TERRESTRIAL PHOTOGRAMMETRY APPLIED TO ARCHITECTURAL RESTORATION AND ARCHAEOLOGICAL SURVEYS

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ABSTRACT

This paper describes and illustrates with examples, the continuous evolution in methods and tools used at the Institute of Photogrammetry of the University of de Los Andes, for applications of Terrestrial Photogrammetry in Architectural Restoration, and Archaeological Surveys. Since the late seventies, when this branch of photogrammetry was initiated at our institute, a series of works have been realised, each time with more complexity. Actually we are using techniques involving the use of CAD software for the 3-D representation of objects, and image processing to incorporate photographs of facades in the restitution, archaeological surveys using small format aerial photographs and terrestrial cameras, and self developed software for the image treatment.

The combined use of those techniques, allows to conduct its applications in the field of architecture and archaeology to vanguard levels, according to the actual trends in photogrammetry.

1 INTRODUCTION

The Institute of photogammetry of the University of Los Andes has dedicated many efforts in the last 20 years to the use of the terrestrial photogrammetry applied to the surveying of architectonic monuments, in order to provide all the geometrical data needed for restoration works. The main advantage of photogrammetry when compared with conventional surveys, in which angles and distances are measured, is its capability of representation of even the smallest details of the structure subject to study. The photogrammetric survey can be considered indispensable in any restoration work, because it provides with high precision a full geometrical description of the elements involved in the structure subject to study.

2 THE PHOTOGRAMMETRIC SURVEY

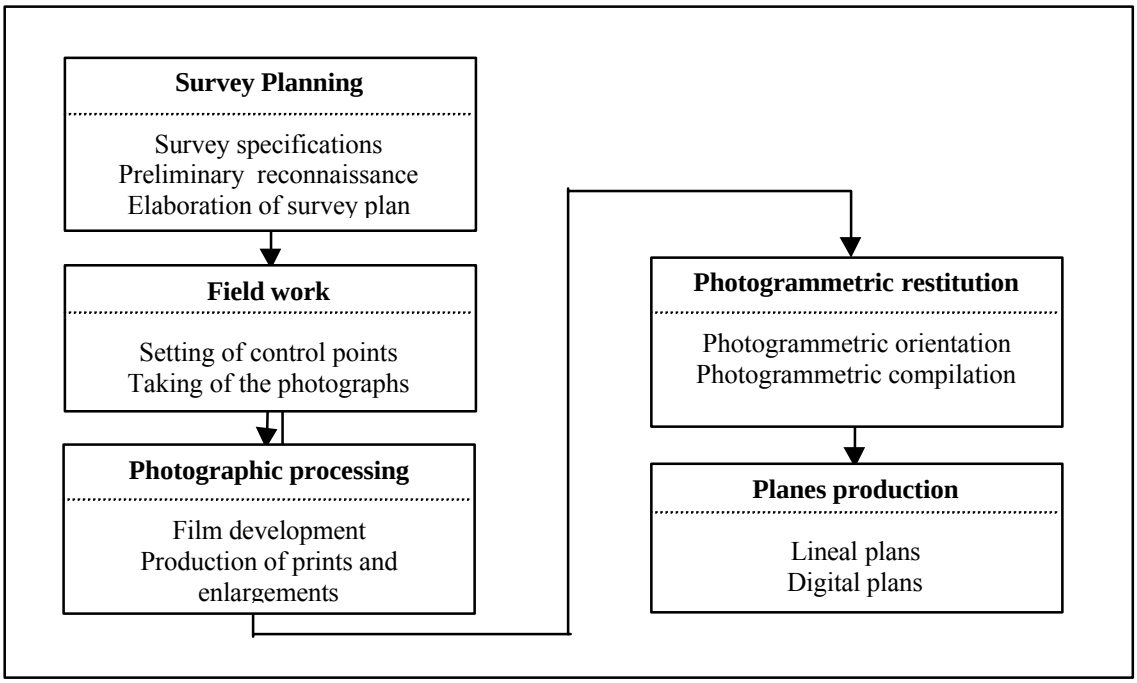
The purpose of the terrestrial photogrammetric survey is to provide precise data on the shape, size and position of a specific structure or monument, at a given time, for evaluating its actual conditions and architectonic aspects. There can be differentiated two types of surveys: General surveys and detailed surveys.

