ARCHITECTURAL AND NATURAL HERITAGE : VIRTUAL REALITY WITH PHOTOGRAMMETRY AND LASER SCANNING

M. Caprioli [*], M. Minchilli [**] , A. Scognamiglio[*] ,G. Strisciuglio[*]
*Politecnico di Bari, Italy
** Università di Sassari, Italy

m.caprioli@poliba.it a.scognamiglio@poliba.it g.strisciuglio@katamail.com

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ABSTRACT:

The present study investigate the possibility to build a three-dimensional model of an Architectural Heritage with the tools of the digital Photogrammetry and with metric survey of Laser Scanning, in order to develop and to promote vision metrology.
They've been realized different survey campaigns with Nikon D100 semi-metric camera and with Laser Scanner Mensi in the sites of S. Catherine's church in Conversano (Bari, Italy) and in the site of speleological complex of "Castellane Grotte" (Bari, Italy).
It is plain that the achievable accuracy, with specific characteristics of every single technique, determines a considerable variety of attainable products that vary from navigable three-dimensional models for tourist and popular aims to 3D Informative System for Architectural Heritage conservation and restoration.
After the acquisition of all the data both Laser that Photogrammetric we have reconstructed the model 3D of our objects of study with different softwares to individualize also in this case the merits and the defects of each of them.
The results reached both with the software of the EOS Systems Photomodeler and Real Works (Mensi) are very interesting, and they can certainly be utilized for three-dimensional models, also with 3D Modelling and Virtual Reality techniques, in order to permit public knowledge and fruition of monuments.
In the future, it will be possible to use the methods of metric survey as the Laser Scanning and the photogrammetric informations to get both summarily resulted descriptive of the volumetries of the Monuments and both for a more rigorous approach for the study and the conservation of the Cultural Heritage.

1.INTRODUCTION

In the circle of the searches conducted in the "Laboratory of Survey and Cartography" of the Polytechnic of Bari some campaigns of test they have been effected, through new methodologies of survey, of the same objects with different tools:

1. Nikon D100 reflex digital camera with 6 Mpixel CCD
2. Laser Scan Mensi.

Theese photogrammetric and laser scanning surveys have been conducted:

- in architectural field of the **S. Catherine's church** in Conversano in the countryside of Bari, with a singular "quadrilobata" plan of unsure origin but with Byzantines, Greeks, Armenians or Syrians influences;

- in the site of speleological complex of **"Grotte di Castellana"** (Bari, Apulia Region), discovered in 1938 from the illustrious Prof. Anelli, with the related "Museo Speleologico" and "Osservatorio Astronomico", constitutes one of the sites of greatest monumental, landscaped, natural and tourist interest in the South of Italy for the exceptional beauty and oneness of the carsick phenomenon that appears to visitors:

  - natural caves of enormous dimensions, with formation of stalactites and stalagmites of interesting colours and forms, similar to works of avant-garde art;
  - underground caves ("La Grave", "La Grotta Bianca", "La Grotta dei Monumenti", etc.) with formations of alabaster of such innocence and shine to recall the decoration of the Cathedrals.

In the field of activities turned to the maintenance, monitoring and safeguard, during the time, of a such important monumental "site" , some modern technologies of metric-qualitative surveying are been experimented.

2.PHOTOGRAMMETRIC SURVEY

The photogrammetric session consists in the survey executed with Nikon D100 digital camera, that we have calibrated in our laboratory with EOS Systems Inc. Photomodeler software for calibration, obtaining both the principal distance and the position of the principal point, and also the constants K1, K2, P1 and P2 to value the radial symmetric distortion of the lens (28mm and 50mm).
The results reached with the EOS Systems Photomodeler are the most interesting from the point of view of the survey and Vision Metrology. This software allows to work with both metric and not metric cameras. In this case, with the knowledge of the interior orientation parameters of the camera, the three-dimensional object model has been plotted starting from the

control points acquired by topographic survey and from the couples of homologous points separately located on the different images.

