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Original article

Virtually preserving the intangible heritage of artistic handicraft

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ABSTRACT

Artistic handicraft is considered to all intents and purposes an important part of Cultural Heritage. The idea of creating a multimedia platform to communicate the tradition of artistic handicraft in Lucchesia (Tuscany, Italy) was born in order to preserve the memory of activities which have contributed in defining this region in terms of history, culture, peculiarity and quality of its products. The town of Pietrasanta, in particular, is well renowned for its artisans, who have been handing down ancient practices for ages, especially in the workmanship of marble and bronze. Our project aims at the valorisation and the communication of the bronze "investment casting" ancient technique through a 3D virtual interactive platform. This platform offers therefore a contribution to preserve this heritage and its memory, by means of a virtual experience inside the processes and the places where bronze sculptures are made. Users can follow from the beginning how such an artwork is created, dwelling on each step of the creation process and analyzing in details its main points.

1. Research aims

Virtual Environments give the opportunity of immersively accessing information embedding the concept of interaction; the use of these new technological means in museums and, generally, in the cultural context, offers novel, appealing and effective ways of accessing cultural heritage.

Our research aims to offer a new resource to preserve and communicate the memory of an intangible cultural heritage like that of artistic handicraft, by setting up an educational virtual environment platform meant for promoting and safeguarding this traditional knowledge, and intended to be expanded in the future into a comprehensive information repository enabling the capture, memory and transmission of artisan processes, more and more at the risk of being lost as time passes by.

Another objective was to evaluate the efficacy of such a form of communication, by analyzing a group of users in their interactive use of the platform in order to receive useful suggestions and retrieve good practices to better tune the design and development of such systems.

2. Introduction

"The death of Artistic Handicraft makes no sound: it is like a wood falling down tree after tree, master after master, workshop after workshop, since more than twenty years. But if we simultaneously listen to the sound of each worker lost, of each fallen tree in this wood, we would realize the roar and the desert of experience created around us. When a workshop closes an entire library disappears, because the master's activity summarizes itself in a year-stratified experience, through a work that involves all the senses." These words [1] comment on Venice situation, although they can unquestionably be extended to the whole European territory, and even further. A deep economical/political analysis would be needed to carefully examine the causes that are determining such a drastic reduction of the handicraft activities. Due to its specific nature, the handicraft process tends to remain isolated in its own workshop entrusting its survival to the passage of knowledge from artisan to artisan. This important artistic process which concentrates the ability of masters and the history of the territory, and, therefore, is indeed a complete cultural asset, runs the risk to be lost in a very few decades.

Knowledge and skills passed through the ages are likely to seem obsolete in a world where information spreads quickly, globally and often superficially, considering also the wide diffusion of technologies that get us used to the homologation and the simplification of processes in the everyday life. Indeed, the latest years have seen a growth of events and projects aiming at the safeguard and the promotion of handicraft tradition, strong signals of a lively attention towards a world whose value is increasing proportionally to its risk

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of going lost. In this sense new technologies are, on the other side, becoming a precious tool for the valorisation of this knowledge, providing appealing and novel approaches to its preservation.

3. Materials

3.1. Manual skills and new technologies

Today's constantly evolving technology and the growing need for information has led to a proliferation of data and knowledge now available in the digital domain. Nevertheless, there are certain types of knowledge that are difficult to digitize; manual skills, for example, are difficult for individuals to acquire and, typically, are easily lost. Indeed, since the Industrial Revolution, entire categories of manual skills have been supplanted by industrial processes or have been lost due to the disappearance of skilled artisans. As manual learning requires a significant investment of time from both students and teachers devoted to hands-on study and practice, there are few technological means for preserving this knowledge. Consequently, the products and processes of such craftsmanship are in jeopardy of being lost. This would be a significant loss for the cultural patrimony, as not only are these crafts an important means of artistic expression, but they represent the foundations of our cultural heritage and a significant aspect of humanity at large.

