

Virtual Reality for the Exploitation of Houses and Historical Gardens. The Example of Villa Arconati.

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Abstract

The virtualisation project of Villa Arconati is part of the process involved in organising the aristocratic houses north of Milan. The project aims to test the use of virtual reality as an instrument of exploitation and multi-platform visualisation for villas and historic gardens. This paper describes the methodology utilised which allows us to create clear models of architectural and vegetation elements that will be contributing towards the final model: a successful compromise between realism and easy visualisation. While the modelling of the architectural components has followed a well defined process, as far as the garden is concerned, the development of the project presented greater problems since the methodology requires a hybrid approach between traditional software for garden design and representation and modelling activities for all the parts of gardens that require mankind intervention such as continuous shape pruning. The historical reconstruction of the house might therefore turn out to be a good basis for providing tourists and visitors with new instruments for learning and understanding, even using experiences in augmented reality, and may also offer planners further means to evaluate projects and support them in the decision-making process.

Categories and Subject Descriptors (according to ACM CCS): J.5 [Art and Humanities]: Architecture. H.5.1 [Multimedia Information System]: Artificial, augmented, and virtual realities

1. Introduction

The virtualisation project of Villa Arconati is part of a vast project of organisation and exploitation of the aristocratic villas north of Milan [DH09], in which numerous boards and institutions are involved, among which IRER (Lombardy Regional Institute of Research) and the Lombardy Regional Authority (Cultures, Identity and Autonomy in Lombardy).

Using virtual reality for the exploitation of historical and artistic products furthers the decision undertaken by the Lombardy Region Authority to use ICT instruments in the way it communicates the artistic wealth within the region. One particular instrument available is the Lombardy Artistic Heritage portal which provides countless products on-line as well as catalogues by means of its Lombard catalogue SIRBeC system (<http://www.lombardiabeniculturali.it>).

On the portal, the system of the aristocratic houses north of Milan is presented as a thematic pathway which can be utilised by the public. The pathway contains 140 catalogue images of houses.

For each one of the houses shown it is also possible to get a detailed geographical picture thanks to the NaDIR system (geographical search engine for data and information about

cultural resources), a WebGIS system which links the relative catalogue images and captions to the houses on the map and provides a three-dimensional overview thanks to a close-up visualisation.

The virtualisation project presented here is in line with these experiences and is a further step in the realistic visualisation of architectural heritage and in the analysis of the potential of virtual reality.

The main objective of the project is the creation of a virtual model - with a very high degree of realism - of a sample house and garden which may be utilised in different ways: visualisation on the web, real time consultation and augmented reality. The second objective is the definition of a methodology which is finalised towards the optimisation of the time required for the creation of the model and, subsequently, the costs of virtualisation by researching the right compromise and the correct degree of alchemy between the precision of data and realism.

The methodology has been applied to a sample area of Villa Arconati and a polygonal model has been created with photo-realistic textures relating to the actual state of a wing of the house, the adjacent garden and a room.

2. The choice of Villa Arconati, the “Castellazzo” of Bollate

The virtualisation project has identified, as a case study, Villa Arconati Sormani Busca, known as the Castellazzo of Bollate, which is considered as being “one of the most interesting and monumental architectural complexes in the Milan area and in Lombardy” [DH09].

The Villa Arconati complex, whose original plan dates back to the 14th century, lies within the landscaped area of the Parco delle Groane, and is built as an actual little village with the house itself along with a succession of numerous courtyards and the adjoining church of SS. Maria and Guglielmo.

The adjoining baroque garden, greatly desired by Galeazzo Arconati (17th century), is considered as one of the most important gardens in all of Lombardy. It is laid out, following the styles of the period, with a wealth of avenues leading to particular views, groups of statues, fountains and aviaries.

Villa Arconati has been chosen for the project, not only on account of the site’s importance but also because it has preserved in a perfectly recognisable way the baroque layout of the garden: an ideal study for the aforementioned objectives of the project. The enormous size of the whole complex has forced us to limit the model to a mere wing of the building and to a portion of the garden. The north-east wing with inner courtyard has been modelled along with the adjoining lemon grove with the water tower and the avenue created by the row of trees leading to the Theatre of Diana.

As a test, an inner room has also been modelled, the Museum Room in its present state, deprived of any object whatsoever on display except several ornamental stuccos and the famous “Statue of Pompeo”.

The decision to work upon this specific portion of the complex was taken on account of there being a co-existence of architectural and vegetation elements along the avenue which leads from the house to the Theatre of Diana.

3. Methodology

The objective of the project – the creation of a highly realistic three-dimensional model which enables visualisation on more than one level – has led to a variety of points to be considered from a merely methodological point of view.

The creation of a model whose objective is solely for visualisation does not actually imply the highest levels of metric precision yet it does allow for a greater degree of flexibility in choosing the instruments used for digitalisation. The architectural and botanical surveys of both the house and the garden, subjected to appropriate verification, might actually provide an excellent source of useful information for the modelling process without having to resort to more expensive surveys in terms of time and resources, like photogrammetry and laser scanning.

