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M. Dellepiane, F. Niccolucci, S. Pena Serna, H. Rushmeier, and L. Van Gool (Editors)

The Petit Trianon in Versailles : The virtual, an historic reality

Noémie Renaudin[1], Bertrand Rondot[2] and Livio De Luca[1]

[1]UMR CNRS/MCC 694 MAP-Gamsau ENSA-Marseille, France
[2]Etablissement Public du musée et du domaine national de Versailles, France

Abstract

It is difficult to grasp the complex history of the successive changes made to the furnishings and to the layout of the Petit Trianon. Our ongoing project addresses this challenge. Based on 3D digitizing, high photorealistic rendering, real-time visualization and spatio-temporal data structuring, our approach provides more than a straightforward 3D model of the rooms : it ensures that the content of the rooms is not fixed in its existing state, but enhanced based on additional perspectives. The refurnished virtual rooms are paradoxically more realistic. They are free from the limitations imposed by visitor traffic and security, and presented not in their current fragmentary state, but as a complete whole. Our data structuring method also enables to explore the successive changes to the furnishings over time (integrating furnitures conserved today in different Museums in the world), providing a dynamic vision of these spaces.

Categories and Subject Descriptors (according to ACM CCS): I.3.3 [Computer Graphics]: Picture/Image Generation—Line and curve generation

1. Introduction

How to discover the richness and complexity of a place, its various successive developments related to its history, beyond its present aspect that can only give a partial and often distorted vision? Which visitor did not ask himself that question by visiting the Petit Trianon, whose name remains associated with the personality of Queen Marie-Antoinette, who made it a symbolic place of refinement of the Old Regime, but whose History reveals other characters and other tastes?

The Petit Trianon, inaugurated by Louis XV and Madame Du Barry in 1768, was given by Louis XVI to Marie Antoinette in 1774, who made it her favorite place. The Queen first devoted herself to landscaping, and then in the 1780s began the renewal of furniture parts. Emptied during the Revolution, the castle was finally taken over by Napoleon the First in 1805 to house his sister Pauline Borghese. But it's for the Empress Marie-Louise, married in 1810, that the major part of new pieces of furniture was provided. During the Restoration, the place remained uninhabited. After the end of it, the furniture supplied under the Empire was completed in the new romantic taste. The fall of the July Monarchy in 1848 led to the abandonment of the Petit Trianon as a residence and it was during the Second Empire that the Empress Eugenie installed there, in 1867, a museum dedicated to the tutelary figure of the place, Queen Marie Antoinette.

This complex history is difficult to grasp by the public. The current presentation focuses on the time of Marie Antoinette on the first floor and mentions the succession of its various occupants at upstairs attic.Thanks to the 3D digital representation, the castle can be refurnished with great accuracy and in accordance with successive historical statements. The virtual tours of furnished rooms allow discovering the different tastes of its occupants at various times.

2. The approach

This modeling can not be just a simple transposition into 3D views of rooms. The digital representation allows not freezing this content to collections actually visible on site, but to enrich it further along complementary axes:

- A virtual refurnishing paradoxically more realistic: the furniture find their natural location and the virtual visitor can move freely in these spaces, without the constraint of flow passages reserved for groups and safety regulations. Moreover, when certain elements of a set, such as chairs, can not be found, set of elements can be restore completly

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by duplicating the original 3D model of the retained element.

- A group of furniture scattered around the world: some furniture and objects are now preserved in various museums abroad. If it is not possible to bring them back - except for a flat desk made for Louis XVI and filed by J. Paul Getty Museum in Los Angeles - it is possible to digitalize them and virtually replace them in the room for which they were conceived. For example, a mechanical table stored in Waddesdon Manor (Great Britain), had been among the first furniture's orders by Marie-Antoinette for the Petit Trianon; with the 3D digital representation, its return is virtually possible.
- Furniture returned in their entirety: modified furniture can be returned in their original state from the modeling of several scattered elements. This is the case of a table with sliding top, belonging to Marie-Antoinette, whose top only is preserved (Victoria & Albert Museum) and whose base type is known from other copies.

