CURRENT STATUS AND PERSPECTIVES FOR THE CONSERVATION, REHABILITATION AND DOCUMENTATION OF THE CUBAN´S ARCHITECTURAL HERITAGE

S. H. González G., B. D. Díaz R., V. Mederos, R. Olivera.
GEOCUBA IC, Loma y 39 Nuevo Vedado, Plaza, CH, Cuba, investigaciones@geocuba.co.cu , geohab@enet.cu

KEY WORDS: accuracy analysis, cultural heritage, photogrammetry, three dimensional, virtual reality.

ABSTRACT.

The possibilities offered by the photogrammetric techniques to study and preservation of our cultural and natural heritage become a fundamental goal to develop in our institution in the next years. For many years the photogrammetrical restitution of the facades and monuments with high historical and cultural values represented a production line with high recognition. It was conditioned by the interest to support the reconstruction and restoration mainly of many places in Old Havana City, a "World Mankind Heritage Site". Regrettably at the beginnings of nineties decreases technician work in Cuba but the protection and restoration plans of the heritage did not stop. The restoration is a permanent task, to which big resources and efforts are dedicated to perpetuate and transmit to present and future generations the values that have been stored by our society. The introduction of the digital technology are aimed to achieve the images reception, as well as their later prosecution and it forms expose and to give the results it reopens the possibility to activate the use of this technique and work method, allowing the interaction with information systems and development of 3D models that lead to the virtual reality. Today, we take account the thematic with the interest to offer different technical activities that are gone from the simple description of the objects to arriving to the modelling and navigating in metric environments of high verisimilitude. The results to reach us will impel toward other thematic that will allow the study of architectural building and engineers letting the displacements determination and deformations; analysis of pathology of the constructions and their modelling. An important line of work is to exchange among specialists to fortify the work of the Commission V of Cuban ISPRS; as well as the insert in CIPA.

1. INTRODUCTION.

When we admire a reconstructed work we feel an immense satisfaction of contributing to the popularization of the values associated to the roots of our history as a fundamental link of our own identity.
In this activity the use of more rational techniques is increasing, to support the rehabilitation of the patrimony, for that reason the photogrammetry activity should not be ignored as a science, technique or method, which being supported by the climax of the automation`s development, accounts modern equipments to carry out the registration, analysis and representation of recorded information.
The introduction of digital photogrammetric stations (DPS) in our country, promote the use of close range techniques in different applications, demanding us to evaluate the possibilities of their exploitation; as well as the development of work methodologies, and then define the work objectives of this topic for an immediate future.

2. ANTECEDENTS.

As close as 1976 Ph.D. Mario Pedroso, introduced in Cuba the terrestrial photogrammetry, activity fundamentally directed to the control of engineering works, using the UMK camera and the Photogrammetric Universal Instruments (Wild A-8 and Wild A-7) which recorded the restitution results on the automatic table Wild TA-2 In the nineties the information was recorded in digital files thanks to the connection of analogue equipments to personal computers, the activity had a high demand, due to the effectiveness of the method and the necessity of the historical centres of our country to carry out the registration of the documental information. (See figure #1).

Figure 1. Initial works in Cuba.

3. REALIZED WORKS.

3.1. Registring graphic information.

The documentation centres of patrimony of “Havana, Trinidad and Santiago de Cuba” cities possess analogical files with a valuable asset of information for the application of photogrammetric activity. To guarantee its perpetuity, it requires digitations, first taking it to raster and then progressively convert it to vectorial format, base of metric analysis and projection toward three-dimensional models; in this sense been executing an analysis that will allow to know

the type of graphic documentation; for each patrimonial work has available as well as the conservation state to establish the strategy that must be followed during the conformation of digital archives of sites and monuments.

3.2. Evaluation of the possible accuracy to reach with the available technologies in Cuba.

The ignorance about the acquired technology demanded to establish, as a first activity, to evaluate the accuracy that the DPS brings when processing terrestrial images as well as define; to specify the level of possible detail that can be appreciated for each scale and resolution should pay attention determine the most common errors toward which the technologists attention and finally to make the corresponding technological documentation. The finding of solutions to those problems mentioned above led us to make some experiments in order to evaluate the possible accuracy is possible we may reach with the use of means we have at the present time. For this purpose was created a control polygon that was photographed with the photogrammetric camera UMK 20/1318. (See figure #2.)

