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THE CIPA "O. Wagner Pavilion" TEST

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ABSTRACT:

World-wide, only a small percentage of the buildings of cultural interest are documented, but many images are taken by architects, historians or others, who are interested in Architectural Photography or just in souvenir photography. There is a great potential for such imagery taken by accident, and it would be advantageous to use this resource in addition to professional photogrammetric imagery for the restitution of the world's heritage.
The aim of this CIPA initiative is twofold: First, To check the current state-of-the-art in Architectural Photogrammetry. Second, to develop a network of photogrammetric institutes with proven expertise in Architectural Photogrammetry.
The test object chosen is one of the Otto Wagner's Stadtbahn Station buildings on the Karlplatz in Vienna, Austria. The building has been properly surveyed and photographed with different cameras. The photographs have been measured by different measuring devices (analytical plotters, small analytical systems, digitizers, automatic measurements on digital images) and the data processed by different software packages. In total sixteen photogrammetric Institutes from ten European countries have participated to this campaign.
In all cases the obtained accuracies where in the order of one to two cm, in the worse cases. Conclusions were drawn concerning : pre- vs. self-calibration, semi- vs. non-metric photography, medium vs. small format, normal vs. general case, minimum vs. rich control, different control distributions, different measuring devices, simple vs. rigid restitution, different adjustment software, different vs. same persons' repetitions. Each participant could clarify these questions for himself and collect experience. The official nomination of the successful participating institutes by CIPA to ICOMOS and UNESCO as centers of excellence for Architectural Photogrammetry is pending.

ZUSAMMENFASSUNG:

Weltweit wurde bisher nur ein geringer Prozentsatz der Gebaeude von kulturellem Interesse dokumentiert, dagegen wurden zahllose Bilder von Architekten, Historikern und anderen aufgenommen, die Interesse an Architekturphotographie oder auch nur an Erinnerungsphotographien haben. Ein grosses Auswertepotential ist mit solchen Zufallsbildern gegeben. Es waere sicher vorteilhaft, diese Bilder zusaetzlich zu jenen der professionellen Photogrammetrie der Denkmalpflege nutzbar zu machen, die hauptsaechlich fuer das besonders wertvolle architektonische Welterbes taetig ist.
Das Ziel dieser CIPA-Initiative ist ein zweifaches: Erstens soll der Stand des praktischen Leistungsvermoegens auf dem Gebiet der Architekturphotogrammetrie ueberprueft werden. Zweitens soll ein Netzwerk miteinander zusammenarbeitender Photogrammetrie-Institute entstehen, die besondere Fachkenntnisse in Architekturbildmessung haben.
Als Testobjekt wurde eines der beiden Stadtbahn-Stationsgebaeude von Otto Wagner auf dem Karlsplatz in Wien gewaehlt. Das Gebaeude wurde terrestrisch aufgemessen und mit verschiedenen Kameras photographiert. Die Bilder wurden mit unterschiedlichen Auswertegeraeten gemessen, wie Analytical Plotter, mit analytischen Kleinauswertesystemen, Digitizern oder auch Digitalauswertesystemen. Die Bildtriangulationen wurden mit verschiedenen Softwarepaketen ausgefuehrt. Insgesamt haben sich an dieser Aktion 16 Photogrammetrieinstitute aus zehn europaeischen Laendern beteiligt.
In allen Faellen wurden Genauigkeiten in der Groessenordnung von 1 bis 2 cm erzielt. Das Verfahren ist also machbar. Schlussfolgerungen wurden zu folgenden Fragestellungen gezogen: Halbmess- oder Amateurkamera, Mittel- oder Kleinformat, Normalfall oder allgemeiner Aufnahmefall, minimale oder
reichliche Kontrollinformationen und deren Verteilung, verschiedene Messgeraete, vereinfachte oder strenge Auswerteverfahren, verschiedene Ausgleichungssysteme, Wiederholbarkeit. Jeder Versuchsteilnehmer konnte diese Fragen fuer sich klaeren und Erfahrungen sammeln.

