

DOCUMENTING, MANAGING & VISUALIZING A HUGE DIGITAL PHOTOGRAMMETRIC DATA SET

J. L. Lerma, C. Portalés, D. Germes

Dept. Ingeniería Cartográfica, Geodesia y Fotogrametría. Universidad Politécnica de Valencia.
C° de Vera, s/n. 46022. Valencia
jllerma@cgf.upv.es

KEY WORDS: Archiving, Photography, Visualization, Architectural Heritage Conservation, Photographic Recording

ABSTRACT:

Photogrammetry is an efficient discipline for documenting graphically and semantically cultural heritage. For decades, photogrammetric documentation following the 3x3 rules has been well-proved and used all over the world. However, when the data set is huge, the control, assessment and manage (e.g. labelling and recovery) of pictures is a crucial point in undefined or poorly structured archives. Furthermore, the digital era makes management of hundreds of pictures complicated because, on the one hand, there are many and big images and they require too much computer space (memory), and, on the other hand, there is no sense to hard-copy them by printing. Thus, this paper shows a way of labelling, retrieving and visualising efficiently digital images by means of multimedia packages, enabling easy and fast access through Internet.

This paper reflects a new way of documenting, managing and visualising in a UNESCO World Heritage Monument, ‘*La Lonja de los Mercaderes de Valencia*’, one of the most famous examples of European Gothic civil architecture.

1. INTRODUCTION

La Lonja de los Mercaderes de Valencia or simply, *la Lonja*, was built in the centre of the city of Valencia at the end of the XV century. Granted the high distinction of Historical-Artistic National Monument on the 4th June 1931, and declared a World Heritage Monument on the 5th December 1996 by UNESCO. This building is one of the most famous examples of Gothic civil architecture that Europe can offer (VV.AA., 2002).

In the workflow of the restoration project of *la Lonja*, managed by the Valencia city council in collaboration with Forum UNESCO “University and Heritage” -joint project between UNESCO and the Polytechnic University of Valencia (Forum UNESCO Home Page: <http://www.forumunesco.upv.es/>)-, a detailed graphical documentation of the current state of the building and its ornaments was needed. In this sense, close range photogrammetry was required as a proven efficient discipline for documenting graphically and semantically cultural heritage.

The documentation of this historical building was taken by applying the well known 3x3 rules. Additionally, more considerations were taken in order to achieve a rich structured digital archive.

In the following sections we will say a few words about the monument itself, *la Lonja*. Then, the photogrammetric fieldwork, image post-processing and the setting up of the digital catalogue will be explained. Finally, some conclusions will be pointed out.

2. LA LONJA

2.1 Main features

La Lonja is made up of three different parts plus a garden (see figure 6) called *Patio de los Naranjos* (Orange Trees’ Patio).



Figure 1. Main facade of *la Lonja*

The bigger part of the building corresponds to the *Salón Columnario* (Hall of Pillars) and covers an area of 35.6 x 21.39 m² (corresponding to almost half of the total area of the building). Its 24 helicoidal columns, eight free-standing and sixteen embedded to the walls, create three horizontal and five vertical naves. These columns allude to the ship ropes or twisted silk, opening out like palm-trees to form ribbed vaults at 17.4 m high (see figure 2 left).

A second part corresponds to *el Torreón* (Tower). In its ground floor is placed the ancient *Capilla* (Chapel), where Gothic mouldings and a ribbed vault can be found. The rooms of the first and second floor were used as prisons for merchants failed in bankruptcy. The access to these last rooms is through the *Escalera de Caracol*, beautiful snail stone staircase without central axis.

The last part of the building corresponds to: *Salón del Comercio* (Commerce Room) on the ground floor, where the Tribunal of Commerce was once suited; *Salón del Consulado del Mar* or *Cambra Daurada* (Golden Room) on the first floor,

where a wonderful wooden ceiling can be appreciated (see figure 2 right); and the *Cambra* (Chamber) on the second floor.



Figure 2. Left: oblique perspective of the *Sal6n Columnario* ceiling; Right: detail of the *Sal6n del Consulado del Mar* ceiling

2.2 Use of *la Lonja*

Although *la Lonja* was originally built to be the centre of the city trade, along its history it was used for many different purposes.

On various occasions, the *Sal6n Columnario* was used as an occasional wheat warehouse when cereals ran short. For military reasons, the building was converted in 1707 into quarters, and the *Patio de los Naranjos* into a cook-room for the troops. It also became a provisional hospital during the cholera plague in the XIX century.

Since 1934, the institution *Consulado de la Lonja*, succeeding the very old institution *Consolat del Mar* that was the centre of the Valencia maritime trade, has been reviving the *Lonja de los Mercaderes* gathering traders and industrials. The session takes place on Fridays. Furthermore, all kind of stamps and coins are traded and exchanged on Sundays.