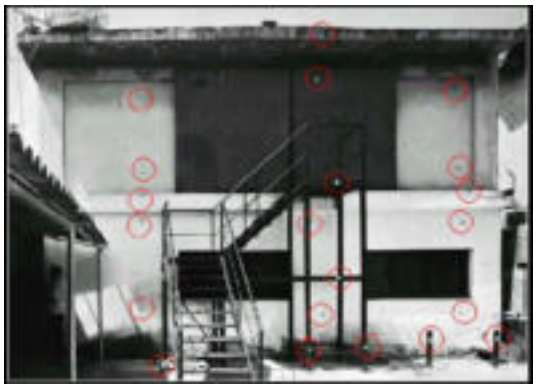

Figure 2. Study polygon.

In the polygon was designed a net with 21 control points, the survey was carried out with the camera UMK 20/1318, adjusting the parameters as follow:

- Focal Distance 200 mm
- Basis of taking 2.83 m
- Distance of taking 8 m.
- Longitudinal overlap 80 %.

This investigation was developed using different control points, that were not include in the absolute orientation of models, the measurements were carried out by two experience operators twice. The result is shown in table #1.
A second experiment was developed to evaluate the accuracy in the relative position among object elements for that, fixed elements were selected on it with dimensions determined with field accuracy. These values were adopted as inicial, and a maximum weight was assigned, to compare them with those measured in the photogrammetric pattern. At the table #2results are shown.
A third experiment allowed to determine the exact accuracy, of measures applied in the object depths. The result is presented in table #3.

Table # 1 Measurement accuracy for the of well defined points (m).

Point	Differs in X	Differs in Y	Differs in Z
5	0.002	0.002	0.005
6	0.001	0.001	0.007
7	0	0	0.006
8	0.001	0	0.007
9	0.003	0.004	0.003
10	0.001	0.001	0.006
12	0.002	0.006	0.005
13	0.001	0.004	0
14	0.001	0.002	0.001
15	0	0.001	0.005
9a	0.002	0	0.002
5	0.001	0.002	0.006
6	0.001	0.002	0.007
7	0	0.001	0.006
8	0.002	0	0.01
9	0.002	0.003	0.004
10	0.001	0.001	0.006
12	0.001	0.006	0.007
Mean error	**0.0012**	**0.0020**	**0.0046**

Table # 2. Accuracy in the relative position among fixed elements. (m).

No.	Measured elements	Terrestrial Dist.	Model Dist.	Abs Error.
	E/ vigas 1 Ancho marco 1 Ancho marco 2 Ancho viga 1 Ancho viga 2 E/ vigas Ancho ventana E/ 9-8 E/ 9-7	0.95 0.565 0.018 0.045 0.01 1.535 0.924 2.685 3.314	0.95 0.563 0.02 0.044 0.01 1.53 0.922 2.689 3.316	0 0.002 0.002 0.001 0 0.005 0.002 0.004 0.002
	E/ 9-11	2.006	2.007	0.001
	E/ 7-11 E/ 7-8 E/ 16-7 E/ 15-9 E/ 11-8 E/ 15-11 E/ 16-11	2.708 1.69 5.886 3.622 3.222 2.953 3.622	2.712 1.693 5.883 3.618 3.222 2.947 3.622	0.004 0.003 0.003 0.004 0 0.006 0
			Mean error.	**0.0025**

Table # 3. Accuracy in the depths´s measurement on the object.

No	Field value	Measured value in the model	Diff. (abs)	Square Diff.
1	0.14	0.14	0.000	0
2	0.3	0.29	0.010	0.0001
3	0.3	0.3	0.000	0
4	0.78	0.77	0.010	0.0001
5	0.07	0.06	0.010	0.0001
6	0.04	0.05	0.010	0.0001
7	0.04	0.04	0.000	0
8	0.29	0.29	0.000	0
9	2.59	2.55	0.040	0.0016
10	0.06	0.06	0.000	0
11	0.07	0.08	0.010	1E-06
12	0.3	0.29	0.010	0.0001
13	0.3	0.29	0.010	0.0001
14	0.07	0.07	0.000	0
			0.110	0.0023
Mean error			0.008	
Standard Desviation				0.0133

