

A NEW EDUCATION AND BUSINESS MODELS BASED IN LOW-COST DIGITAL PHOTOGRAMMETRIC WORKSTATIONS

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ABSTRACT:

Digital Photogrammetry has caused a revolution in the cartographic world thanks to a simplification of the photogrammetric systems. This fact, along with the ever greater need for fast and precise cartography, has increased the number of potential digital photogrammetric users. Despite the simplification of these systems, it is still important to take into account the high necessary investment of digital photogrammetric systems, particularly for sporadic users. Accordingly, it is fundamental that low-cost systems are developed which incorporate at least some of the tasks of need to initial users. These tasks could, basically, be limited to the extraction of information from images previously oriented (monoscopic and stereoscopically) and the generation of orthoimages, like such as basic documents on which to support another type of works. The STEREOVISOR system has been developed specifically with this idea in mind. STEREOVISOR is a digital photogrammetric workstation designed to provide maximum benefits for a low cost. The hardware incorporates a stereoscopic vision system by means of anaglyphs and the floating mark movement is controlled using a conventional mouse. The system incorporates several functions: a) project management; b) stereoscopic vision; c) vector information extraction, from previously oriented images as maps; d) orthoimage generation. Potential users are basically university and educational centers, governmental agencies and companies that actually are photogrammetric products customers. Such users could receive the oriented images and the program so that they can extract such information as may be of interest whenever they want.

1. INTRODUCTION

Prior to the digital era, Photogrammetry moved from sophisticated optical-mechanical instruments to electronic analytical systems, but always with the need for expert operators. Digital photogrammetry has eliminated the need for such optic-electronic systems, as well as, to a certain extent, the need for expert operators. Digital images are processed with algorithms that allow automatic measurement, and they are observed using a conventional computer display screen for interpretation.

In production environments, the software applications can be very simple (visualization only) or very complex suites that incorporate diverse programs that encompass the entire digital photogrammetric production workflow (Gómez-Molina, 2000).

The most important results that can be obtained from digital photogrammetric systems are:

- Digital aerial images
- Oriented images using direct (INS) or conventional procedures
- Digital Elevation Models (DEM)
- Digital Orthoimages

These products usually are structured in cartographic photogrammetric projects. Currently, these projects must fulfill the following characteristics:

- *Fast:* They must be executed in under a 2-year time limit, and must allow for future updating.
- *Integral:* They must cover the territory by a single stroke (municipality, province, region or nation).
- *Homogeneity:* Technically, they must use the same procedure for the entire territory.
- *Available information:* The photogrammetric products must be available for the users (government agencies, companies ...).

The best way to prevent the information for ending up forgotten in some drawer is to provide adequate tools for a direct manipulation by final users, accompanied by an adequate pricings policy for distribution and sale.

Photogrammetric products must be catalogued and include the corresponding metadata information in order to allow for searching, localization, visualization and exploitation in a fast and friendly manner.

Such a quantity of information and digital photogrammetric products need adequate applications that allow for two primary objectives:

- visualization
- information exploitation

In order to allow for the interactive information management that is included in the photogrammetric products, we have designed an integrated software system running in Windows environment according the structure that is shown in figure 1.

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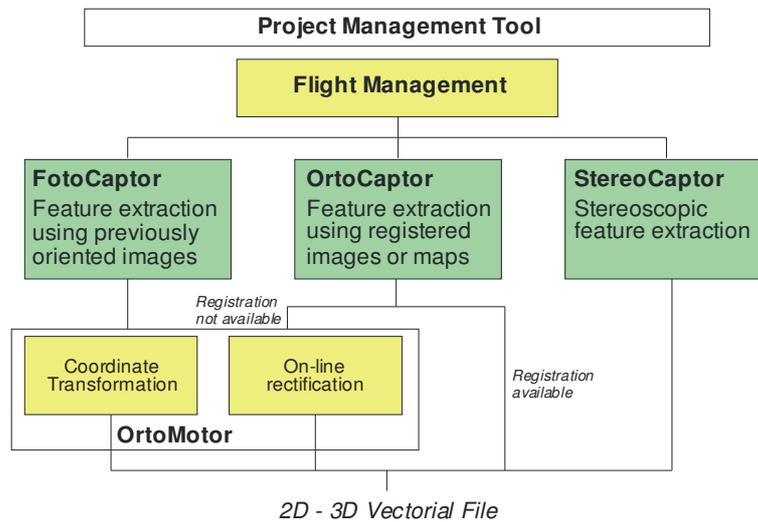