3. FIELDWORK

3.1 Instrumentation

The photographic recording was carried out with the digital camera CANON EOS D60. It has a resolution of 6,3 megapixels. The objective used was the Sigma AF 15-30mm F3.5-4.5 EX DG with a principal distance varying from 15 to 30 mm.

For the measurement of control points, a Leica laser theodolite was used.

3.2 The 3x3 photogrammetric rules

The so-called ‘3x3 rules’ have been described for simple photogrammetric documentation of architecture in those cases where non-metric cameras are used. These are structured in three triplets of rules (Herbig *et al*, 1997):

- Three *geometrical rules*, where the preparation of control information, the photographic coverage and stereo-partners are considered
- Three *photographic rules* regarding to the inner camera geometry, illumination and camera format
- Three *organisational rules* consisting in making proper sketches, protocols and final check

These rules were considered in our work but, additionally:

- The camera was selected according to a high geometric resolution, high stability, image quality and handling.
- A proper camera objective was selected according to its high lens resolution, low lens distortion and small principal distance.
- Photographs were labelled according to a specific numeric system (see section 6.1)
- An interactive digital catalogue was made in order to visualise comfortably all the data (see section 6.3)

3.3 “In-field” work

3.3.1 Photograph collection

Photographs were taken with a side overlap of more than 70% for stereo-partners. Oblique photographs were also taken from various points of view in such a way that every part of the building is at least three times imaged (usually four or more).



(a)



(b)

Figure 3. Photographs taken from the third floor of the opposite building: (a) upper-side normal image; (b) middle-side oblique image.

For the exterior facades, distant to the object could not be kept constant due to some narrow streets surrounding the building. In those cases, photographs were taken from the ground floor in the street and also from a first, second or even third floor of the surrounding buildings (when possible, figure 3a) in order to avoid too forced perspectives (figure 3b).

A set of 713 high quality digital images were taken occupying an amount of 2,431 MB.

3.3.2 Control point measurement

As it was pointed in section 3.1, for the control points' measurement a laser theodolite was used. With this instrument, control information can be rapidly achieved thanks to its red laser pointer. This pointer is really useful when poor illumination conditions exists.

Control points for the whole building were measured according to a pre-defined ground coordinate system. Afterwards, their 2D-facade coordinates were computed (when necessary) in order to perform the rectification process (see section 5).

4. IMAGE POST-PROCESSING

4.1 Radiometric correction

In most of the works, making a good survey of the building is the main task, whereas taking beautiful pictures is not so important. In our case achieving good pictures was also relevant. As a matter of fact, it was requested that all the pictures were "equal illuminated for the human eye". This was our main issue because of the so different natural illuminations of *la Lonja's* rooms.

In some of the rooms, for instance the *Capilla* and the *Torre*, the poor natural and the absence of both natural and artificial illumination made necessary the use of some powerful spotlights. In the *Salón Columnario* was the other way round: the natural illumination was so strong that photographs had to be taken in the afternoon when the daylight was weaker. At that time, lights were already on. Another problematic room was the *Escalera de Caracol*. Besides its poor natural illumination, not artificial lights could be used because of the shadows, on the one hand, and the reduced space of the room, on the other. With respect to the building's facades, photographs were quite homogeneous due to the cloudy weather during the fieldwork.

Due to all this "in-field" problems, great effort was done in a post-processing step. Radiometric correction was required in order to overcome the matters appointed above. In figure 4 an extreme case is shown.



Figure 4. *Escalera de Caracol*. Left: input image (original); Right: output image after radiometric correction

4.2 Image rectification

Some architectural ornaments had to be rectified for further plotting tasks. Additional photographs were taken for each one of the ornaments in order to ensure the best possible image quality. A minimum of four control points were measured for each photograph. The 3D control point coordinates were reprojected to the corresponding facades to obtain the 2D

coordinates necessary for the two-dimensional projective transformation (Lerma, 2002; Hemmleb, 1997).

Once the image rectification was performed, the Kirsch filter operator was applied to highlight borders and corners (see figure 5).

A total of 72 ornaments were rectified.



Figure 5. One of the rectified ornament belonging to the main facade. Up: original image; Down: filtered image

5. DIGITAL CATALOGUE

The realisation of a huge photogrammetric digital catalogue makes necessary a good data set management, including the image classification, data retrieving and visualisation. Without these, future work would not be an easy task.

5.1 Image classification

Photographs should be classified in such a way that makes it easy to relate them to the corresponding parts of the monument. This can be achieved by adopting a suited photograph's labelling.

For the photographs taken in *la Lonja*, a numeric labelling was chosen in such a way that all the following factors could be identified without any doubt:

- The constructive parts of the building (patio, tower, etc.).
- Facade, ceiling and/or ground.
- Level of the photographic shots.
- Number of the photographic shots.
- Principal distance of the camera.

