

USING PHOTOGRAMMETRY AND LASER SCANNING IN SURVEYING MONUMENTAL HERITAGE: LE GROTTE DI CASTELLANA

M.Caprioli^a, M. Minchilli^b, A.Scognamiglio^a G.Strisciuglio^a,

^a Dipartimento Vie e Trasporti - Politecnico di Bari
v. Orabona 4 - BARI

^bUniversità di Sassari

m.caprioli@poliba.it

Commission V, WG V/4

KEY WORDS: Cultural Heritage, Photogrammetry, Modelling, Laser scanning

ABSTRACT:

Using the most recent survey techniques of an Architectural or Monumental Heritage, this study investigates problems on three-dimensional modelling in order to develop and to promote vision metrology.

Treatment of different survey techniques aims at defining, in a systematic way, their own distinct procedures and, meanwhile, investigating numerous uses for various fields of application.

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.

As a first approximation, it is intuitively remarked that Laser Scanning and Metric Cameras Photogrammetric survey products will be addressed to precious Monumental Heritage, in which accurate control operations of spatial information, with perfect metric object knowledge for conservation and restoration, it is necessary. All this is true both for Architectonic manufactures and other artistic and historical works that would be studied and preserved.

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 public knowledge and fruition of monuments. In this case we want investigate in such situations, and with what accuracy they already are a valid alternative in the field of Monument metric description.

In this study we analyse a monumental site, “Le Grotte di Castellana” situated in Castellana (Bari), in the Apulia region.

It has been realized a survey campaign with Laser Scan Mensi GS 100, Photogrammetric instrumentation: Nikon D100 reflex digital camera with 6 Mpixel CCD calibrated in our laboratory.

We have investigate different methods of camera calibration with commercial softwares (StereoView, Photomodeler, etc) and we have product orthophotos using Digital Surface by Photogrammetric correlation.

The survey process had 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.

Such spatial informative system model can aid image analysis operations, supporting future Restoration and Conservation projecting decisions.

Introduction

“Le 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;
- tightened way of passage in which the time seems to have stopped to the epoch in which the course of water, that has created the caves, flowed.

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, particularly the Laser-Scanning method and the digital Photogrammetry.

The experimental study, started with the present job, has the purpose to predispose a feasibility project for the realization of a virtual run of elevated metric-qualitative characteristics that allow a "virtual visit" to all people of the same caves and the chance of worldwide web logon, in order to promote the same monumental heritage.

Laser Survey

A test has been effected in the first cave of the tourist run: "La Grave" (dimensions mt 100x40 in ampleness and height of about mt 60), that would require a survey of precision for its largeness and for the exceptional characteristics of environmental value. This is difficult to realize with the traditional methods and it's very expensive from the economic point of view.

First of all, "La Grave" has been entirely surveyed for a first qualitative evaluation.

The used instrument is the Laser-Scan GS100 of the MENSI, that has an angular maximum resolution of 0.02 gon, with a window of scanning of 60° in vertical and 360° in horizontal, that allows to get, therefore, scannings with least grate, at small distance of mm 3x 3.

The range of distance measurement, through "time of flight", varies from mt 2 to over mt 100, maintaining a good resolution, but it's possible to reach a value greater than mt 150. A particular characteristic it's the lack of conditioning of the damp (94 - 100%) present inside the caves on the instrument, both in the range and in the accuracy field.

The result of the scanning, gotten in few minutes, it's shown in the Fig. n. 1.