Figure 1. General schema of STEREOVISOR system

2. PROJECT MANAGEMENT

The Project Management tool is designed for the search, consultation and visualization of available photogrammetric information of a determined geographic zone. This is the data selection module that will be used in the feature extraction process.

The database includes the information about aerial photographs (figure 2), orientation parameters, digital elevation models (figure 3) and orthoimages (figure 4).

This module allows for alphanumerical and graphical data visualization and query. Also it is possible to view other auxiliary information, such as flight maps, in order to complete the project information.

These different data types must be completed with the corresponding metadata in order to provide the simple and agile consultation and management of the available information. The metadata must also contain the orientation parameters and complementary photogrammetric information that will be necessary for a correct evaluation and analysis of available information.

The Project Management tool allows for appropriated data selection for subsequent vector feature extraction. Depending on available data, the system will select among the three available feature extraction tools: StereoCaptor (from stereoscopic models), OrtoCaptor (from orthoimages) and FotoCaptor (from orientated images). It is possible to access the different feature extraction tools using the Flight Management tool or export the select data in order to use them directly from the feature extraction tools.

3. VISUALIZATION AND FEATURE EXTRACTION

The feature extraction tools include the graphic functions for vector and thematic information extraction obtained from

previously oriented images (from direct –GPS/INS– or indirect orientation methods), stereoscopic models or orthoimages (with or without DEM).

The tools are designed to provide the necessary tools for thematic information extraction (land use, vegetation, forest maps) or urban and rural mapping from large scales (1/500 to 1/2.000) to small scales (1/5.000).

The system includes all the functions that are usually available in digital photogrammetric systems.

All the functions are common for the different feature extraction tools, making it a user-friendly system that is easy to learn. Functions are also fully customizable according to the particular characteristics of the work or user preferences.

3.1 StereoCaptor

The StereoCaptor tool allows for 3D feature extraction from stereoscopic models, using a similar schema as in conventional stereoplotters.

The stereoscopic visualization is based on the use of anaglyph images and it is specially designed to obtain perfect vision when infrared images are used (figure 5).

The vector information is superimposed to the stereoscopic imagery.

To put the extraction cursor on the ground, you can: (a) move the cursor manually with the mouse; (b) use the Snap-To-Ground function (the computer will automatically put the cursor on the ground using correlation functions, provided you have positioned it approximately); or (c) provide a terrain data file and instruct the software to have the extraction cursor “track” the DTM.