The digital representation must also enable to deal with the chronology of successive furnishings in a dynamic vision of spaces. Thus the bedroom of Queen Marie-Antoinette - originally used by Madame Du Barry - was then occupied by Pauline Borghese, then the Empress Marie-Louise and finally the Duchess of Orleans. Some furniture was retained from one period to another, other replaced with more modern furniture. The visitor may view, online, successive furnishings, according to chosen chronological marks, corresponding to different inventories:

- **A state in 1780**, after the first orders placed by Marie Antoinette before the full refurnishing her apartment in 1787-1788;
- **In 1811**, corresponding to the inventory drawn up by the Empress Marie-Louise in 1810, completed the following year;
- **In 1839**, corresponding to the inventory drawn up by the Duchess of Orleans.

The virtual tour is coupled with an interactive database. Not only the technical and historical information on each piece of furniture and objects are presented, but also a "virtual grip" of every element is possible, which allows to manipulate the object in space, and thus to discover their secrets (webbing seats marked with their inventory numbers, built furniture ...).

3. 3D reconstruction

This project is based on the integration of techniques of digitizing, geometric reconstruction and three-dimensional visualization [DVF06].

3.1. 3D digitizing of rooms

The interior spaces of rooms are digitized using a 3D phase-shift laser that can acquire up to 100,000 coordinates per second. Point clouds resulting from this acquisition are assembled to make a precise geometric model of existing spaces (Fig.1). In addition, a high-definition photography campaign has been led to record the visual appearance of surfaces. The 3D reconstruction of the rooms is based on an interactive geometrical modeling starting from relevant profils extracted from the point cloud [DVF06]. The linking of the geometric model of spaces with all the photographs allows restituting the visual appearance of surfaces by projecting textures taken directly from these photographs (oriented on the 3D model by resection).

Figure 1: *Point cloud obtained by laser scanning*

3.2. 3D digitizing of furniture

Apart from surveying the architectural volumes, the project concerns the digitalization of pictorial pieces and furniture which are now preserved in different places. The geometry and texture of 91 elements, in France and in the United Kingdom have been actually acquired. Other campaigns are being organized in the United States. The 3D digitizing has been performed with a triangulation laser witch acquires shapes which millimetric precision and a high definition camera. Different 3D reconstruction techniques (automatic meshing, image-based modeling, reconstruction by parametric surfaces, etc...) are implemented according to the morphological complexity of the object and to the nature of its materials.

3.2.1. Laser-based modeling

In the case of restitution of sculpted objects such as busts, point clouds were automatically obtained by commun meshing algorithms [Lev99]. Meshes of resulting models contained between 100,000 and 400,000 polygons, providing a very accurate reproduction of the complex geometry of the object. In order to enhance the visual aspect of the objects, an "ambient occlusion" rendering has been realised and its result has been assigned to each vertex of the mesh (Fig.2).

3.2.2. Image-based modeling

The 3D reconstruction by image-based modeling is perfectly applicable to most objects with a more 'simple' geometric structure [DTM96]. This modeling system is used to extract the 3D geometry of the object based on the determination

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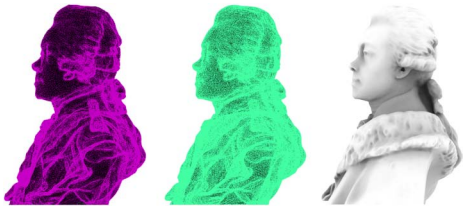

Figure 2: *Visual levels (point cloud, geometry, ambient occlusion render)*

of matching points between the different pictures of this object. The links established between photos during the calibration phase allow extracting textures from one or more images that are then projected onto the model to reproduce the visual appearance of the object. Using image-based modeling provides 3D models with geometric structure adapted to the multimedia broadcasting but also responding to the requirements of visual rendering and extraction of dimensional information (Fig.3).

Figure 3: *Example of reconstruction by image-based modeling*

3.2.3. Hybrid (laser/image) modeling

Some kinds of objects, because of their complex geometrical structure, require a combination of treatments. In this case it is necessary to separate the different parts of the object based on their structure and their materials so they can be treated independently. The structure of the object is processed by photomodeling or interactive modeling starting from relevant profils and 3D coordinates, while the laser-based modeling is used for the sculpted part, on which is applied a material in order to restitute its visual appearance (Fig.4).

