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Ideja konferencije je proistekla iz potrebe za povezivanjem kulturne baštine sa savremenim materijalima, tehnologijama imetodama ispitivanja.

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Editori se zahvaljuju svim autorima na učešću.

SADRŽAJ

APPLICATION OF DIGITAL GRAPHICS TOOLS AND CONTACTLESS MEASURING INSTRUMENTS IN 3D SCENE RECONSTRUCTION

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Abstract
Innovative technologies often join their methodologies, instruments and techniques in solving various types of sophisticated problems in the area of architectural cultural heritage. Beside precise photogrammetric and laser scanning methods, the other less expensive and less time consuming methods for 3D scene/object reconstruction exist. The choice of tools/instruments and methodologies depends on large scale of factors (time or space limitations, finances, availability of instruments and graphic software, etc.). For particular project's purposes, 3D scene reconstruction, the chimney of an old brick factory in Belgrade with its surrounding buildings, was performed and presented as 3D digital model. The combination of 3D modeling graphic software tools, measurement data recorded by laser based geodetic instrument and image data taken by digital camera were employed for architectural scene reconstruction.
Since there was no available technical documentation, first part of the project included measurements of existing objects. The task concerning precise dimensioning and spatial positioning, especially regarding the chimney was set. The scene (chimney and surrounding objects) was recorded by photo camera Canon Powershot A710 IS from the second floor of the Institute of Physics' building, while real geodetic measurements were obtained by geodetic instrument - total station Sokkia SET3130R3 positioned at the same view-point. Based on coordinates of some characteristic points on the chimney and the building, the scene was reconstructed and modeled in real dimensions in graphic software Auto CAD. Classical Descriptive geometry method for single image restitution was employed in addition for the purposes of correct spatial positioning (mutual relationships) of two recorded objects, and comparison of obtained results as well.
This reconstruction project has its educational, cultural and documenting aims. Hence employed and gathered various disciplines and knowledge gave an adequate solution of practical engineering multidisciplinary task.
Key words: 3D scene reconstruction, contactless measurements, 3D digital graphic model

1. INTRODUCTION

Contemporary trends in cultural heritage preservation inspire civil engineering/architecture professionals to explore possibilities of particular objects' revival for their utilization in new life-stream [1]. Among them auxiliary objects such as chimneys of old ruined or destroyed factories exist. One of them is prepossessing chimney of an old brick factory in the beautiful surroundings of the Danube river bank and in the vicinity of important scientific institution (Fig. 1).

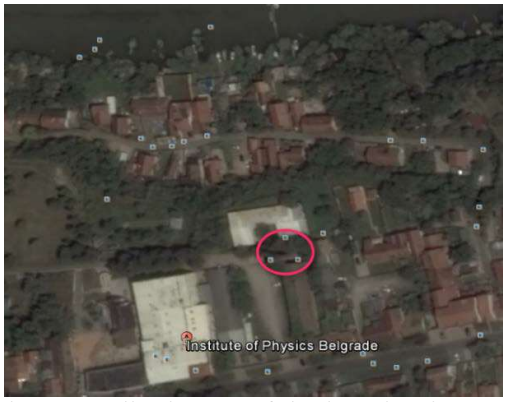

Fig. 1 Satelite image of the location in Zemun (Google Earth screenshot)

Fig. 2 Photo image taken from the window of Institute of Physics

The inspiration for 3D presentation of this object came from an interesting photo taken from the window of the Institute of Physics (Fig.2). The old chimney is a representative of a certain expiring time and culture, hence an impulse for "saving" the scene and present it in the form of 3D digital model seemed worthy in several aspects. Just a few similar objects exist in old Belgrade's parts. It looked like a challenging task to unite several disciplines and employ new technologies. Without any technical documentation one should found practical (not expensive one) solution for measurement data and graphic design.

2. EXPERIMENTAL: RECORDING THE SCENE

In order to obtain some reliable data total station—Sokkia SET3130R3 (Fig. 3) was employed for several characteristic coordinates (Table 1) on the chimney (points along one of the visible edges of the octagonal object as presented in Fig .4). The instrument is positioned at the view point of the "photographer" - at the second floor of the Institute. The coordinate system of the instrument was pursued with coordinate system of 3D model [2]. The measurement accuracy of Sokkia total station for angles is 3" and 3 mm + 2 ppm for lengths, if a laser beam is used. This was the case in Zemun's project.
The scene (chimney and surrounding objects) was previously recorded by photo camera Canon Powershot A710 IS (Fig. 2), as mentioned. The raster image file was imported in AutoCAD drawing file in order to start perspective restitution drawing procedure.