Moreover, a model which is visible on different platforms - web, real-time, augmented reality (AR)- requires, on one hand, the use of standard formats -VRML, i.e.-; they could

act as a connecting element between different software with differing languages. On the other hand, a good compromise between the weight of the model, in terms of the number of polygons, and realism, thereby also guaranteeing easy access from the web.

The double nature of the complex of Villa Arconati, which combines architectural elements with vegetation elements has required a hybrid approach to the process of virtualisation as well as a methodological structuring which will be able to manage the problems that might arise. For this reason, the modelling of the architectural and vegetation components has been administered in a separate way, thereby creating two parallel processes and defining different procedures which converge towards a sole objective. As far as the architectural components are concerned the process has been based upon a methodology that has been elaborated and tested in previous projects [CP07; CS08]. This has enabled us to create models with a high level of realism in a shorter amount of time.

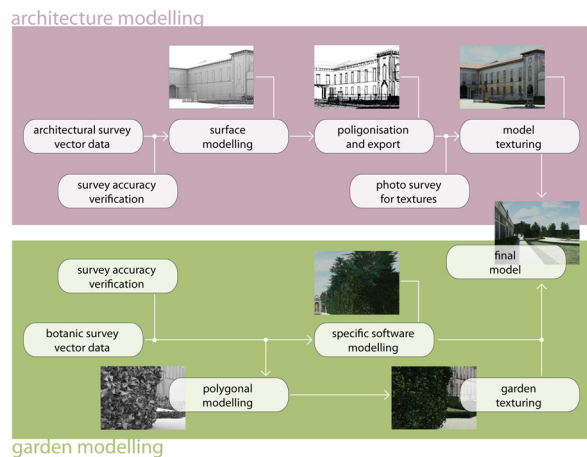


Figure 1: Methodological approach

The departure point for the modelling of the house was a detailed architectural survey in a vector format (scale 1:50/1:100), that was already in existence, which has enabled us, by means of a careful verification of the reliability of the data available, to model the architectural components relatively quickly.

The three-dimensional modelling took place after the vector data was provided, by means of software used for the modelling of surfaces (Rhinoceros 4.0) which guarantees dimensional and formal control and the immediate conversion of the data already available.

Furthermore, we should also point out that not all the architectural components were modelled with the same degree of precision, defining a maximum level of detail beyond which the modelling would only have weighed down the final product without consistently improving the degree of realism.

Where allowed, there has been a formal simplification of the complex components (stuccos, decorations), outlining the curved surfaces in an appropriate way, in order to facilitate

the subsequent phase of polygonisation.

The model built with mathematical surfaces was actually subsequently transformed into polygonal meshes in order to encourage its joining with the garden models, that had been created as polygons. This phase was managed in a very accurate manner, without using automatic conversion systems, in order to guarantee a light-weight high level of realism to the final model. The conversion parameters from surfaces to polygons were defined, as the necessity arose, depending on the formal complexity involved and on the importance of the components: limiting the number of polygons for simple components that were only slightly visible and increasing the complexity for those components that were more visible and articulated.

The polygonal model was subsequently exported to a modeller (3Ds Max) in which photographic textures were applied. These textures were obtained by means of a detailed photographic survey that was created in loco.

The mapping of photographic textures is useful in guaranteeing a degree of realism for the final model and the use of bump textures enables us to overcome certain limits due to simplifications that were produced during the phase of surface/polygon conversion.

With the mapping of the textures on the architectural components the first phase of developing the architectural model ends. This phase will contribute towards the complete final model. The departure point for the modelling of the garden is the same as the architectural modelling since there already exists a detailed botanical survey, in vector format, from which the exact position of the vegetation and the trees can be deduced.

In the first phase in the development of the research, for the modelling of the garden's vegetation components (plants, shrubs, grass) a piece of dedicated and specific software was selected (produced by Bionatics) which enables us to create three-dimensional models of plants starting off from the seeds of a variety of trees and to control their condition and seasonal phases. This software turned out to be a powerful and swift instrument for the modelling of plants whose condition is not modified by mankind. However, the software showed limitations in the representation of plants which require continuous pruning. The software actually allows for the pruning of branches but it does not modify the growth of the tree following such intervention, as would happen in nature. This limitation revealed itself to be particularly evident in the test for the modelling of the birch wall, which skirts the avenue from the house to the Theatre of Diana, and in the modelling of the box-trees which decorate the flower-beds in front of the lemon grove.

The result of the preliminary tests and the objective limits that emerged from them during the creation of the prototype has highlighted the inability to follow a sole modelling strategy for all the garden and thus the demand for a hybrid approach by using two procedures.

