Activity Report 2016

Team DEFROST

Deformable Robotic Software

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

RESEARCH CENTER
Lille - Nord Europe

THEME
Robotics and Smart environments

Table of contents

Team DEFROST

Creation of the Team: 2015 January 01

Keywords:

Computer Science and Digital Science:

- 2.3.3. - Real-time systems
- 3.1.1. - Modeling, representation
- 5.10. - Robotics
- 5.10.1. - Design
- 5.10.3. - Planning
- 5.10.4. - Robot control
- 5.10.5. - Robot interaction (with the environment, humans, other robots)
- 5.10.8. - Cognitive robotics and systems
- 6.2.1. - Numerical analysis of PDE and ODE
- 6.2.6. - Optimization
- 6.4.3. - Observability and Controlability
- 6.4.4. - Stability and Stabilization
- 7.1. - Parallel and distributed algorithms

Other Research Topics and Application Domains:

- 2.5.1. - Sensorimotor disabilities
- 2.7. - Medical devices
- 2.7.1. - Surgical devices
- 5.1. - Factory of the future
- 5.6. - Robotic systems
- 5.7. - 3D printing
- 9.2. - Art
- 9.2.2. - Cinema, Television
- 9.2.4. - Theater

1. Members

Research Scientists

Christian Duriez [Team leader, Inria, Senior Researcher, HDR]
Olivier Goury [Inria, Researcher]

Faculty Members

Jeremie Dequidt [Univ. Lille I, Associate Professor]
Alexandre Kruszewski [Ecole Centrale de Lille, Associate Professor]

Engineers

Eulalie Coevoet [Inria]
Mario Sanz Lopez [Inria]
Damien Marchal [CNRS, Research Engineer]
Bruno Carrez [Inria, Research Engineer]

PhD Students

Frederick Largilliere [Univ. Lille III]
Thor Morales , Bieze [Univ. Lille I]
Maxime Thieffry [Univ. Valenciennes]
Zhongkai Zhang [Inria]

Visiting Scientists

Alejandro Rodriguez Aguilera [PhD Student, Visiting Scientist, from Mar 2016 until Jun 2016]
Ugo Chouinard [Inria, Polytechnique Montreal, PhD Student, from Sep 2016 until Dec 2016]

Administrative Assistant

Anne Rejl [Inria]

Other

Piyush Jain [Inria, from Apr 2016 until Sep 2016]

2. Overall Objectives

2.1. Overall Objectives

The DEFROST team aims to address the open problem of control and modelling methods for deformable robots by answering the following challenges:

- Providing numerical methods and software support to reach the real- time constraint needed by robotic systems: the numerical solutions for the differential equations governing the deformation generate tens of thousands degrees of freedom, which is three orders of magnitude of what is frequently considered in classical methods of robotic modelling and control.
- Integrating deformation models in the control methods of soft robot: In soft-robotics, sensing, actuation and motion are coupled by the deformations. Deformable models must be placed at the heart of the control algorithm design.
- Investigating predictable interaction models with soft-tissues and pa- rameter estimation by visual feedback from medical imaging: On the contrary to many cases in surgical robotics, the contact of the soft robot with the anatomy is permitted and it creates additional deformations on the robot.

3. Research Program

3.1. Introduction

Our research crosses different disciplines: numerical mechanics, control design, robotics, optimisation methods, clinical applications. Our organisation aims at facilitating the team work and cross- fertilisation of research results in the group. We have three objectives (1, 2 and 3) that correspond to the main scientific challenges. In addition, we have two transversal objectives that are also highly challenging: the development of a high performance software support for the project (objective 4) and the validation tools and protocols for the models and methods (objective 5).