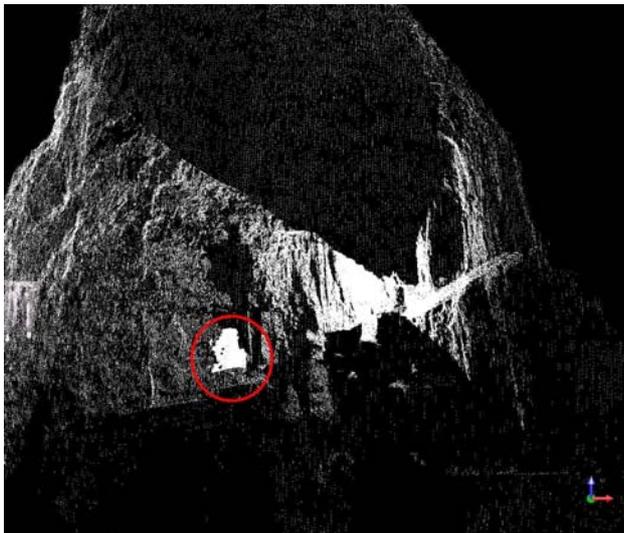


Figure 1: Laser scanning of the "Grave" and stalagmite

In the same figure it has been underlined, with a red ring, the group of stalagmites that appears to visitors in the entrance of the great cavern; subsequently it has been surveyed with the maximum resolution allowed by the instrument (mm 3x3), getting a cloud of points that describes with great accuracy the surface of the same stalagmites.

The result is shown immediately after the laser scanning operation, directly during the survey campaign, Fig. n. 2.

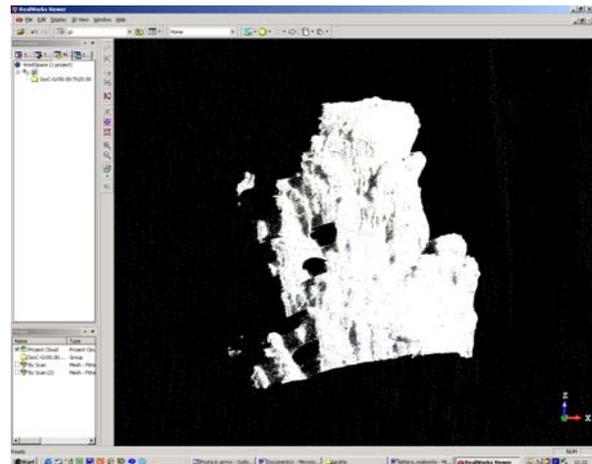


Figure 2: Laser scanning of the stalagmite

The software for the elaboration of the laser data, "REAL WORKS", has allowed the following treatment of the points' cloud to get a model of the surface (3D meshes) as shown in the Fig. n. 3.

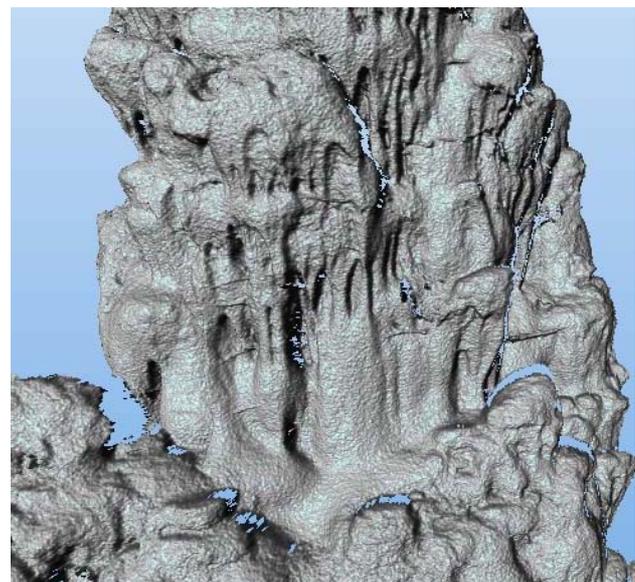


Figure 3: Mesh of the stalagmite

Besides, it's possible to attain a different representation of surveyed object associating to every single point the information linked to its color, recorded during the scanning by the inner camera tool, getting the photo-realistic model shown in the Fig. n. 4.



Figure 4: Laser scanning with RGB information

Photogrammetric Survey

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.

