

Haptic interaction with virtual sculptures

Massimo Bergamasco, Marcello Carrozzino, Fiammetta Ghedini

PERCRO
Scuola Superiore Sant'Anna
Pisa, Italy

The separation between art and technology initiated during the Renaissance, when science became codified as a segregated set of processes and worldviews [1]. Since that time, many artists and theorists have challenged this separation, questioning the role of art in society, our perception and awareness of technology and cutting-edge research.

Art – just like research – can actually explore technological and scientific frontiers and allows us to ask questions about the possibilities of innovation and the agendas of technology. Artistic creativity and cultural commentary represent the need to rethink the relationship of art to scientific and technological research, exploring also the perspectives for future mutual influence, and an opportunity to forecast the influences and new trends that technological evolution continuously bring into our society and everyday life. One of the most prominent example of this process is Virtual Art [2], an art practice defined by the use of Virtual, Augmented and Mixed Reality as a medium, that has been pioneering and exploring social, technological and emotional implications and potentialities of Virtual Environments (VE).

VEs are simulated environments generated by the computer which the human operator can interact with through different sensory modalities. VEs commonly provide visual and acoustical feedback, although other sensory modalities may optionally be activated, mainly through haptic (related to the sense of touch) and inertial feedback (related to the sense of motion). A system of sensors is needed to retrieve positional information about the user, in order to correctly generate sensorial feedback and to recognize user inputs. After having aroused a great interest in the 90's as one of the most promising among emerging technologies, applications of VEs have been appearing with an increasing pace, although still in very specialized contexts, notably the industrial and the medical sector. VE technologies are gaining consent and positive reception also in the field of Art and Cultural Heritage, especially for conservation and education purposes, but also to create new forms of art or new paradigms of art fruition by means of interaction.

Art since many years ago has been forecasting the visualisation revolution that has come finally true with the advent of Virtual Reality. Indeed, since the mid of the 19th century, new representation techniques such as the "Panoramas" became very popular to represent historical events and landscapes. These huge cylindrical paintings (often more than 100 m long) wrapped up the public at 360°, providing a feeling of high immersion and illusion, anticipating the interaction and immersion feeling of VE [3] Panoramas began to undermine the monopoly of perspective, an abstract and "sensory-deprived" form of visualization, placing in the centre of representation the spectator and his/her emotions. In the 60's, minimal and early installation art have began to introduce in the public discourse about art concepts like the role of the visitor's body, human perception and interaction. Such issues, explored in early times by artistic experimentation, have lately become main issues in VEs research. Interacting with VEs requires setting up an interface layer between the human user and the VE itself. This usually involves the use of several specialized devices, either wearable or external, such as displays for the sight, loudspeakers for hearing, motion platforms etc. As far as the sense of touch is concerned several interesting approaches have been explored, the most effective being that of haptic interfaces (HI). HIs are robotic devices able to exert force feedback stimuli on the user body, acting on the haptic perceptual system (a perceptual system that exploits cutaneous and kinaesthetic stimuli to acquire information about object properties).

The sense of touch has a special relationship with artistic expression. Touch has always been a neglected sense in Western society, since it has been considered predominantly utilitarian in function, and remotely related to will, reason, and aesthetic sense. But, if removed from theory, touch has been emerging worldwide in the practices of artists. Chinese craftsmen created ivory, jade and pottery objects to be carried in the pocket, consciously worked with a view to their being handled (a property called "tactile appeal"). Indeed, touch can deliver emotions, gives us the sense of the "inside" of things, and of their interconnections. Following Marshall McLuhan [4], touch has been the obsession of modern Western artists that, since Cezanne, have

been trying to escape from the predominance of vision in order to “get in touch”, using an appropriate word, with the expression of tactile awareness.

Nowadays we know that our knowledge and understanding of the world would be impossible without bodily and haptic awareness. Studies confirm that a combination of touch and visual cues is essential to understanding and learning, providing more than each for the construction of a meaningful image of the world. To touch means getting something whole, to grasp it: touch is a complete act of knowing, that allows analyzing our percept intellectually and affirming their reality.

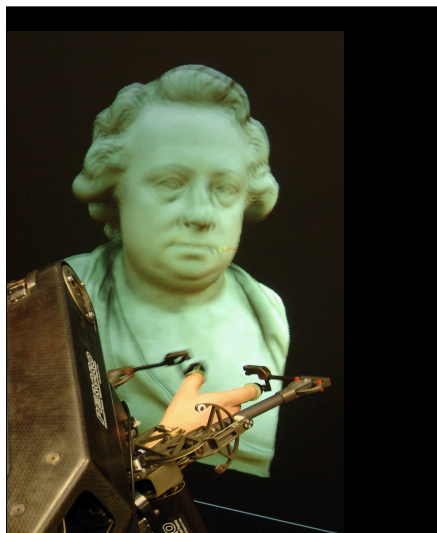
PERCRO is an engineering laboratory of Scuola Superiore Sant’Anna of Pisa, Italy, whose mission is to conceive and develop advanced interaction concepts and technologies for improving the communication between the humans and the environment, with special attention to Virtual Environments and Robotic Systems. Most of PERCRO research is focused on increasing the realism of the information conveyed to the senses and, at the same time, on investigating novel communication modes that build on the human ability to transmit and receive physical cues like gestures, force and tactile stimuli. This vision was the basis of several research projects exploring this topic on a number of different applications, including ergonomics investigations [5], development of interfaces for user with special needs [6], and the setup of methods and technologies for the transmission of enactive knowledge [7] and human skills [8]. A consistent effort in PERCRO research has been also devoted to the field of art and cultural heritage, in particular investigating how the aforementioned technologies may be used for the conservation and the divulgation of tangible and non tangible heritage, exploring interaction paradigms that allow to go beyond the usual cultural experience, either real or virtual.

