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INTEGRATION OF HAPTICS INTO THE DESIGN

A designer oriented tool for virtual clay modeling

Abstract

The design process of aesthetic products includes a typical iterative sequence of activities. The process starts from an initial idea or concept of the product and moves on to the representation of this idea through a modelling phase. The modelling phase may be performed producing a physical model (Yamada, 1997) or a digital model. In case digital models are produced, the evaluation of the concept is initially performed purely visually, and then it is done on the physical prototype (PMU – Physical Mock-Up) of the digital model. In case, as it often happens, the shape is not fully satisfactory, some modifications are performed on the model -in its digital or physical form- and the process cycles several times on this loop until a fully satisfied result is reached, or the time available has expired.

The moving from the two product model evaluation phases (visual and physical) is not straightforward. In fact, the physical mock-up cannot be immediately derived from the digital model, but instead it requires a production phase that can be manual or consisting of a technological process including CAM (Computer Aided Manufacturing), milling and finishing activities or through Rapid Prototyping.

Before reaching a final satisfactory shape of the product the various activities are performed several times; that means that several loops are carried out, and therefore several physical prototypes are built. Just to give an idea of the size of the problem we report some figures provided by Alessi (http://www.alessi.com) - a well-known Italian company operating in the sector of household design-related to the role of PMUs in their design process. Alessi produced about 1000 physical prototypes in year 2007, had about 300 open projects and 50 products finally developed, and plans to produce more than 1200 physical prototypes in year 2008.

Every time a PMU is needed for the evaluation of product the design process breaks up in order to physically build the prototype. This activity requires long time that is at least an order of magnitude higher than the time required by the other phases. It often happens that in order to meet time constraints the number of PMUs is dropped down and fewer solutions can be evaluated to the disadvantage of products quality.

The problem of companies is to find a trade-off between obtaining the best result among the various identified solutions in the shortest time. We have seen that in the design process most of time is dedicated to build PMUs. Ideally, the number of PMUs should be diminished while maintaining high level of quality of the product. Since PMUs are important to the aim of assessing the product design, the focus of the research is studying new tools that support the reduction of the number of PMUs maintaining and possibly increasing the quality and the knowledge acquired by the designer. In the industrial design domain technology is expected to support creativity and to enable the re-use and exploitation of designers' know-how and amplify the knowledge and acquired experience in a shorter time.

The traditional methods currently supporting industrial design have some limits. As previously said, it typically requires the construction of a physical mock-up which is highly time-consuming. Moreover, the existing Computer Aided Styling (CAS) and Computer Aided Design (CAD) tools require the tedious manipulation of control points and a careful specification of constraints. The idea of bridging physical and virtual modeling by maintaining the effective and performing aspects of digital modeling and enriching tools with some new modalities of interaction more oriented to exploiting designers' skills is at the basis of the research work described in this paper. The paper presents the results of the research project *T'nD – Touch and Design* funded by the European Union (http://www.touch-and-design.eu), which aims at developing a system that allows designers to generate digital shapes in a natural and intuitive way by manipulating haptic tools that closely resemble the physical tools they use in everyday work (Bordegoni and Cugini, 2006).

The most innovative aspects of the research concerns the development of designer-oriented haptic interfaces resembling craftsmen tools like rakes and sandpapers, and of a physics-based shape modeling tool based on sweep operators computed on class A surfaces. Haptic interfaces provide force feedback output to the user, so that he can perceive physical contacts and reactions when interacting with the virtual representation of an object (Laycock, 2003). Figure 1 shows a designer operating a haptic tool simulating a physical rake for modelling a digital shape of a car body. The quality of the sculptured digital model is such that it can be used directly within the downstream design process activities without any further mathematical manipulation and reconstruction of the surface. The integration of haptics into design is expected to improve the bandwidth of interactions and shorten the design cycle.

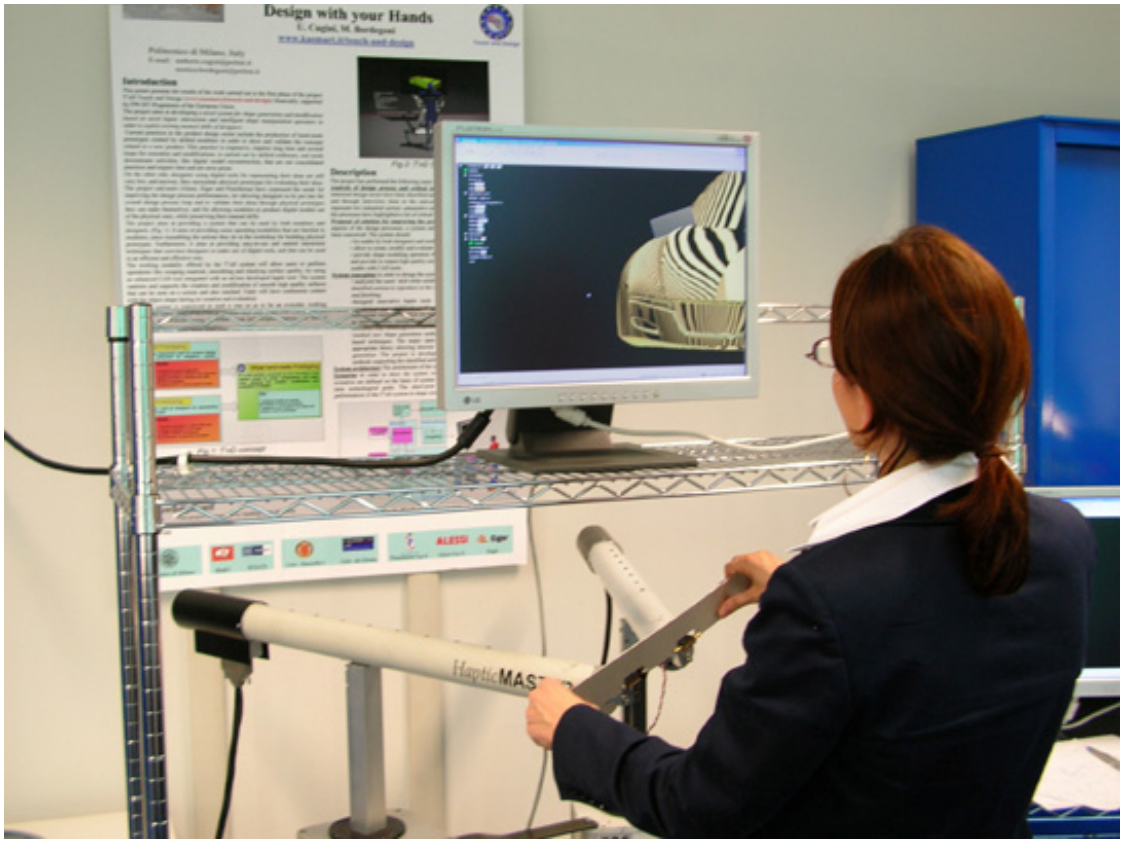

Fig. 1: Designer uses the haptic tool resembling a real rake for modelling a virtual model of a car. At each scraping operation the system reshapes the digital model by computing a boolean

intersection between the virtual rake and the object model; the user feels a force feedback when entering in contact with the virtual surface.

References

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