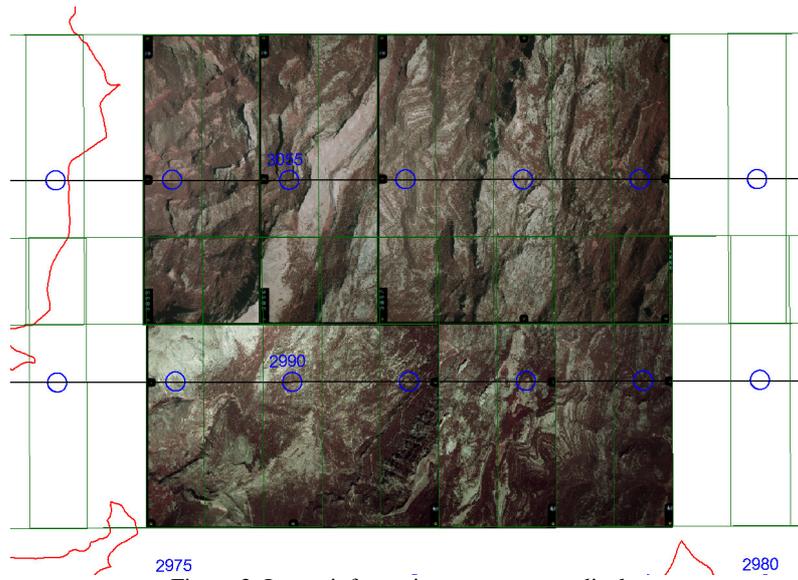


Figure 2. Image information management display

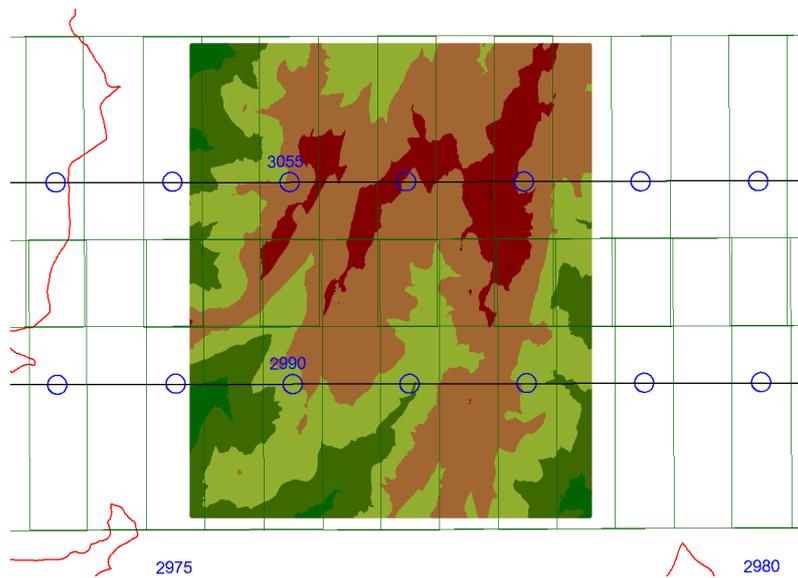


Figure 3. DEM information management display

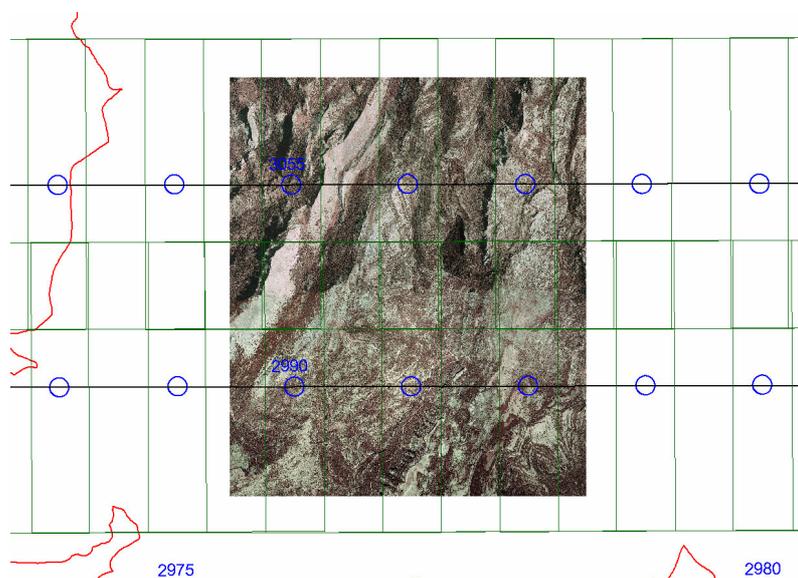


Figure 4. Orthoimages information management display

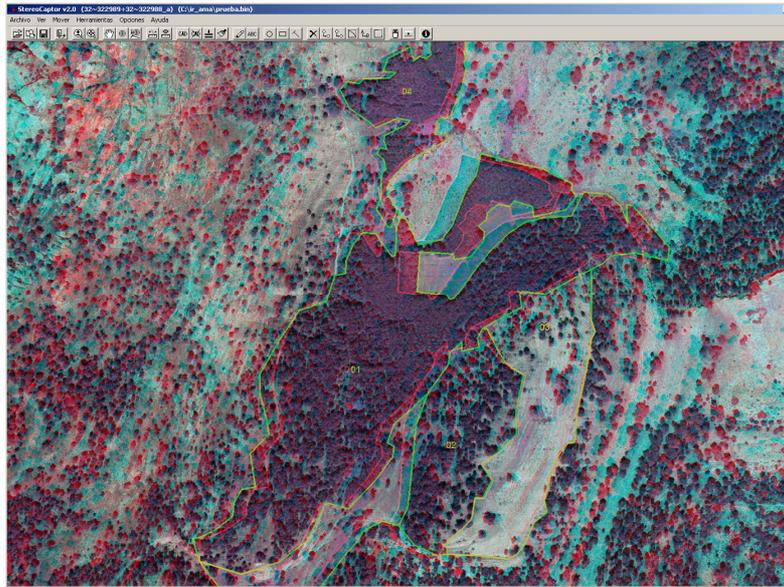


Figure 5. Superimposition vector information over infrared stereoscopic model (StereoCaptor tool)

The main characteristics of StereoCaptor tool are:

- Stereoscopic cursor displacement functions:
 - click and drag area selection,
 - roaming using the ground positioning through correlation functions,
 - roaming using a previous digital elevation models available on the area.
- Focus and parallax adjustment associated to the mouse wheel or keyboard.
- Zoom functions: windows zoom, zoom in, zoom out, model extension zoom, zoom 1:1
- Move to point function: the cursor will be displaced to a specific X,Y,Z position that is included in any of the project models.
- XYZ cursor position will be displayed in real time.
- Measure tool: Accumulated distance length measurement and the area and perimeter polygon calculation.
- The options will be available from main menu, tool bar or accelerator keys and the user-defined cursor.
- Cursor movement using a mouse or keyboard.
- User configurable display resolutions depending on the available graphics card.
- Semi-automatic model selection loading among the project models and among the available projects.
