PHOTOGRAMMETRIC IMAGING FOR VIRTUAL REALITY: AN EXAMPLE OF SETTLEMENT DOCUMENTATION

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ABSTRACT

At present, the representation of monumental sites is performed more and more with the support of orthoimages and photo-realistic visualisations; the geometric model is connected to the symbolic one utilising both raster and vector techniques in a hybrid database.
The ancient small village of Oneta, located north-east of Milan, is known as a possible homeland of Harlequin, the famous Italian mask character. This site has been surveyed for archiving and documentation, in order to schedule a plan of restoration; vector-raster information, being collected during the measure activity, was processed by photogrammetric tools for imaging and photo-texturing as a 3D virtual reality model, able to allow an effective support to representation and thematic analysis.

1. INTRODUCTION

The inventory of a monumental site can be developed nowadays through referenced orthoimagery and vector-raster CAD techniques, oriented to 3D visualisation as virtual reality modelling.
In addition to the raster form of perception (geometric model), all the thematic aspects (i.e. bounds of pictorial details, zones of material decay, splitting patterns of structures, cross-sections, a set of local information about the object, etc.) are outlined as vector layers (thematic model), in a general reference system (Colombo, 1996 - 97).
The creation of three-dimensional CAD models of real-world objects (such as historical buildings in architectural applications) and their rendering through photo-texture techniques, are new topics of the technological enhancement in the sector of representation. Since the use of photo-realistic visualisations improves the perceived information, a good level of naturalism is highly desirable, inside the so-called 3D solutions (Tempfli, 1997).
The benefit of photo-textures for the representation of the fronts of buildings, for instance, is the high degree of description of the texture-data, that can't be found, instead, in vector-data; this fact is very important, because the occurrence of preservation is assuming a meaningful role in technical applications of photogrammetry.
Raster images, after their orthorectification, scaling and georeferencing, open new possibilities for analysis and inspection of architectural objects in the present; these products may be considered, furthermore, a very effective way to realise thematic maps.
3D digital plotting, performed by projecting each image pixel either over a plane or an interpolated surface (developable on a plane, like a cylinder, with no deformation), could become a standard for presentation aspects. The basis for a description of morphology is a DEM and a geometric transformation with resampling. If the object has a shape close to the reference surface, a simple rectification is needed.
Orthoimagery and mosaicking of it can be utilised as a support in superimposing vector data for feature definition: this information might be extracted directly through a digitising process over the screen. The capacity to represent vector-raster data, in a correct spatial overlay on the model, is named draping or photo-texturing: in this way a realistic viewing becomes feasible, according to the computer vision techniques (Gruen, 1995), and one speaks about Virtual Reality Modelling (VRML is the standard for Internet, now at the release 2).
A complete building survey has to include recording of the façades as well as cross-sections determination, attitude of elements and general morphology investigations; for these aspects a combination of photogrammetry and electronic tacheometry is required.
As known, specific needs for Cultural Heritage inventory are just regarding the quality of raster information, above all image acquisition and monument representation: the reproduction must be more and more of high quality, both for metric and chromatic aspects, i.e. the image presents an adequate degree of detail and colours show, in a faithful way, the radiometry of reality.

2. THE TEST-SITE HARLEQUIN'S VILLAGE

The small settlement in Brembana Valley named Oneta (the site is close to Bergamo, a town of North Italy, not far from Milan), is known as Harlequin's village because history or legend recognise it one of the homelands of the famous Italian mask-character, by tradition supposed to be from the city of Venice.
Figure 1 shows a planimetrical description of the ancient site, with the different buildings surrounding the historical mansion.
This village, whose origin dates fourteen century, preserves the characteristic architectural aspects (for example balconies, arcades, etc.) of ancient commercial stations for foreign trade of the Venetian Republic, together with the mansion being supposed to represent the "House of Harlequin".
Some of the most significant details of this site were

