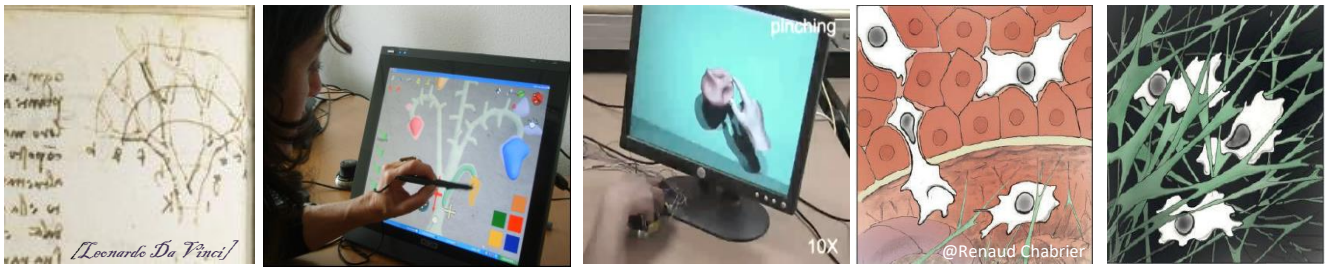
PhD thesis proposal

Creative AI: Towards a smart 3D authoring system for the visual exploration of scientific models



Advisors: Renaud Chabrier & Marie-Paule Cani, laboratoire LIX (Ecole Polytechnique – CNRS)
Contacts: renaud.chabrier@m4x.org, Marie-Paule.Cani@polytechnique.edu
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Motivations

Scientists cannot understand or reason about the world without some, at least mental, visual representation. The latter not only heightens their intuition, but also helps them structure the observed phenomena into a series of simpler stages. Over centuries, scientists used static sketches for expressing their thoughts, despite of the difficulties for 2D drawings to convey animated 3D shapes. They had to iteratively modify these representations as their mental picture crystallized. With the advent of visual computing, one would expect digital images to have replaced such traditional practices. Unfortunately, while captured images cannot convey a scientist's vision in a meaningful way, the use of 3D modeling also fails to solve the problem: Indeed, designing animated 3D contents requires an iterative process between the scientist and a digital artist trained on dedicated tools, leading to weeks of tedious work and successive refinements. Moreover, the resulting 3D contents are sterile, they cannot be used as a testbed to play with ideas and improve them.

Goal

Could digital images be turned into a creative media, more expressive but as simple to use as a pen, enabling scientists to directly express their mental vision of their object of study in the form of interactive 3D environments? This is the goal of this PhD. More precisely, the objective of this work is to extend 3D authoring environments towards creative testbeds enabling scientists (eg. in biology, physics, etc) to convey their vision of static or animated phenomena, manipulate thee resulting visual models through interaction, test different hypotheses and inject new data on the fly. Such a tool should become a key support for scientists willing to think about a problem, discuss and share their vision with colleagues, or communicate their knowledge with the public.

Methodology:

Indeed, recent advances in Artificial Intelligence open the way to such a revolution of contents creation. However, AI should be revisited from a user-centered perspective. This will imply bridging the gap between (i) Expressive gesture-based creation, based on sketching, sculpting or smart copy-paste, developed so far

for isolated 3D shapes, and still to be extended to distributions of animated shapes; (ii) Procedural models for visual simulation, conveying prior knowledge through rules and constraints, but often slow and difficult to control; and (iii) Learning processes that build on data and examples, but should be extended to real-time light-learning methods in other to ease user control, and should enable to inject new examples of the fly, with the ability to smartly copy-paste specific features to the current model, based on perceptual analogies.

In contrast with intelligent systems that would tackle creation by themselves, the resulting "Creative AI" authoring system is aimed at supporting and enhancing users' creativity. It will therefore always keep the user in the loop - trying to reduce their workload by providing them some smart, automatic handing of details and constraints, but while offering them an adequate (and tunable) level of control.

Results and validation:

The resulting authoring system, implemented in WebGL/Three.js, should make scientific illustration directly possible in digital form, from early intuitions to progressive refinement, testing, finalization and communication of an idea. To achieve this, this work will be conducted with applications to biology in mind (this choice enabling to consider extremely rich and diverse categories of representations and behaviours). Therefore, frequent discussions with our collaborators in this field will take place throughout the project, and the resulting authoring system will finally be validated through experimental user-studies with these experts. If time enables, a couple of examples from other discipline(s) (eg. physics, chemistry, etc) will be explored, to test the generality of the chosen approach.

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