- Save user configuration for later executions.
- 3D view print capability.
- It is possible to store a determined model in the main memory in order to improve the speed for slow computers.
- Vector information visualization of the active file and other reference files. Capturing and edition of vector information and associated attributes.
- If there are no stereoscopic models available, it is possible to use an orthoimage for feature extraction using the OrtoCaptor tool. If a DEM is available, it is possible to obtain 3D information (Z coordinate accuracy will be the corresponding of the associated DEM).

4. ON-LINE ORTHORECTIFICATION

OrtoMotor (*OrthoEngine*) module is designed for performing the necessary bidirectional transformations between the photocordinate system and the ground coordinate system (terrain) (figure 6). Using this transformation coordinate schema also allows for the transformation between an oriented individual photogram and orthoimage or map, and vice versa. That way, all the vector information collected in a photogram, photogrammetric model or orthoimage can be shared.

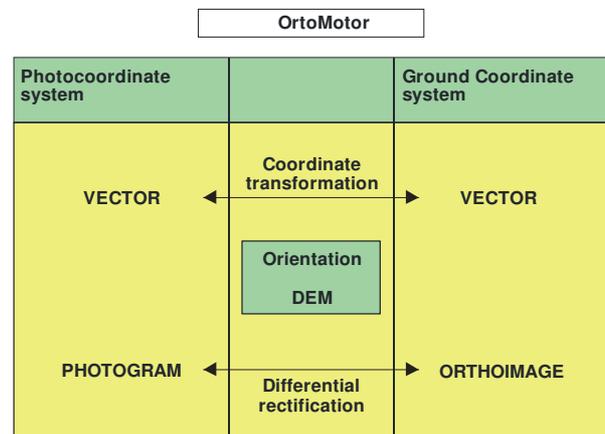


Figure 6. OrtoMotor coordinate transformation schema

Using the OrtoMotor module, it is possible to use the OrtoCaptor module even though an orthoimage is not available. OrtoMotor can generate an orthoimage in a real-time process by using differential rectification method with the orientation parameters and the digital elevation model of the desired area.

