NEW TRENDS IN DIGITAL PHOTOGRAMMETRY TEACHING AND DIFFUSION: THE Z-GLIF SOFTWARE

Luca Menci (*), Fulvio Rinaudo (**)

(*) MENCI SOFTWARE s.r.l.- Via Martiri di Civitella 11 - 52100 Arezzo
tel. +39 0575 300552 - fax +39 0575 355832
E-mail: info@menci.com
(**) Politecnico di Torino – DITAG - C.so Duca degli Abruzzi, 24 – 10129 TORINO
Tel. +39.011.090.7659 Fax. +39.011.090.7699
E-mail: fulvio.rinaudo@polito.it

KEY WORDS: Photogrammetry, Architecture, Teaching, Software, Digital, Experience

ABSTRACT

Many experiences have been done in the past in order to promote a wide diffusion of the photogrammetry both in teaching and professional works.
Only the digital evolution allowed a real step forward in this direction. In the last years prof. Jachimski and prof. Grussenmeyer offer interesting and low-cost software solutions which help a lot the diffusion of the photogrammetric approach as a standard tool for architectural and archaeological applications.
The paper presents a new easy-to-use but rigorous photogrammetric software named Z-Glif, produced by Menci Software, a private Italian software house which collaborates with Politecnico di Torino in order to produce new solutions in digital photogrammetry.
Z-Glif allows a single model orientation and plotting. Both aerial and terrestrial, metric and non metric digital images can be used.
Exterior orientation can be performed by using: the traditional two-steps approach (relative and absolute); the rigorous bundle adjustment solution; a simple method based on the relative orientation of a stereo-pair and the subsequent scaling by using just a known distance on the object to be surveyed (so absolutely oriented in a local 3D reference system).
Considering that an automatic relative orientation can be computed by the software, Z-Glif is open also to unskilled users: the 3 x 3 rules for a correct stereo-pair acquisition and a basic use of the software is the only skill required to manage a complete and rigorous photogrammetric survey in a local reference system. The fit of the local system into the survey reference system can be performed directly inside a CAD environment.
Also non metric images can be managed: a DLT approach is implemented in order to calibrate and orient a non metric stereo-pair: this procedure allows the management of old and film based images which are often the only source of historical metric data.
The bundle solution allows the calibration of modern digital cameras by using a self calibration approach.
Thanks to the digital approach, many automatic procedures have been implemented in order to simplify the management of a photogrammetric process by not skilled users. Semi automatic interior and relative orientation allow the user to speed up the preliminary phases of the photogrammetric process.
The needed hardware is a simple PC without any particular device for the stereoscopic view: the stereoscopy is guaranteed by means of the color anaglyphic method.
License policy provided are of three types: installation on a single workstation; installation on Internet and local server.
Z-Glif collects the most important results and experiences acquired in the field of digital photogrammetry and in the architecture and archaeological applications of the photogrammetric technique thanks to the experiences and studies promoted inside CIPA in the last decades.

INTRODUCTION

Photogrammetry are becoming more and more the best technique to be used for the metric survey of architectural objects. Also the LIDAR technique require a wide integration with photogrammetry in order to give affordable results in terms of accuracy, readability and fruition of the metric survey.
It is well known that the development of the Digital Photogrammetry has represented a true revolution in terms of diffusion of this technique.
Today the acquisition of digital images is a common task and the metric management of them can be approached at different quality levels: calibration of non metric digital cameras, management of high resolution digital images are today possible by using standard PC.
Also the orientation and plotting phases has been speed up by digital approach: the autocorrelation algorithms allow the use of photogrammetry to unskilled people. Automatic orientation and homologous points collimation are today well known and the results can be used inside a photogrammetric survey with an high level of accuracy.
Also the teaching has been improved thanks to the digital approach of the photogrammetric technique.
Today during a standard course of 100 hour or less it is possible to give to the students all the knowledge and practice they need to approach a photogrammetric survey with the needed degree of competency.
In the following paragraphs a new photogrammetric software is introduced: Z-Glif.
It runs on standard PC, uses the most advances in digital photogrammetry in order to give the possibility to manage a complete and rigorous photogrammetric software and it has been conceived in order to allow a direct approach also to unskilled people.
In addition the low costs let to classify Z-Glif as a new software following the tradition of CIPA to propose cheap and rigorous solutions to expand the use of Photogrammetry in Cultural Heritage Documentation.

