THE RECONSTRUCTION OF THE ARCHAEOLOGICAL LANDASCAPE THROUGH VIRTUAL REALITY APPLICATIONS: A DISCUSSION ABOUT METHODOLOGY

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ABSTRACT:

The virtual reconstruction of the archaeological landscape is a very complex process including in a virtual ecosystem many kinds of data, activities, according to a multidisciplinary approach.
This system of relations, interactions and behaviors assumes perceptive, cultural, psychological and relevance.
The virtual environment and archaeological structures, as they are today, can be reconstructed through different techniques and data sources, integrated in a coherent methodology of elaboration and communication: cartographic data, remote sensing, photo-interpretation, topographic survey, laser scanner data, photogrammetry, photomodelling, computer vision and so on.
Each technique is selected according to the kind of structures and information we need and is intimately connected to the typology and the particularities of the entities to examine.

1. INTRUDUCTION

The archaeological landscape, as we can observe today, is the result of a long process of transformation and it is very important to create diachronic relations describing as the territory and the sites have changed during the time, to propose a correct interpretation of the cultural context.
The bottom up approach needs to be integrated by the top down process: the critical study of bibliographic references, typological comparisons with similar and historical buildings, iconographic sources, analysis of fragments, decorative patterns, collapsed areas and so on. In this way we can be able to interpretate function, aspects, uses, habitual visiting of structures and places and propose a reconstruction, more or less reliable but always supported by a scientific approach.
Another very important aspect is the multiplication of levels of detail, from an holistic to a monographic vision, in order to extract from territory different scales of detail.

2. METHODS AND RESULTS

The Vhlab is working on different projects such as the reconstruction of the archaeological landscape of the ancient Via Appia and Via Flaminia, using methodological conclusions for the creation of a virtual reality system based on a unique model of high accuracy and detailed data, that is an example of integration of spatial data, different technologies and methodologies.
Our discussion about methodology will sometimes refer to some study-cases to explain clearly some general concepts and our approach on virtual reality and cultural heritage.

Figure 1. Flaminia project: Villa of Livia, VR application

The aim of the Via Flaminia project is the construction of a digital environment, oriented towards a real time application, that individualizes two levels of perception.
In the first one we have an holistic vision of the entire road from Rome to Rimini, based on maps, archeological and technical cartography, aerial and satellite photos, to realize a web gis. In the second one, we can have a micro-space vision that focuses the attention on four sites. This local entities are Grottarossa, Ponte Milvio, Malborghetto-Tor di Quinto and Villa of Livia.

The case of the Villa of Livia, due to the complexity of the architectonic system, the insufficient and partial credibility of the planimetry in public archives and the scarce information caused by incomplete excavations, has made use of advanced technology of the laser scanner to obtain 3d relieves with a resolution of 6mm. This technology represents an enormous potential of publishable, up-to-date, available and, above all, georeferenceble information, fundamental for an archaeological

contextualized knowledge of the territory and in a position to transmit a strong evocative and communicative component.
The acquisition of 3D data with the laser scanner generates a high resolution model with questionable and exact data, with generated and interpolated faces.

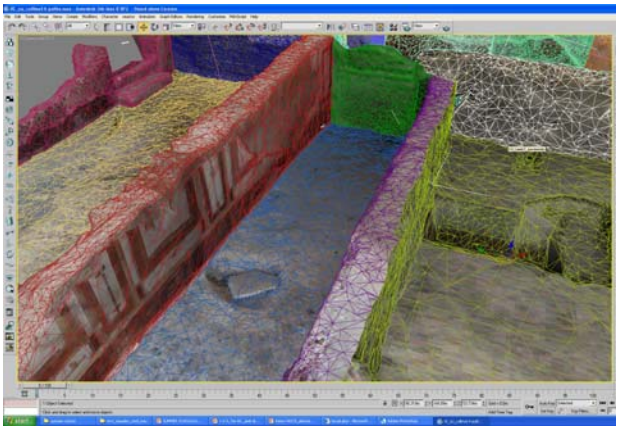

Figure 2. Flaminia project: Villa of Livia. Rooms modelled with RapidForm and textured with 3ds Max