Virtual Reality (VR) and haptic devices are already used to help in teaching complicated skills such as surgery or piloting, and are becoming more and more used in other sectors, such as rehabilitation, training and so on. These new technologies can help in storing, coding, analyzing and transferring data related to manual skills and related abilities [2], in order to digitally preserve this heritage and to set up powerful teaching tools exploiting the learning-by-doing approach. In this respect, an interesting project has been realized from the Department of Management Information Systems, Central Taiwan University of Science and Technology of Taichung [3]. The main aim was "to preserve ancestor's wisdom in addition to artefacts". The system constructs a digital library for folklore preservation and provides instructional interactive materials to support educational methodologies more appealing than non-interactive or traditional classroom learning.

Interaction appears to be the key; in [4] the social effects of the digital revolution are investigated, concluding that people (especially youngsters) like and expect not only to passively stand on, but assume that media includes consuming, producing and sharing. Even the minimum level of involvement and interaction transforms spectators in users.

The process that introduces new paradigms of accessing cultural heritage is one-way: close to the traditional recover and safeguard function, it is now needed to put side by side a new form of cultural transmission, open to new relations with the public and the territory; the contribution of new technologies involves not only modifying the praxis but rather a global careful rethink [5,6].

4. Methodologies

4.1. System overview

The aim of our research was to explore the resources of Tuscany related to the artistic handicraft as a new branch of content of the Virtual Museum of Sculpture (VMS), an existing virtual platform [7] enabling users to interact with an archive of digitized artwork in correlation with the artistic town of Pietrasanta for historical and cultural reasons.

This expansion of the VMS has brought us into the artistic foundries of Pietrasanta, a town counting a long artistic tradition known and appreciated at international level not only for its natural resources, such as precious marbles, but also for human resources, i.e. extremely talented craftsmen. Pietrasanta is rich of handicraft workshops where marble and bronze are still processed according to long and ancient processes. In our project, we dealt with bronze sculptures, still often realized using the "lost wax" (or "investment casting") technique. This special technique is one of the most remote and complex ones: it consists of several steps which have remained almost unchanged through the ages. It can be summarized imagining a process where the sculpture gets prepared by alternating phases of positive/negative (i.e. solid/hollow) till the final result is reached.

Fig. 1. An artisan at work.

The project consisted of two fundamental parts. The first one involved documenting the whole process of creation of a statue (a sculpture of San Francesco), followed step by step in a local foundry, in order to have a real contact with local artisans (Fig. 1) and to acquire original material. The second part was related to the implementation of a virtual environment offering different levels of interaction and providing users the opportunity to decide, at each step, which content to examine in depth. Our aim was to create a platform centred not only on technological features but also including an original content, developed by an expert and able to arouse interest and inform people about such a peculiar, still alive handicraft and therefore offer a faithful cross-section of this reality. Although the presented content is strongly bound to the specific activities of this type of handicraft and, in particular, to the peculiarities of the place, the structure of the platform is easily adaptable to other types of similar thematic.

We finally asked a group of people of different age, sex, education, and background to test our system, so as to have a feedback as complete as possible about the quality of the developed platform.

4.2. Storyboard

In the same fashion as the bronze handicraft workflow, which is subdivided in various phases, the application consists of five stages each set in a different 3D virtual environment evocative, with its materials and tools, of the place where the work is performed. Each phase is introduced by a short video clip explaining how the artwork is processed and which operations are performed in it. The subdivision of the working phases, and consequently of the virtual stages (Fig. 2), has been chosen in order to replicate the typical alternation of negative and positive copies of the original.

Fig. 2. Some of the stages of the Virtual Environment.

The navigation begins with an introductory phase where the investment casting is historically and artistically contextualized, giving the user the possibility to familiarize with the topic and the virtual environment. After this "passive" introduction, the 3D environment becomes interactive and users are allowed to select some hotspots triggering various events, like the visualization of documents, the activation of other interactive sections and so on.

The different interactive environments are therefore virtual rooms, each representing and explaining a corresponding phase of the sculpture creation, which the user can move through selecting particular sensitive areas. These areas triggers informative material like text, graphics or movies either related to historical or technical aspects, plus an "exit" (a door, a sign or other similar well recognizable elements) to the next stage. The progression among the stages is therefore linear, allowing users to follow the entire creation process with a guided exploration approach using an interaction kept very simple, so as to let people not experienced with VR to quickly get used in the experience.