1. PREVIOUS EXPERIENCES

During the last 10 years two experiences were presented to CIPA participants in order to speed up the diffusion of Photogrammetry among the Cultural Heritage measurement practitioners.
The first one is ARPENTEUR [Drap, Grussenmayer, 1998]. Designed in 1998 by two French research teams (GAMSAU-CNRS and ENSAIS), this software has been developed in JAVA for a use on the Internet. It is mainly dedicated to close range terrestrial applications, but aerial images (can be also handled. It can manage images from a wide range of cameras (metric and non-metric camera, digital amateur camera). ARPENTEUR has been used in many research projects and for teaching activities.
The second interesting project presented to CIPA was VSD (Video Stereo Digitizer) developed and produced by the Department of Photogrammetry and Remote Sensing of the AGH of Krakow (Poland) under the direction of prof. Joseph Jachimski. This software represented a good way to teach photogrammetry thanks to its rigorous approach to digital procedures.

2. Z-GLIF DIGITAL PHOTORAMMETRIC SOFTWARE

Z-Glif is a new digital photogrammetric software which allows an easy teaching of the photogrammetric practice thanks to the use of the most advanced solutions in digital photogrammetry.
The main goal of the software is to allow the possibility to practice photogrammetry in a standard PC LAB as it is possible to find now inside each University: no special hardware is required and only a local server is required in order to manage the licences.

2.1 Minimum hardware requirements

The needed hardware is a simple PC without any particular device for the stereoscopic view: the stereoscopy is guaranteed by means of the color anaglyphic method. Each user has to be equipped with a pair of glasses (red/cyan) and can appreciate the benefit of an easy color stereoscopic view.
Z-Glif runs on Windows 2000 and Windows XP OS and the needed PC devices are:

- display adapter with at least 128 MB of dedicated memory;
- hard disk with at least 80 GB of free space;
- 512 MB of RAM;
- Intel Pentium 4 2.6 GHz (o equivalent) processor;
- 3 buttons mouse with wheel.

License policy provided are of three types:

- **Local**: installation on a single workstation. An USB hard key is used for software's authentication.;
- **Remote**: workstations where the software is installed must be ever connected to Internet. The software's authentication is provided by Menci Software remote server without any hard key;
- **Lan**: a local Lan authentication server is installed on a particular machine that is accessible from other workstations on the Lan. The server machine must have a static IP address and an hard key. Client workstations must obtain the authentication from Lan server.

The Lan solution allows to overcome the traditional Photogrammetry Lab structure: By using this solution students can find a photogrammetric plotter directly on their PCs beside other basic tools as world-processors, CAD, etc.

2.2 Image management

Z-Glif can manage all kind of images: aerial and terrestrial, metric, semimetric and non metric scanned images and digital images (metric or non metric).
The images to be imported can be recorded by using the most diffused formats (e.g. TIFF, JPG, ECW, JP2) but they are managed inside the software in a TIFF TILED format. This format allow a quick management of the images useful both for computation and visualisation tasks.
In case of metric (photographic or digital) and semimetric images the user has to fill in the calibration certificate in order to communicate to the software all the information useful to correctly manage the data.

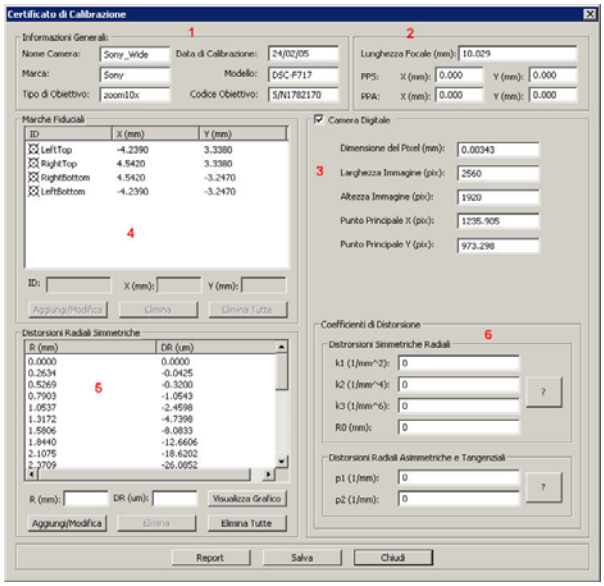

Figure 1 – Calibration certificate input

2.3 Interior orientation

The interior orientation runs automatically in case of digital images and in semi-automatic mode if digitized traditional images are used.
The proper calibration certificate is associated to each image and the user has just to check if the procedure has been done in the right way.

