LEARNING KIT AND TUTORIALS FOR THE DIFFUSION OF THE DIGITAL PHOTOGRAMMETRY

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ABSTRACT

In recent years the digital photogrammetry has led available low cost instruments that are useful for the analysis of land and the cultural heritage. The learning *Kit* and tutorials could be new tools for the diffusion of these techniques.
The objective is the creation of an interactive guide, that is being suitable both as a traditional "paper" guide and an *on-line* guide, which, divided into modules, supplies both operative information and theoretic elements relative to digital photogrammetric process. The Kit is an instruments that allows a link between the world of the school and the professional world; it is also an efficient instrument for the formation of students and new operators. It could offer a great contribution in the ambit of co-operation with developing countries as it promotes low cost techniques.

1 INTRODUCTION

The ever increasing interest shown towards digital photogrammetry for applications connected to the analysis of the land and the cultural heritage has led to the necessity of a greater diffusion of digital restitution techniques both at the professional and teaching level.
This project arises from a collaboration between the Politecnico di Torino and Nikon INSTRUMENTS s.p.a.
The objective of the learning Kit is the creation of an interactive guide that furnishes both operative information and theoretic elements relative to digital photogrammetric restitution for the formation of new users: students, teachers or photogrammetric operators and managers.
a new formative way where there is no a division between theory and practices but rather a continuous interacting between these two parts.
It arose as an experimentation of a didactic methodology to learn restitution techniques through a new concept on low cost photogrammetric systems based on PC platforms, developed in the HTLM language and therefore implementable with internet.
The Kit could offer a great contribution in the ambit of technical-cultural co-operation with developing countries as it promotes low cost techniques that can be used by unskilled workers and gives guidelines for a correct use of these instruments.
The authors here present the structure and the subjects of the learning Kit, how the tutorial is organized and the kind of data it contains.

2 STRUCTURE AND SUBJECTS

The learning Kit has a modular structure. Each module contains a subject that is developed on three different levels.
The first level (practical/operative, A) guides the user in the use of the instruments and software that are necessary for each operative stage.
The second level (main concepts, B) introduces the general concepts that are relative to the photogrammetric procedure. It also contains the motivations and the comments on the results obtained during the operation described in the first level.
In the third level ("in depth studies", C) the subjects are completed and the users enter into the details of the problems (algorithms). There is also some information on the theoretical and technological development of the subjects. The users can choose the subjects and the level of information. The users can therefore have different preparation levels, but however acquire a complete vision of the field in which they are working.

The hierarchic structure, organized on different levels, allows use of the learning Kit for many different formative aims. The operative parts are dedicated to surveying students, the main concepts are useful devices for university graduates students, while the "in depth studies" offer more detailed knowledge to graduates and Phd students. This organization is both useful for the formation of digital photogrammetric operators and for the updating of skilled operators, programmers and technical managers.
The Kit, as previously mentioned, is developed in HTLM language and it is organized in different sheets.
The sheets are divided into two parts (see figure 1), one contains the link to a general index, a general bibliography and *Tutorials*, while the second contains:

- a title that define the module and the subject;
- an alphanumeric reference that show the level (A,B,C);
- links to an image or general definitions for complete treatment of the subjects.;
- links to a specific bibliography;
- links to the others levels;

Figure 1. Learning module example

At the first level the *ipertext* link with the images allows a step by step description of the different described procedures. The subjects of the Kit are organized in chapters (see Figure2).
The photogrammetric main concepts and definitions are introduced in the first part. This part is dedicated to the description of the acquisition units (DTP scanner and digital camera) and restitution units, with an analysis of the necessary hardware and software. The procedure necessary for the acquisition of the images, the recording in raster image format and the pre-treatment with image restoration and image enhancement techniques are also described.
The second part of the Kit is dedicated to the restitution unit. The photogrammetric orientations of the models, data acquisition and resolution of the aerial triangulation, the restitution procedure and some auxiliary restitution functions such as the automatic generation of DEM are described in this part.
The third part deals whit the problems linked to the production of photomaps and digital rectification.
The last part is dedicated to the "stereo-photomap" and the 3-D navigator.