S.Caterine's church

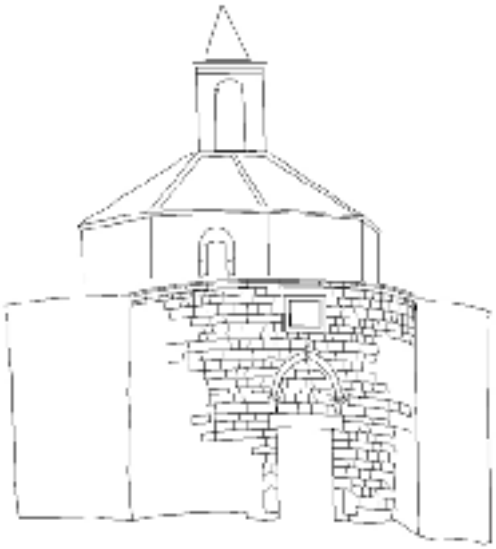

Fig. n.1 Draft plotting of S. Catherine's church.

The Figure n.2 shows the first model images used with the location of the over 1000 homologous points.

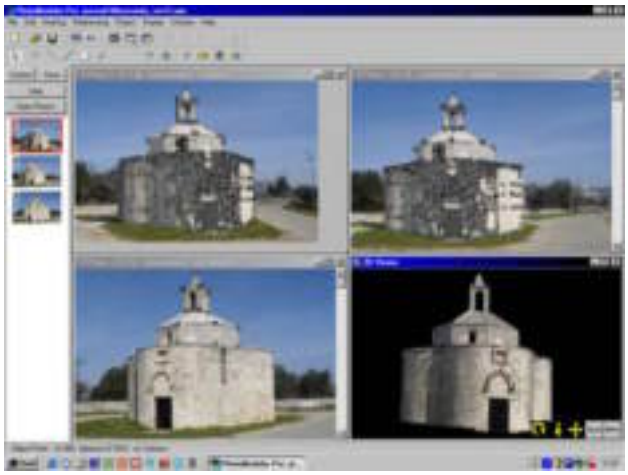

Figure n.2 The homologous points located on the two photograms.

The Figure n. 3 shows the three-dimensional raster model, obtained from the same images used in the plotting phase. It has been processed with the VRML format, suitable for the Internet browsers visualization.

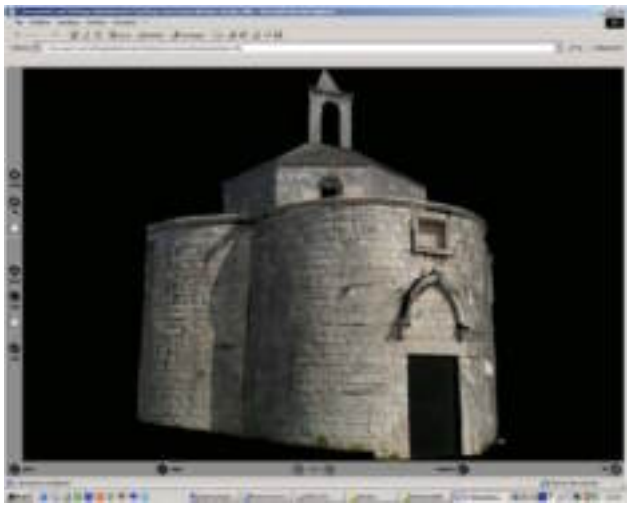

Figure n. 3 The three-dimensional photorealistic model of S. Catherine's church.

"Grotte di Castellana"

On the same carsick formation, it has subsequently been effected the metric survey with total station LEICA TPS 700 (no-prism). They have been individualized, with target placed in opportune positions, a series of check-points those constitute the reference scheme for all the subsequent operations.(Fig. n. 4)

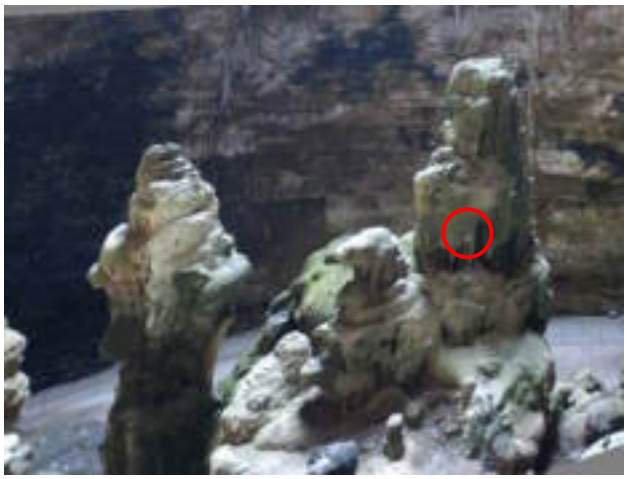

Figure n.4 Stalatgmites group with target points.