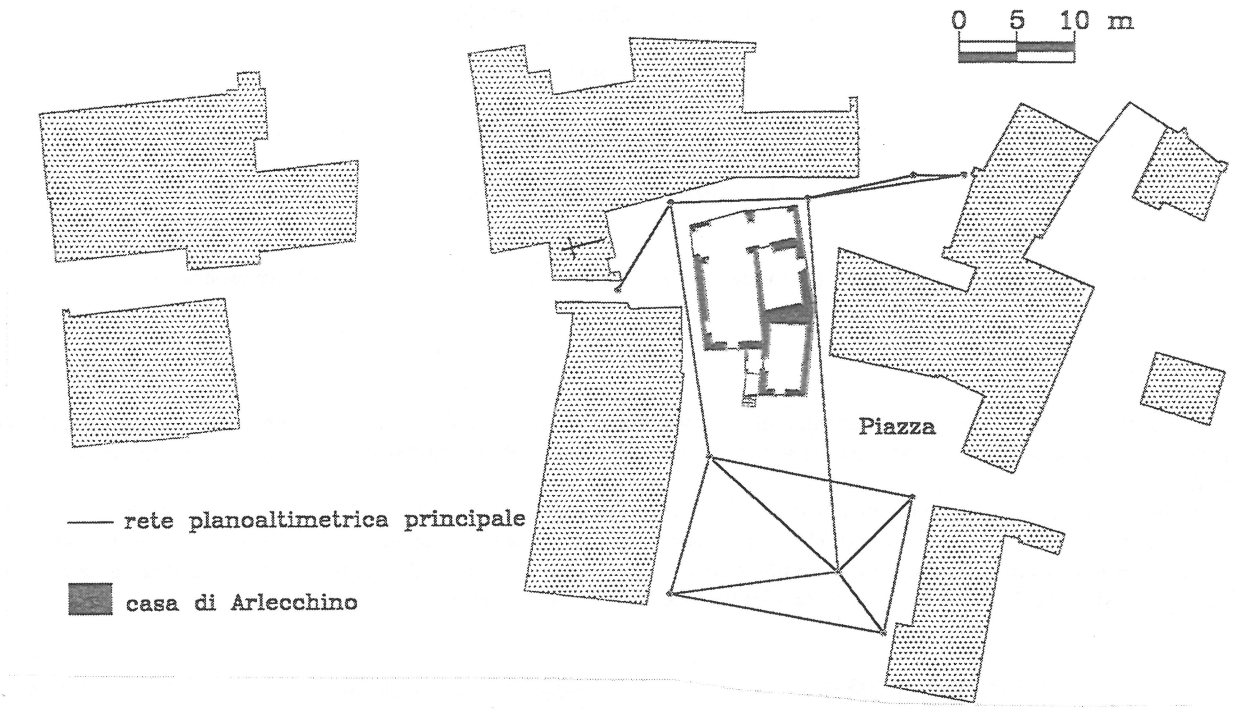

Fig. 1 - The planimetry of the ancient settlement, close to the town of Bergamo.

Fig. 2 - Raster imaging of the main façades for a building (ortogonalisation, scaling, mosaicking and georeferencing).

surveyed, in a global reference system, for documentation and restoration; photogrammetric techniques have been applied till now to the building curtains facing the small central square: vector and raster information, through photogrammetric imaging, were mosaicked by a CAD modeller to perform a photo-textured virtual model.

The congruence among corresponding elements of the model was checked according to the tolerance value for the required degree of knowledge; this aspect is significant in order that a metric visualisation can be guaranteed; on the printouts, just to underline dimension and shape, the reference grid is always superimposed.

To describe details whose geometry can't be reconstructed by the photogrammetric tool (simulation of the roofs, for instance), direct local measurements were performed: the features collected in this way are characterised by a synthetic texture against the surveyed photo-textures.

So, the whole object can be represented but sharing different manner and accuracy of the acquisition techniques.

