

Hands on Virtual Clay

Adeline Pihuit⁽¹⁾, Paul Kry⁽²⁾, Marie-Paule Cani⁽¹⁾

⁽¹⁾University of Grenoble and INRIA, ⁽²⁾McGill University



Goal: To provide the artist with an intuitive system for virtual sculpting

Motivations

Current 3D modeling systems are not user-friendly: most of the time, the user must deal with the underlying mathematical representation of the model. However, some recent virtual clay models solved this problem by providing excellent clay-like behavior.

But none of these systems provide a device that allow the user to sculpt the clay with a virtual hand.

Contributions

This new system allows hands-on sculpting: the sculpting tool is a **virtual hand** with **realistic behavior**.

It provides the **immersion** of the user through 3 feedbacks:

- **Visual feedback** through the deformation of the virtual hand
- **Passive tactile feedback** through a proxy (deformable foam ball)
- **Possible active feedback** through a Phantom device

Virtual Clay and Virtual Hand

- Virtual clay [Dewaele et Cani, 2004]

- Simulated through a 3D grid storing the density of clay in each cell (0 for an empty cell, and 1 for a full cell).
- The surface is defined as the iso-surface at 0.5 of clay density.
- Clay behavior is captured by a **layered model** ensuring 3 properties:
 - **Large scale deformations** (fig.1)
 - **Mass conservation** by pouring the excess of matter in neighbouring cells (fig.2)
 - **Surface tension** for preventing the clay from spreading over space (fig.3)

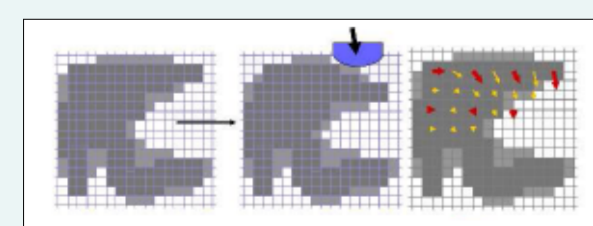


Fig. 1 : Large scale deformation

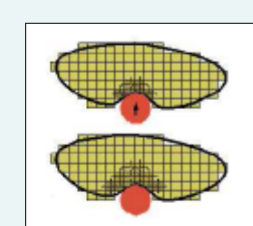


Fig. 2 : Mass conservation

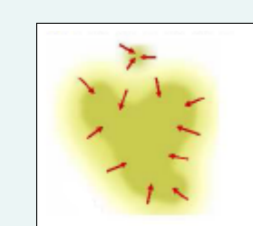
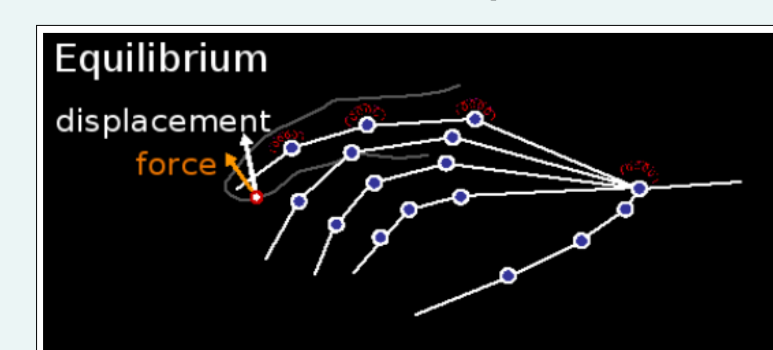


Fig. 3 : Surface tension

- Physically based virtual hand [Kry et Pai, 2006]

- Deformable sculpting tool.
- Simulated through an **articulated spring-based system** keeping the virtual hand at equilibrium.



Spring-based system of the virtual hand



Model visualized for the user

New device with passive tactile feedback

This new hands-on sculpting device combines:

- **a Phantom device** that controls both global position and orientation of the virtual hand
- **a foam ball** for providing **passive tactile feedback** to the user while exerting pressures
- **5 pressure sensors (fixed to the foam ball)** for the user to control independently the behavior of each virtual finger



User Immersion through Visual Feedback

Simulating **realistic visual behavior** for the virtual hand is essential for the user to consider it as his own hand : **the virtual hand's shape must depend on both desired gesture and contact with environment.**

