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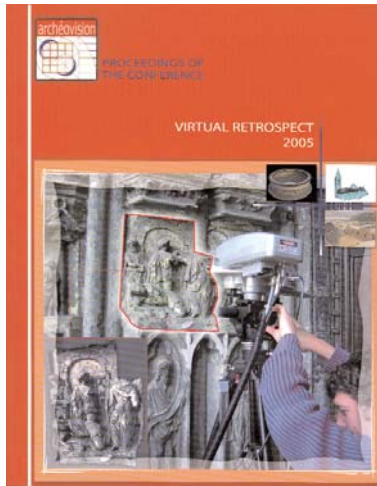
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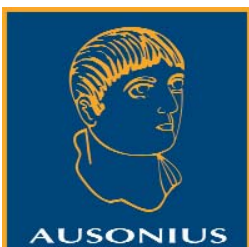
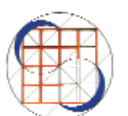
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## PROBLEMS WHEN GENERATING VIRTUAL MODELS REPRESENTING REAL OBJECTS: HONDARRIBIA WALLS

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**Abstract :** This report shows an example of virtual modelization applied to a heritage construction, the walls of the city of Hondarribia. Therefore, it is not a model recreating a building upon hypothetical data obtained from archaeological remains but a true representation of the walls, as we know them today.

To accomplish the model, first of all, it is necessary to create a three dimensional geometric model using surveying techniques in order to guarantee the metric accuracy expected in order to meet further cartographic and restorational needs. After bringing together the necessary documentation, a mesh-covered model is obtained which is prepared to be draped with real high-resolution photographic textures, which in turn must be geometrically corrected to eliminate the distortion accentuated by perspective and consequently position the pixels as close as possible to their real place.

The process we have just described had been tested in previous projects and yielded satisfactory results. However, more extensive projects as the one in Hondarribia become almost unfeasible due to the huge amount of information involved. The following paragraphs will show the tips used to solve this handicap.

**Keywords :** Real object — wall — photographic texture — mesh — hierarchical model.

### 1 Introduction

Virtual models representing real objects such as historical buildings, monuments and archaeological remains are an excellent tool for supporting historical research, maintenance jobs and restoration projects. The main issue when endeavouring to obtain the geometric elements of an object (monument) is to measure every part of its surface with the accuracy and level of detail that will make the resulting model useful for the above-mentioned purposes.

The present lecture shows the process of documentation of the Hondarribia walls. The kind of model required for this project

was a true representation of the walls as we know them today. Therefore, geometric and aesthetic fidelity were of utmost importance, which in turn brought about difficulties.

To achieve the level of accuracy required for the model, its scale was determined taking into account the size of the smallest object that had to appear in the model. But bearing in mind that amount of data increases in the same proportion as the level of accuracy and also the size of the object of our model (the ancient walls of the city), data management problems had to be solved in order to fulfil our task satisfactorily.

The next paragraphs show every step taken: metric, and aesthetic accuracy establishment, model creation as well as the difficulties found in the process and the solutions taken.

### 2 Model generation

As we have previously said, our aim in this project was to create a true representation of the Hondarribia walls as they stood at the moment we took on the job. We shall call this type of representation “description model” to distinguish it from recreation models. The difference between them is that in recreation models the aim is to create a hypothetical model from a few remains and historical research. In recreation models metric questions are not important because in most cases they are unknown, as for example in the picture, the height of the columns of the Tusculum church cannot be obtained from its remains. What is priority in recreation models is its aesthetic evocation.





Fig. 1: Remains of Tusculum church and its recreation model.

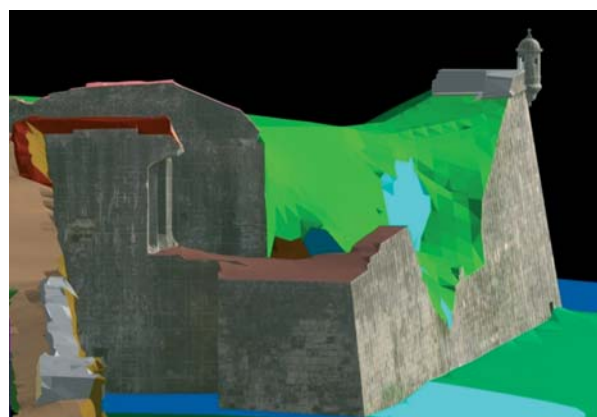


Fig. 2: Remains of Hondarribia wall and its description model.