This 3D graphical model, will be later utilised as a reference for linking historical, architectural and thematic hypertexts generally inside Internet or Intranet databases; in particular, Intranet uses the existing world wide tools of Internet to improve the exchange of information within a single company (Marini et al., 1996). Surveying procedures for vector determination of buildings' frames, vertical profiles of walls, control-point location over natural details, have been performed by means of an electronic theodolite (Leica), in addition to a DIOR EDM, capable to measure directly on any material.

The packages AutoCad, Corel Draw, PhotoShop, Archis with RPS (Siscam, Florence) and 3DStudio are the ones selected to develop the different steps of this work.

The mean scale of the photogrammetric images is 1:200; the processing was carried out starting from a pixel-size of 25 microns (1000 dpi) and a RGB colour resolution, according to standards for scanning at the needed scale of representation (1:50).

Orthogonalisation of the raster images, related to the façades of each building, are produced through a mosaic of simple rectifications, because of the significant planarity of the objects; to enhance the visualisation of zones with metric values versus the qualitative ones, the elements inside or outside the reference plane are represented in b&w instead of colour (fig. 2 on the previous page; fig.3). Through this imaging management, supported by surveying measurement, a photo-realistic model of the monumental site has been carried out; it points out, with suggestion, the great effectiveness of texture-data (Leberl et al., 1994).So, figure 4 presents a wire-framed model of the settlement, performed by means of a 3D Studio package; in this direction figure 5 depicts a realistic reconstruction of the site, with raster orthoimaging superimposed to the walls as a metric photo-texture. A detail of this reconstruction is the subject of figure 6.

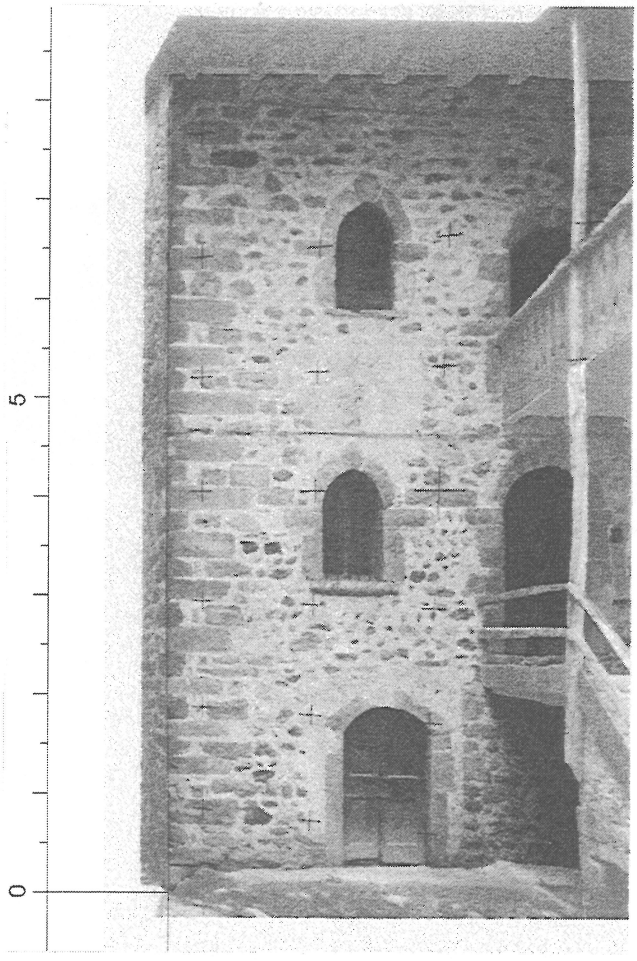

Fig. 3 - Raster imaging of the main façade for Harlequin's mansion (particular).