Digital images	Definition Sampling Memory storage Radiometric resolution	Raster image formats: - TIFF - JPG	Compression algorithms: - LZW - JPG
Digital photogrammetric unit	Definition	Hardware e software for acquisition unit Hardware e software for restitution unit	
Digital image acquisition	Direct acquisition: digital camera	Radiometric characteristics Geometric characteristics	Digital camera calibration
	Hard copy scanning DTP scanner	Radiometric and geometric characteristics in DTP scanner	DTP Scanner calibration
Digital image processing	Pre-processing Brightness and contrast control Chromatic correction	Image RESTORATION Image ENHANCEMENT	Radiometric stretching Local average filter Sigma filter K-nearest neighbour Adaptive noise reduction EPS HBF Wallis filter
		Image pyramids	Image pyramids generation Hierarchical multilevel representations
		Resampling	Notes
Restitution unit	Stereoscopic vision	Pixel matching Sub-pixel matching Interest operator	Pixel matching Sub-pixel matching Foerstner operator
Photogrammetric orientations	Inner orientation definition	Inner orientation	Inner orientation algorithms
	Common orientation two-step	Relative orientation Absolute orientation Orientation parameters precision	Automatic relative orientation algorithms
	Common orientation single-step	Spatial resection	
Photogrammetric triangulation	Photogrammetric triangulation definition	Photogrammetric triangulation Parameters precision	Observations equations Precision Assisted triangulation Semi-automatic triangulation Automatic triangulation Tie points selection Sketch
Restitution	Coding Points restitution Planimetric restitution Countour lines restitution Editing	Computer assisted collimation	Feature extraction Assisted collimation algorithms
Computer assisted Restitution	Automatic DEM extraction	Analysis of procedure	Algorithms VLL algorithm Approximate height Weighted windows
Digital orthophotos	Definition Digital rectification	Mathematical tools	
	Orthophoto image	Orthoimage generation	Height resampling *Anchor point* method
Stereo-photomap 3D Navigator	Stereo-photomap Navigation inside a block	Production of a Stereo-photomap Properties of the 3D Navigator	Algorithms. Data structure

Figure 2. Modules structure

3 TUTORIALS

The tutorial is the part that contains the practical exercises. The examples and the exercises are organized in such a way asto have a continuous correspondence between the “manual” and the practical operations.

It is a set of *data*, *results* and *comments*. The *data* are all the information that is useful for the development of the photogrammetric operation. The *results* are the data obtained by the restitution operator and the *comments* are the explanation and evaluation of the results and possible observations.
The tutorial is divided into two parts, one is dedicated to aerial photogrammetry while the other is dedicated to terrestrial photogrammetry.