1. MOTIVATION

We are responsible for protecting the natural and built environment and its moral, social, natural and cultural meaning. Wars, earthquakes, floods, fire, storms, and other natural disasters take a heavy toll each year. Decay, questionable attempts at modernization, and the demolition of buildings to gain space for traffic and housing also removes traces of the past.

Several international agreements address the situation:

- *The UNESCO Convention (The Hague, 1954) for the Protection of the Cultural Property in the Event of Armed Conflict.*
- *The International Restoration Charter (Venice, 1964) of the 2nd Congress of Architects and Specialists of Historic Buildings, for the Protection of the World Heritage as well as the National Heritage of Important Buildings and Local Sites (It followed the creation of ICOMOS, the International Council on Monuments and Sites in 1965).*
- *The UNESCO Convention (Paris, 1972) for the Protection of the World Cultural and Natural Heritage.*
- *The Washington Charter (Washington, 1987) for the Protection of the Historic Towns and Regional Sites.*

More than a technique, Photogrammetry is a useful, basic tool for the planning, construction, reconstruction and revitalization of architecture. It is also a good means for preserving knowledge about architecture for future generations in case of decay or destruction. Therefore, Photogrammetric Recording of our Cultural Heritage is a necessary civil defense against its extinction.

It is known that until today only a small part of the existing buildings has been properly documented by photogrammetry, and many of these documented buildings have been restored or altered in the meantime, without keeping their records up-to-date. Worldwide there exists an urgent and tremendous demand for Architectural Photogrammetry, which is the only means for fast, complete and visual documentation of architecture.

CIPA agreed that the production of photogrammetric documentation is needed besides the few professional high-quality work currently performed. In the opinion of CIPA, this work should be assisted not only by photogrammetrists, but also by the many practitioners in different disciplines, who already do architectural photography. In order for these people to be able to offer help, they need to be properly trained in minimum control requirements, planning and execution of the photography, camera requirements, collection of documentation information, etc.

The aim of this CIPA initiative is therefore in general twofold: First, To check the current state-of-the-art in Architectural Photogrammetry, especially regarding the necessary minimum control requirements, the use of semi- and non-metric cameras, and the use of new technology (camcorders, CCD-cameras, digital photogrammetric techniques). Second, to develop a network of photogrammetric institutes with proven expertise in Architectural Photogrammetry, able to perform photogrammetric restitutions, offer training to non-specialists and cooperate and assist others whenever more experts are needed for local or regional tasks.

Regarding the first aim the scope of the test was to draw conclusions on:

- pre- vs. self-calibration
- semi- vs. non-metric photography
- medium vs. small format
- normal vs. general case
- minimum vs. rich control
- different control distributions
- different measuring devices
- simple vs. rigid restitution
- different adjustment software
- different vs. same persons' repetitions

The main aim was to test whether the results reached are good enough for emergency cases, and if architecture may be resconstructed from plans restituted from amateur photography or freely oriented semimetric cameras.

Regarding the second aim the setup was as follows: Each partner is responsible for a defined national region. As soon as another institute proves expertise in Architectural Photogrammetry, it is added to the list of the partners. As soon as a region has been trained by its center, the region or country would be represented as a whole. This way the non-photogrammetrists could be trained to help speed up the process of metric photographic recording of monuments and sites. The professional photogrammetrists could then be concentrated on the more complicated projects, where immediate restitution is required.

2. THE TEST MATERIAL

The test object chosen is one of the Otto Wagner's Stadtbahn Station buildings on the Karlplatz in Vienna, Austria. Its dimensions are 15x8x10m^3.

Figure 1. "O. Wagner Pavilion" test object as appears in an Austrian stamp issued in 1991, on the occasion of the 150th birthday of O. Wagner.

