

## **Low Cost 3D Visualization and Measuring “Tool” for Architectural and Archaeological Photogrammetric Applications**

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Digital Photogrammetric Stations normally refer to specialized personnel and high operational costs. However, Photogrammetry is used increasingly more from non-photogrammetric professionals like Architects or Archaeologists. Generally, their needs are more primitive and elementary than that of a map making. However they can always take advantage of some of the value added modules of a Digital Photogrammetric Stations such as the 3D viewing and measuring subsystems.

Nowadays the cost of a 3D graphics card is very low. Using such a card with active polarization glasses and a wheel mouse it is rather easy to create a low cost “tool” with 3D viewing and measuring capabilities. Additionally many of the typical photogrammetric procedures could also function in automated mode.

Such a low cost price operating system with a user-friendly environment has been implemented in our laboratory.

The system is equipped with the procedures for epipolar geometry and least square image-matching techniques in order to provide the appropriate data for 3D viewing and sub-pixel accuracy measurements.

### **1. Introduction**

In order to produce digital photogrammetric products using a conventional photogrammetric process one can use an image capturing device and some specific hardware and software equipment. There are different categories of equipment that can be used and the appropriate one for each kind of different discipline is a subject to the expected accuracy and scientific background of the end user.

Especially, for the disciplines of Architecture and Archaeology the demanding accuracy of the photogrammetric products can be very high although the background of the end user (non-photogrammetrist architect or archaeologist) is rather poor in the photogrammetric procedures.

In that case, the operation of a high end Digital Photogrammetric System (DPS) is more than an architect or archaeologist can handle. There are cases, such as the recording of an archaeological site, that only a few of the capabilities of a standard DPS need to be used, such as the measuring of the depth in some single points of the excavation hole. In other cases, tools that can be of great help to an architect or an archaeologist, become very complicated in the programming environment of the DPS'. As an example, these simple tools can do the measuring of the 3D coordinates of single points or the measuring of lengths and the calculation of areas on the 3D model.

The main disadvantage of a DPS is the price, which can be prohibitively high. It is not the cost of the hardware equipment that makes inaccessible the DPS to a potential buyer, since the price of all the hardware equipment has become lower worldwide. The cost of the software and its maintenance contributes much more to its high price.

Therefore a big question arises and has to be answered. Is it worthwhile to buy an expensive DPS just for measuring the 3D coordinates of single points, the lengths of lines and areas or restituting a simple 3D model?

This paper proposes the use of another bundle of software programs and hardware equipment that can help a specialist in the scientific field of Architecture and Archaeology to do the above-mentioned job, using just the minimum amount of money.

## 2. Proposed system

The proposed system consists of a typical computer although with a special 3D graphics card, which has the capability of stereoscopic vision using virtual reality (VR) active polarization glasses. A cost of such a desktop computer can be very low. The price of a computer with the following features:

- 1.7MHz,
- 17" display monitor,
- 256MB RAM,
- 30Gbytes hard disk,
- Special 3D graphics card and VR glasses,
- Network card,
- CD R/W drive

cannot be more than 2000 euros.

The graphics card together with the VR glasses is used to browse the epipolar images on the screen in an interlacing mode, giving the illusion of stereoscopic vision to the user and allowing him to collect 3D points' measurements by bringing the conjugate points of the epipolar images into coincidence. Special software has been developed for this purpose, using the name **Dimension**. The program has been developed using the C/C++ programming language of Microsoft Visual Studio 6.0 development package. The characteristics of this computer program are mentioned below:

- Combining of epipolar images in interlacing mode, allowing stereovision of the object. The epipolar images include interior and exterior orientation information.
- Restitution of the 3D object's model by drawing simple polylines in interlacing mode
- Calculation of 3D coordinates of conjugate points, using forward resection algorithm
- Measuring of distances between points on the model, and the total length of a polyline
- Calculation of the area enclosed by a polyline.
- The appropriate information (exterior and interior orientation parameters) is loaded from text files, allowing the user to browse and edit it using a simple text editor.
- The output files are saved in text files also giving the ability to the user to edit the data.
- Export text data of the restituted object in standard DXF format for further editing and printing using a CAD program.

The epipolar images can be produced using another software package (Tsioukas et al, 2000) that can do all the preliminary job of a typical photogrammetric procedure that is:

- Orientation of image pairs (interior, relative and exterior)
- Control and tie points measurement
- Production of epipolar images
- Production of ortho images
- Mosaicing of ortho images

## 3. A simple procedure

Since the orientation of a stereo pair has been calculated and the epipolar images have been created a text file project is created and can be loaded from the **Dimension** software package. Three Multiple Document Interface (MDI) windows are created showing the left, right and stereo (in interlacing mode) images (fig. 1). Popup windows of the thumbnail images (left, right and interlaced stereo images) are used instead of the scrollbar of the windows for a better navigation on the images.

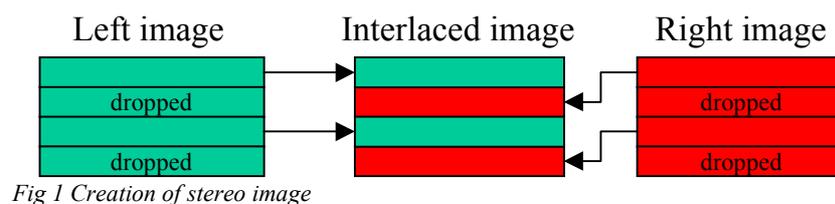


Fig 1 Creation of stereo image

Using the wheel of the mouse performs the roaming of the stereo image. By rolling the mouse up and down the images converge or diverge to each other. When the images have been placed so that two conjugate points coincide, the user can take the measurement of its 3D coordinates by pressing the left

mouse button, using forward resection algorithm. In order to achieve sub-pixel accuracy measurements, least squares image-matching techniques are used to define the exact location of conjugate points on the epipolar images (Tsioukas, 1999). Additionally the user can record those point's coordinates into a text file by activating the appropriate tool on the basic toolbar of the program.