General surveys are performed to represent the shape of the building in a general form, just showing the main architectural lines. These surveys are used in preliminary restoration works, as well as in inventory studies.

Detailed surveys are complete and rigorous ones, used in the systematic documentation of the buildings to be restored. Its aim is to produce all the geometrical information needed to prepare the planes required for the restoration works These surveys has to be done with high precision.

3 PROCEDURE USED IN THE PHOTOGRAMMETRIC SURVEYS

The photogrammetric surveys of structures or monuments is a complex procedure, that requires a good planning of the activities involved, in order to obtain satisfactory results. The following procedure has been establish for the photogrammetric surveys:



4 TYPES OF PHOTOGRAMMETRIC RESTITUTTION

4.1 Lineal photogrammetric restitution

In this case, lineal plans are elaborated by means of the orthogonal projection of the structure photographed onto a previously defined reference plane. The position of the used reference plane has to be known in the coordinates system used for the terrestrial control. Usually, in the restitution of facades, are used vertical reference planes parallel to the main direction of the structure surface. As an example of this type of restitution, Figure 1 shows a general survey of Milla Church, in Mérida, Venezuela, where the plotting scale was 1/100. This survey was done for inventory purposes.

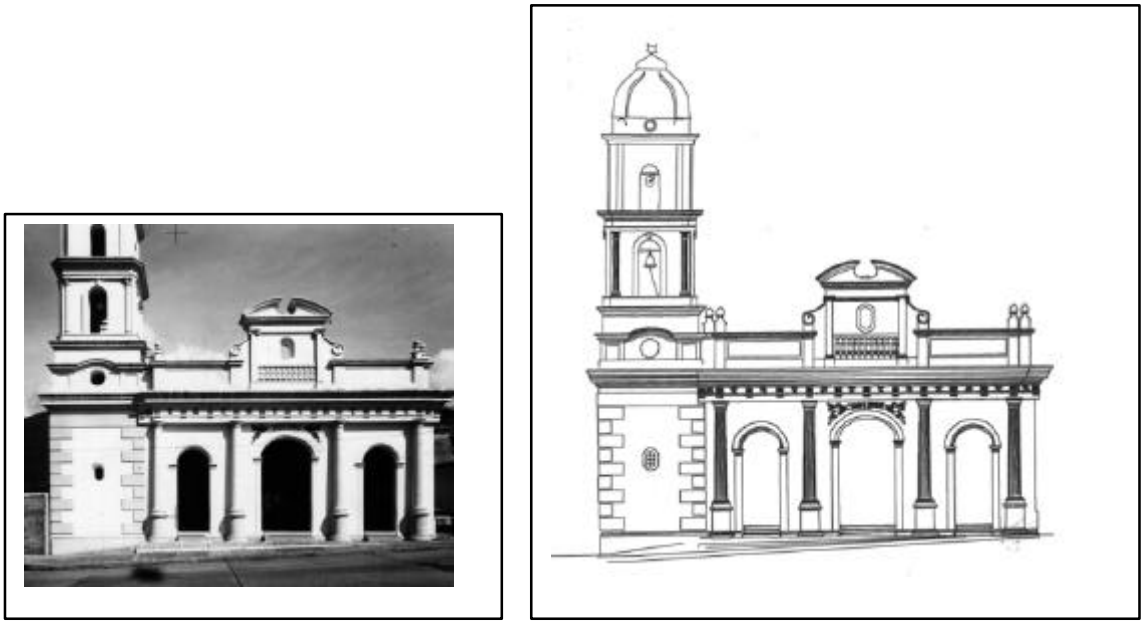


Figure 1. Terrestrial photograph and lineal restitution of Milla Church, in Mérida, Venezuela.

4.2 Digital photogrammetric restitution

Through digital restitution, the coordinates X, Y, Z of every point representing the building is determined. In this case no reference plane is used, but a coordinates reference system, in which all measurements are performed. When using analogue plotting instruments, as in our case, digital restitution is done by means of adapting analogue to digital converters to the instrument, and by means of an electronic interface the digital output coordinates are send to the computer (PC) where they are processed by a CAD package, as AutoCad ™ for example, in order to produce a digital drawing. Figures 2 and 3 shows an example of a digital restitution. This is a detailed survey of the Congress building in Caracas, Venezuela, in which all features of the structure has to be represented in a 3-D way using AutoCad ™, in order to create files with all the detailed geometrical information. The plotting scale used was 1/25.