A 6-station surveying network has been established around the building and the polar coordinates of 44 (partly natural but well defined points, see examples of sketches, partly targetted by black stickers, 2cm diameter, cirular) control points have been measured. After the adjustment of the surveying measurements, the local cartesian coordinates of the control points have been determined with an rms values of 2mm. These points cover all four exterior facades.

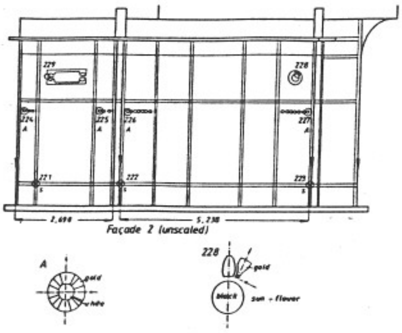

Figure 2. Sample figure of the control points used in the test.

Subsequently the object was photographically covered. During this campaign the following cameras have been used:

- Rollei 6006
- Hasselbland 500 EL/M
- Leica Elcovision
- Nikon FE2
- Pentax PAMS 645P
- Pentax ME-Super
- Canon AE1
- Contax RTS III
- JVC-S77 camcorder

totaling to more than 100 photographs. The scale of the images range from 1:200 to 1:400 for the medium format cameras and from 1:500 to 1:800 for the small format cameras.

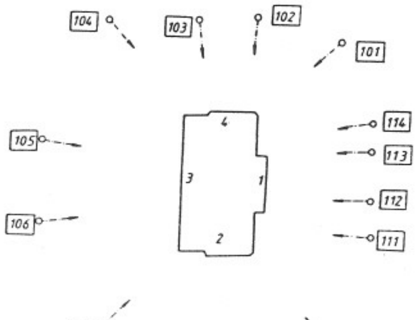

Figure 3. Sample figure of the photo configuration.

The photographs have been measured by different measuring devices (analytical plotters, small analytical systems, digitizers, automatic measurements on digital images) and the data processed by different software packages.

3. THE PARTICIPANTS

A network of 26 University Institutes of Photogrammetry in 16 mainly European countries has been formed. 12 Universities have been working together on a project known as "Engineering Photogrammetry of CEI (Central European Initiative)" since 1991. The remaining 14 Universities joined the group in 1992, at the request of CIPA. From those participants 16 Institutes have completed their contribution to the test, according to the following table.

Three Pilot Centers have undertaken the job for administration of the test. More specifically, TUV (Vienna, Austria) is administrating the whole project, took the most of the photography and perfomed the surveying of the monument. AUT (Thessaloniki, Greece) undertook the analysis of the numerical results, and the statistics of compatibility of the different solutions. GRA (Granada, Spain) performed the analysis of the graphical presentations from the photogrammetric restitution.

The participants were free to select the method and the instruments as available.

4. DATA PROCESSING

The participants work resulted in a total of 107 different solutions, using either semi- or non-metric camera, medium or small format, measuring devices of different accuracies, and minimum or maximum control.

In order for all these solutions to be able to compare to each other the following strategy has been followed:

4.1 Transformation to a common frame

The minimum constrained solutions obtained so far have been transfered to the same reference frame which provides the minimum norm and it is defined by the free-network adjustment. The transformation of the minimum constrained solution to a free-network solution requires an S-(Helmert) transformation. The points kept fixed (base points) during this transformation are the same for all participants. The coordinates and the respective covariance matrix are then transferred to their free-network respectives.

4.2 Accuracy assessment

In order to access the accuracy of the adjusted coordinates we computed a number of criteria, ranging from local criteria to global criteria. It should be pointed out that all these are accuracy criteria since they refer to the actually known (from surveying measurements) object coordinates of the withheld from the adjustment check points.

