services.	**LG2** Web dev. PHP, Javascript MySQL Mercurial HG Linux
2012 - 2011	In a team with two infographers, and being the only developer, I took care of the frontend and backend development of dozens of websites. I also had to take care of several development, staging and production servers.	**BLSOL** Web dev. PHP, JS, MySQL
2010 - 2009	Schedule and route optimization software for various public transport systems. My main tasks the implementation of various software improvements and bug corrections for different clients all over the world.	**Giro inc.** Software C++ dev. C++, Oracle SQL

Summary of research

Thesis project

Context

One of the great challenges in the field of real-time simulation is the resolution of soft body deformations for augmented reality applications such as computer-assisted surgery. The process must mimic the behavior of a deformable organ, usually reconstructed from 3D medical images, in real time. The modeling is based on the resolution of a complex system of partial differential equations for which the finite element method is generally favored. However, the latter method requires a discretization of the simulated model into a sequence of well-formed geometric elements connected to each other, a tedious process. Indeed, the biomechanical model must often be reconstructed from complex and non-concave surfaces, sometimes even with holes or generated from incomplete or erroneous data.

Research

We are therefore interested in methods for solving deformable dynamics which are accurate and fast, but also robust to against unpredictable and often non-physical inputs. In the first part of my thesis, I looked at so-called meshless or element-free methods. This particular branch of numerical methods makes it possible to approximate a displacement field inside a volume and to estimate the elastic forces using a simple point cloud based discretization. These points, frequently called particles, are forming the set of degrees of freedom to be solved. Thus, where traditional finite element methods require complex discretization, meshless methods merely require the simulated object's volume to be filled with points.

The second second part was the start of a new direction of research. We have left the world of meshless methods, this time returning to traditional methods of discretization with isoparametric elements. However, unlike traditional finite element methods, we are interested in the world of fictitious domains. Here, the simulated object is immersed in a grid of regular elements. This grid is then used to solve the initial boundary problem. The difficulty of meshing a complex surface using the finite element method is therefore transposed to the handling of grid elements cut by the boundary surface of the simulated object.

Publications

Exploring new numerical methods for the simulation of soft tissue deformations in surgery assistance. Jean-Nicolas Brunet. Thesis, Université de Strasbourg, 2020. https://hal.inria.fr/tel-03130643

Use of stereo-laparoscopic liver surface reconstruction to compensate for pneumoperitoneum deformation through biomechanical modeling. Andrea Teatini, Jean-Nicolas Brunet, Sergei Nikolaev, Bjørn Edwin, Stéphane Cotin, Ole Jakob Elle. VPH2020, Virtual Physiological Human, Paris, 2020. https://hal.inria.fr/hal-03130613

Data-driven simulation for augmented surgery. Andrea Mendizabal, Eleonora Tagliabue, Tristan Hoellinger, Jean-Nicolas Brunet, Sergei Nikolaev, Stéphane Cotin. Developments and Novel Approaches in Biomechanics and Metamaterials. Springer, Cham, 2020. 71-96. https://doi.org/10.1007/978-3-030-50464-9_5

Physics-based deep neural network for real-time lesion tracking in ultrasound-guided breast biopsy. Andrea Mendizabal, Eleonora Tagliabue, Jean-Nicolas Brunet, Diego Dall'Alba, Paolo Fiorini, Stéphane Cotin. Computational Biomechanics for Medicine. Springer, Cham, 2019. https://doi.org/10.1007/978-3-030-42428-2_4

Physics-based deep neural network for augmented reality during liver surgery. Jean-Nicolas Brunet, Andrea Mendizabal, Antoine Petit, Nicolas Golse, Eric Vibert, Stéphane Cotin. International Conference on Medical image computing and computer-assisted intervention. Springer, Cham, 2019. https://doi.org/10.1007/978-3-030-32254-0_16

Corotated meshless implicit dynamics for deformable bodies. Jean-Nicolas Brunet, Vincent Magnoux, Benoît Ozell, Stéphane Cotin. WSCG 2019-27th International Conference on Computer Graphics, Visualization and Computer Vision. Západočeská univerzita, 2019. https://doi.org/10.24132/CSRN.2019.2901.1.11

Analyse des méthodes par éléments finis et méthodes sans maillage pour la déformation de corps mous en simulation chirurgicale. Jean-Nicolas Brunet. Dissertation, École Polytechnique de Montréal, 2017. https://publications.polymtl.ca/2529