This project was an opportunity to assess the relevance of

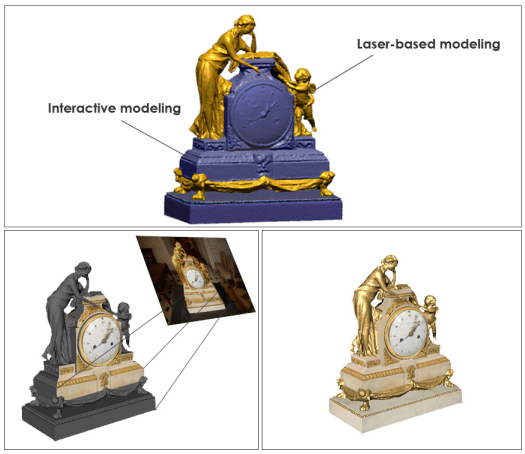

Figure 4: *Hybrid reconstruction by interactive modeling and laser-based modeling*

the most appropriated reconstruction methods according to the heterogeneity of the objects treated (Fig.5).

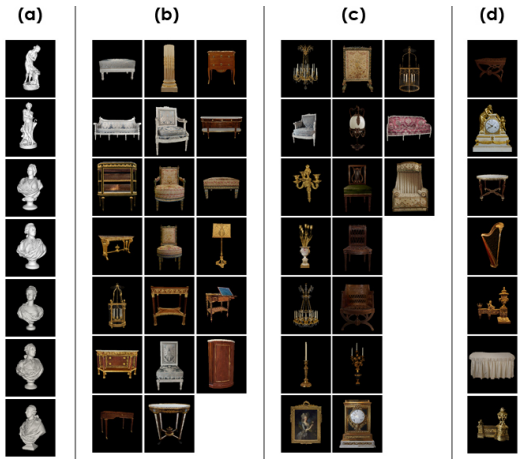

Figure 5: *Distribution of objects based on 3D reconstruction methods: a.Laser-based modeling, b.Image-based modeling, c.Interactive modeling, d.Hybrid modeling*

4. 3D database

All acquired information and data developed during surveying campaign and geometric reconstruction are structured and stored in a 3D database developed under the project NUBES (http://www.map.archi.fr/nubes). A database, developed in MySQL, retains the raw surveying data (point clouds, photographs, etc...), data processing (geometry, textures, etc..) and optimized files for 3D visualization in real time. An interactive 3D scene, developed in Virtools DEV, allows the visualization and the han-

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dling of 3D representations (Fig.6). The data of the digital representation of each element is associated with documentary information in connection with the management software of the collections of the Palace of Versailles TMS (The Museum System) [DBS*11].

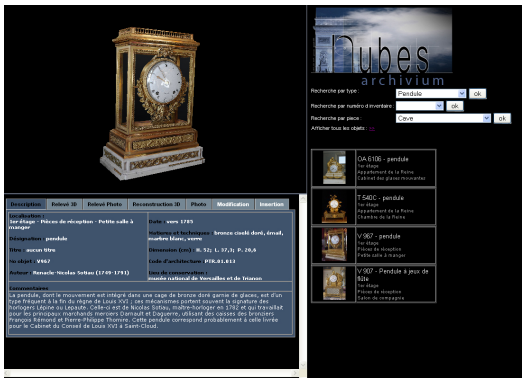

Figure 6: *The 3D elements database*

5. Virtual composing of 3D scenes

The 3D restitution of rooms is based on an approach of virtual furnishing guided by the assumptions made by the curator. A photographic environment (fisheye) representing the external environment is first added to the representation of the geometry of the rooms, then digitized furniture are integrated, finally a lighting transport calculation is performed to merge the 3D renders of the room and furniture based on a common illumination condition (Fig.7). The interactive scenes are the result of the use of panoramic images with cubic projection oriented in a 3D scene containing the envelopes of objects. As all elements of the scenes keep a constant link with the 3D database, it is possible to display and manipulate in space a selected element in the scene, to access to all its information (technical, documentaries, etc...) and also search and collect items based on spatial, temporal and / or semantic criteria.

6. Conclusions

In addition to detailed restitutions of the rooms of the Petit Trianon and their furnishings, this ongoing project takes also into account a temporal and historical dimension. In fact, visitors can discover a new interaction with places and objects that could, until now, only partially be accessed and known. Basing on the application of tools and techniques used and developed in the laboratory, this project is part of the process of conservation and scientific investigation of the site but also responds to recovery concerns and constitutes a real innovative communication tool.

For more informations about the project, readers can visit the project website:

Figure 7: *Virtual composing of 3D scenes (Render of the room, adding the external environment, integration of furniture, lighting transport calculation)*

http://www.map.archi.fr/3D-monuments/site_trianon

7. References

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