**Projet M2R 2012-2013**

Detail preserving deformations of 3D objects

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Motivations

Being able to deform a 3D model intuitively and efficiently is an essential issue not only for interactive modeling applications but also for applications related to computer animation.

Nowadays deformation tools succeed in preserving repetitive details at different levels of resolution coherently. But these methods generally fail in case of local scale change, such as stretching or compression. In this case, the details undergo a scale change as well, which may destroy the natural morphology of the model. Stretching for example a tree trunk having some bark, a dinosaur wearing some salient chips, or a terrain composed of trees, would imply stretching of these details as well. In contrary, the user would expect that only the base shape deforms while some of the repetitive details duplicate or vanish in case of compression, so that the global aspect of the model is conserved (figure below)
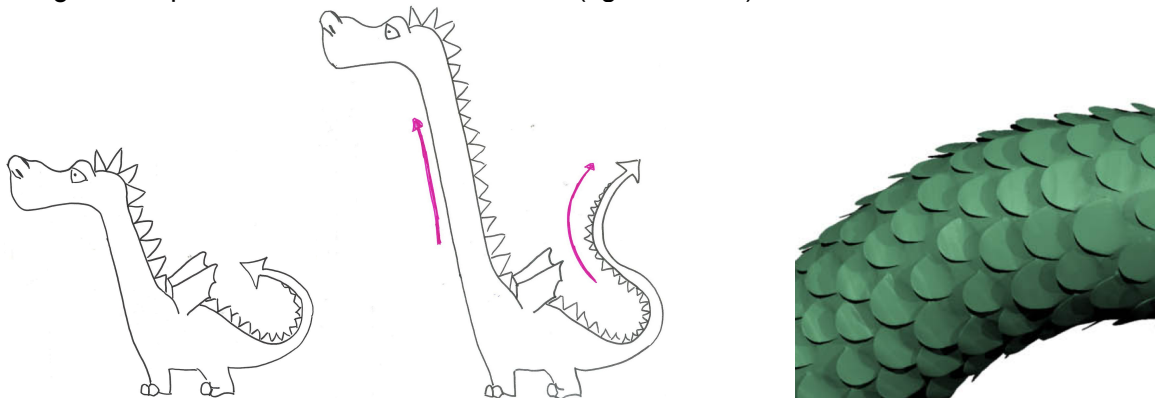
Goals

The method to be developed takes as input a 3D model with known repetitive geometric or functional details on its surface. The goal of the internship is to set up representations and algorithms able to preserve those details during non-isometric deformations of the 3D model such as local scaling, shearing and twisting. We are in particular interested to handle deformation of « natural » objects, in contrast to "artificial » (manmade) ones, which are much more regular and easier to handle.

More precisely, this new method should be able to continuously add details in case of stretching, or to smoothly remove details in case of compression. Moreover, the properties of the initial distribution of size and space of the details must be preserved during the deformation.

Particular attention should be paid to the preservation of dynamic continuity of appearance/removal of details [1] during deformation, in order to not perturb the user when sculpting the model.

A 2D proof-of-concept of the method developped in our team is already available (see figure below). Experiences with the 2D method will help in identifying the specific requirements of a full 3D solution.
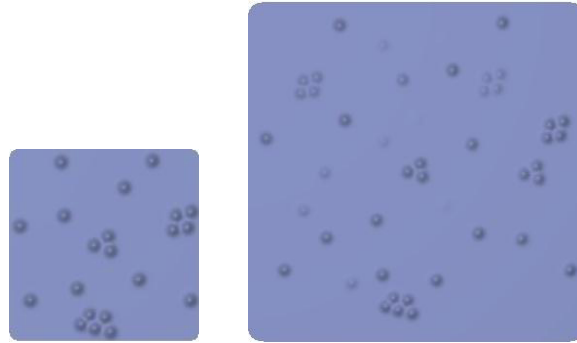
Figure: left: a 2D pattern with 3D geometric details as little bumps. Right: the 2D pattern is stretched in x-y direction and the distribution of the geometric details is preserved.

Organisation:

The Master thesis focuses on the following two aspects:

• The first part of the internship will focuss on extending the 2D approach for a full 3D mesh while preserving the requirements mentioned above. The research aspect consist in defining a new measure of triangle comparison that compensates for the deformation related to the parameterization of the 3D mesh. Moreover, the algorithm will need to handle parameterization in charts to work with objects of arbitrary topology.

• The second part, if there is sufficient time, will be devoted to handle oriented details exhibiting anisotropic behavior when the surface is deformed. The dinosaur example above shows a one-dimensional isotropic deformation and replication of details. In the anisotropic setting such as fibrous structures one might distinguish between replication/removal of details or stretching the details depending on the direction of deformation.
In such a case, the details can be represented by a set of 2D frames (and not only by point-sets). Therefore new rules of deformations will have to be defined to handle both the change of position and the change of orientation of such details.

The topic is scientifically original and can be continued with a PhD thesis. It requires the student to have a strong background in geometric modeling and processing, linear algebra and graphics programming.

Références
1. Ibraheem Alhashim · Hao Zhang · Ligang Liu : Detail-replicating shape stretching, The Visual Computer, pages 1–14, 2011.
2. Bénard Pierre; Cole Forrester, Golovinskiy Aleksey; Finkelstein Adam : Self-Similar Texture for Coherent Line Stylization, ACM. *NPAR (2010)*
3. Hui Fang, John C. Hart : Detail preserving shape deformation in image editing. In ACM SIGGRAPH 2007 papers, SIGGRAPH '07.
4. Lin Chen, Xiangxu Meng : Anisotropic resizing of model with geometric textures. InSIAM/ACM Joint Conference on Geometric and Physical Modeling, SPM '09, pages 289–294, 2009.
5. Owada, Nielson, Igarrashi: Copy-paste Synthesis of 3D Geometry with Repetitive Patterns, LNCS Springer (2006)
6. Ge, Xu, Hui, Wang: Detail-preserving sculpting deformation, CAD Conf. (2009)