When the aim of the model is to represent the existing reality, a description model is developed. In this case, certain accuracy requirements must be met. In the present case, the scale of the model was fixed at 1: 200, so the accuracy margin between every point of the geometric model should be less than 4 cm at most.

The following flow chart shows every stage of the work done. The red boxes are tasks related to fieldwork, the blue ones to office work and finally, obtained outcome is indicated in green.

The following table summarizes the difference between both kinds of models:

	Available data		Purpose		
	Preserved remains	History	Hypothetic appearance	Current real appearance	History
Recreation Model	✓	✓	✓		
Description Model	✓			✓	✓

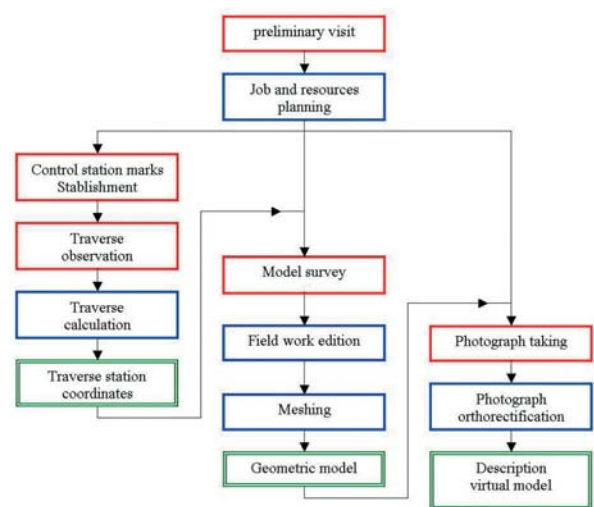


Fig. 3: Work flow chart.

The three-dimensional geometric model is obtained using surveying techniques gathering point, line and surface data. Next, every surface must be covered by its real high-resolution photographic texture (in its true dimension every pixel must be between 1~2 cm long). These textures must be geometrically corrected to eliminate the distortion accentuated by perspective and most consequently position the pixels as close as possible to their real place before covering surfaces with them. Other elements have to be taken into account too, for instance, the geometric adaptation of the textures, the radiometric variation between textures obtained from different pictures and the deformation produced by lack of data in the process of geometric correction.

When the three-dimensional model is finished the outcome is presented to the customer. A complete documentation of the work is prepared which includes the report of the work done and a set of plans (site and façade elevation plans, cross-sections...) that could allow other experts involved in the project to use this geometrical information in their investigations and design projects.