Initial	Country	Institute	Responsible	Photography	Device	Software	Contribution
ANC	Italy	Ancona University	**Prof. G. Fangi**	Rollei	Calcomp 9500	PHOX DLT (own)	1, 2, 3, 5, 9, 11
AUT	Greece	Dept. of Cadastre, Photogramm. & Cartography The Aristotle University of Thessaloniki	**Prof. P. Patias** Prof. D. Rossikopoulos Dr. O. Georgoula	Rollei, Hasselbland scanned images JVC GR-S77	Digital Photogr. Station	own GAP	1, 2, 5, 7, 9, 11, 14, ▪
BLG	Italy	Istit. di Topografia, Geodesia e Geofisica Mineraria University of Bologna	**Prof. G. Folloni**	Rollei, SMK 120, Leica, Hasselbland Pentax ME Super	Digicart 40 Calcomp 9500	MR2 ELCOVISION PHOX	2, 9
BRA	Czech Republic	Katedra Geodesie Slovenska Technicka Univerzita, Bratislava	**Eng. M. Ragalova** Dr. J. Cernansky	Leica, Hasselbland	Comparator	ORIENT	1, 2, 3, 5, 10
BRN	Czech Republic	Institute of Technology Technical University Brno	**Dr. V. Hanzl** Prof. Z. Marsik	Rollei, Leica Hasselbland	Stecometer	ORIENT	1, 2, 3, 5, 10
EEA	Spain	Escuela de Estudios Arabes Granada	**Arq. A. Almagro**	Rollei, Nikon	ADAM MPS2	ORIENT	3, 5, 13, ▪
INN	Austria	Institute for Geodesy Innsbruck University	**Prof. K. Hanke**	Rollei	TopoCart	ORIENT	1, 5
KRA	Poland	Dpt. of Photogramm. & Remote Sensing Informatics University of Mining and Metallurgy, Krakow	**Prof. J. Jachimski** Eng. A. Pilat	Rollei, Leica, Nikon Hasselbland	Stecometer	ORIENT	2, 3, 5, 11
KRL	Germany	Institute of Photogrammetry & Cartography Fachhochschule Karlsruhe	**Prof. G. Hell** Prof. B. Pfeiffer	Hasselbland, Leica	Stecometer C	BINGO	1, 2, 3, 5
SOF	Bulgaria	Department of Photogrammetry & Cartography Uni. of Architecture, Civil Eng. & Geodesy, Sofia.	**Prof. L. Pavlova** Eng. B. Marinov	Contax RTS III	Stecometer C	ORIENT	1, 10, 11
STR	France	Laboratoire de Photogrammetrie Ecole Nat. Super. des Arts et Industr. de Strasbourg	**Prof. P. Grussenmeyer** Eng. B. Merckel	Rollei, Nikon, Leica, Hasselbland Cannon AE1	Aviolyt AC1	ORIENT	1, 2, 3, 5, 6, 11
TOR	Italy	Dipartimento di Georisorse e Territorio Politecnico di Torino	**Prof. S. Dequal** Eng. F. Rinaudo	Rollei, Nikon, Leica, Hasselbland Pentax ME Super, Pentax PAMS 645P	Stereobit 20	SEMINE AMATO	2, 3, 5, 11, 12
TUV	Austria	Institute of Photogrammetry & Remote Sensing Technical University of Vienna	**Prof. P. Waldhäusl** Dr. H. Kager	Rollei, Nikon, Leica Hasselbland	Analytical Plotter	ORIENT	1, 2, 3, 5, 11, ▪
UDI	Italy	Dipartimento Urbanistica e Pianificazione University of Udine	**Prof. F. Crosilla**	Rollei, Nikon	OMI AP6 Calcomp 23120	DLT (own)	2, 5, 7, 12
VEN	Italy	Istituto Universitario di Architettura, Venezia	**Dr. C. di Thiene**	Rollei	Calcomp 9500	RESEAU MR2	2, 9
ZUR	Switzerland	Institute of Geodesy & Photogrammetry ETH - Zuerich	**Prof. A. Gruen** Eng. A. Streilein	JVC GR-S77 (camcorder)	Digital Photogr. Station	GAP	1, 2, 5, 7, 9, 11, 14