The photogrammetric survey of the same group of stalagmites has been effected with the digital camera NIKON D100 (6 Mpixels, f=28mm) to adapt it for the photogrammetric use: they have been calculated the parameters for its internal orientation. Subsequently, through the software Photomodeler of the Eos Sys., that uses the surveyed check-points, their coordinates are also been attained through the photogrammetric method, as shown in the following Fig. n.5.

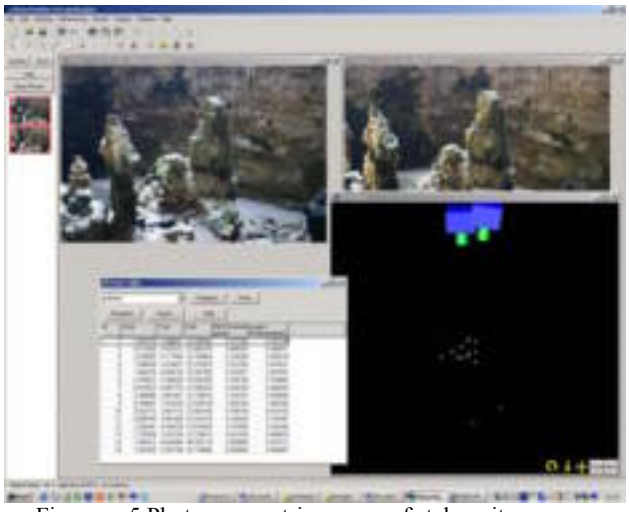

Figure n. 5 Photogrammetric survey of stalagmites group.

3.LASER SURVEY

MENSI GS100 3D laser scanner is the exceptionally versatile solution for accurately capturing large sets of coordinates. With a 360º x 60º field of view and a range of 2-100 meters can capture large scenes or objects with less individual viewpoints. GS100 is capable of collecting up to 5000 points per second resulting in an highly detailed point-cloud data.
GS100 provides highly accurate data after the merging of individual viewpoints. The scanner offers an uninterrupted panoramic capture of a scene up to 200m x 200m x 60m indoors or outdoors. As well as capturing 3D coordinates, GS100 provides easy recognition of scanned data combined with color images of the objects created by an integrated video camera equipped with digital zoom.

S.Caterine's church

The laser survey has been effected in two steps with the aid of 3D targets of spherical form positioned in each one acquisitions. The first acquisition for the exterior surface and the second one for all the interior surface has been merged and we have obtained the 3D model.
We see the plan projection of the cloud of over a million points in the Fig. n. 6.

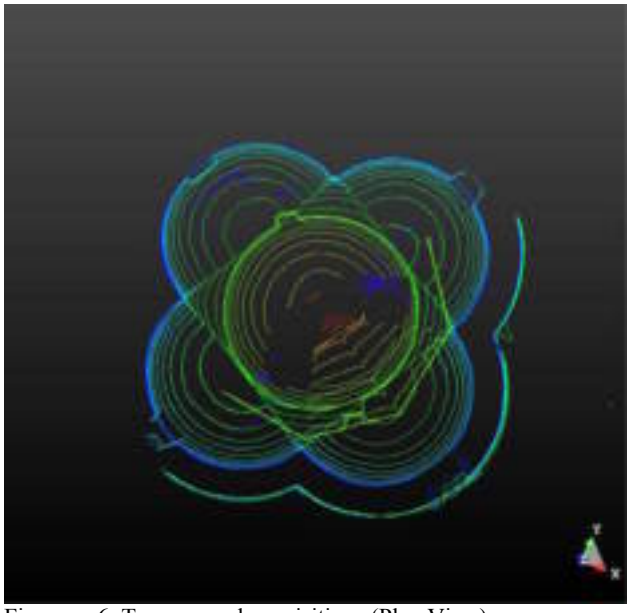

Figure n. 6 Two merged acquisitions (Plan View)

In the following figures we show the results of acquisition with the information about color in Fig. n. 7 and about brightness in the Fig. n. 8.

Figure n. 7 The 3D model of the interior surface with RGB.

Figure n. 8 The 3D model of the exterior surface with brightness

From the 3D model so obtained, we can extract the mesh surface shown in the next figure n. 9 and all the section we need as we see also in figure n. 6 and n. 7.

Figure n. 9 The model with mesh surface and vertical sections.