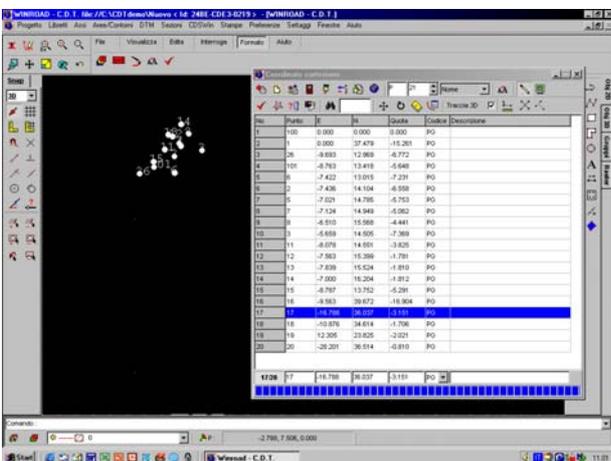


Figure 5: Topographic survey

The photogrammetric survey of the same group of stalagmites has been effected with the digital camera NIKON D100 (6 Mpixels, f=28mm) previously calibrated in the Laboratory of Topography and Cartography of the Polytechnic of Bari, 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.6.

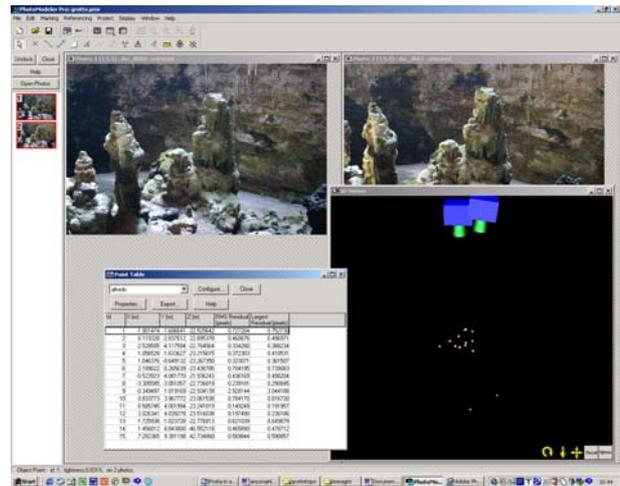


Figure 6: Photogrammetric survey

Conclusions

From the acquired data it's easy to product an orthophoto of the same "group", gotten by the projection of the photos realized with the Nikon D100 camera on the cave leading plan, using the coordinates of the surveyed points.



Figure 7: OrthoPhoto

Besides, it's possible to get, with great precision and rapidity, the sections of the studied element in all the directions, using the data of the laser scanning survey, as it results evident from the following Fig. n. 8.

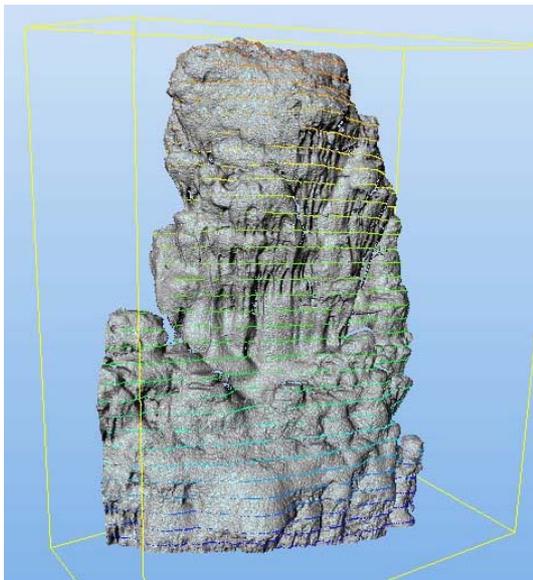


Figure 8: 3D model with sections

They are still in execution phase, the operations related to the transportation in the same reference system of the coordinates of points attained by the laser survey and those attainable from the digital photogrammetric model produced.

At this point, it will be possible to link the consequential advantages from the two used techniques:

- metric accuracy of laser scanning survey campaign;
- high resolution and semantic argument of the Photogrammetric survey.

A further product, in course of elaboration, it will be constituted by an ortophoto of the surveyed monumental detail: it has a greater metric accuracy and photo-realistic quality.

In conclusion it will be realized the three-dimensional model of the surveyed object, having contemporarily the qualities of the two techniques.

The example realized confirms the feasibility to realize in the future a virtual navigable three-dimensional model for the whole monumental heritage of "Le Grotte di Castellana", in order to allow a better knowledge and fruition for tourist and popular aims.

Such procedures are also essential to start a system of control, verification and monitoring, during the time, of a naturalistic site of so great importance and delicacy.

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