In this end, one possibility will be to adapt and extend the formulation that we developed for the design of marionettes’ design parameters (e.g. lengths of the strings, attachment points) such that the marionettes are manually operated by strings. In particular, we will investigate algorithms to automate this process.

The goal of this PhD is to develop novel computational tools to help casual users and artists to design and control marionettes. This PhD will be funded by Inria (CORDI-S grant) and will be supervised by Mélina Skouras and Rémi Ronfard.

**Mission confiée**

Context:
Marionettes are puppets actuated by strings attached to different marionettes’ body parts and to rigid control plates. Thanks to the simplicity of their structure and their actuation mechanism, marionettes are relatively easy to fabricate. However, the relation between the pose of a marionette and the orientation of the rigid plate, which also depends on the number, locations and lengths of the strings, is far from intuitive and mastered only by skilled marionette puppeteers - the marionettists.

Therefore, the use of marionettes is mostly reserved to these professionals, and marionettes are almost exclusively seen on the stage of dedicated marionette theaters. This PhD aims at developing novel computational tools to help casual users to design hand-operated marionettes so that they can be used for broader applications. Indeed, as physical embodiments of imaginary characters, marionettes could be exploited to facilitate the exploration of alternate choreographies by artists, for social experiments [2], as tangible interfaces [3], for educational purposes or simply for casual entertainment. This goal brings new challenges related to the optimization of the marionette design parameters (number, locations and lengths of the strings), which typically depends on the targeted marionette performance, and to the representation of this target performance itself, which will need to be as intuitive as possible. This project is thus distinct from previous research in the field, which mostly focused on robotic marionettes with fixed design policies [6]. While Murphey and Egerstedt tackled the problem of automation of marionettes plays [2], they assumed the marionettes strings locations and lengths to be known, whereas we are concerned with the design of the full system, which makes the problem more difficult, but also more interesting.

**References**


**Assignments**

The goal of this PhD is to develop novel computational tools to help casual users and artists to design marionettes manually operated by strings. In particular, we will investigate algorithms to efficiently simulate the movements of the marionettes and to automatically optimize the marionettes’ design parameters (e.g. lengths of the strings, attachment points) such that the marionettes can be used to replicate target animations or to be able to reach static target poses. To this end, one possibility will be to adapt and extend the formulation that we developed for the design...
of actuated deformable characters, based on a constrained minimization problem that encourages sparsity of the actuation points [3]. Along the way, this PhD will try to address several open research questions. Since marionettes are under-actuated, several solutions for the strings locations and lengths can lead to the same pose. Can we leverage this redundancy and optimize these parameters such that users can easily compose the results obtained for canonical movements into a single animation? What’s the best way to represent the target motions? From a broader point of view, this PhD will be the opportunity to work on the co-optimization of design and actuation parameters of dynamic systems as well as on the representation of complex target motions from, for example, simpler building blocks.

**Principales activités**

Research, design and implementation of algorithms for the direct simulation and inverse modeling of marionettes.
- Design and implementation of graphical user interfaces for interacting with the above algorithms.
- Evaluation of the developed methods
* Additional activities:
- Writing of research papers
- Presentation of research work in conferences, seminars

**Compétences**

The candidate should be fluent in English and hold a Master’s degree (or be about to earn one) or have a university degree equivalent to a European Master’s (5-year duration). He/she should be proficient with C++, have a strong background in computer science and applied maths, and ideally some experience with computational fabrication or computer graphics.

**Avantages sociaux**

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

**Rémunération**


Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year (medical insurance included).