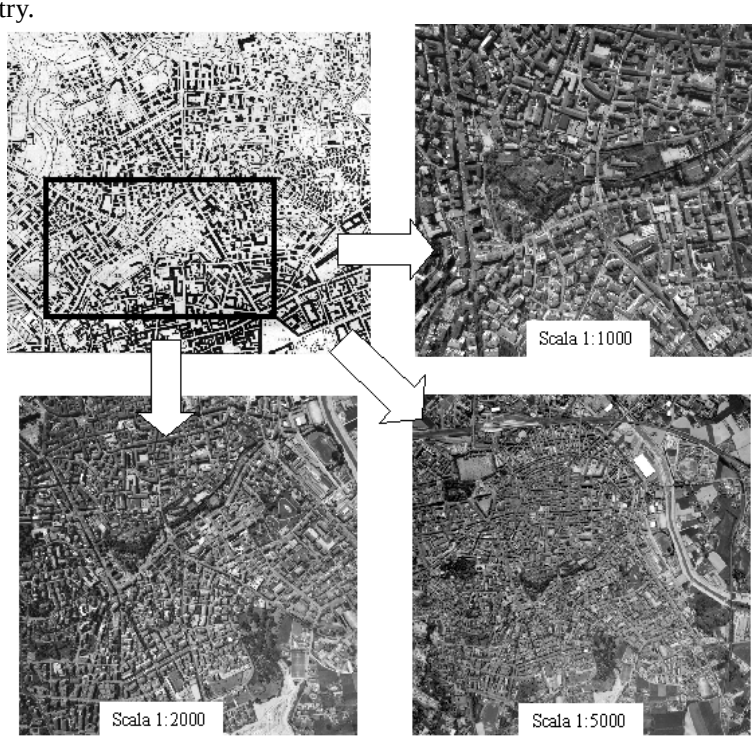

Figure 3 . Tutorial example (aerial photos)

The material for the tutorial has been produced in the photogrammetry laboratory at the Politecnico di Torino.
The tutorial part that is dedicated to the aerial photogrammetry gives an example of restitution and the production of cartography of the same part of the land at three different scales (1:5000, 1:2000, 1:1000) (Figure 3). The tutorial gives, as examples, information on the problems linked to the precision in the orientations and on tolerance in the production of cartography in the different scales. There are suggestion about the details that could be represented at 1:5000 scale or at 1:1000 scale. The example is completed with the restitution drafts and the final cartographic product.

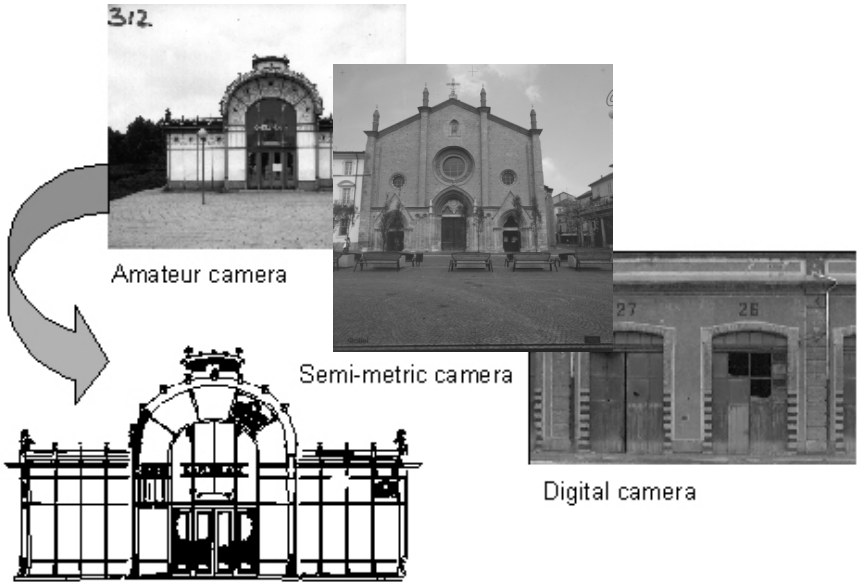

Figure 4 . Tutorial example (terrestrial photos)

The part of the tutorial that is dedicated to terrestrial photogrammetry supplies three examples of taking with three different kinds of cameras: amateur camera, semi-metric camera and digital camera. In this tutorial, the users learn to understand the different between an aerial restitution and a terrestrial one and the difference between tolerance, representation and codification.
The tutorial also guides the users in the production of a "stero-photomap" and in the use of a new instrument, named 3-D Navigator, which is suitable for exploring the stereo-photomap. This is an instrument that allows one to have access to the information offered by the images, without any need of a preliminary restitution.
In the Tutorial the users can practise on real examples, compare their results with the results of an expert operator and understand the meaning of the data that they obtain. The tutorial is a fundamental part in the blank structure: it allows the students to check the level of learning and suggest news practical exercises for a deeper knowledge of the instruments and operations. The exercises are in fact developed not only at the first level, but also at the second and third levels.