3.2. Objective 1: Accurate model of soft robot deformation computed in finite time

The objective is to find concrete numerical solutions to the challenge of modelling soft robots with strong real-time constraints. To solve continuum mechanics equations, we will start our research with real-time FEM or equivalent methods that were developed for soft-tissue simulation. We will extend the functionalities to account for the needs of a soft-robotic system:

- Coupling with other physical phenomenons that govern the activity of sensors and actuators (hydraulic, pneumatic, electro-active polymers, shape-memory alloys...).
- Fulfill the new computational time constraints (harder than surgical simulation for training) and find better tradeoff between cost and precision of numerical solvers using reduced-order modelling techniques with error control.
- Exploring interactive and semi-automatic optimisation methods for design based on obtained solution for fast computation on soft robot models.

3.3. Objective 2: Model based control of soft robot behavior

The focus of this objective is on obtaining a generic methodology for soft robot feedback control. Several steps are needed to design a model based control from FEM approach:

- The fundamental question of the kinematic link between actuators, sensors, effectors and contacts us- ing the most reduced mathematical space must be carefully addressed. We need to find efficient algorithms for real-time projection of non-linear FEM models in order to pose the control problem using the only relevant parameters of the motion control.
- Intuitive remote control is obtained when the user directly controls the effector motion. To add this functionality, we need to obtain real-time inverse models of the soft robots by optimisation. Several criteria will be combined in this optimisation: effector motion control, structural stiffness of the robot, reduce intensity of the contact with the environment...
- Investigating closed-loop approaches using sensor feedback: as sensors cannot monitor all points of the deformable structure, the information provided will only be partial. We will need additional algorithms based on the FEM model to obtain the best possible treatment of the information. The final ob- jective of these models and algorithms is to have robust and efficient feedback control strategies for soft robots. One of the main challenge here is to ensure / prove stability in closed-loop.

3.4. Objective 3: Modeling the interaction with a complex environment

Even if the inherent mechanical compliance of soft robots makes them more safe, robust and particularly adapted to interaction with frag- ile environments, the contact forces need to be controlled by:

- Setting up real-time modelling and the control methods needed to pilot the forces that the robot imposes on its environment and to control the robot deformations imposed by its environment. Note that if an operative task requires to apply forces on the surrounding structures, the robot must be anchored to other structures or structurally rigidified.
- Providing mechanics models of the environment that include the uncertainties on the geometry and on the mechanical properties, and are capable of being readjusted in real-time.
- Using the visual feedback of the robot behavior to adapt dynamically the models. The observation provided in the image coupled with an inverse accurate model of the robot could transform the soft robot into sensor: as the robot deforms with the contact of the surroundings, we could retrieve some missing parameters of the environment by a smart monitoring of the robot deformations.

3.5. Objective 4: Soft Robotic Software

Expected research results of this project are numerical methods and algorithms that require high-performance computing and suitability with robotic applications. There is no existing software support for such development. We propose to develop our own software, in a suite split into three applications:

- The first one will facilitate the design of deformable robots by an easy passage from CAD software (for the design of the robot) to the FEM based simulation
- The second one is an anticipative clinical simulator. The aim is to co-design the robotic assistance with the physicians, thanks to a realistic simulation of the procedure or the robotic assistance. This will facilitate the work of reflection on new clinical approaches prior any manufacturing
- The third one is the control design software. It will provide the real-time solutions for soft robot control developed in the project.

3.6. Objective 5: Validation and application demonstrations

The implementation of experimental valida- tion is a key challenge for the project. On one side, we need to validate the model and control algorithms using concrete test case example in order to improve the modelling and to demonstrate the concrete feasibility of our methods. On the other side, concrete applications will also feed the reflexions on the objec- tives of the scientific program.

We will build our own experimental soft robots for the validation of objective 2 and 3 when there is no existing « turn-key » solution. Designing and making our own soft robots, even if only for validation, will help the setting-up of adequate models.

For the validation of objective 4, we will develop « anatomical soft robot »: soft robot with the shape of organs, equipped with sensors (to measure the contact forces) and actuators (to be able to stiffen the walls and recreate natural motion of soft-tissues). We will progressively increase the level of realism of this novel validation set-up to come closer to the anatomical properties.