The same technique is used to detect both the architectonic compound of the Villa of Livia and the hill on which it exists.
The acquired and elaborate models are further optimized within other three and bidimensional graphic softwares (3D Studio Max, Photoshop CS2), used for texturing, decimation and the improvement of the graphical quality of the rendering (techniques of multires, normal maps, UVWrap, render to textures).

In other case, for examples **Malborghetto,** we are in presence of a monument with a very regular geometry, moreover there are no relevant obstacles to an all-around photographic relief, so the choice was to employ the photomodelling technique.

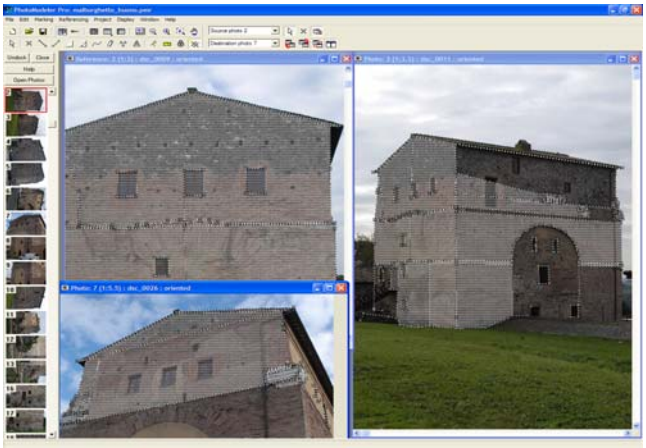

Figure 3. Flaminia project: Malborghetto. Photomodelling is the technique to survey place

Photomodelling is a technique that extracts measurements and 3D models from photographs.
The acquired pictures are imported into a specific software in which it is possible to correct the perspective distortion of the lens of the camera through specific functions of calibration.
PhotoModeler combines the photographs and locates the marked features in three dimensions.
The final result is a 3D model textured, scaled and spatially correct, that can be transferred to any 3d modelling or CAD program.

3. INSTRUMENTS OF COMMUNICATION

The reconstruction of the archaeological landscape should not limit to the representation of an empty space: space has to become “place”. The main aim of virtual reality is the creation of a digital virtual ecosystem to integrate geographical, topographical, perceptive, historical interpretative, narrative and symbolic data. According to us the virtual is not a “reproduction” of the real, but an enhancement of the real: it gives us the possibility to represent and simulate what is hidden, imaginary, abstract, far, in other words it allows to join perception and interpretation.
All the contents and metadata are connected to 3D models, as affordances, cultural relations that the contexts and its elements can develop. Every objects, rooms and so on have relations of contents, such as Space, Time, Use, Type, Similarity. The user can interact with the model also de-constructing it, activating its affordances.

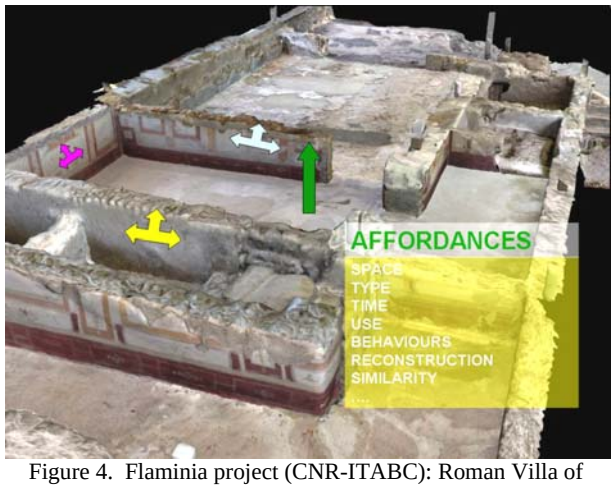

Figure 4. Flaminia project (CNR-ITABC): Roman Villa of Livia, Rome. Here is a schematic representation of the cybermappa.