3.3. Façade restitution.

The façades restitution topic is focused to the development of several objectives that contemplates the study of EFD possibilities and the existent metric cameras. For the achievement of this objective were carried out experiments on a façade of "La Plaza Vieja" located in the historical centre of Havana City, where the restoring activity has allowed the rescue of works of incalculable historical and cultural value that nowadays offer a special scenario for knowledge, education and healthy enjoyment of our society. The restitution was carried out using the cameras: UMK 20/1318, with focal distance of 199.87 mm, with film AGFA ICQ 25 ASA, exposition speed 4 sec. with a opening diaphragm aperture 11. The façade area was covered with 3 pictures, with a base of 7.0 m. there were carried out takings with turns of 15º to cover the superior part of the object, at the same time was verified the possibility of working with high degree of inclination of systems, this activity was impossible to carry out with the analogue technology. The control points positions were determined with the Total Station Leica TCR 307 with a precision of 7" for direction measurements, and a precision for linear measurement of 3 mm ±2 ppm without prism.
The images were transformed into digital format with the employment of the scanner ULTRASCAN 5000 at a resolution of 1200 dpi. The restitution was developed in the station DELTA GeoSystem, combining the images of different degrees of inclination. The graphic result is shown in figure #3, where the vectorial file was combined with the digital ortophoto, the established in the field network, the restored vectors, and data of the DEM generated with the use of the application DiAP DTM in the EFD DiAP. As need as at the previous cases, points used were distributed over the whole area of the façade were used to evaluate the accuracy of representation in the three axes of the captured elements. The results are shown in table # 4.

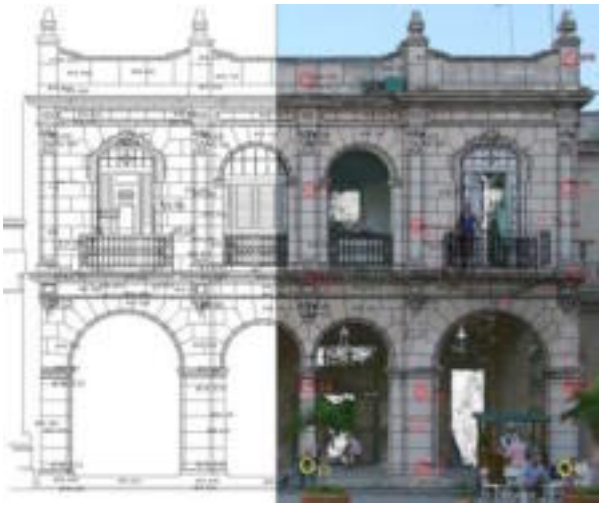

Figure 3. Restitution resultds on façade.

Table # 4. Accuracy in the representation of surveyed elements.

N° Punto	Measurements on the model			Abs Diff. (x)	Abs Diff. (y)	Abs Diff. (z)
	X	Y	Z			
6	25.69	1000.13	978.79	0.004	0.004	0.007
8	31.66	999.98	978.63	0.003	0.004	0.003
17	31.18	1007.06	978.17	0.001	0.005	0.021
19	22.59	1010.11	978.53	0.007	0.009	0.006
23	25.66	1014.12	978.83	0.016	0.005	0.02
24	28.15	1014.14	978.57	0.004	0	0.002
13	20.69	1007.08	978.16	0.002	0.003	0.016
4	20.51	1000.06	978.53	0.003	0.004	0.01
11	27.37	1000.08	978.56	0.001	0.001	0.008
20	27.07	1010.05	978.56	0.011	0	0.007
13	20.69	1007.08	978.17	0.002	0	0.006
22	22.72	1014.16	978.53	0.006	0.004	0.003
Mean error				**0.005**	**0.003**	**0.009**

4. LINES OF DEVELOPMENT.

4.1 Assembly based on a SIG (SIT).

The previous work stages are intended to organize the information filed analogically, as well as to evaluate the inventory of monumental works and the interrelation between both informations, for the execution of this task has been created an application CARTOSIG, system which permit to carry out the administration and analysis of information, the first stage will allow the achievement of spatial, descriptive and graphic analysis from the photographic image of each work of patrimonial value for the analysis realization and consults. The design and structure of databases conceive the specialized description of each work object, aimed to allow the information.

4.2. 3D Modelling.

The result of the photogrammetric restitution aimed to three-dimensional description of objects will allow the development of volumetric objects of interest; this result will be introduced for its evaluation and visualization inside the implemented system. With regard to this thematic, the modelling of isolated urban environments has initially been approved, processing the that possess a link to database so as to identify and consult its
restored vectors according to a methodological design that characteristics.
contemplates the stages shown in figure 4.

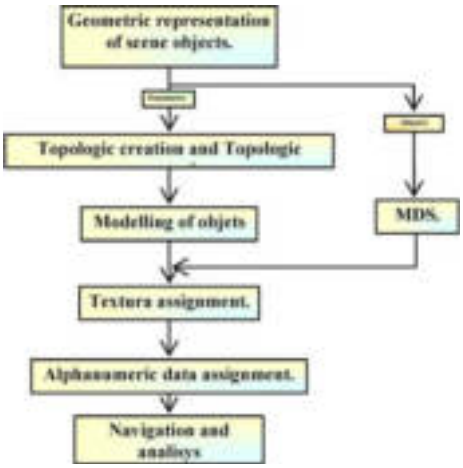

Figure 4. General design for modelling urban environments.