An interesting point is that the virtual environment is not only itself a source of information – by means of its 3D components which, reproducing real elements of the working environments, have a per se significant meaning in the context – but also a container of information of other types. Indeed, explanatory movies, recorded during our tour in local foundries, are shown embedded in the 3D context (Fig. 3), as if each component of the 3D environment (like curtains, walls, easels) might act as a projection surface.

With this approach, users do not have to perceptually switch context when accessing 2D or 3D information, and the overall sense of immersion in the virtual environment is therefore greatly improved.

4.3. Implementation

The platform was realized making use of the XVR [8] technology, a self-developed general-purpose framework for VR development organized around a dedicated scripting language – giving developers a means to deal with 3D animation, positional sounds effect, audio/video streaming and user interaction – and a virtual machine, able to accommodate a wide range of applications. Although compiled languages like C or C++ usually offer superior run-time performances, the XVR virtual machine offer some real-life advantages like a dedicated language syntax and constructs and a very fine control over the run-time permissions, allowing to run compiled byte code in a safe and controlled environment and to deploy them in contexts where security is a major concern, i.e. web browsers, with minor or negligible performance penalties in most of the cases. XVR is easily extendable through external modules made available by means of C/C++ DLLs. Although currently XVR runs only on Windows® platforms, its implementation as a VM permits an easier portability to other platforms, such as Linux® and MacOS®, whose support is planned for the future.

The system runs either on a typical desktop setup or on an immersive L-shaped system, which is a room-sized cube where the front wall and the floor surfaces serve as projection screens for digital stereo images. In the latter case, the interaction is driven by the Wii Remote® controller by Nintendo®, but still remains a simple point-and-click (Fig. 4) interface in order to be quickly usable by all kind of users. The use of XVR makes it possible to rapidly implement a web version of the application, as XVR contents can be easily embedded into HTML pages by means of an ActiveX Control container.

Fig. 3. A movie embedded in the 3D context.

Fig. 5. The final bronze sculpture.

The application has been developed as a state machine where each phase corresponds to a state. All the logic of the interactive section is managed only when an input occurs. In order to provide additional functionalities to XVR, we have developed dedicated modules (integrated into a single package, named XVR Powerpack) dealing with embedding audio-video textures into the 3D environment (based on the ffMPEG open-source library and using a multi-thread solution to achieve the audio-video synchronization), with the management of the Wiimote controller (based on the Wiiuse open-source library), and with an efficient use of materials and shaders through a dedicated Scene Manager. The first two libraries have been developed in C++ and imported in XVR as external modules, while the Scene Manager has been realized directly using the XVR scripting language. The Scene Manager is based on nodes (cameras, renderable objects, lights, etc.) which can be linked to controllers (objects which can change attributes of controlled objects). For instance, the class AnimationController is a specialized controller that change the value of an attribute (for instance position, orientation etc.) based on key frames. A controller can also receive user inputs, for instance in order to move camera or objects with input devices. In the state machine, a state manager is in charge of appropriately dealing with events and managing transitions. Events are triggered:

Fig. 4. Selecting and querying the Virtual Environment elements.

- when a state starts; usually implies loading resources like geometry meshes, textures, audio, video, etc.;
- when a state ends, to clean the scene manager and leave in only the data needed for the next state, for instance common objects shared over the virtual rooms;
- when a frame is rendered, mainly to check if a movie in execution is ended;
- when an input is received; it is obviously the main event to manage interaction, as it allows to check if an object has been selected, etc.;
- when a timer expires, typically to manage actions that need to be executed at a greater frequency than the frame rate (typical tasks needing this timing, like collision detection or physics, are not addressed in this implementation, but they are possibly expected to be used in next implementations making use of Haptics).

As far as the realization of the VE is concerned, rooms, tools and other components of the environments have been manually modelled using photos and videos of original artisan workshops as reference. The models have been created with a low polygonal budget, preferring to add details on textures rather than on polygons. Illumination data and light maps have been generated using Turtle®, an Autodesk Maya® rendering engine specialized on baking lighting data.