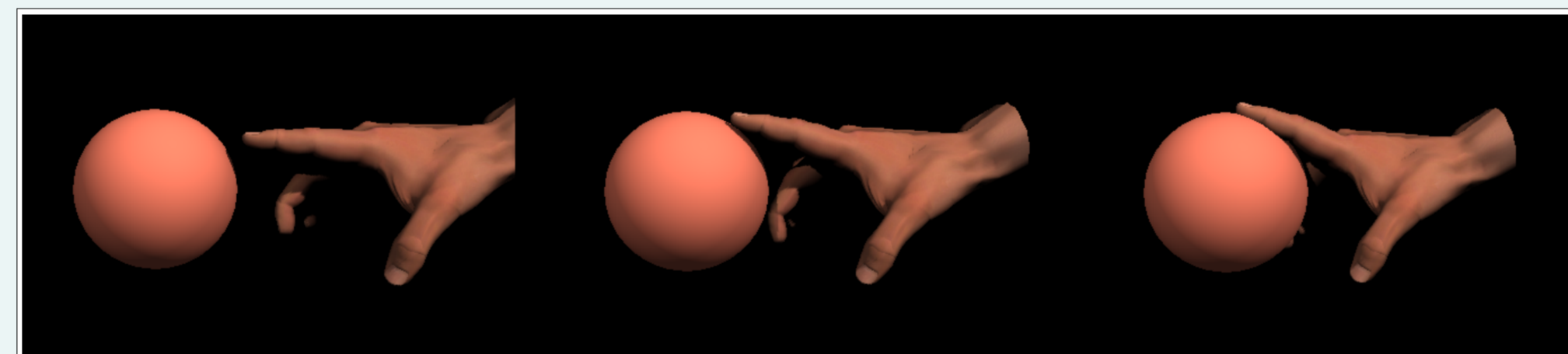
- Virtual physical interaction

- Deformation of the virtual hand

Forces are applied on virtual fingers' joints when the virtual hand is making contact with the clay.

These forces depend on the gradient of the clay surface at the contact point, and both density and fluidity of the matter.

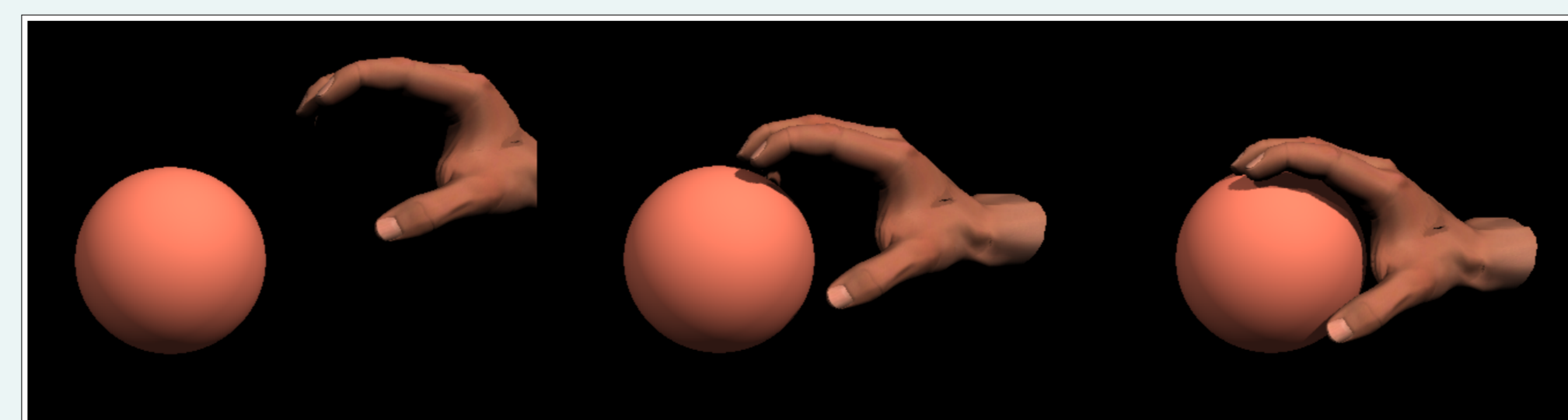
The goal is to visually simulate the resistance of the matter and its effect on the virtual hand.



- Anticipation of the contact with the clay

The virtual hand is gradually opening when approaching the clay.