Therefore, the photograph labelling was composed by a total of six digits where:

First digit:

- 1: *Salón Columnario*
- 2: *Capilla* and *Torre planta 1ª*
- 3: *Salón del Comercio*, *Salón del Consulado del Mar* and *Cambra*
- 4: *Patio de los Naranjos*
- 5: *Escalera de Caracol*
- 6: Exterior facades

Second digit:

- 1: SW facade
- 2: SE facade
- 3: NE facade
- 4: NW facade
- 5: ceiling
- 6: ground

Third digit:

- 0: ground floor
- 1: first floor
- etc.

Fourth and fifth digits:

- From 01 to 99 indicate the shot number

Sixth digit:

- 1: images taken by a 15 mm focal length
- 2: images taken by a 30 mm focal length
- 3: images taken by a 17 mm focal length

5.2 Image recovering

After labelling the images they were organised in different folders according to its first and second digit values and then stored in CD-ROMs under JPEG format. This makes the image access, loading and retrieving an easy and quick task for the user.

5.3 Image visualisation

With the incoming of the digital era, the visualisation of digital images can be carried out by means of multimedia packages, enabling “user-interactivity” and also an easy and fast access through Internet. Moreover, this helps the user to a better understanding of the photographs’ spatial situation and the real dimension of the image space.

Therefore, an interactive digital catalogue of *la Lonja* was created and stored under *html* format for further Internet publishing.

In this catalogue, data was organised according to six main sections. These are briefly described in the following lines:

Inicio (home page): It includes an attractive intro with various characteristic photographs of *la Lonja*.

Numeración del archivo (archive labelling): The image labelling is explained in order to avoid misunderstandings.

Archivo fotogramétrico (photogrammetric archive): Here all the stereo-partners, normal and oblique photographs are shown. They are perfectly distributed according to which part of the building they illustrate and are accompanied with their labelling numbers, some sketches and a brief legend. The user can access the whole set of images by means of successive interactive ground plans of the building (see figures 6 and 7).



Figure 6. Choosing one of the building’s rooms by means of an interactive ground plan of *la Lonja*



Figure 7. Stereo-partners of the *Salón Columnario*’s ceiling together with a magnified sketch

Detalles (details): In this section the rectified images can be seen. They are also accompanied with some sketches (see figure 8).

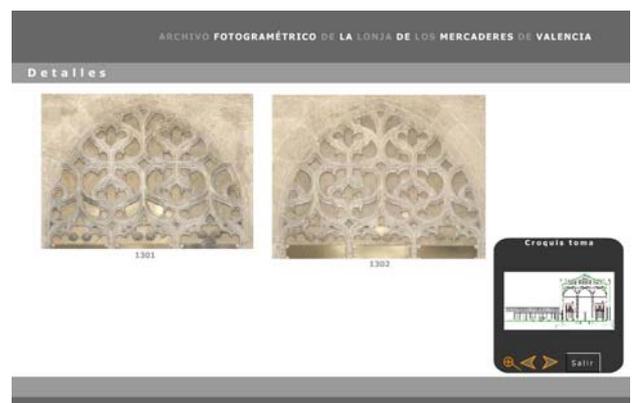


Figure 8. Two of the rectified images as displayed in the digital catalogue

Enlaces de interés (related links): Different Web-links directly related to the work are placed here.

Sobre nosotros (about us): Finally, in this section some information about the restoration project of *la Lonja* and the digital photogrammetric catalogue's authors can be found.

6. CONCLUSION

Documentation, management and visualisation of a huge digital photogrammetric data set requires additional specifications to the well-known 3x3 rules.

This paper has shown an efficient way to build up a complete digital catalogue for a UNESCO World Heritage Monument, '*La Lonja de los Mercaderes de Valencia*'. Aspects such as fieldwork, digital image post-processing, image retrieving and image visualisation on a multimedia package for Internet purposes have been pointed out. Furthermore, some snap shots of the developed user interface have been also displayed.

7. ACKNOWLEDGEMENTS

This work has been supported by Forum Unesco "University and Heritage" under the project: "*Estudio y Diagnósis de Manifestaciones Patológicas de la Piedra y Proyecto de Ejecución y Dirección de las Obras de Limpieza y Conservación de la Lonja de los Mercaderes de Valencia*".

8. REFERENCES

Forum UNESCO Home Page: <http://www.forumunesco.upv.es/> (accessed 24 July 2003).

Hemmler, M., 1997. Digital rectification and generation of orthoimages in architectural photogrammetry. *IAPRS*, XXXII (5C1B), pp. 261-267.

Herbig, U., Waldhäusl, P., 1997. APIS – Architectural Photogrammetry Information System. *IAPRS*, XXXII (5C1B), pp. 23-27.

Kasser, M., Egels, Y., 2002. *Digital Photogrammetry*. Taylor & Francis, London, pp. 315-317.

Lerma, J. L., 2002. *Fotogrametría Moderna: Analítica y Digital*. Universidad Politécnica de Valencia, Valencia, pp. 74-76.

VV.AA., 2002. La Lonja de Valencia, world heritage monument. *Ajuntament de Valencia, delegació de turisme*.