4. Application Domains

4.1. Industry

Robotics in the manufacturing industry is already highly diffused and is one of the ways put forward to maintain the level of competitiveness of companies based in France and to avoid relocation in cheap labor countries. Yet, in France, it is considered that the level of robotization is insufficient compared to Germany for instance. One of the challenge is the high investment cost for buying robotic arms. In the recent years, it has led the development of « generic » and « flexible » (but rigid) robotic solution that can be produced in series. But their applicability to specific tasks is still challenging or too costly. With the development of 3D printing, we can imagine the development of a complete opposite strategy: a « task-specific » design of robots. Given a task that need to be performed by a deformable robot: we would optimize the shape of its structure to create the set of desired motion . An second important aspect is the reduction of the manufacturing cost: It is often anticipated that the cost of deformable robots will be low compared to classical rigid robotics. The robot could be built on one piece using rapid prototyping or 3D printers and be more adapted for collaborative work with operators. This remains to be « proved », but it could open new perspectives in robotic applications. A last remarkable property of soft robots is their adaptability to fragile or tortuous environment. For some particular industry (chemistry, food industry...) this could also be an advantage compared to existing rigid solutions. For instance, the german company http://www.festo.com/Festo, key player in the industrial robots field, is experiencing with deformable trunk robot and we are working on their accurate control.

4.2. Personal and service robotics

The personal and service robotics are considered as an important source of economic expansion in the coming years. The potential applications are numerous and particularly include the challenge of finding robotic solutions for active and healthy aging at home. We plan to develop functional orthosis for which it is better not to have a rigid exoskeleton that are particularly not comfortable. These orthosis will be ideally personalised for each patient and built using rapid prototyping. On this topic, the place of our team will be to provide algorithms for controlling the robots. We will find some partners to build these robots that would fall in the category of « wearable robots ». With this thematic we also connect with a strong pole of excellence of the region on intelligent textile Up-Tex.

4.3. Entertainment industry and arts

Robots have a long history with entertainment and arts where animatronics have been used since years for cinematographic shootings, theater, amusement parc and performing arts. These animatronics are either radio-controlled by a team of professionals or using recorded movements. Our FEM-inversed approach to control soft robots may simplify animatronic control and thus impact this field. We are currently working on implementing demonstration of a deformable animatronic puppets in which motion tracking systems are used and the gestures and movements directly control the puppet. We are also collaborating with the art school Le Fresnoy based at Tourcoing, in particular with the artist Jonathan Pepe (see figure 1).

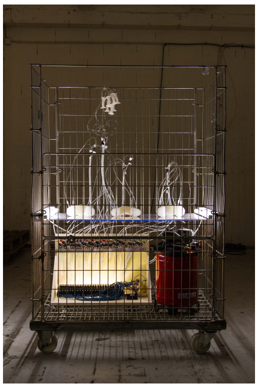

Figure 1. Our team has worked with the artist Jonathan Pepe on this art work that will be presented at the museum Le palais de Tokyo in 2017.

5. Highlights of the Year

5.1. Highlights of the Year

New Research scientist

Olivier Goury was selected to join the team as new Inria research scientist.

Robosoft Grand Challenge

The team participated in the Robosoft Week in Livorno, with a workshop on simulation of soft robots held by Christian Duriez, Thor Bieze and Eulalie Coevoet. In addition, 2 prototypes were presented to the Robosoft Grand Challenge, reaching the 4th place of the competition.