“ Grotte di Castellana “

Also in the **“ Grotte di Castellana “** we have realized two laser scanning acquisitions the first for the cave all around 360° at lower resolution and the second one for the stalagmites group at the highest resolution of the instrument.
In this survey we haven’t moved the position of the Laser Scanner and then we have merged the two clouds of points without registering any targets.
In the next figure we shown the two clouds of points only with 3D coordinates obtained in a very short time.

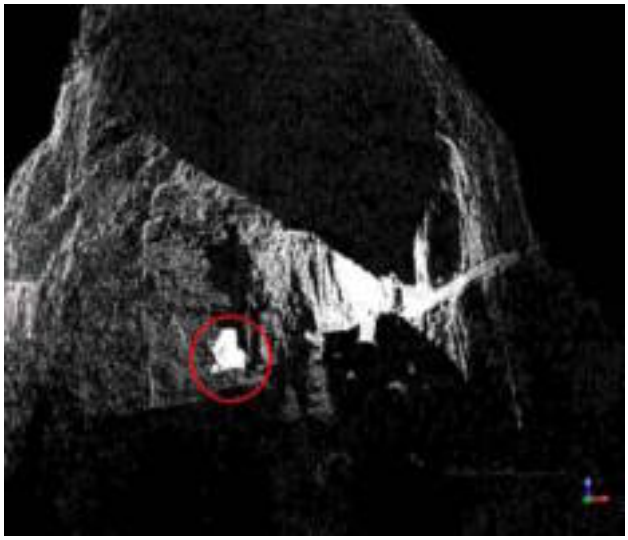

Figure n. 10 The cloud of the cave and of the stalagmites group

Also for the caves we have product a meshed surface of the stalagmite detail and in the Fig. n. 11 we show in the same time the surface and the horizontal sections obtainable.

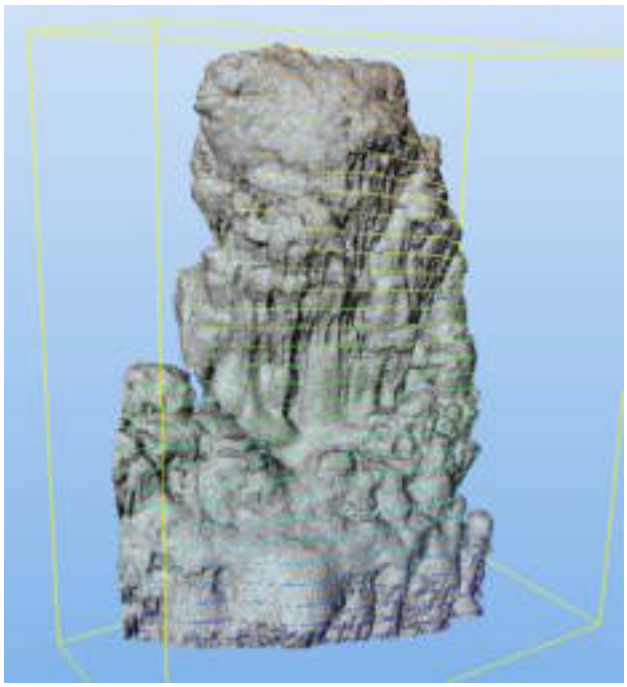

Figure n. 11 3D mesh of the surface and horizontal sections.

4. CONCLUSIONS

The achievable accuracy with any specific technique determines a considerable variety of attainable products that vary from navigable three-dimensional models for tourism to 3D Information System for Architectural Heritage conservation and restoration.
Recent instruments with minor accuracy achievable (digital cameras, etc.) can certainly be utilized for three-dimensional models, also with 3D Modelling and Virtual Reality techniques, in order to permit knowledge and fruition of monuments.
The laser survey acquisition has permitted three-dimensional coordinates identification of scattered points. These describe an opportunely treated geometry of surveyed object and consent three-dimensional model realization of its exterior surface.
This model can aid image analysis operations, supporting future Restoration and Conservation projecting decisions.
This study shows that both the used systems easily produce an three-dimensional model enjoyable in Virtual Reality with the characteristic of further information both of form that metrics in the case of the Laser, while with greater semantic contents in the case of the Photogrammetry.
The same modern laser systems (i.e. Mensi) they already allow to associate to every surveyed point the relative value RGB.
We believe that, in the future, we will be able to use the methods of metric survey as the Laser Scanning and the Photogrammetry to get both summarily resulted descriptive of the volumetries of the Monuments.
In the next searches the procedures of merge will be verified among the products of the two systems of survey with the purpose to improve the quality of our model 3D for the Virtual Reality.

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