The trees in the garden that have not, throughout the years, undergone a substantial amount of man-induced modification work have been modelled by using dedicated software, thus maintaining the ability to manage their growth/condition as well as the seasonal variations. The trees

and the shrubs that have, on the other hand, undergone continuous pruning which has modified their appearance have been modelled with a traditional approach [HL01], by using commercial polygonal modelling software (3Ds Max). As in the case of the architectural features, the use of photo-realistic textures and graphic solutions to augment realism, like bump and displacement textures, has enabled us to render the products of the two procedures comparable and to obtain a final model which combines "polygonal" vegetation and the modelled trees with the dedicated software.

4. Results obtained

The product obtained with the aforementioned procedures realistically represents the actual state of a portion of the complex of Villa Arconati. In particular, the modelling has concentrated on:

- North-east wing of the main building of Villa Arconati
- East courtyard and railings
- Lemon grove and Water Tower
- Interior. Museum Room

Birch row and garden which develop along the perspective avenue between the courtyard and the Theatre of Diana.

The combination of all the aforementioned components into one model was completed in 3Ds Max from which both the photo-realistic renderings of inside and outside areas were obtained as well as animations simulating promenades in the garden and shots of the interiors within the complex.

The model exported in VRML format lends itself to the navigation of the model in real-time which might take place in two ways: navigation on the web with the use of open source navigators and navigation within the model itself in real-time in a virtual theatre by means of dedicated software.

In the first case, navigation takes place by means of a normal web browser with appropriate plug-in and does not require particular hardware requisites; in the second case, on account of a greater immersive performance and additional functions there is also the need for a greater amount of hardware and the use of dedicated commercial software.



Figure 2: Textured model of the lemon grove

The results described have been achieved thanks to the combined work, not continuous, of 5 resources for a total of 3 months. In particular, apart from the role of scientific and

operative coordination two resources have also been involved concerning the modelling (architectural modelling and garden modelling) as well as a further resource for the acquisition of quality photographic textures.

5. Conclusions

The Villa Arconati virtualisation project has been approached as a test to see how virtual reality can be used as a means of exploitation for houses and historical gardens.

The digital model obtained reconstructs with a high degree of realism the actual state of a consistent portion of the architectural group of the house and of a section of the garden and it has satisfied the prerogatives of the project, i.e. the achievement of a model which may support a multi-platform visualisation. It would be wise, however, to make some clarifications about the efficiency of the method and potential problems that might arise in the future.

The modelling of the architectural components has followed a linear process, thanks to the use of consolidated methodology which has enabled us to develop a realistic model in the short time available. Such activity has been considerably simplified by the existence of a detailed architectural survey in vector format which has enabled us to significantly reduce the time employed in the modelling. Whenever detailed vector data is not available the methodology used introduces survey sessions which obviously increase the time necessary for the development of the model.

As far as the garden is concerned, the development of the project presented greater problems since the methodology used is only currently being defined and the software originally identified for the development of the model did not turn out to meet expectations.

The necessary recourse to a hybrid approach to the modelling brings with it two problem issues: the first is the noticeable difference in detail between vegetation components modelled by means of polygons and the components obtained with specific software whilst the second regards the inability to simulate growth and seasonal variation for the components modelled by means of polygons.

At this point, it is also necessary to point out that the vegetation modelled with the traditional approach brings about a high number of polygons which reverberate on the navigability of the model and that work involved in the reduction of the complex causes a reduction in detail and quality. On the contrary, the vegetation modelled with dedicated software offers the possibility to automatically calibrate the quantity of polygons according to how the model is used.

Furthermore, it is also necessary to make some clarifications regarding the level of realism since the model currently realised boasts a high performance level on account of the textures obtained with a photographic survey of the present state of the area.

If the model is utilised for the historical reconstruction of the house or the creation of a potential project of requalification and restoration, the level of realism has to decrease because

it will be necessary to operate by elaborating existing photographs or by reconstructing textures from new.

Taking all these problem issues into due consideration as well as their potential implications for future development we are able, however, to be highly satisfied with the outcome of the research project since we have been able to define a process of flexible research which may be modified and implemented according to needs.

6. Expected developments

The experience described above enables us to identify new potential scenarios in which we may contribute and in which we may verify the potential of virtual reality in the exploitation of architectural and landscaped complexes possessing artistic and historical value.

An initial area for some form of action regards the modelling of the entire complex of Villa Arconati, along with the wings of the house that have not currently been included, the adjoining village and the addition of the portions of garden that are still missing.

In the same way, as we have already stated, the model may constitute a basis for new projects of historical reconstruction of the house within a certain historical period or, on the contrary, in order to verify restoration work or new project work.

Therefore, a variety of new applications might be created that may be used, on one hand, for information purposes and, on the other hand, for project purposes [Bat07].

The historical reconstruction of the house might therefore turn out to be a good basis for providing tourists and visitors with new instruments for learning and understanding, for example by using the model for experiences in augmented reality. The use of the model for restoration projects or for new re-qualification projects may offer planners further means by which the impact is evaluated and how the projects might be supported in the decision-making process.

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