The San Francesco sculpture is a low poly (about 50K triangles) version of the hi-res model (about 1 M triangles) obtained by a laser scan of the original plaster. Normal mapping has been used to recover the original visual detail of the statue. For the final version of the sculpture, a Cook-Torrance [9] shader has been used to achieve a realistic bronze shading (Fig. 5). The rooms 3D models are generally mapped with simple diffuse textures plus light maps, although some components use shaders whenever a more realistic lighting was deemed important.

4.4. Evaluation and discussion

The platform has been tested by a group of 13 volunteers, although more extensive test sessions have been planned when the system will be open to the public. We asked male (46%) and female subjects (54%) from three age groups (15–18: 31%, 18–27: 23%, 27–40: 46%), with different education (23% primary, 17% secondary, 53% master degree, 7% Ph.D.) and background (53% mainly humanistic, 47% mainly scientific/technological) to use the platform through all the stages (mainly on the desktop setup, although

Fig. 6. Test users interacting with the desktop setup (a) and with the immersive setup (b).

for each user one of the stages was experienced in the immersive setup), to answer to an evaluation questionnaire (specifying their agreement to a statement on a 5-point Likert scale) and to have a short interview (Fig. 6).

The overall evaluation was quite positive, with an average of 3.92 related to the satisfaction for the provided content, 4.07 for the possibility of interacting, and 4 for the overall appreciation. As for usability, the statement "Exploring the VE was natural and intuitive" had an average of 3.92. As far as learning is concerned, "This experience has made me learn something new" had an agreement rating of 3.61, while "This experience stimulated curiosity about the topic" received an average of 3.76. The statement "Immersion improved my involvement in the experience" was agreed with a rate of 3.46, a bit less than expected, although the "young" group (15–18) has given significantly higher agreements.

As for personal impressions, almost everybody appreciated the fact that "traditional" contents like 2D movies have been embedded in the 3D environment: many of them pointed out that the same contents, presented in a more classical way (like a traditional audio-video documentary film) would have been definitely less appealing. Many users appreciated the fact that each stage provides a minimum amount of "compulsory" information, and then users are free to explore the virtual environment and choose the content they want to deepen. This allows users to customize their own experience. One subject, for instance, since the beginning asserted she was not interested in historical facts and wanted to examine only the technical material.

One of the reasons why the immersive setup received slightly less enthusiasm than we expected is probably due (as some of the subjects pointed out) to the fact that, once in an immersive environment, they would expect to more freely move and act. Some of them suggested improvements, like adding a time-bar to the movies, so that users may have a precise idea of the "commitment" required by each document and be able to skip it, if desired.

Many observed that interaction helped them in keeping concentration on content, and that the opportunity of moving around inside virtual environments faithfully reproducing real working environments helped them to better understand the context.

5. Conclusions and future work

Pietrasanta is definitely an excellent example of local realities rich of a kind of knowledge at risk to decline, a type of art considered as "minor", and therefore neglected, that indeed needs to be preserved and promoted, even exploiting new communication means.

We believe it is necessary to support these extraordinary cultural and historic resources with studies and innovative applications, as the one we have hereby presented, in the strong belief that a continue renewal is the best way of preservation.

Three major updates are possible for the multimedia platform of the Artistic Handicraft of Lucchesia in the context of the VMS. The first one is related to expanding the content base adding chapters related to other forms of typical local handicraft, the most notable example being the marble craftsmanship. The second upgrade consists in extending the fruition of the platform also on the Internet, which will be easily possible thanks to the native web capabilities of the XVR technology.

The third one regards the expansion in "depth" of the content, including also data relevant to the performance of artisans and to their manual skills. This expansion could exploit the results obtained in the SKILLS EU project (http://www.skills-ip.eu) which addresses the research on skills analysis and transfer in a complete organic approach. The vision is to gather data relevant to the execution and learning of manual skills related to specific varieties of craftsmanship in order to build up an information repository enabling the capture, memory and transmission of kinaesthetic artisan processes. This base of data is meant to be used also to realize tools that, using a participatory approach, could be applied both in teaching and training at vocational schools.

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