The 3D modelling has been achieved after the linking and flowing the information obtained in the DPS, Microstation and ACAD systems and the handling of solids in 3D Studio. A section of the modelling area is shown in figure 5.

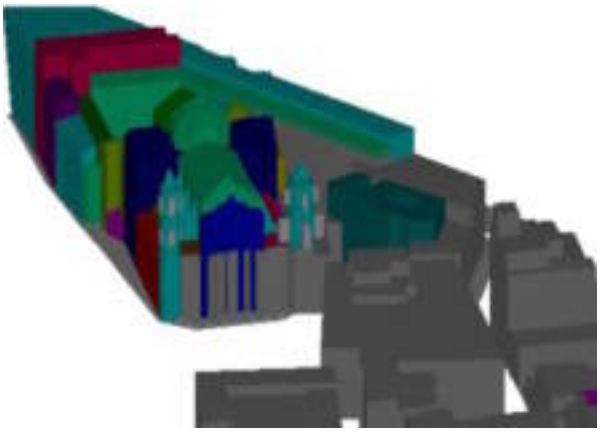

Figure 5. Section of urban area modelling.

4.3. Navigation inside 3D urban environments.

The development of virtual reality with the necessary techniques constitutes a higher stage. The inserted scene in the SINAG system allows the interactive analysis with 3D objects. In the navigator GIS function patterns have been included along with information linked in databases that allow in this stage the realization of preliminary consultations to satisfy certain analysis objectives. Searching on the navigator environment the answer to the questions before mentioned focuses the future works to the development of applications that guarantee us agile solutions in the interaction with 3D models in a direct way, without weeding in GIS entries, allowing to manage the information in the threedimensional environment. In figure 6 the new navigator environment SINAG is shown along with the modelling scene and the interaction with objects Figure 6. A view of the modelled scene in the SINAG navigator.

5. CONCLUSIONS.

The presented summary about the carried out investigations describes the determination of our group to strengthen the photogrammetry activity in our country and the necessity of systematizing its use.

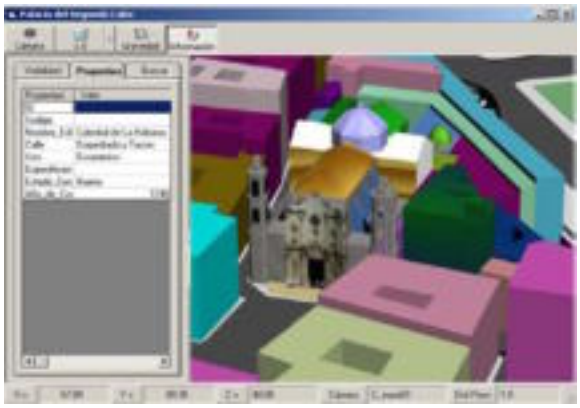

Figure 6. A view of the modelled scene in the SINAG navigator

Many stages need to be carry out and developed. In fact, the next 2006 year the GEOMATICA international congress will be carried out a specialized workshop about the state of close range photogrammetry, and the use of advanced technologies, in which our necessities and strategies will be evaluated. It will be great pleasure to have the support of international organizations and personalities that are identified with such zeal for the realization of this event.

REFERENCES

H. Mordechay “Virtual Reality and GIS: Applications, trends and directions.”2002

J. Trinder, “Digital Photogrammetry”, “State of the Art of Digital Photogrammetry and Remote Sensing”, conferencias magistrales,. Geomatica 2004

K. Tempfli. 3D topographic mapping for urban GI. ITC Journal 1998-3/4. p 181. Letellier, R. Virtual reality. A new tool for sustainable tourism and cultural heritage sites management. CIPA Olinda.1999.

S. H. González G. Estado actual del uso de las técnicas fotogramétricas en Cuba. La Habana 2000.

S. Zlatanova, K. Tempfli. “Modelling for 3d GIS: spatial analysis and visualisation through the web” Book 4C. 2000 ISPRS XIX Congresss S H González G. "Metodología para la modelación cartográfica de entornos urbanos a partir de información obtenida por métodos fotogramétricos" 2005.

ACKNOWLEDGEMENTS

The authors wishes to thank to the GEOCUBA, ISPJAE and the Office of the Historian of The City of Havana institutions for the support granted for the development of investigations. Special thanks to specialist Ph. D. Francisco Rivero Aguirre author of SINAG, Engineer Raúl Muñoz Salabarría author of CARTOSIG and Ph. D. Maribel Páez Moro for her important help. We deeply appreciate the contribution of specialists Yosniel González in the graphic design and Erki Polo as author and programmer of SINAG system