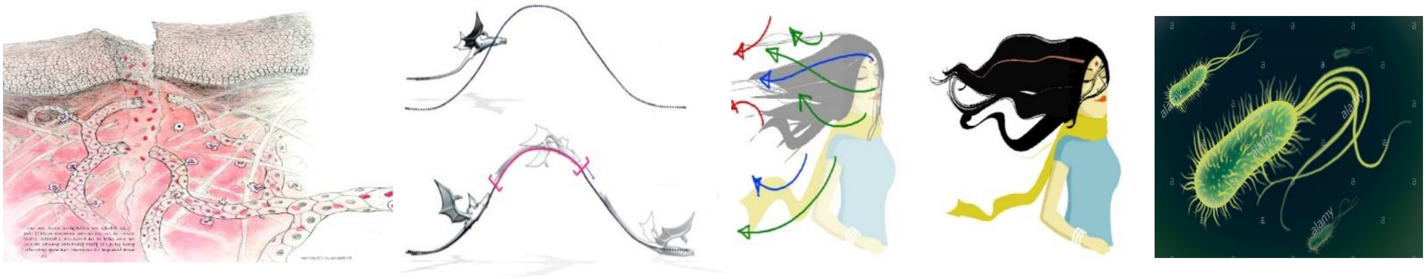
Master 2 internship

Sketching Animations of Organic Shapes



Illustrations from Renaud Chabrie, [1], [4] and @Alamy

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Motivations and context

Our understanding of many natural phenomena, such as biological ones – from blood cells circulating in vessels to bacteria evolving in their environment and interacting with each other, can be highly enhanced by scientific illustrations. Contrary to captured data, these illustrations aim at conveying the main structure and deformation of the typical shapes and behaviours involved, while proposing a simplified representation, which is essential for structuring our thoughts. Among them, animated illustrations convey the temporal aspect of motion and deformations, which would be very hard to grasp using static images only. They are usually designed by talented scientific illustrators and digital artists, but their generation typically requires a tedious cycle of trials and errors, while scientists explain their visions to these artists, and the later manipulate their preferred specialized tools to create contents, until the results get closer and eventually converge to the visions the scientists wanted to convey.

Alternatively, proposing a tool where an organic-like shape could be easily animated through a few sketched strokes, or simple gestures indicating an example of motion, could be a very powerful tool for designing and exploring the animated scientific illustrations. More globally, it would be a first step toward an interactive tool helping natural scientists to directly create, explain and test virtually the scenarios they have in mind, in an expressive and efficient way.

Objective

The objective of this project is to propose a new computer graphics method to depict, analyse, and apply animated deformations to simple organic-like, 3D shapes. Ideally the representation used for conveying animation should be easy to depict or to input using other gestures, and should provide a high-level, sparse representation of the expected motion and deformation, without requiring a full depiction of the space-time trajectory of the vertices as in standard interpolation/morphing. In addition, users should be able to interactively edit and refine their animations to be able to continuously iterate between observations and illustration.

Methodology

We may consider three main types of expressive inputs to depict or constrain motion:

- Sketched strokes, which may be used to indicate the general trajectory or a subpart of the shape, and more generally, velocity/dynamic information in a 2D plane. This high-level information can be inspired from cartoon techniques to represent motion [1,2]. Parametric animated deformations could also be explored using strokes structure such as its oscillations [3,4].
- Geometrical constraints expressing laws could be attached to a shape or painted to a subpart of it. These constraints can be for instance the preservation of the volume/area/length, or of differential properties that could be depicted from their velocity field such as constrained rotational or divergence [5]. In addition, interaction between shapes could also be set by general pre-set behaviours (ex. constrained distance between shapes, merging, attachment, sliding, etc.).
- Sparse examples may be used to depict and learn complex deformation of a given shape, or to extend motion to a distribution of shapes. The objective will be here to propose some lightweight learning method (distribution relation [6], local coordinates [7], Bayesian inference, etc) to extract and interactively learn the animation from sparse input.

During this project, we may tackle one or more of these aspects, depending on the student's interests and results. To ease the creation of the 3D models, we may use the simple, implicit-based 3D sketching tool provided by the Open-Source software "Matisse" [8].

Research lab

This work will take place in the Geometry & Visual Computing (GeoViC) team of LIX, bâtiment Alan Turing building, 1 rue Honoré d'Estienne d'Orves, 91128 Palaiseau, on the campus of Ecole Polytechnique. All the necessary material (computer, sketching tools) will be provided.

After a successive internship, the candidate will be given the option to pursue and extend this research as a PhD student, by apply for a grant to the CREATIVE AI fellowship, funded by the institute Hi!Paris.

Expected skills

We are looking for an excellent candidate, with a good scientific background in both math and computer science. Previous experience in CG programming is mandatory (ex. C++/OpenGL, JavaScript/WebGL). Experience in Computer Animation is highly recommended. Knowledge in machine learning and statistical inference is a plus, as well as interest for scientific and/or cartoon illustration.

Bibliography

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[4] Jun Xing, Rubaiat Habib, Tovi Grossman, Liyi Wei, Jos Stam, George Fitzmaurice. Energy-Brushes: Interactive Tools for Illustrating Stylized Elemental Dynamics. UIST 2016.

[5] Thomas Buffet. Field-based approaches for the collision-free animation of layered and dynamic clothing (chapter 3). Thèse de l'Institut Polytechnique de Paris.

[6] Pierre Ecormier-Nocca, Julien Pettré, Pooran Memari, Marie-Paule Cani. Image-based Authoring of Herd Animations. CASA, 2019.

[7] Pierre-Luc Manteaux, Ulysse Vimont, Chris Wojtan, Damien Rohmer, Marie-Paule Cani. Space-Time Sculpting of Liquid Animation. MIG, 2016.

[8] Matisse: Painting 2D regions for Modeling Free-Form Shapes.
https://www.lix.polytechnique.fr/geovic/software.html