Contribution

1. *comparison of pre- vs. self-calibration*
2. *comparison of semi- vs. non-metric photography*
3. *comparison of medium vs. small format*
4. *comparison of normal vs. general case*
5. *comparison of minimum vs. rich control*
6. *comparison of different control distributions*
7. *comparison of different measuring devices*
8. *comparison of simple vs. rigid restitution*
9. *comparison of different adjustment software*
10. *comparison of repetitions*
11. *development of training material*
12. *development of software / Information Systems*
13. *graphical presentation*
14. *test devices and procedures of Digital Photogram.*

- ▪ ***Pilot Center***

Local criteria are the Mean Square Error $\acute{o}_i$ of a point i, the volume of the error ellipsoid, and the characteristics of the error ellipsoid (lengths of the axes, etc).

$$\sigma_i = \sqrt{\frac{\sigma_x^2 + \sigma_y^2 + \sigma_z^2}{3}}$$

Although the use of the local criteria is useful for each individual solution, for checking the accuracies in different areas of the object, they are of little help in drawing overall conclusions. Therefore additional global type of criteria have to be defined and computed for each solution.

Such global criteria can be the RMS value corresponding to the mean variance D_2, the Mean Standard Deviation D_1, and the Maximum Standard Deviation D_{max}.

$$D_2 = \sqrt{\frac{\sum_{i=1}^{k} \sigma_i^2}{k}}$$

$$D_1 = \frac{\sum_{i=1}^{k} \sqrt{\sigma_i^2}}{k}$$

$$D_{max} = \max \sqrt{\sigma_i^2}$$

4.3 Graphical presentations

In order to graphically present the results, the following plots have been prepared for each solution:

- Projections of the error ellipsoid of every point onto the X-Y, Y-Z, Z-X planes.
- Discrepancy vector plot, showing the differences between the point coordinates obtained through the prior adjustemnts and those obtained after the S-transform. These discrepancies can be used to determine possible misfit between the individual dataset and the common reference frame used for the comparisons.

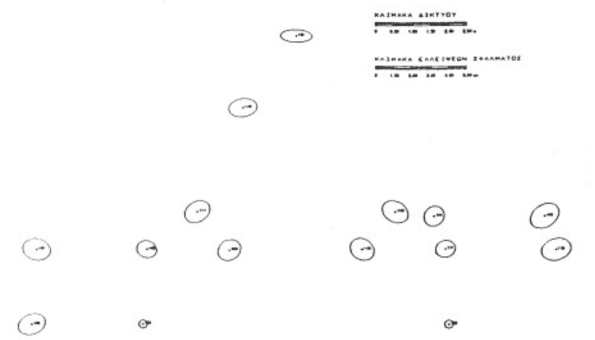

Figure 4. Sample plot of the projected error ellipsoid.

5. THE RESULTS

5.1 Concerning adjustment software

- 81% participants have used bundle adjustment software.
- 19% participants have used DLT software.
- 25% participants have used own software.
- Many of the programmes do not make available to the user (either partly or fully) covariance information.

5.2 Concerning pre- and self-calibration

- 48% solutions used pre-calibration.
- 52% solutions used self-calibration.
- In all cases the obtained accuracies are better than 1cm.
- In the majority of the cases self-calibration gave better results.
- In some cases (20%) self-calibration gave worst results, which means that it has not been handled correctly.

5.3 Concerning semi- and non-metric photography

- 42% solutions used semi-metric photography.
- 53% solutions used non-metric photography.
- 5% solutions used CCD's or camcorders.
- Medium format, semi-metric photography gave the best results.
- Small format, non-metric photography gave the less food results, but good enough for architectural emergency purposes.
- Small format, semi-metric performed as good as the medium format, non-metric photography.

5.4 Concerning medium and small format

- 43% solutions used medium format photography.
- 57% solutions used small format photography.
- Medium format performed better than small format.
- There is a strong connection between format and measuring device regarding the achieved accuracy.

