

SIMPLE PHOTOGRAMMETRIC SURVEYING OF RURAL INDUSTRIAL CONSTRUCTIONS IN GALICIA

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ABSTRACT:

This paper deals with the development of a simple photogrammetric method to obtain graphic and metric documents of historic rural-industrial constructions of the north-western Iberian Peninsula. Many of them were built in Galicia for agricultural use(s), which are nowadays archaeo-industrial constructions and a heritage of the recent past and memory of the old country way of life. The method is based on the use of a low-cost digital camera, some plumb lines and a tape measure. The scale of the model is obtained by placing two targets on the plumb line at a determined distance. Z axis of the model will match up to the gravity vector. The spatial origin of the model will not be known, neither will the X,Y axis orientation, but it does not effect on the accuracy of the model. Once digital data is filed, anyone can access to the full document through internet in order to obtain metric information of the constructions, to make 3D models or to develop photo-models using realistic textures.

1. INTRODUCTION

1.1 Motivation

The Heritage concept has been extended successively containing new ambits. From the oldest concept of monument to the generic present day concept of Cultural Heritage an increasing awareness about the value of the human action exists. According to Almagro (2003), one of the most recent attitudes of this awareness is focused on the safeguard of the actions made by people who have shaped the natural setting through farming and through traditional ways of exploiting the natural resources. In that way men have shaped the cultural landscapes. This awareness, related to the interest of nature conservation, is concentrated on the protection of natural surroundings which are being transformed by this action. These natural surroundings are proof of mans way of living and adapting to the environment in which they once lived.

The conservation of large monuments and some groups of monumental groups has taken place for many years. However, if we only protect them without any other type of consideration, we will save an important part of our cultural heritage but it will be without roots and out of its environmental context site .We will pass on part of the cultural heritage but the entire heritage, which is a cultural reflection on ones country, will be irretrievably lost.

There has been a threat which has affected cultural heritage and popular architecture for many years in Galicia (Spain) due to social-economic changes that are necessary but at the same time destructive as well as uncontrollable that lead to this transformation. As is indicated by De Llano (1981), prior to the

There are a wide range of documents and measuring techniques (Böhler & Nickerson 2003), but because of the volume and characteristics of these constructions the search for simple, fast and economical methods are needed to make it easier to understand them in accordance to the recommendations of the CIPA (Almagro & Grussenmeyer, 2003). The simplicity of the

70's an alarming disappearing of the cultural heritage began to occur in Galicia. There are several reasons that have caused the decadence of traditional rural constructions. Emigration to cities as a result of the crisis in the agriculture economy, the rapid development of modern techniques of construction, the changes in the productive orientation which has caused an increase in new construction, drastic reforms and the neglect of many traditional buildings which are still in use.

This neglect generally ends in the dilapidation of constructions which, apart from representing a cultural heritage that should not be lost, also represents an architectural heritage of major importance for the region. Its study becomes imperative in order to avoid the disappearance of old ways of life, which is the heritage from a not too distant past. The knowledge of the present situation of deterioration, abandonment makes it necessary to document.

This problem is stressed in the traditional agro-business constructions which have been studied in depth in the works of Bas, 1991; Cañas et al., 1997; Varela Aenlle, 2001; Vázquez, 1999; González Pérez, 1994. In this work the present problem that threatens the conservation of these buildings is studied. The usefulness of photogrammetry of close objects is analysed through simple methods to graphically and metrically document traditional agro-industrial constructions (Arias et al., 2002). In this way we will be able to contribute efficiently to its understanding and consequently to its conservation.

1.2 Aims

method adopted is a key point so many people who do not have previous specific studies or knowledge can apply it. A reduction in time is advantageous due to the number of constructions included in this typology.

Improving this situation is a task that concerns society. From this work a method is put forward that can serve to alleviate one part this problem, the initial stage of studying and knowledge, which is necessary for a later approach to ideas, solutions or actions. Therefore the aims pursued are as follows:

1. To promote the analysis of the main traditional agro-industrial constructions in Galicia are mainly characterised for their simplicity and rusticity.
2. To contribute to reduce the loss of cultural heritage that has been occurring for years, providing tools for its study and knowledge.
3. To obtain a simple methodology in order to apply the technique(s) with a minimum amount of equipment that is cheap and readily available.
4. To increase the information collected (2D and/or 3D plans, textured models, animations, etc.)in order to facilitate the decision making in later actions.

Through the documentation the information about the condition of the construction at the moment of the shot is collected,

2. METHODS, INSTRUMENTATION AND RESULTS

2.1 Methods

The method developed is organised in sequential and clearly different phases following the rules 3?3 (Waldhäusl & Ogleby, 1994); in the first phase called field work, the photographic shots of the chosen construction will be taken and enough information for its subsequent orientation and scale will be collected. In the second phase known as laboratory work all the information collected in the field work phase will be processed to obtain plans and three dimensional models from the chosen construction.