The goal is to show the artist the virtual hand is about to touch and modify the clay



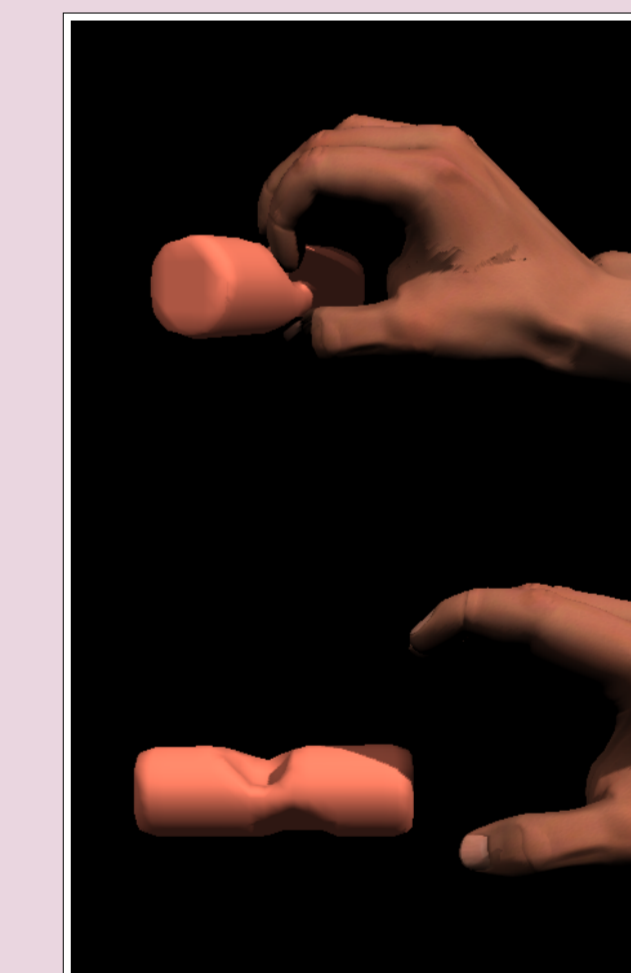
- Sculpting by controlling individually each virtual finger

- Each **virtual fingertip** is considered as a **sculpting tool** and deforms the clay.
- Varying pressure on a sensor allows the corresponding virtual finger to be flexed or extended.
- The user can easily evaluate the action he is applying on the virtual clay thanks to the passive tactile feedback of the foam ball.

Results

This new device for hands-on sculpting allows precise shape modeling and deformations thanks to

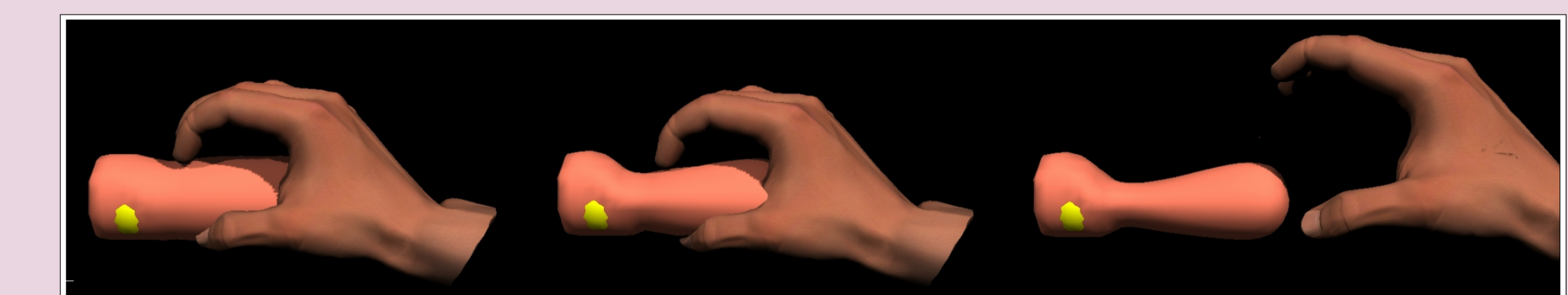
- **simple and natural hand gesture** for controlling the sculpting tools
- a **good immersion of the artist**, through the combination of visual clues (realistic deformation of the virtual hand) and tactile feedback.



Pinching the clay between thumb and forefinger



First sculpture, made by a novice user, from a ball of virtual clay



Stretching and smoothing a bar of clay by translating the virtual hand and pinching the clay

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