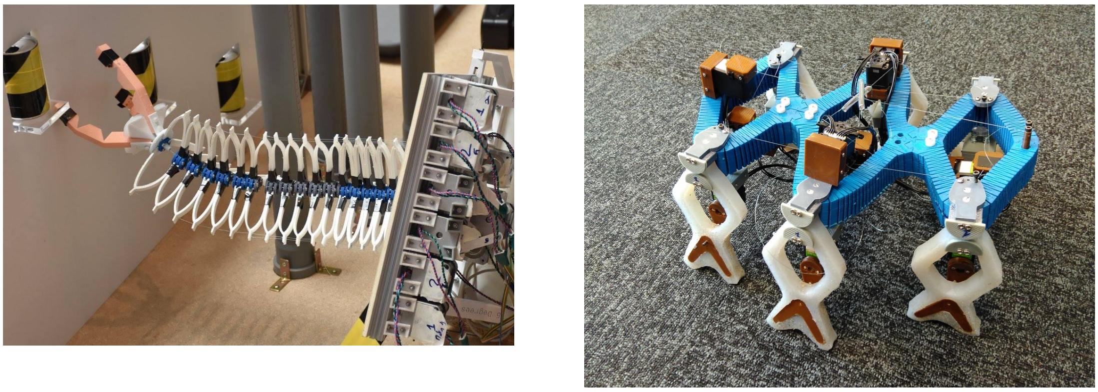

Figure 2. (a) EchelonIII (b) SOFIA

ERC evaluation grade A

The project COMOROS submitted for ERC Consolidator "fully met the ERC's excellence criterion" and evaluated as grade A. Unfortunately, it could not be funded, given the available budgetary resources of ERC for the call. But the region Haut-De-France should be able to finance a part of the project during the 3 coming years thanks to the FEDER funds.

6. New Software and Platforms

6.1. SOFA

Simulation Open Framework Architecture
KEYWORDS: Real time - Multi-physics simulation - Medical applications
FUNCTIONAL DESCRIPTION SOFA is an Open Source framework primarily targeted at real-time simulation, with an emphasis on medical simulation. It is mostly intended for the research community to help develop new algorithms, but can also be used as an efficient prototyping tool. Based on an advanced software architecture, it allows : the creation of complex and evolving simulations by combining new algorithms with algorithms already included in SOFA, the modification of most parameters of the simulation (deformable behavior, surface representation, solver, constraints, collision algorithm, etc.) by simply editing an XML file, the building of complex models from simpler ones using a scene-graph description, the efficient simulation of the dynamics of interacting objects using abstract equation solvers, the reuse and easy comparison of a variety of available methods.
Since 2016, SOFA development and maintenance is now coordinated by the SOFA Consortium.
DEFROST is an active member of the consortium steering committee; beside his mission of Inria continuous integration support team coordinator, Bruno Carrez is in charge of the continuous integration setup of the SOFA consortium.

- Participants: Christian Duriez, Jeremie Dequidt, Bruno Carrez, Damien Marchal, Eulalie Coevoet, Frederick Largilliere
- Partner: Sofa consortium, projet-team Mimesis, projet-team Imagine, projet-team Asclepios, In-Simo, Anatoscope
- Contact: Hugo Talbot
- URL: http://www.sofa-framework.org

6.2. Soft-robot plugin for Sofa

Soft-robot plugin for Sofa

KEYWORDS: Simulation - Soft-Robot - Inverse models - Finite Element Method - Quadratic Programmings

FUNCTIONAL DESCRIPTION The soft-robot plugin consists in a new framework to simulate and control soft robots. This framework is based on a mechanical modeling of the robot elements in Sofa combined with fast real-time direct/inverse FEM solvers.

The keypoint of the approach implemented is that the same modeling is used for interactive simulation of its behavior and interactive control of the fabricated robots. This plugin was developped during the ADT project SORBET that ended in 09/2016.