5.5 Concerning measuring devices

- 62% solutions used measuring device with precision 1ìm to 5 ìm.
- 29% solutions used measuring device with precision 5ìm to 30ìm.
- 8% solutions used measuring device with precision larger than 30ìm.
- The role of high-precision measuring device is more profound in semi-metric and medium format than in non-metric and small format.
- The degradation of accuracy when using lower-precision measuring device is very high (up to 100%)

Local criteria are the Mean Square Error $\acute{o}_i$ of a point i, the volume of the error ellipsoid, and the characteristics of the error ellipsoid (lengths of the axes, etc).

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Such global criteria can be the RMS value corresponding to the mean variance D_2, the Mean Standard Deviation D_1, and the Maximum Standard Deviation D_{max}.

$$D_2 = \sqrt{\frac{\sum_{i=1}^{k} \sigma_i^2}{k}}$$

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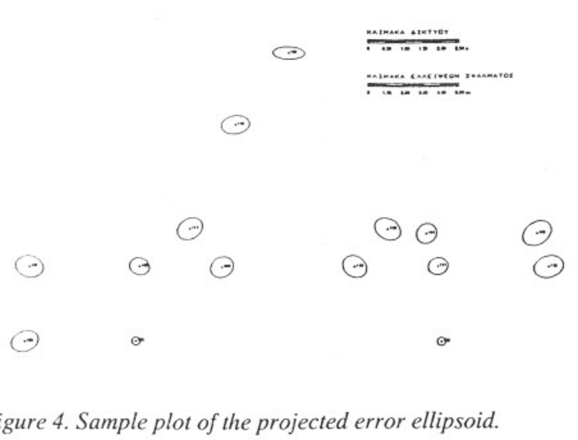

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for semi-metric and medium format, whereas negligible for non-metric and small format.

5.6 Concerning control information

- 31% solutions used minimum control information.
- 69% solutions used maximum control information.
- The flunctuation of the results is little when using max. control in contrary to min. control (given measures as distances and defined verticals) solutions.

5.7 Photogrammetric restitution results

Although the main objective of this test has been to evaluate the different programs of bundle adjustments available, as well as to proof the possibility of using amateur cameras for recording with photogrammetry our cultural heritage, it should not be forgotten that the fundamental application of photogrammetry in the field of architecture continues to be that of obtaining graphic records.
Up until the present, only two centers have carried out a graphic plotting of the building presented here. As a comparative element we have at our disposal a plotting previously carried out by the Bundesdenkmalamt using a SMK metric bi-camera from Carl Zeiss Oberkochen and an analogical plotter. In our case we have used the photographs obtained with the Rolleimetric 6006 camera and the ADAM MPS2 stereoplotter. For this instrument an interface for working directly in Autocad have been used. As records of reference, three of the four elevations have been plotted, since the two lateral elevations are practically identical. By joining the elevations we were able to make up a three-dimensional model with which to construct perspectives of the building from different positions and angles.

By comparing the results of the analogical plotting carried out by the Bundesdenkmalamt with the drawings now effected, a similarity may be appreciated both with regard to the precision achieved and with regard to the graphic result. The most remarkable difference can obviously be observed in the lighter weight and greater ease in the use of the equipment used at present, particularly with reference to the photographic camera, and above all, the considerable advantages there are on the availability of the results in CAD and with three dimensions recording. This whole system provides undeniable advantages, from the simplification of data-taking thanks to the use of light cameras which are easy to transport and to handle as well as to the reduction in control data. At the same time there are possibilities of obtaining a graphic quality similar to that achieved by means of traditional equipment.