The final aim of each archaeological research and should to understand how was the mind of ancient people, their behaviors, values, activities, the way they lived in the territory.
Also virtual reality system in the field of cultural heritage should develop in this direction, not limiting the exploration to the perception of space, but establishing behaviors, relations among different levels of contents.
For this reason we think that also the introduction of avatars and characters can be usefully to perceive, understand, simulate, story tell.

In the Virtual Reality the “avatar” is a virtual character controlled by the user with the specific aim of identifying a person inside a virtual world. The term *avatar* comes originally from the Hindu religion, and literally means the incarnation of a higher being (deva) or the Supreme Being (God) in the world.
The avatars in Virtual Reality can be considered powerful

instruments of communication. For instance, the avatars can be used to explore a virtual area; they can be employed as tools to give information (otherwise difficult to communicate) to the users, or to simulate actions; avatars are able to use instruments, to speak a lot of languages and to share data. Basically, the avatar is the projection in the 3D space of every single person.

3.1 THE AVATAR

Different approaches can be used to realize an avatar, in order to find the best and fastest way to build it.
One of the main problems in the avatar creation process is represented by the low number of polygons that has to be spent for each virtual character. In fact, due to the limits (in term of visualization) of the virtual reality systems, it is necessary to adopt very restricted parameters to describe and animate the models which compose the virtual world.

Figure 5. This image shows the avatar after the application of the texture

In order to establish the best pipeline of work, it is necessary to try to use different techniques of modelling and acquisition of the data. Generally we use traditional techniques of modelling to construct the 3D characters, employing, where necessary, technologies like laser scanner, or computer vision – in order to improve the details. In fact, many times we realized the clothes or the faces of the avatars directly from real models of statues. Unfortunately after the mesh optimization process, we usually lost all the details described by the laser or by the computer vision. For this reason, for each model we often create the "normal maps", interpolating the mesh information of the high resolution model with the optimized model.

Normal bump mapping is a way of adding high-resolution details to low-polygon objects. It is especially useful for real-time visualization devices such as game engines, and it can also be used in rendered scenes and animations.
Unlike the greyscale maps used for regular bump mapping, a normal map is a RGB colour map; the red channel encodes the left-right axis of normal orientation, the green channel encodes the up-down axis of normal orientation, and the blue channel encodes vertical depth. Trough these maps we improved the detail models until obtaining a good visualization of the characters.

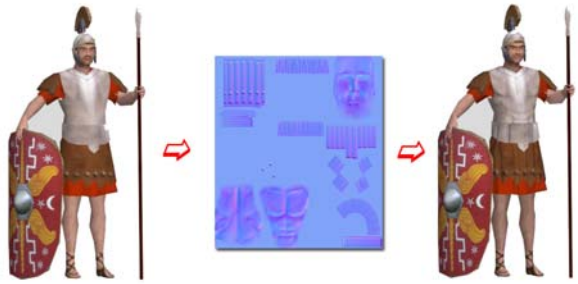

Figure 6. This image shows the avatar after the application of the normal map

After the creation of the character it is necessary to follow a specific pipeline to create its animation. Animate a character for the Virtual Reality is very complex, because the actions of the avatars are influenced by the behaviour of the users. To make possible the interaction "users-system", its is necessary to prepare a sequence of independent and cyclical movements for each character; in this way the system can manage the animations, following the different interactions which the users decide to make.

It is absolutely necessary to follow rigid rules in order to merge correctly an animated model in the virtual reality engine. Moreover, there is another problem connected to the movement of the virtual character: the properties of the clothes and bodies are difficult to describe during the animation due to the low number of mesh polygons. For this reason is necessary to create more polygons in the parts where the avatar moves more: for example, the elbows, the knees and the shoulders.