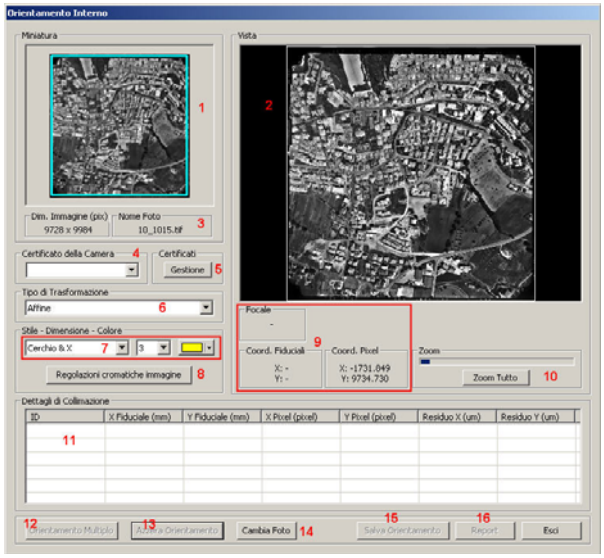

Figure 2 – Interior orientation dialog window

2.4 Exterior orientation

Z-Glif can be considered a basic level photogrammetric software oriented to students who know the basics of Photogrammetry and able to understand the meaning of the different phases of the photogrammetric process.

The software can manage only stereopairs so no photogrammetric triangulation is possible in this context.

The images can be oriented by using all the possible approaches:

- relative and absolute orientations;
- bundle adjustement;
- self-calibration of non metric images;
- relative orientation and scaling by using a known distance on the object.

The last two possibilities are especially devoted to give to the students the possibility to manage a photogrammetric survey without any problems of to have specific instrumentation (e.g. metric camera or total stations).

The first two approaches are managed in a very effective way.

Once the left image has been downloaded a special filter. based on the well known Förstner interesting operator, find out the best points for the autocorrelation considering all the tiles of the image separately.

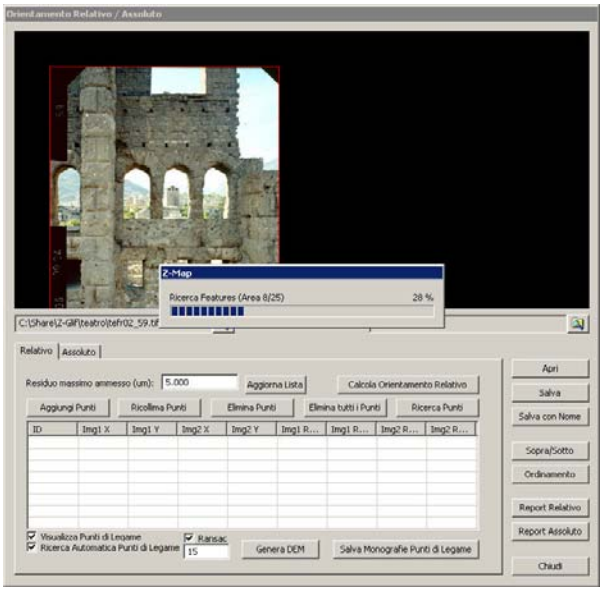

Figure 3 – Feature search

After the right image downloading, a similar procedure is applied to this image and an iterative process of "wedding" of the interesting points on the two images allows the definition of a set of possible tie-points (homologous but unknown points).

The user can check the correct distribution of the selected tie-points, eliminate or add tie-points and (in case of bundle adjustment) add the control points.

During the collimation of a new tie-point (or of a control point) the software require a monoscopic collimation inside one of the two images.

Splitting on the second image the software automatically (by means of a autocorrelation procedure extended at sub-pixel accuracy) try to find out the homologous point. The user can check the result of such automatic search and, in case of need, recover possible mistakes of the automatic procedure.

When the radiometric texture of the images is at a good level of quality no human interventions are required and then the relative (or bundle) computation can run automatically.