In traditional museums visitors may only observe the exposed statues because, for security reasons, they are not allowed to touch them. On the other hand, the haptic perception represents the most immediate way of interacting with sculptures, allowing the observer to perceive the concept of space the artist has impressed on the art forms while shaping them. In the perception of sculptural pieces of art, the mere observation by sight is a limit which prevents the observer from fully appreciating the artistic value and the intrinsic beauty of those art pieces. Moreover, any fruition of these artistic works is denied to blind and visually impaired users.



.1 User interacting with the Museum of Pure Form

Through Virtual Reality, the Museum of Pure Form [9] offers art a way out of such limits by giving the haptic perception of artistic forms the same essential role it had for the artist when creating them (Fig.1).

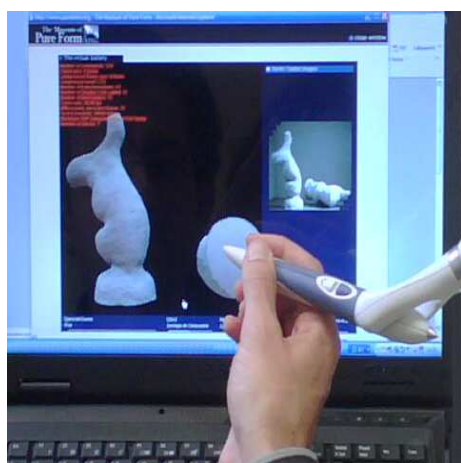


2 Touching a virtual statue

The use of innovative technologies allows users to perceive suitable tactile stimuli able to simulate the hand while in contact with the digital copy of a real statue. Besides this, the realism of the virtual simulation is increased and integrated by the stereoscopic visualization of digital models, giving users the real feel of touching the surface being visualized and placed in the space under their own hands (Fig. 2)

A selected set of sculptures belonging to the collection of partner museums has been digitally acquired to create a database of artworks copies that constitutes the core of a new web-based computer network among partner museums and other European cultural institutions. Two specifically devised Haptic Interface systems, composing the MPF system, have been installed in temporary and permanent exhibitions of partner museums, where the visitors are allowed to explore, in a multisensorial perspective, the digital shapes while immersed in the Virtual Environment.

Nowadays, the deployment of virtual expositions of high quality 3D models is a common practice in several cultural initiatives, not only in physical museums but also over the World Wide Web. However, the web experience, due to technological limitations, is often built only around visual aspects of virtual exhibitions: very little has been explored about the potential benefits that the sense of touch might introduce in the web interaction paradigm.



3 Haptic interaction with the Web

Recently, a substantial decrease in price and availability of portable haptic interfaces has allowed a fair diffusion of these devices, and recent advances in hardware and software technologies have opened new and exciting opportunities for the creation of haptic enabled multimodal web systems

PERCRO, in the framework of the Museum of Pure Form, has developed a Web site [10] (hosted at <http://www.pureform.org>) using advanced 3D technologies where all the digitized sculptures are accessible in a single, unified virtual exposition, in which haptic interaction has been enabled as well (Fig. 3).

The Museum of Pure Form has thus become a distributed installation that enables users in scattered locations around the world to experience haptic exploration of digital sculptures, giving the hint of a future moving towards technological and sensorial connectivity.

References

- [1] The Two Cultures, C.P. Snow, 1959 Rede lecture

- [2] O. Grau, *Virtual Art, From Illusion to Immersion*, 2003, M.I.T. Press
- [3] E. Couchot, N. Hillaire, *L'art numérique*, Flammarion, Paris, 2003
- [4] M. McLuhan, *Understanding Media: the Extension of Man*, McGraw-Hill, New York, NY, 1964
- [5] Frisoli A., Carrozzino M., Marcheschi S., Salsedo F., Bergamasco M., "Haptic systems for simulation of primary commands of cars", *Research in Interactive Design Proceedings of Virtual Concept 2005*, Fischer, Xavier; Coutellier, Daniel (Eds.), 2006, XV, 121 p., Softcove, ISBN: 2-287-28772-8
- [6] Avizzano C. A., Marcheschi S., Angerilli M., Fontana M., Bergamasco M., "A Multi-Finger Haptic Interface for Visually Impaired People", *Proceedings of the IEEE International Workshop on Robot and Human Interactive Communication*, 2003, Millbrae, California, USA
- [7] [http:// www.enactivenetwork.org](http://www.enactivenetwork.org)
- [8] [http:// www.skills-ip.eu](http://www.skills-ip.eu)
- [9] Bergamasco M., Frisoli A., Barbagli F., "The Museum of Pure Form", *Proc. of ICAR 2003*, Coimbra-Portugal.
- [10] Tecchia F., Carrozzino M., Ruffaldi E., Frisoli A., Bergamasco M., *Multimodal Interaction For The Web*, *Proceedings of Museums and the Web 2007*