- Participants: Eulalie Coevoet, Olivier Goury, Frederick Largilliere, Bruno Carrez, Damien Marchal, Jérémie Dequidt and Christian Duriez
- Contact: Eulalie Coevoet and Christian Duriez
- URL: https://project.inria.fr/softrobot/

7. New Results

7.1. Cochlear Implants

Publication at MICCAI 2016 (Medical Image Computing and Computer Assisted Intervention conference): **Numerical Simulation of Cochlear-Implant Surgery: Towards Patient-Specific Planning**, *Olivier Goury, Yann Nguyen, Renato Torres, Jeremie Dequidt, Christian Duriez*. **Abstract.** During Cochlear Implant Surgery, the right placement of the implant and the minimization of the surgical trauma to the inner ear are an important issue with recurrent fails. In this study, we reproduced, using simulation, the mechanical insertion of the implant during the surgery. This simulation allows to have a better understanding of the failing cases: excessive contact force, buckling of the implant inside and outside the cochlea. Moreover, using a patient-specific geometric model of the cochlea in the simulation, we show that the insertion angle is a clinical parameter that has an influence on the forces endured by both the cochlea walls and the basilar membrane, and hence to post-operative trauma. The paper presents the mechanical models used for the implant, for the basilar membrane and the boundary conditions (contact, friction, insertion etc...) and discuss the obtained results in the perspective of using the simulation for planning and robotization of the implant insertion.

https://hal.archives-ouvertes.fr/hal-01370185

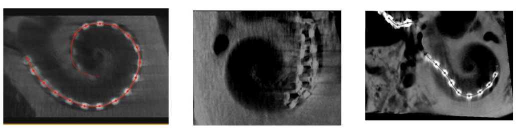

Figure 3. Three outcomes of implant insertion (from left to right): successful insertion; failed insertion (Folding tip); incomplete insertion

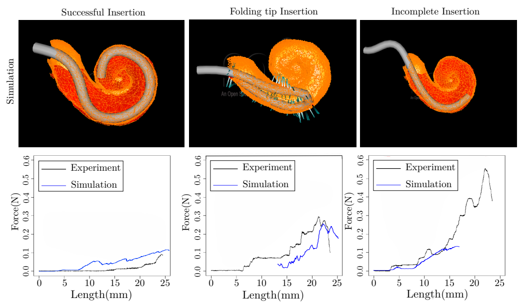

Figure 4. Reproduction of real insertion cases with the simulation

7.2. Physics based model of soft-robots

Book chapter in Soft Robotics: Trends, Applications and Challenges, Springer, 2016 **Soft Robot Modeling, Simulation and Control in Real-Time**, *Christian Duriez and Thor Bieze*. https://hal.inria.fr/hal-01410293. We were asked to write a chapter in this book on Soft Robotics. Our chapter presents new real-time and physics-based modeling methods dedicated to deformable soft robots. In our approach, continuum mechanics provides the partial derivative equations that govern the deformations, and Finite Element Method (FEM) is used to compute numerical solutions adapted to the robot. A formulation based on Lagrange Multipliers is presented to model the behavior of the actuators as well as the contact with the environment. Direct and inverse kinematic models are also obtained for real-time control. Some experiments and numerical results are presented.

7.3. Kinematic Modeling and control of soft robots

Publication at IROS 2016 : **Kinematic Modeling and Observer Based Control of Soft Robot using Real-Time Finite Element Method**, *Zhongkai Zhang, Jeremie Dequidt, Alexandre Kruszewski, Frederick Largilliere, Christian Duriez.*. **Abstract.**This paper aims at providing a novel approach to modeling and controlling soft robots. Based on real-time Finite Element Method (FEM), we obtain a globally defined discrete-time kinematic model in the workspace of soft robots. From the kinematic equations, we deduce the soft-robot Jacobian matrix and discuss the conditions to avoid singular configurations. Then, we propose a novel observer based control methodology where the observer is built by Finite Element Model in this paper to deal with the control problem of soft robots. A closed-loop controller for position control of soft robot is designed based on the discrete-time model with feedback signal being extracted by means of visual servoing. Finally, experimental results on a parallel soft robot show the efficiency and performance of our proposed controller. https://hal.inria.fr/hal-01370347