A good compromise between a low polygon model and a good level of animation can be achieved using some strategies: normal maps, not accidental dispositions of the polygons, good textures. Moreover, we can obtain soft movements very close to the reality using animation files realized trough motion capture systems.

3.2 THE VIRTUAL REALITY SISTEM

The application, in the example of Via Flaminia project, is based on very innovative methodological approaches in the field of digital virtual heritage:

- the storytelling
- the multi-user domain.

The first develops narrative techniques and metaphoras, through virtual characters, avatars, "speaking" objects, and sometimes game dynamics and rules. The aim of storytelling is to make the space "alive" an to communicate cultural themes.
The multi-user domain allows many users to interact in the same time in the virtual environment, recognizing each other and developing shared purposes and joined actions.

Another important issue for us is "transparency": 3D models, reconstruction of the actual and of the ancient landscape have to declare the methodology and the type of data from which they

have been obtained, so to allow the discussion, the critical awareness of the public and therefore their cultural impact.

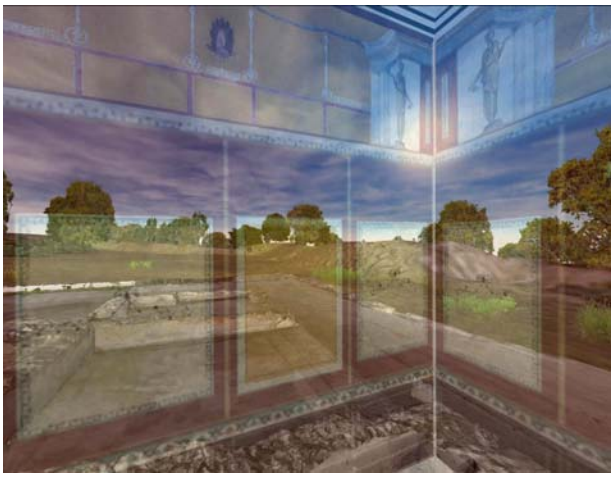

Figure 7. Flaminia project: Villa of Livia, VR application

4. CONCLUSIONS

Only in these conditions we have just described we can communicate the “sense of place” and obtained an impressive cultural result. The virtual environment should be alive, a space we can experience, interpretate, change, transform through our behaviors and personal cognitive approach.

The main aim of the virtual reality application is the creation of a digital virtual ecosystem to integrate geographical, topographical, perceptive, historical interpretative, narrative and symbolic data. All this contents and metadata have been connected to 3D models, as affordances, cultural relations that the contexts and its elements can develop.
We think that this metodology offers many advantages.
First of all it speeds up the time of fruition because the exploration and the interaction are collective: everything discovered by one user is avalaible and usefull for all the public. This is very important for us, also in consideration of the large amount of informations we would like to transmit in a quite limited time.
Secondly it enforces a conception of virtual reality that is particularly efficacious inside museum's context.
The innovation consists also in the integration of many media and metaphors of fruition: virtual reality (creativity and personalization of choices and interaction), game-rules (discovery and award dynamics), storytelling and cinema (real time movies performed by all users' interaction on the large screen), enhancement of 3D perception (stereoscopic vision).

In its traditional applications on and off-line, virtual reality, in the field of cultural heritage, creates quite exclusive relationship between the user and the rules that regulate the exploration. Fruition, interaction, comprehension of the dynamics and behaviours are individual experiences.
On the other side the main mission of museums should be the promotion of collective and shared communication of cultural contents.
This project is an attempt to match this kind of needs: according to us virtual reality systems, virtual storytelling and multi-user domain, combined in an integrated methodological approach, can offer very efficacious and innovative solutions to generate a strong educational impact and involve the public in a collective fruitions of cultural contents that, in the same time, allows to follow personal interests and to personalize cognitive processes.

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