OrtoMotor module allows for the use of digitized photograms and a digital elevation model in order to capture 3D data, this operation is made using the FotoCapture module. The characteristics and operation of this module are similar to the above mentioned modules.

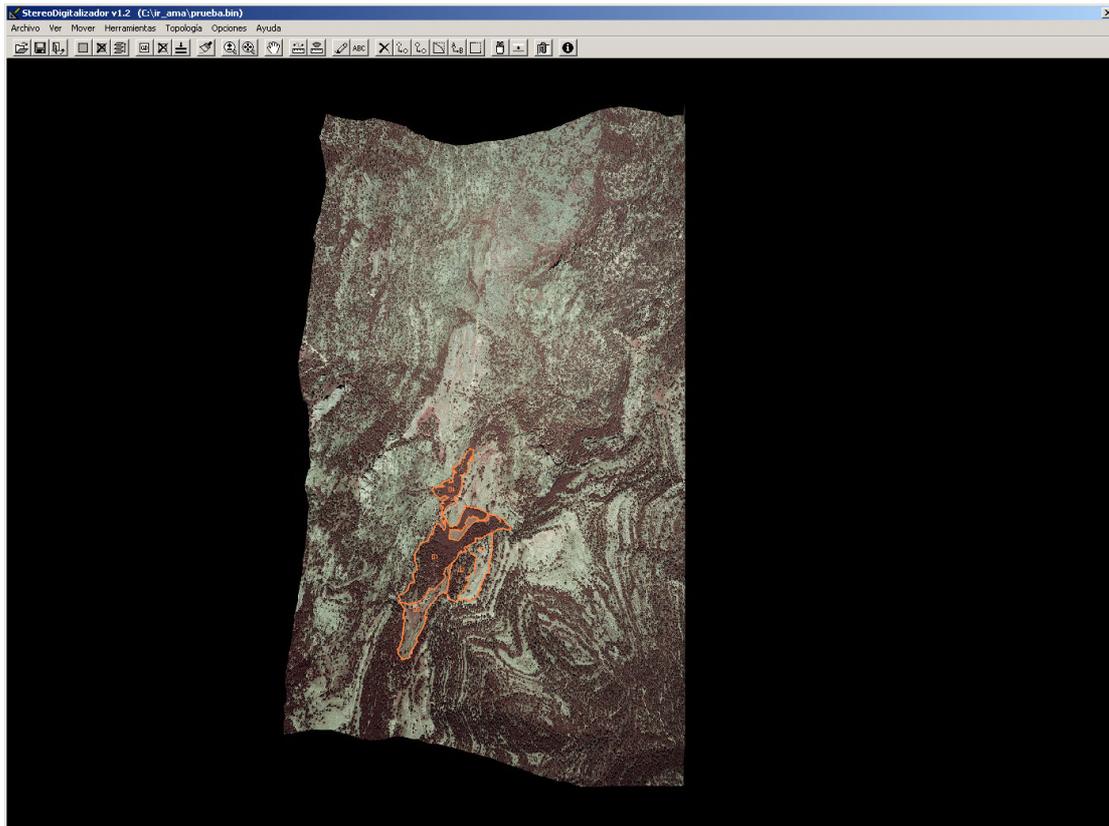


Figure 7. On-line orthorectification (working with OrtoMotor module)

5. TOPOLOGY CONSISTENCY

All the feature extraction modules include the necessary tools for the data collection (point, line, polygon and text entities). Each vector element has associated a code that allows grouping the different types of elements that have been captured and the color and width are automatically assigned. The color and width configurations can be configured by the user.

The system includes several assistant tools that allow the drawing of basic elements (arc, perpendicular to a determined line, 3 point circle, 3 point rectangle, ...). Two different options can be used in the capture of linear elements, the discrete mode (point to point) or the continuous mode (continuous line), also the system incorporate several snap utilities (automatic or semiautomatic) in order to guarantee a correct connection between elements.