7.4. Stiffness rendering

Publication at IROS 2016 : **Stiffness rendering on soft tangible devices controlled through inverse FEM simulation**, *Frederick Largilliere, Eulalie Coevoet, Mario Sanz-Lopez, Laurent Grisoni, Christian Duriez.* **Abstract.**Haptic rendering of soft bodies is essential in medical simulations of procedures such as surgery or palpation. The most commonly used approach is to recreate the sense of touch using a specific design and control of a robotic arm. In this paper, we propose a new approach, based on soft-robotics technology. We create a tangible deformable device that allows users to " touch " soft tissues and perceive mechanical material properties, in a realistic manner. The device is able to dynamically provide user touch with different stiffness perceptions, thanks to actuators placed at the boundaries. We introduce a control algorithm, based on inverse Finite Element Analysis, which controls the actuators in order to recreate a desired stiffness that corresponds to the contact with soft tissues in the virtual environment. The approach uses antagonistic actuation principle to create a wide range of stiffness. We validate our algorithm and demonstrate the method using prototypes based on simple mechanisms. https://hal.inria.fr/hal-01386787

7.5. Framework for soft robot simulation

Publication at SIMPAR 2016 : **Framework for online simulation of soft robots with optimization-based inverse model**, *C. Duriez, E. Coevoet, F. Largilliere, T. Morales-Bieze, Z. Zhang, M. Sanz-Lopez, B. Carrez, D. Marchal, O. Goury, J. Dequidt*. **Abstract.**Soft robotics is an emerging field of robotics which requires computer-aided tools to simulate soft robots and provide models for their control. Until now, no unified software framework covering the different aspects exists. In this paper, we present such a framework from its theoretical foundations up to its implementation on top of Sofa, an open-source framework for deformable online simulation. The framework relies on continuum mechanics for modeling the robotic parts and boundary conditions like actuators or contacts using a unified representation based on Lagrange multipliers. It enables the digital robot to be simulated in its environment using a direct model. The model can also be inverted online using an optimization-based method which allows to control the physical robots in the task space. To demonstrate the effectiveness of the approach, we present various soft robots scenarios including ones where the robot is interacting with its environment. https://hal.inria.fr/hal-01425349

7.6. Closed-loop control

Closed-loop control based on dynamic models of soft robots. Model-order reduction provides a system of achievable size to apply traditional control science techniques. During the internship of Maxime Thieffry, we obtain the first results in that direction that will be extended during a PhD thesis.

8. Bilateral Contracts and Grants with Industry

8.1. A.I. Mergence

A.I. Mergence is a startup company based in Paris. The transfer contract was about building a soft robot prototype. The aim of the demonstration was to show that we can improve the appearance and user interaction. They have a usage of our license for 12 months. Amount of the contract: 1500 euros.

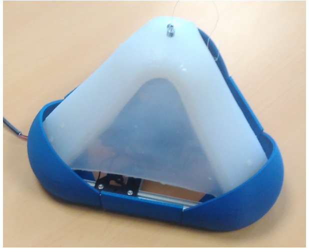

Figure 5. Prototype for A.I. Mergence

8.2. TruPhysics

TruPhysics is a german startup, using SOFA for the simulation of industrial robots. We did an expertise and research contract on modeling grasping tasks in SOFA with a deformable gripper. Amount of the contract: 7940 euros.

8.3. InSimo

InSimo is a French startup, based in Strasbourg, that was created by members of the team in 2013. The goal of InSimo is to create a new generation of surgical simulators with high quality biomechanics. We have signed a contract to work on the simulation of suture during the years 2016-2017. Amount of the contract: 33000 euros.

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Inserm

Olivier Goury was hired as a postdoctoral researcher by the "Réhabilitation chirurgicale mini-invasive et robotisée de l'audition" to collaborate with the DEFROST team on the simulation of Cochlear Implant surgery. The contract stopped since Olivier has been recruited as a Research scientist. The collaboration with Inserm will be continued with the hiring of Piyush Jain as an engineer.