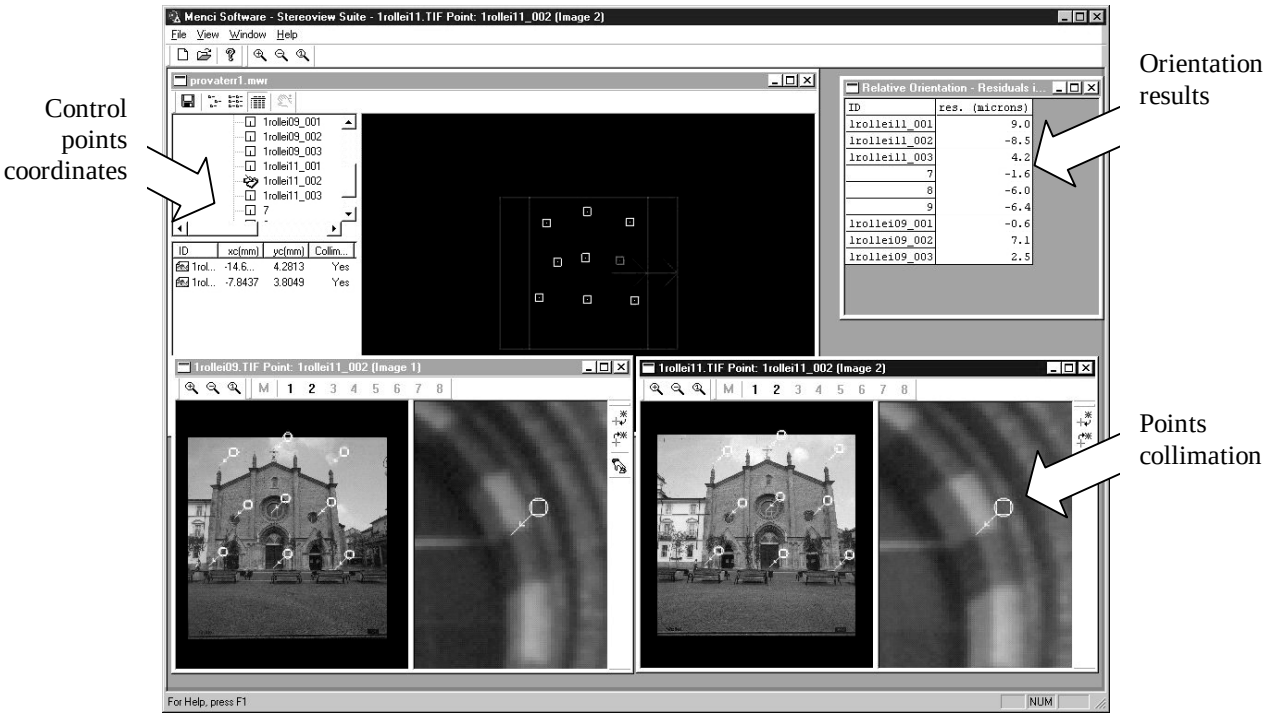

Figure 5 . Tutorial example (terrestrial photos)

4 CONCLUSIONS

The learning Kit could be a good instruments for the diffusion of digital photogrammetry techniques.
The diffusion of digital photogrammetry, using low cost and friendly instruments (PC platform and windows), could lead to the necessity of more operators. In this contest the learning Kit and tutorials could be an efficient instruments for the formation of new operators or for the updating of analytical expert operators. Developing countries in particular could start to learn about , to the digital technology in a economic manner.
The collaboration with Nikon INSTRUMENTS s.p.a. and the Politecnico di Torino has led to the desire to coincide theory with practise and the world of the school with the professional world. The practical part together with the theoretical part, apart from supplying effectiveness and research ideas for the students, also leads to an updating and in depth studies for technicians in the sector.

REFERENCES

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