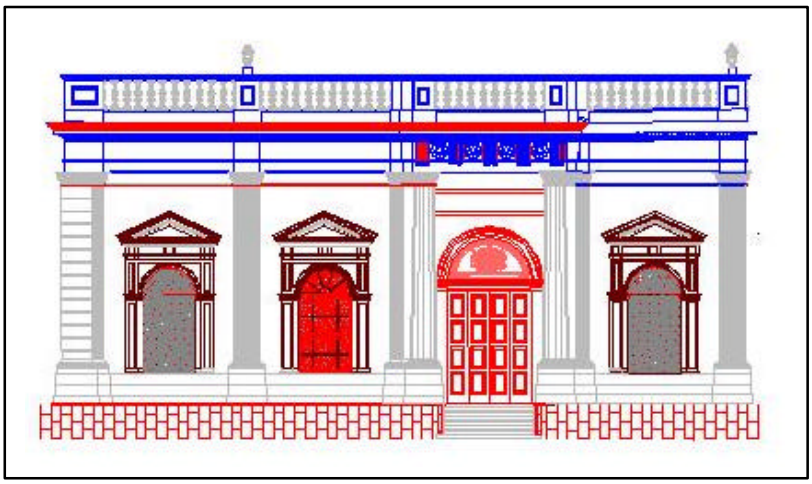


Figure 2. Partial front view of digital restitution of Congress Building, Caracas, Venezuela.

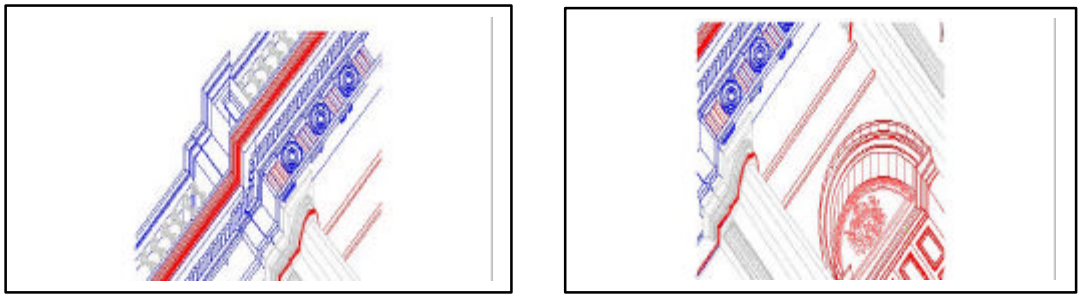


Figure 3. Details of façade shown in figure 2.

4.3 Lineal restitution superimposed on rectified digital images

As the terrestrial photogrammetry includes works of restitution of monuments of historical interest in some projects, it was needed to do the restitution of façades which are represented only by its contour or by the limits that defines the construction. Due to the simplicity of then, but their richness in texture, they deserve a better representation than the lineal one.

With the advance in technology, we can make use of powerful computers, CAD and digital image editing or processing programs and peripherals as scanners and plotters of photographical quality, to make possible today, the union between the classical techniques and the photographical rectification, in order to offer a product similar to a picture in their general aspect, but with the geometrical characteristics of a plane. To achieve this kind of geometrically correct images, two classes of data have to be jointed: The linear map obtained from the restitution of photographs, and the digital image of that pictures.

To obtain a digital image, there are two means: directly, using a digital camera, or by the use of a scanner; this one is still preferable to the digital camera, because we can have a greater amount of pixels if we scan an enlargement, so the final image can be plotted at a scale 1:50 or 1:25 without loss of detail.

The processing of the image is made up in three forms. At first, it has to receive pictorial improvements, as contrast, hue and luminosity. With the image improved, the rectification is made; sometimes, in very simple façades, a rotation and scale will be enough. The third operation consists in eliminate of the image the elements that not belong to the facade.

The Institute of Photogrammetry of the University of Los Andes, had under his responsibility to make the aerial and terrestrial photogrammetrical surveying and the photointerpretation of a zone occupied by the ruins of an ancient mission's town, founded in 1620, and abandoned two hundreds years ago. To achieve this objective, techniques of rectified digitased fronts and digital orthophotomaps from zones of archaeological interest were carried out. Figure 4 shows an example of application of this technique.