9.1.2. ANR

- **Sorcery** The goal of this project was to work on the modeling, simulation and control of soft surgical robot with a particular focus in cochlear implantology. A very good consortium was built around the project that went to phase 2 in the ANR project. Unfortunately, the project has not been funded.
- **IDeaS**, Image-Driven Simulation, Jeremie Dequidt, Magrit, MIMESIS and Nancy Hospital, 42 months,: this is a project targeted at per-operative guidance for interventional radiology procedures. Our main goal is to provide effective solutions for the two main drawbacks of interventional radiology procedures, namely: reduce radiation exposure and provide a fully 3D and interactive visual feedback during the procedure. To do so, our project relies on an original combination of computer vision algorithms and interactive physics-based medical simulation.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Program: FET Open

Project acronym: RoboSoft

Project title: Coordination Action for Soft Robotics

Duration: 2014-2016

Coordinator: Cecilia Laschi (Scuola Superiore Sant'Anna)

9.3. International Initiatives

9.3.1. Declared Inria International Partners

We have a collaboration with King's College (Profs Kaspar Althoefer and Hongbin Liu) on soft hydraulic robots with the support of the program North European associate team of the center Inria Lille North Europe (2014-2016)

We have started a collaboration with the Université Libre de Bruxelles (Profs Denis Terwagne, Serge Massar, Marc Haelterman and Guillaume Tillema) on the use of soft robot simulation to build control strategies based on artificial intelligence algorithms (2016-2018)

9.3.2. Informal International Partners

This section includes some recent collaboration. We have initiated research work with Prof. Bordas at the University of Luxembourg on Model reduction with contacts. We are also working with Adrien Escande and with Prof. Yoshida, at AIST Japan, on the simulation of deformable objects in contact and with Prof Miguel Otaduy at URJC Madrid on human hand grasping and manipulation (Conference paper in 2014 and journal paper in 2015).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Ugo Chouinard was a research intern in the Defrost team from September to December 2016. He is a PhD candidate in mechanical engineering at Polytechique Montréal (Canada) and obtained the Mitacs-Globalink Research Award that allowed him to join our team for a few months. He investigated the effect of design change on the compliance of deformable manipulators. The result of his research will help to better understand and design soft robotic manipulators. Indeed, with the research he carried out, it will be easier to design robots that meet the design specifications. Furthermore, his internship might lead to further collaboration with Polytechnique Montréal for the design of soft robotics systems.
- Alejandro Rodriguez Aguilera from the University of Granada, stayed from March to June 2016. His works on GPU computing allowed him to develop a parallelized hydraulics systems simulation and integrate it into the SOFA Framework.

9.4.1.1. Internships

- Valentin Owczarek was a research intern in the Defrost team from March to September 2016. He worked on using genetics algorithm to generate task specific soft-robot designs.
- During the internship of Piyush Jain (India) from April 2016 to September 2016, it was observed that it is possible to create the concept of self-contained pneumatic actuation for soft robots without the need for an external pneumatic supply.

10. Dissemination

10.1. Promoting Scientific Activities

10.1.1. Scientific Events Organisation

10.1.1.1. Member of the Conference Program Committees

- Jeremie Dequidt is member of the CP committee of the AFIG (Association Française d'Informatique Graphique) conference and VRIPHYS conference
- Christian Duriez is member of the CP committee of Eurohaptics

10.1.1.2. Reviewer

- Jeremie Dequidt has been reviewer for International Journal of Computer Assisted Radiology and Surgery (IJCARS) and AFIG 2016
- Damien Marchal has been reviewer for IEEE 3D User Interface 2016 (3DUI 2016) and EuroHaptic 2016.
- Christian Duriez has been reviewer for the conferences IEEE VR 2016 and ICRA 2017.