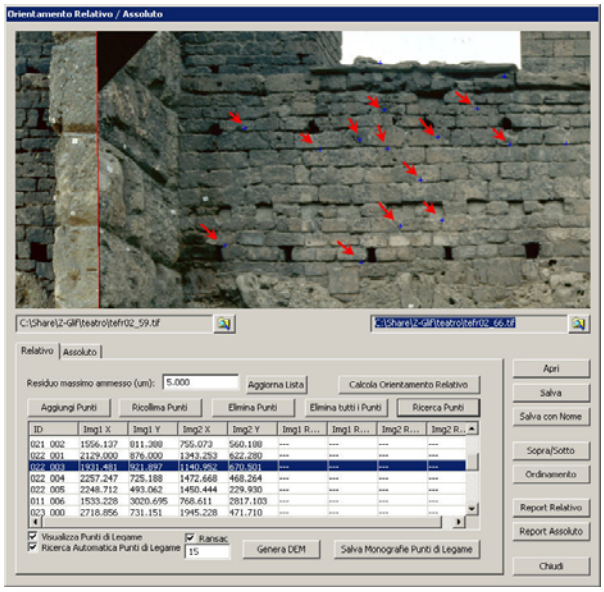

Figure 4 – Tie-point automatic selection on a stereopair

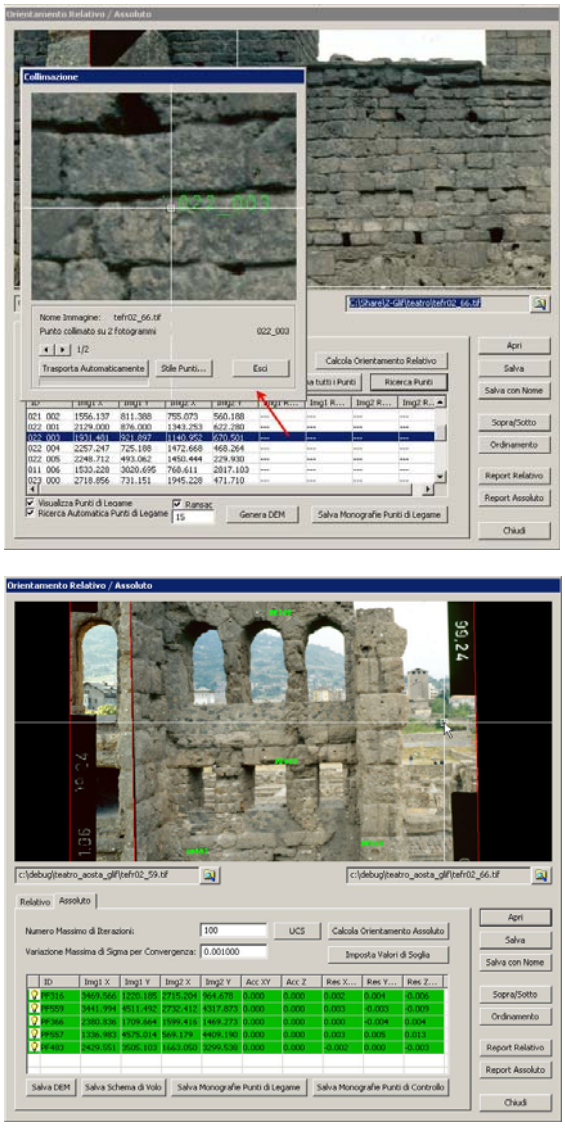

Figure 5 – Tie-point editing and automatic relative orientation

The self-calibration and the scaling of a stereomodel after the relative orientation are developed inside a CAD window.
In the first case the user imports the image or the two images inside the CAD and the control points to be used for the calibration.
Then the operator connects each control point with the corresponding position on the images and the software provide the adjustment of the calibration parameters.

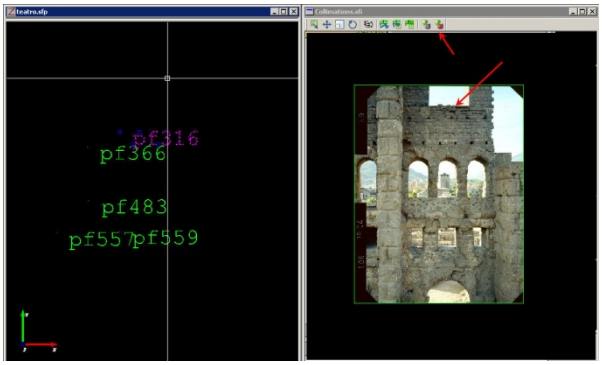

Figure 6 – Self- Calibration procedure

2.5 Stereo-plotting

When the images have been oriented it is possible to use colour anaglyphic view and a simple mouse to perform the plotting of the stereomodel.
The acquired entities are recorded inside a traditional CAD windows and exported in a DXF format per the editing and the final drawing.