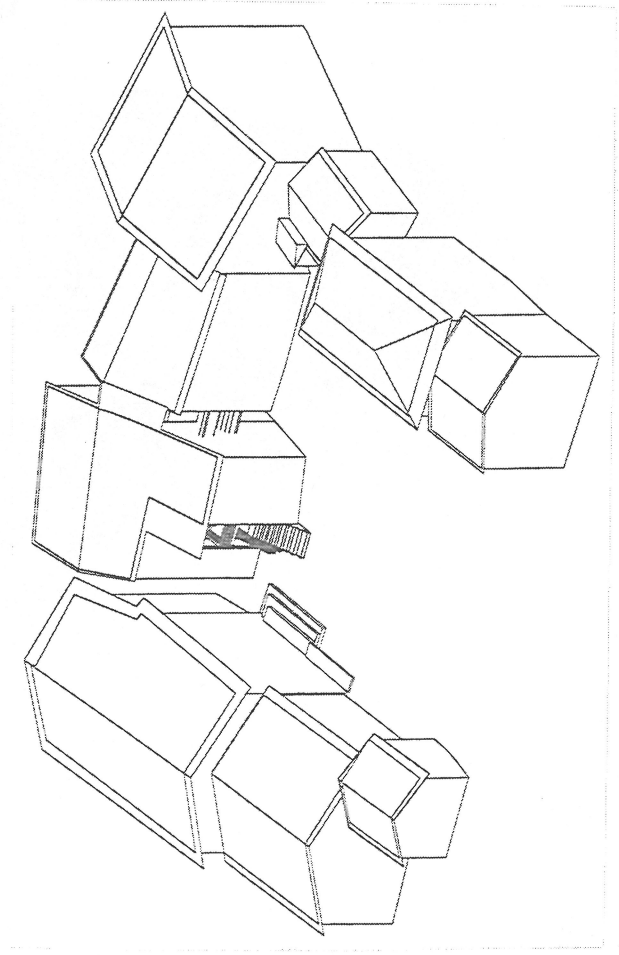

Fig. 4 - A wire-framed CAD model of the site.

3. OUTLOOK FOR REPRESENTATION

The application of raster techniques to the representation of Harlequin's village, points out a different approach of surveying and photogrammetry in order to produce realistic 3D syntheses for Cultural Heritage. Historical buildings and sites to be preserved and documented take large advantage from the new raster methodologies, closer to the end-user needs. Therefore a more correct relevance could be given to the step of geometrical knowledge, till now generally neglected in comparison with other steps of investigations, except for few relevant cases (Pomaska, 1996).

Nowadays, the final aim in every planning for inventory is a GIS compilation; digital photogrammetry is ideal for the required graphic aspects, for the interesting development of automation and the great versatility of this technique.
Just this evolution of the photogrammetric data processing is producing a progressive disappearance of the classical dedicated-devices, with the subsequent increase of Geoinformatics expert-systems. Bottle-necks of the process are still the access time and the data transfer rate, above all for low cost hardware: furthermore positive answers are coming from the latest generation of Pentium II processors (up to 333 MHz).