10.1.2. Journal

10.1.2.1. Member of the Editorial Boards

- Christian Duriez is member of the editorial board of IEEE Transaction on Haptics

10.1.2.2. Reviewer - Reviewing Activities

- Christian Duriez has been reviewer for the journals ACM Transaction on Graphics, Computer and Graphics, IEEE Transactions on Robotics, Soft Robotic Journal (SORO).

10.1.3. Invited Talks

- Christian Duriez and Thor Bieze were invited for a talk at the Spring School on Soft-robotics at Livorno (April 2016)
- Christian Duriez was invited for a talk at the conference POSS in Paris (november 2016).

10.1.4. Scientific Expertise

Christian Duriez is a scientific advisor of InSimo (Inria Spin-off)

10.1.5. Research Administration

Christian Duriez is vice-responsible of Research Jobs Committee at Inria Lille.

10.2. Teaching - Supervision - Juries

10.2.1. Teaching

Licence : Jeremie Dequidt, Programming, 54h, L3, University of Lille/Polytech Lille, France

Licence : Jeremie Dequidt, Advance Programming, 16h, L3, University of Lille/Polytech Lille, France

Licence : Jeremie Dequidt, Databases, 12h, L3, University of Lille/Polytech Lille, France

Licence : Frederick Largilliere, Computer science fundamentals, 48h, L1, University of Lille 3, France

Licence : Frederick Largilliere, Certificate of computer science and internet knowledge, 27.5h, L2 - L3, University of Lille 3, France

Master : Jeremie Dequidt, Theoretical Computer Science, 24h, M1, University of Lille/Polytech Lille, France

Master : Jeremie Dequidt, Surgical Simulation, 12h, M2, University of Lille/Polytech Lille, France

Master : Thor Morales Bieze, Bio-inspired robotics, 20h, M2, University of Lille/Polytech Lille, France

Master : Damien Marchal, Reality-Virtual et Interaction, 20h, M2, University of Lille, France

Master : Christian Duriez, Interactive hysics-based enginesh, M2, University of Lille, France

10.2.2. Supervision

PhD in progress: Frederick Largilliere, Stiffness control of interfaces based on soft robots through numerical modelization, 01/11/2013, Laurent Grisoni, Christian Duriez

PhD in progress: Thor Morales Bieze, Design, modeling and control of soft, continuum manipulators, 10/10/2013, Rochdi Merzouki, Christian Duriez

PhD in progress: Zhongkai Zhang, Visual servoing control of soft robots based on real-time Finite Element Method, 01/10/2015, Jeremie Dequidt, Christian Duriez

PhD in progress: Maxime Thieffry, High velocity control of soft robots, 01/10/2016, Christian Duriez, Alexandre Kruszewski, Thierry Marie Guerra

10.2.3. Juries

- Christian Duriez was president of the committee of the PhD jury of José Dolz (University of Lille 2)

- Christian Duriez was reviewer of the PhDs of Johan Sarrazin (University of Grenoble) and Pierre-Luc Manteaux (University of Grenoble)
- Christian Duriez was examiner of the PhD of Zilong Shao (University of Lille)

10.3. Popularization

- Olivier Goury and Christian Duriez participated in "Fête de la science: Opération Chercheurs itinérants", which involves giving scientific lectures in middle and high schools.
- Christian Duriez and Mario Sanz Lopez participated in the "Bourse aux Technologies" at Bercy, Paris (22 March).
- Popularization session 13:45 on the topic of Arduino by Mario Sanz Lopez.
- Popularization session 13:45 on the topic of Software development good practices by Bruno Carrez.
- Damien Marchal participated in "Chti'Code". Chti'Code is an action of the University of Lille 1, which aims to promoting computer education in primary schools. Damien Marchal intervened with computer science student in 4 CM2 classes for a total of 20h.
- Jeremie Dequidt was jury member of the second robotic competition SI / @ Baggio.

11. Bibliography

Major publications by the team in recent years

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