It is possible to associated alphanumeric information (attributes) to the captured features in order to use this information in Geographical Information Systems.

There are several necessary tools for modification and edition of the captured features (figure 7):

- Delete element
- Recover deleted element
- Move element
- Copy element
- Edit vertex (linear or polygon features)
- Edit text
- Edit Attributes
- Partial deletion of linear or polygon features
- Break elements
- Find text

- Element information query
- Code element change

All the measurement and edition tools allow for the automatic movement of the visualization image position, when the cursor is near to the edge of the display, the image will be re-centered. The speed cursor is also configurable.

The visualization of the vector information can be activated/deactivated according to the associated code. The system also includes several tools for checking topology of the extracted features, such as, for example, code and attributes verification, dangle nodes, All the vector and alphanumeric information that it is collected with this system can be exported to other formats.

6. BUSINESS MODEL

The end user license agreement is not based on the traditional system in which the licenses are associated with a particular computer and are autonomous.

In this case the software is associated to a determined project and it is supplied to the final user (in a CD or via Internet) that includes the project images and associated orientation or registration data. There can be as many users as needed for the particular project. The basic licensing concept is project associated license and can be duplicated in many computers as the user needs.

The license includes the personification according to the specific uses or needs to the user or project. Only those characteristics that the user really needs will be supplied in the program.



Figure 8. Tool bar of the feature extraction module

7. SYSTEM CONFIGURATION

STEREOVISOR has been developed in ANSI-C for Windows programming language. The system runs on Microsoft Windows 2000/XP operating systems. One of the most important conditions that we have imposed to this system is that can be run in a conventional personal computer and does not included non-standard hardware requirements. It uses the DirectX technology available in the Windows Me/NT/2000/XP operating systems that are common among the potential users of this type of systems. In order to reduce the hard-disk space storage requirements, the system uses compressed images (using the ECW format).

The stereoscopic visualization system is based on an anaglyph vision that uses two different color filters (red and blue) for the images presentation. This solution allows showing the stereoscopic image with an adequate visual quality and practically do not need any hardware requirement (only anaglyph glasses). Another important advantage (fundamental for educational purposes) is that the stereoscopic model can be printed, projected (using a video projector for a large numbers of users) or used in laptop computers. The user can select the desired display resolution among the possible resolutions according to the capabilities of the corresponding graphics card.

The basic customers of this product are the non-specialized photogrammetric users (Leberl, 1992). In this vein, the system has been designed for simplicity of use. The user interface follows the usual structure of the MS-Windows programs. The interface includes menus, tool bars, accelerator keys (hot-keys) and other usual elements of this platform.

The basic requirements of the system are:

- PC (Intel Pentium processor).
- Microsoft Windows 2000/XP operating system.
- Recommended RAM 128 Mb.
- 8Mb memory Graphics card (minimum resolution 1024 x 786, 24 bits color).

8. CONCLUSIONS

Actually, there are several digital photogrammetric systems that can be used for the 3D image interpretation which are focused on the cartography and DEM production. Usually, they require expensive hardware and specialized personal for its use. A software system for 3D visualization of the available information related with a photogrammetric project has been developed.

This software does not have cumbersome hardware requirements and it has been designed thinking about the user's real needs. The information (features) can be collected from previously oriented photogrammetric images, registered images or orthoimages.

The system includes all the main tools that are usually employed in data collection of punctual, lineal, polygonal and text entities.

The main advantages of the system are:

- based in a low-cost hardware using anaglyph vision system
- flexible system that can be used by a large number of potential users
- the photogrammetric information is available for the final user in a reduced time
- it is possible to provide the oriented digital images for quality control of the photogrammetric process
- it is possible to provide stereoscopic view to a large number of users using a video projector connected to a normal personal computer
- uses intermediate products (like original images, orientation parameters, digital elevation models) that are normally unprofitable for the final user in the conventional digital photogrammetry work scheme
- using this system, there is possible 3D visualization through Intranet or Internet
- the end-user digital photogrammetry software licensing concept is changed to a project license concept

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