2.1.1. Field Work: is based on collecting information about the construction and can be summarized in the following processes:

1. Previous definition of pursued objectives. Before starting any documentation work it is necessary to define clearly and precisely the pursued aims, the ambit and the importance of the action (type of construction that is interesting to document and which elements are interesting to know).Objectives that are not very precise will directly affect the laboratory work and consequently the quality of the final results.
2. Positioning and measuring of plumb lines. These are used in the levelling, forming a scale and definition of the photogrammetric models. The direction of the plumb line will determine the direction of the x axis. It will be necessary to establish a series of marks on the plumb lines which can be perfectly identified in the photographs. The distances between the marks, which form the scale and geometrically define the models, must be measured accurately.
3. Carrying out photographic shots. In order to do this, cheap conventional digital cameras with CCD as the

allowing a vast knowledge of its condition. In this way, the diverse aspects of the constructions can be analysed , highlighting the following:

1. Techniques and styles of construction.
2. Materials used.
3. Conservation condition, pathological processes, location of visible damages.
4. Analysis of the structural organisation.
5. Detection of damage and structural problems.
6. Obtaining the real geometry of the construction components.

This information conveniently analysed will be able to be used as the base for the actions carried out such as:

1. Ethnographic or historical studies .
2. Typological classifications .
3. Actions of reconstruction or restoration.
4. The reuse of buildings.
5. Relocation of structures and/or buildings.

image sensor element are recommended. The shots will be taken considering the following points:

- a) Adequate lighting of the photographed object. Avoiding shadows, reflections, over exposure, etc.
- b) A camera with high values of depth of field should be used, so as not to run the risk of these shots being out of focus.
- c) It is recommended to use either a camera tripod whenever possible or to rest the camera on something stable to avoid camera movement.
- d) Each element depicted must be contained in a minimum of three photograms.
- e) The convergence between photograms taken from different positions will have to have optimum values of 90° and good values of 60°, so that the beam adjustments are carried out well.
- f) Whenever possible, a shot must always be taken perpendicular to the face of the object.
- g) There must be at least 50% overlap between photograms.
- h) The shots must be taken in such a way that the element covers the majority of the photogram surface.

In Figure 1, two examples of photographic shots of different faces of the construction studied are shown. In the right-hand image the direction of z axis defined by the plumb line is indicated.



Figure 1. Example of the photographic shots. In the image on the right the direction of z axis defined by the plumb line can be seen.

2.1.2. Laboratory work: Once field work has been finalised, laboratory work begins, proceeding with the analysis and processing of the information collected. With this information saved and classified two different alternatives are raised. The information can either be filed away until the need arises to process it, or it can be immediately processed, resulting in 3D models of the original structure. In order to reach this objective it will be necessary to resort to the photogrammetric stations. Due to the characteristics and aims of this work, the use of Digital Monoscopic Photogrammetric Systems are recommended. A series of successive steps will be carried out when processing this data, as is briefly stated below:

1. Orientation of the Photographs. In this process the position of the shots is calculated.

2.2 Instrumentation

In the designed method put forward, one of the objectives pursued was the minimal dependence on complex equipment and material which is difficult and expensive to acquire. Therefore the equipment needed will be the following:

1. Plumb lines. These can be made using coloured cord between 2mm and 10 mm thick (depending on the size of the structure and the distances measured) which can easily be seen. Another fundamental point will be the weight of the plumb bob itself which lends to the vertical position of the cord. Anything of sufficient weight can be used (usually a stone or something similar found at the site).
2. Tape measure. A retractable tape measure is necessary (one of 5 meters should suffice). This will be used to measure the distances between the marks previously made on the plumb lines.
3. Digital cameras. Cheap conventional digital cameras and a CCD as a sensor element to take the

2.3 Results

The results obtained can be divided into two clearly different areas. Firstly the theoretic results where the values obtained in the process of orientation are shown, and provide information on the quality of the process. Secondly the graphic results which can be seen with the help of plans and photo-realistic textured models.

In table 1 the theoretic results obtained can be seen when the processing was carried out on a “Photomodeler Pro 4.0” digital photogrammetric station. The shots were taken with a “Ricoh

2. Levelling and forming the scale of the model. From the direction defined by the plumb lines, z axis is established and so the model will be levelled. The scale is attained from the distances measured on the plumb lines.
3. Restoring of points, lines, polylines or other graphic sources of interest, thus obtaining numerical values, measurement and 2D and/or 3D models (wire models, models of surfaces, models of textures, etc).
4. The three-dimensional models generated are now able to be transferred into conventional formats (dxf, dxb, vrm, etc.) or to other programs for their display and/or processing treatment.

photographic shots. The precision will improve by increasing the resolution of the cameras used. Moreover, a camera preferably without a zoom and with sufficient internal stability that allows the determination of its aberrations is preferred.