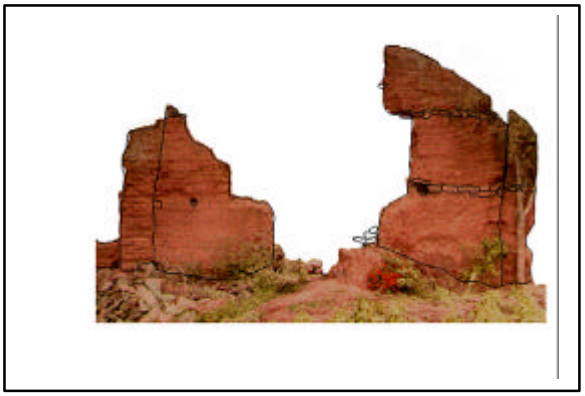


Figure 4. Restitution superimposed on digital image of the Church ruins of Mucuño, Venezuela.

4.4 Use of small format aerial photography

The Laboratory of Photogrammetry of the Forestry Sciences Faculty, lent the camera used in this mission. It was a Hasseblad 553 with a lens of 40mm focal length, using Kodak Vericolor film, and equipped with an intervalometer home-made. The camera mounting, also of this laboratory, was of the lateral luggage door type, made to fit in a Cessna 182 aircraft. The fact of flight over a closed zone with strong winds, obliged to make the photographs a little early in the morning (10:00 a.m.), with the disadvantage of have a disturbing shadow in the ruins. Another consecuence of topography of the place was that the flight had to be made against slope. A total of two strips with 5 pictures each was taken of the town of San Antonio de Mucuño, at 2000 m height and a scale 1/15000. The restitution of the models was superimposed over the scanned pictures rectified, as shown in figure 5.

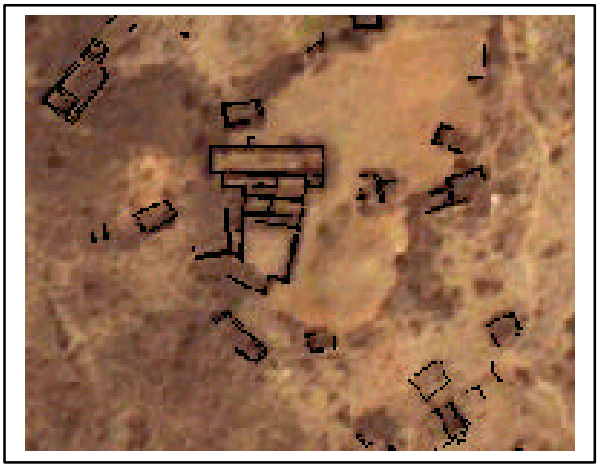


Figure 5. Small format aerial photograph of archaeological site, with superposed plannimetric information.

5 CONCLUSIONS

With the experience acquired by us in the fields of architectural and archaeological photogrammetry, we can make the following remarks:

The terrestrial photogrammetric method, due to its many advantages, is the best technique for detailed survey of complex shape structures.

The new digital photogrammetric workstations encourage the use of this technique, envisioning in the short future a widespread application of terrestrial photogrammetry for restoration surveys.

The use of images scaled and rectified allow to visualise in an optimal way the constructions with poor architectural details. This case of representation has the same geometrical qualities of a plan. Therefore, those can be measured in distances and angles. However, this kind of images present two disadvantages: the time of elaboration doubles the time used in a linear restitution. The second one is the cost of the image, increased by the longer time of work and the materials and equipment used in the impression.

The aerial photography is a very valuable instrument to join at others archaeological techniques, due to the complete vision obtained of the studied zone. In the subject presented herein, the SFAP, take from a single motor aircraft, suited perfectly to the task, due to its high manoeuvrability, which permitted to flight in a place surrounded of mountains. In order to have the control points marked in the photographs, those were encircled in the ground with a band of lime, with a radius of 50 cm.

From the restitution and photointerpretation of the aerial photographs, it was corroborated that some objets whose definition can be made easily in place, as the traces of superficial foundations, cannot be appreciated in the photographs, but some ancient motions of the soil can be seen clearly in the interpretation. In both cases, geometrical differences, or homogeneity of vegetation will determinate in which form of data, terrestrial or aerial an man made object should be identified.

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