The restitution of the object is just as simple as the determination of the 3D coordinates of a point. Once the corresponding tool has been activated the user can bring in coincidence the conjugated points (rolling of the mouse wheel) and a line is drawn on the left and right image window. In the stereo image window two lines are drawn. The first line corresponds to the left image and its pixels are drawn only for the odd rows of the window and the second line corresponds to the right image and its pixels are drawn only for the even rows of the window. Simultaneously the 3D coordinates of every point of the polyline are entered in a text file, together with the image coordinates of the conjugate points on both epipolar images. By clicking the right mouse button the user ends the drawing of the polyline.

#### 4. Measuring of lengths and areas

For an archaeologist the determination of the depth for various points of the site and the total area of the excavation hole is very important information. This information can be acquired very easily using the measuring tool. Activating the measuring tool on the basic toolbar of the program a popup window appears (fig.

2). By clicking on the appropriate points on the stereo window the 3D coordinates of the points are shown on the status bar of the windows program and the distance between the last two points are shown on the popup window. The total length of the polyline and the total area of the inclosing polygon are also shown on the popup window. This information can be very easily recorded in text files.

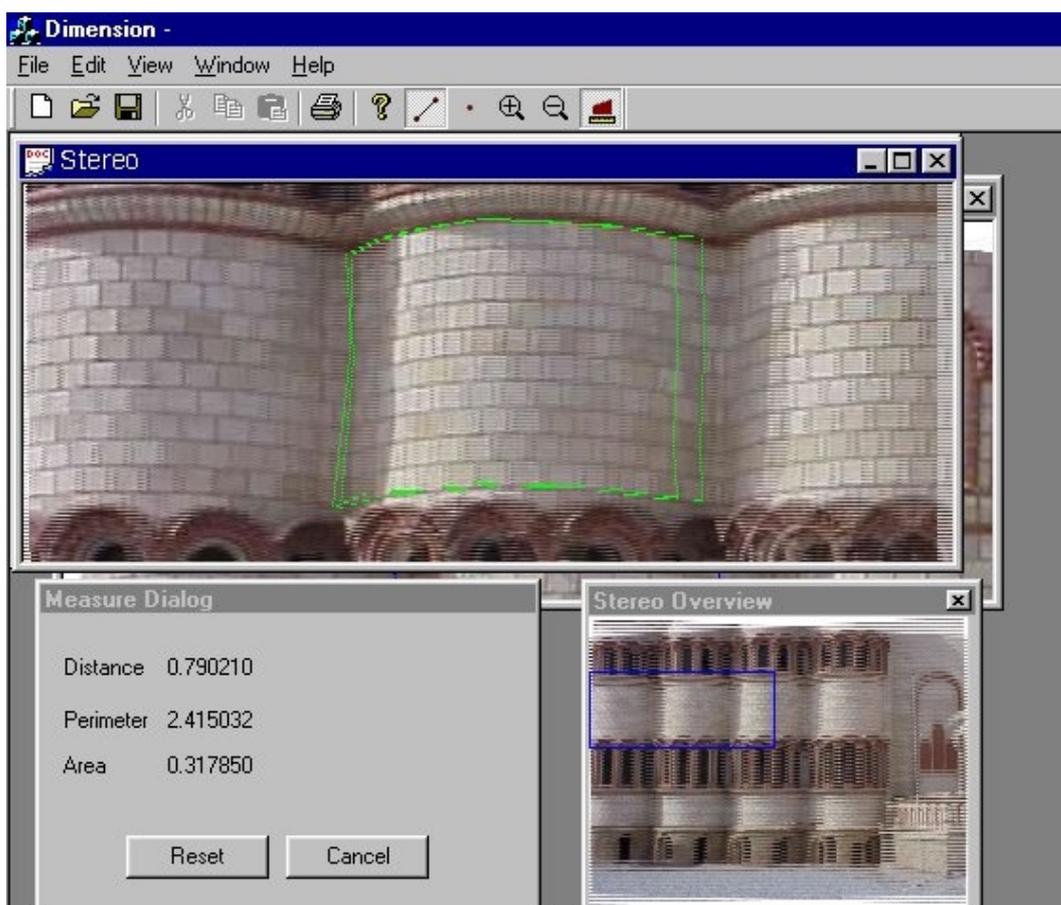


Figure 2. The measuring procedure on the stereo image window

## 5. Conclusion

The suggested low cost visualization and measuring “tool” for architectural and archaeological photogrammetric applications, tries to bring photogrammetry closer to the two disciplines that can certainly take advantage from the photogrammetric processes and the value added photogrammetric products. This effort is also supported by the downfall of the hardware components prices and especially of the special graphic subsystems.

It has been accomplished to develop a system that can fully support the capabilities of a graphic card with stereoscopic vision capabilities and the photogrammetric process have been introduced to a simple software application that can easily be operated by a novice user such as an archaeologist or an architect.

The developers will try to embed more tools and automation in the application that can help the job of an architect or archaeologist. For that reason, the successful cooperation of the photogrammetric community with the other two communities is essential. So far, a cooperation (Patias et al, 1999, Georgiadis et al, 2000) of the developers with certain groups of architects and archaeologists has been very successful and it will surely continue the same way in the future.

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