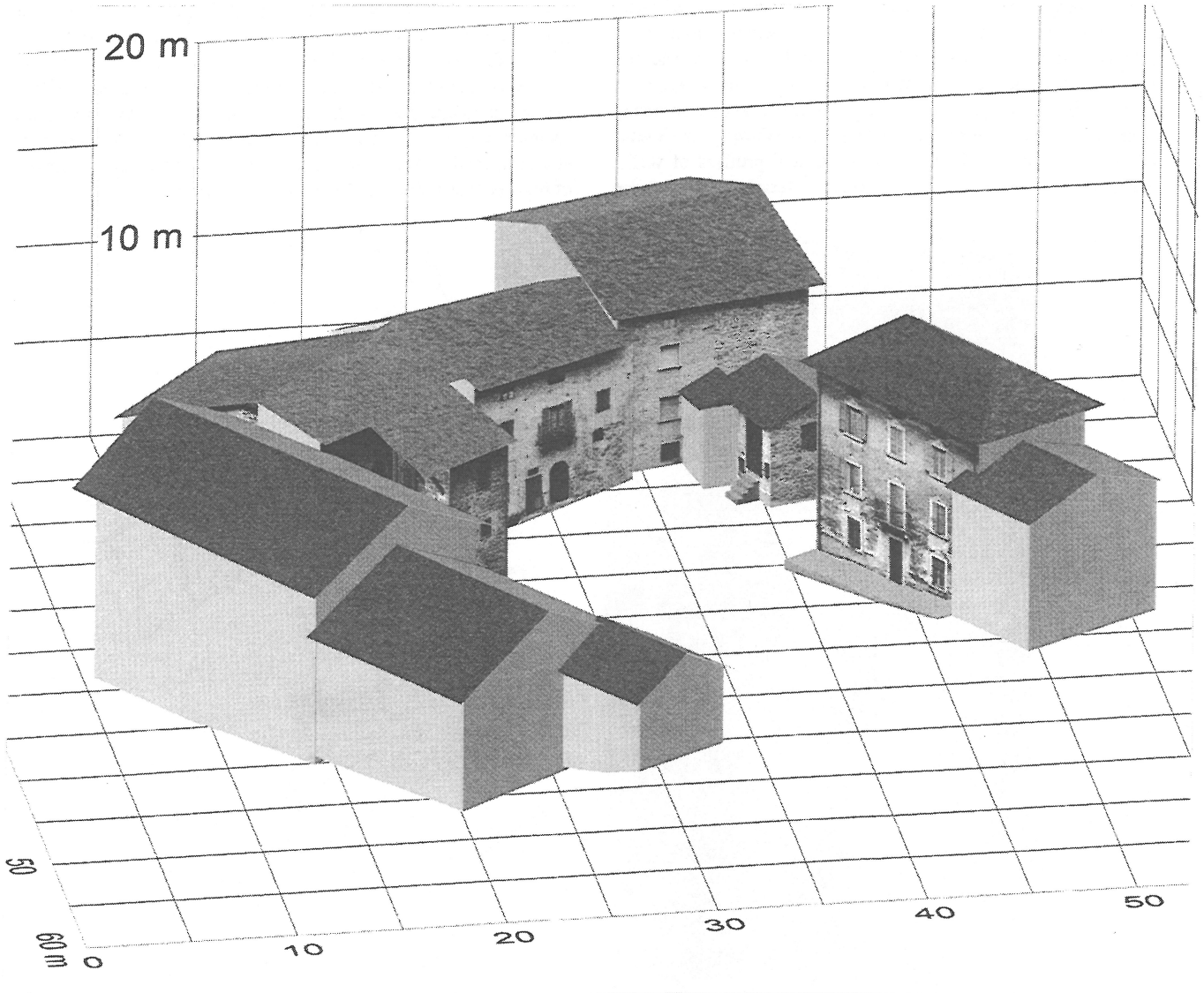

Fig. 5 - The photo-textured rendering of the settlement's buildings.

Besides, the technological enhancement of the photogrammetric field has introduced more support to the daily operational activity: for instance, manual stereoscopic observations can be replaced with effectiveness by image matching techniques in some cases. The most evident consequence will be the development of a "distributed photogrammetry", with the end-users (architects, archaeologists, etc.) directly involved in the final production (thematic analyses, etc.).
This new approach should make the phase of survey less expensive, easier and faster, improving at the same time the quality of the outputs (three-dimensional data bases, the texture-mapping procedures, net availability of the graphical document) according to the user requirements.
In this way, a more spread and accurate inventory of Cultural Heritage should become feasible, together with the preservation of historical testimony, too often decayed by natural calamity and human negligence, as recent Italian events have dramatically underlined once more.

Contributions

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Fig. 6 - A detail of the photo-realistic visualisation.

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