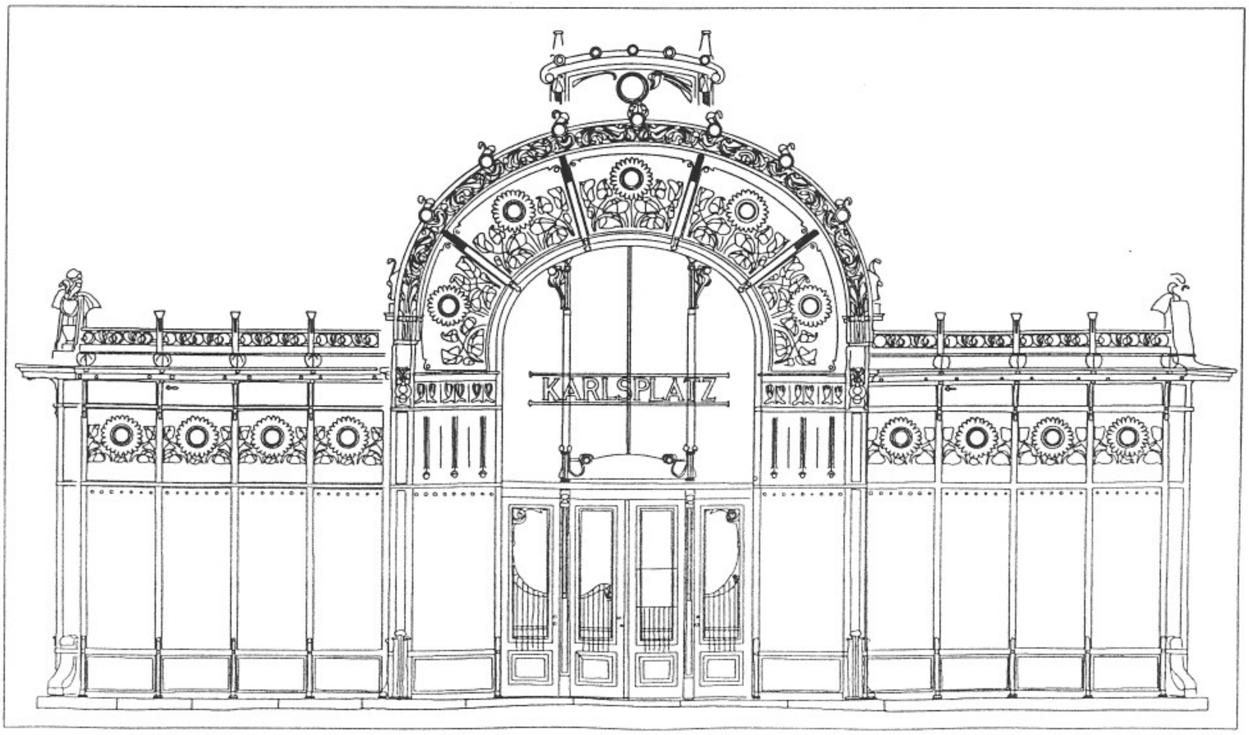

Figure 5. Sample graphical output of the photogrammetric restitution.

6. CONCLUSIONS

- Assuming enough (minimum) control, proper pre-calibration or careful self-calibration procedure, adequate results for architectural use are obtained (1cm-2cm) even with small-format non-metric photography.

- The three major factors affecting the accuracy are :
  - *Photoscale (is connected to the format)*
  - *Metric characteristics of the camera*
  - *Measuring device*

  The bigger the photoscale (bigger format) the more information contained in the image can be used by a high-precision device. Conversely, there is no reason in using a high-precision device when the information is not recorded (small format).

  Besides, the resolution of the information and the stability of the camera are two factors that are interelated. For example, if the highly resolved information (medium format) is not geometrically stable (non-metric) we can not recover the losses by using a high measuring precision.

- Combined (terrestrial + photogrammetric) measurements adjustment did not improve the results considerably.

- Solutions using minimum control information (according to "3x3 rules") provided almost as accurate results as by using minimum constrained solutions with surveying data.