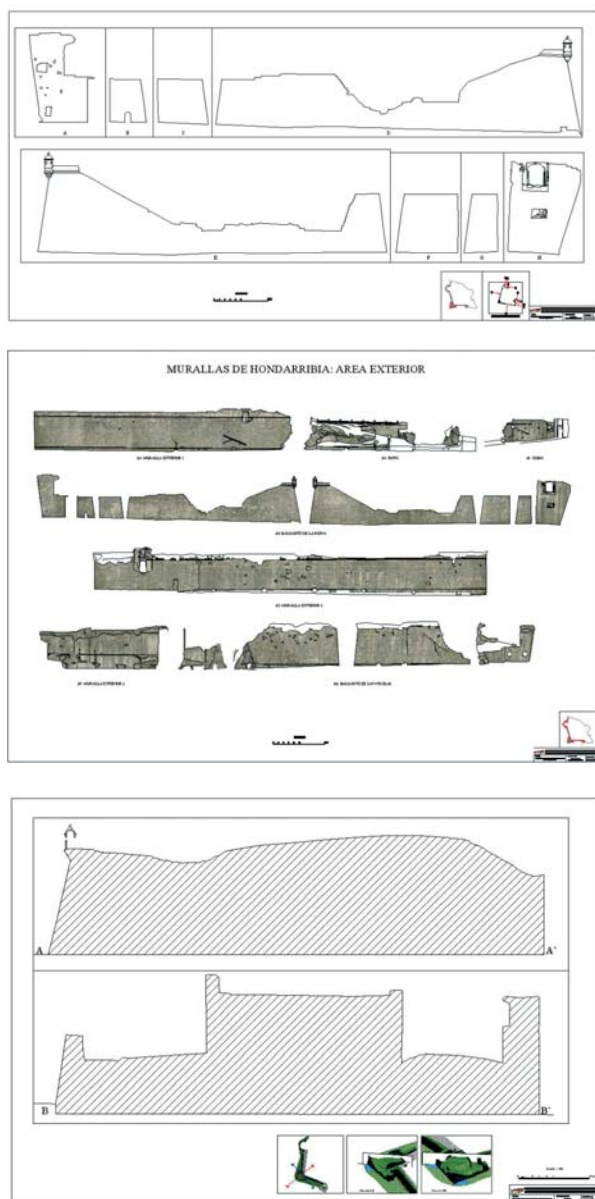


Fig. 4: Façade elevation plans, façade orthophotographic elevation plan and cross-sections.

The way that geometric data are gathered in the field (every part of the building is located in the same coordinate system) allows the generation of a three-dimensional photographically real-shape texturized virtual model. This model makes it possible to analyze the function of the different parts of the building and possible relations between them. This is an interesting issue in models of large sized buildings such as Hondarribia Walls.

The process we have just described had been tested in previous projects which yielded satisfactory results. However, for more extensive projects as the one in Hondarribia, creating a high-resolution model became almost unfeasible due to the huge amount of information involved.

### 3 Presentation and exploitation

To make good use of the virtual model, two possibilities are considered:

- Guided exploration: an animation that visits all the building can be done. The disadvantage of these choice is that the object is always and only seen from the same point of view and at the same distance. This possibility doesn't make the most of the potential of the model, because if the animation presents a general route, most of the details are not going to be appreciated and in some cases they will remain unnoticed. On the contrary, if the animation gives a very detailed route, an excessively long video clip will be generated. In this case the animation could lose inefficiency in choosing the part of the building that requires to be visited.

- Interactive exploration: this choice allows a free exploration of the model by the observer and offers the possibility of choosing the most meaningful point of view and distance to observe the different parts of the building for archaeological research and architectural or restoration projects.

Taking into account both the model's accuracy and the purpose it is generated for, we consider the second choice more suitable.

To develop this option VRML has been chosen, due to the following reasons:

- VRML is a standard language that can be subsequently treated with several computer tools. This allows the customer, the owner of the model, freedom to handle and even modify the virtual model regardless of both the owner of the used format and the producer of the model. This freedom of modification is very limited using other virtual reality formats and browsers.

- VRML language is ASCII based, which grants control to the producer of the model to manipulate and modify the model easily.

- VRML language makes it possible to browse virtual models via Internet so contributing in publicizing the object represented and grants the possibility of including the model in multidisciplinary multimedia about the documented building.

- It is a free software, both for the producer of the model and for the user (the one that navigates through it) so reducing production costs. This makes it interesting for low budget projects and facilitates its integration in multidisciplinary ventures where the virtual model is a work tool and not the aim of the project.

However, VRML language shows some disadvantages and can't be considered the perfect virtual reality format: on the one hand, provides a very limited lightning and shadowing rendering which yields a poor performance. This is not a handicap when photographic textures are used because they have their own lightning. On the other hand, VRML browsers, of which have to handle at least 5000 triangular shapes, in most cases, handle hardly more than twice this amount with the most powerful ones barely capable of handling a model with 86000 faces, which was the case of Hondarribia walls model.

#### 4 Solutions taken

We propose three options to browse a large model interactively, meaning by large one that cannot be loaded straight forwardly:

- Partial models.
- Route models.
- Hierarchical models.