4. Tripods. The photographic shots must be taken based on the fundamentals of both photography and photogrammetry, therefore it is recommended that a camera tripod be used for stability.
5. Digital monoscopic photogrammetric systems. Due to the characteristics and objectives pursued in this work the use of these systems will be recommended. Its main characteristic will be adaptability making it possible for anyone without prior training to use on any type of computer. These photographic systems are perfectly integrated with conventional CAD systems, making its use extremely easy in a wide variety of areas and applications.

6000” digital camera, exclusively using plumb lines on which the distances were previously marked for the orientation, scale and to obtain the model geometry. The results viewed indicate: an average of 95% of the accuracy of the points and the quadratic composition of the averages; the average quadratic error, the average error and the maximum error in metres observed in the parallax; standard deviation in pixels and maximum value of the residues observed for one point.

	Precisions of 95% (m)			Parallax (m)	RMS (pixels)	Largest Error (pixels)
	X	Y	Z			
Average	0,002	0,01	0,006		0,661	
		4				
Quadratic Comp.	0,016					
Standard deviation				0,005		
Average error				0,004		
Maximun error				0,010		2,021

Table 1. Results obtained processing the data with a digital photogrammetric station “Photomodeler Pro 4.0”

In figure 2, an elevation and a profile obtained from three-dimensional points model , lines and polylines are shown, which are restored on the digital photogrammetric station

“Photomodeler Pro 4.0”. Later the three-dimensional models were transferred and processed on CAD software.

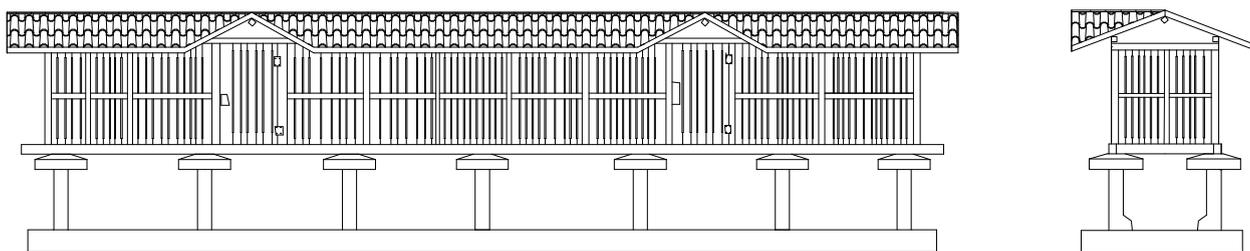


Figure 2. Elevation and profile of the structure studied.

Different renderings of photo-realistic textures, have been obtained from the three-dimensional surface model, such as those seen in Figure 3. These textures have been applied from photographic shots of the object itself.



Figure 3. Rendering with photo-realistic textures

3. CONCLUSIONS

The precision obtained in the process of generating three-dimensional models, correspond perfectly with those expected when applying simple photogrammetry principles of close objects.

The values and precision obtained conform to the characteristics of the traditional agro-industrial structures studied in this work Therefore an accuracy of between 2 and 5 cms is thought to be necessary (Scherer, 2002).

In regard to field work, it is highly important to plan well from the beginning as this will reduce the total amount of time needed so as to optimize the results. A sketch of the object, the position of both the plumb lines and the camera as well as the field covered by each shot is fundamental in order to facilitate

later classification and processing work of the information collected during this phase.

A fundamental part of the work which will determine the standard of the final results will be the photographic shots taken and the principles of photography and photogrammetry have to be followed

Digital cameras are considered to be ideal in situations in which there is a limited budget to purchase equipment and when a high degree of precision is not essential. Furthermore, this type of camera suitable because the cost of developing the photos is practically nil. Therefore it is recommended to take many shots (from different positions and view points), a factor which will directly influence the degree of precision reached.

The use of digital monoscopic systems are recommended, as are well known digital monoscopic photogrammetric systems, to

process both data and also to obtain 3D models of the studied structures. The fundamental motives will be due to the reduced cost of the above (approximately 1200 €, as long as the purchase of vision stereoscopic systems is not necessary. However if necessary and due to its versatility, it will not

present many requirements of the system and can be installed in practically any type of computer (laptop or PC) Lengthy training will not be required prior to its use as is needed with the stereoscopic systems.

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