Concluding this CIPA test we should now proceed with the following tasks of Architectural Photogrammetry :

- Quick and worldwide photogrammetric documentation of the architectural heritage.
- The analytical methods of restitution should be further developed and further propagated.
- Databases are to be developed for national and international cooperation in the various fields of cultural resource management, including information on where photography or plans exist, where subdatabases are not exist and which fields are covered by them (MetaDatabases).
- Digital Photogrammetry and digital image processing are to be further developed.
- Promotion of Photogrammetry among potential users.
- Promotion of activities of National Delegates. Cooperation with other committees and organizations.
- Promotion of cooperation with the military and the local fire brigades.
- Cultivation of macrophotogrammetry. Cadastre of small monuments and museumphotogrammetry.

REFERENCES

Dallas, R.W.A., 1990. A specification for the Architectural Photogrammetric survey of Historic Buildings and Monuments. Proc. of the CIPA XIII International Symposium, Cracow, Poland, pp. 79-92.

Grussenmeyer, P,, B. Merckel. 1995. Architectural Photogrammetry with metric and non-metric cameras. ENSAI Strasbourg Report.

Patias, P., D. Rossikopoulos, O. Georgoula. 1993. CIPA Test: "O. Wagner Pavilion". Preliminary Report. Presented at the CIPA XV International Symposium, Bucharest, Romania, September 22-26, (Executive Summary under publication in the proceedings).

Patias, P., Petsa, E., and Streilein, A., 1995. Digital Line Photogrammetry. Report IGP Bericht Nr. 252, ETH, Zurich, Switzerland.

Patias, P. and Karras, G., 1995. Contemporary Photogrammetric methods applied to Architecture and Archaeology. Thessaloniki, Greece, (in Greek).

Streilein, A., 1993. Application of a S-VHS Camcorder in Architectural Photogrammetry. Proc. of the CIPA XV International Symposium, Bucharest, Romania, September 22-26, (under publication).

Streilein, A., 1994. Towards Automation in Architectural Photogrammetry:CAD-Based 3D-Feature Extraction. ISPRS Journal of Photogrammetry & Remote Sensing, Spring 1994.

Streilein, A. and S. Gaschen. 1994. Comparison of a S-VHS Camcorder and a High-Resolution CCD-Camera for use in Architectural Photogrammetry. Proc. of the ISPRS Intercongress Symposium, Melbourne, Australia, March 1-4, 1994, pp. 382-389.

Streilein, A., 1995. Towards automation in Architectural Photogrammetry: CAD-based 3D-feature extraction, ISPRS Journal of Photogrammetry and Remote Sensing, 49(5), pp. 4-15.

Waldhäusl, P., M. Brummer. 1989. Architectural Photogrammetry world-wide and by anybody with non-metric cameras?, Proc. of the CIPA XI International Symposium, October 1988, Sofia, Bulgaria. pp. 35-49.

Waldhäusl, P. 1992. Defining the future of Architectural Photogrammetry, International Archives of Photogrammetry and Remote Sensing, Vol. 29, Bart B5, pp. 767-770

Waldhäusl, P., 1994a. The 4th International Symposium for Architectural Photogrammetry of CIPA. Report in

ISPRS Journal of Phtogrammetry and Remote Sensing, 49(2), pp. 38-41.

Waldhäusl, P., 1994b. Photogrammetric Documentation of Architecture - Simple and Fast. Proc. of IRIS 1st International Colloquium, Bari, Italy, November 1994, pp. 138-141.

Waldhäusl, P. and C., Ogleby, 1994. 3x3 rules for simple photogrammetric documentation of Architecture. International Archives of Photogrammetry and Remote Sensing, Proc. of Com. V Symposium, Melbourne, Australia, Vol. XXX, Part 5, pp. 426-429.

Waldhäusl, P., 1995. Photogrammetric Heritage Recording: Standard and Emergency approaches. APT Bulletin, Special issue on Computers in Conservation, January 1995, pp. 20-22.

Waldhäusl, P. and J., Peipe, 1995. Report of the CIPA - Working Group on Control Information. In: Architectural Photogrammetry, Proc. of ICOMOS' 10th General Assembly of the International Scientific Committee.