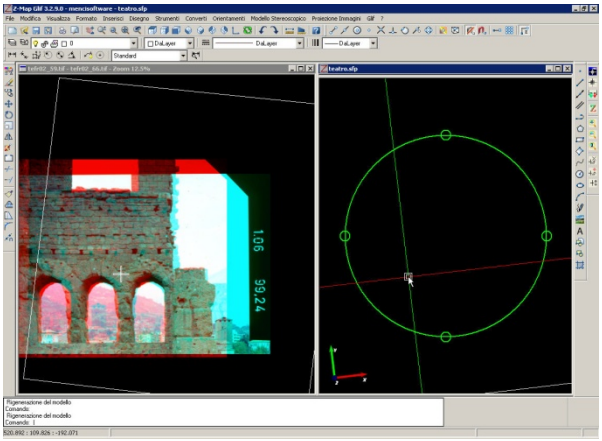

Figure 7 – Stereo and CAD windows

3. TEACHING EXPERIENCES

The Z-Glif software has been installed into 4 Informatics Laboratories of the Politecnico di Torino as basic tool for the survey courses both for architects and engineers.
The basics of Photogrammetry and the training by using Z.Glif are organised in 5 CFU courses usually followed by senior students after a general course on metric survey where basic information on least square adjustments and on the general organisation of a survey are given.
The theory of the photogrammetry is presented during the first lessons and after a good comprehension of the photogrammetric process the students are engaged in a practical work.
They plan the taking of the images considering the final tolerance required, the control point survey by using a traditional total station approach (connection to an existing control network, survey of the points and sketches production).
After that a short training on the basic functionalities of Z-Glif is given and then the students orient the images by using all the possible approach.
In order to appreciate the real achieved accuracy the students compare distances directly acquired on the object with the homologous quantities measured on the different stereomodels built-up by using the four orientation procedures.
Finally they start with the stereoplotting phase in order to generate a draft of the 3D model of the surveyed object and a final drawing based on the geometric information extracted by using the Z-Glif software.
At the end of the course (60 hours of theoretical lessons and a training and 65 hours) all the students are able to manage a complete photogrammetric survey in order to support the practical activities of other specialisation courses (restoration, monitoring, etc.).

4. CONCLUSIONS

Z-Glif represents a useful step forward in teaching activities connected to Photogrammetry diffusion.
In a short time it is possible to teach a good photogrammetric approach to metric survey to a big amount of people thank to the low economic impact of the licence policies.
Also the basic hardware requirements are favourable to all the universities where standard PC are provided as a general tool for all the students. In the past Photogrammetry Labs require ad hoc hardware solutions in particular to guarantee the possibility of the stereovision.
After the course all the students can access the Z-Glif in order to manage by themselves a photogrammetric survey.
The automatic solution adopted are realised in order to make clear their impact and to force an intelligent use of them.
In the opinion of the authors, Z-Glif can be used as a standard tool for the teaching of Photogrammetry not only inside traditional University curricula but also in “ad-hoc” training course for Documentation of Cultural heritage and standard application of the Photogrammetry into the different fields of activity of Engineers and Architects.

5. REFERENCES

Pierre Drap, Luc Long, «Photogrammétrie et archéologie sous-marine profonde. Le cas de l’épave étrusque Grand Ribaud F», Revue XYZ • (N°103, partie 1 et N° 104, partie 2) – 2e trimestre 2005

Pierre Drap., Pierre Grussenmeyer, Gilles Gaillard. Pierre-Yves Curtinot.2004 " Presentation of the web based ARPENTEUR tools: towards a Photogrammetry based Heritage Information System”. ISPRS XXth CONGRESS, ISTANBUL, 12-23 July 2004

Pierre Drap, Pierre Grussenmeyer, (1998). ARPENTEUR, an Architectural PhotogrammEtry Network for EdUcation and Research. ISPRS Comm. V Symposium, Hakodate, June 2-5, Japan. Int. Arch. of Photogrammetry and Remote Sensing, Vol. XXXII, part 5, pp. 537-542.