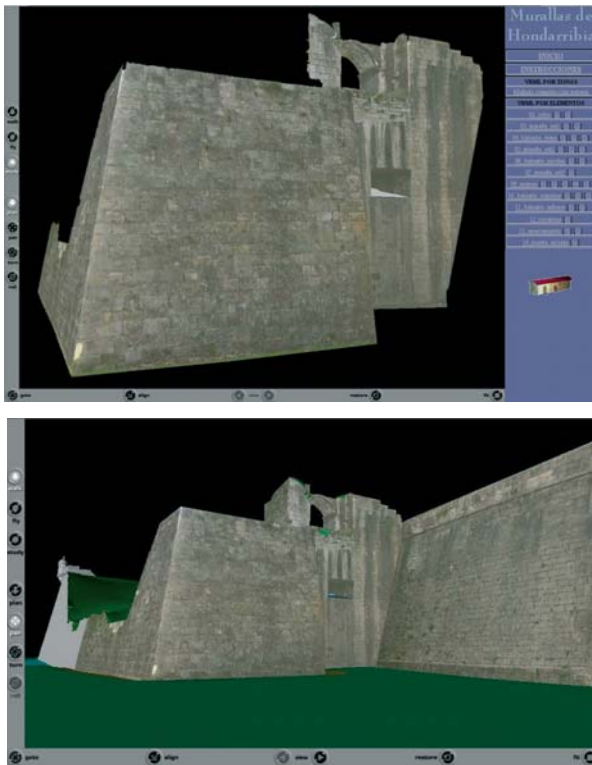


Fig. 5: In the first picture the building can be viewed in parts, by selecting each part in the menu on the right. In the second one, a hierarchically organized model is shown, the parts of the model that are closer to the viewer appear with photographic rendering and the ones further away with colour rendering.

The first option, that is, creating partial models, implies dividing the general model into smaller sub-models that can be handled by the system. The overall unity of the model must be preserved in such a way that the user can know at any time what part of the general model is being visualized and can load the subsequent partial model. This is an adequate solution whenever the observer is positioned outside the model and moves the objects in his/her field of vision.

Route models are a best option for models that cannot be explored satisfactorily from the outside but are better suited to be visited via a journey through the virtual surroundings. Consequently only part of the objects are within the field of vision at a time. As browsers only take into account whatever they have in their visual field, the information to be processed is considerably reduced.

Finally, hierarchical models load the information using different degrees of resolution depending on the distance at which the observer is positioned:

- high resolution only for the closest elements,
- low resolution for distant but yet visible items,
- avoid loading the areas not visible at each stage.

There are various possibilities to reduce the degree of resolution of the model: the size of the textures can be reduced, the geometry of the objects can be simplified or even both these can be done at the same time.

Reducing the size of the textures is a simple task, not so simplifying the geometry. There are mesh reducing algorithms, however, these cannot be applied straightforwardly as they would also have to incorporate the reprojection of textures which means that extra information like the point from where the pictures were taken and the features of the cameras must be taken into consideration.

Another hindrance is the fact that the external boundaries must be preserved in order to be able to match them to the rest of the parts of the model, regardless of the resolution at which they are being visualized. Hierarchical models can give problems of continuity whenever distant elements have not been loaded that are within the field of vision.

#### 5 Conclusions

This document describes virtual models that, due to their purpose, demand a highly detailed geometric definition and the use of high-resolution photographic textures. These models are used to obtain orthophographic representations, detailed analysis of structures, general studies of the historic evolution and function of the objects represented by the model, analysis of non-accessible areas that have been temporarily reached (using cranes for instance) or as a historic register prior to modifications.

The size of these models renders them inadequate for interactive browsing for touristic or educational purposes. Nonetheless, their technical use makes it necessary for them to be interactively visited which can be done resorting to techniques that present the information in a hierarchical way. The user will not be able to visualize the whole of the model simultaneously but the overall idea is kept.

All this, taking into account the shortcomings but also the advantages that using free-use standards like VRML brings.

#### 6 Acknowledgements

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