Table 1. Coordinate data of recorded points

	X	Y	Z	Name
101	5000	3000	100	view point
1	5000	3058.235	102.629	ring
2	4999.984	3058.262	104.009	ring
3	4999.958	3058.311	105.488	ring
4	4999.927	3058.362	107.573	ring
5	4999.9	3058.415	110.003	ring
6	4999.874	3058.491	112.465	ring
7	4999.826	3058.552	115.155	ring
8	4999.79	3058.618	117.703	ring
9	4999.762	3058.702	120.202	ring
10	4999.738	3058.749	122.574	ring
11	4999.741	3058.83	125.352	ring
12	4999.78	3058.847	127.577	brick below the ring
13	4999.76	3058.892	127.802	ring

Fig. 3 Total station Sokkia SET3130R3
http://www.geosurvey.co.uk/set3130r3-tachymeter-stations

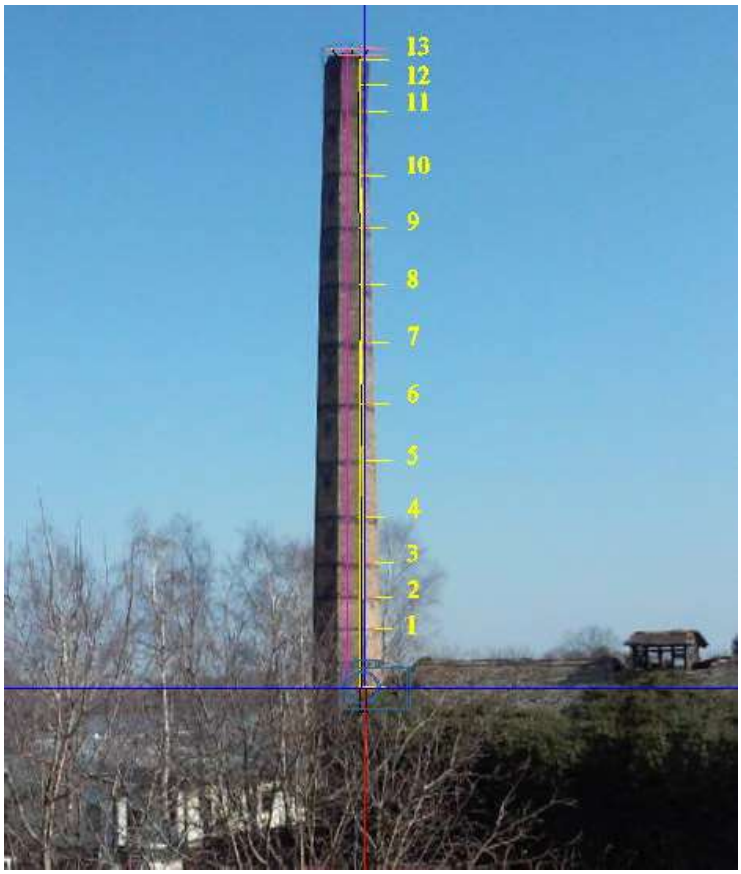

Fig.4 Disposition of recorded points on the chimney

Interpretation of the task by descriptive geometry methods

Descriptive geometry has its important role in image reconstruction procedure [5]. Main principles of classical perspective drawing (determination of vanishing points and lines of characteristic objects on perspective photo image) in inverse procedure for determination of the observers' view point were applied in procedure of scene restitution. (Fig.5a). According to obtained dimensions in image restitution, the plan restitution followed (Fig. 5b). Angular and

lenght dimensions are presented in order to define mutual relations – disposition of observed objects: the chimney and outbuilding. The dimensions of the Institutes' outbuilding were compared to the data obtained by common measurements. The difference between accuracy of the recorded data obtained by precise geodetic device and those obtained by image restitution was neglected. The reason is that image restitution could not give precise dimensions because of rather small image size (*.jpg file image imported into Auto CAD drawing). The correctness of perspective restitution results was satisfactory regarding the lack of any technical documentation.

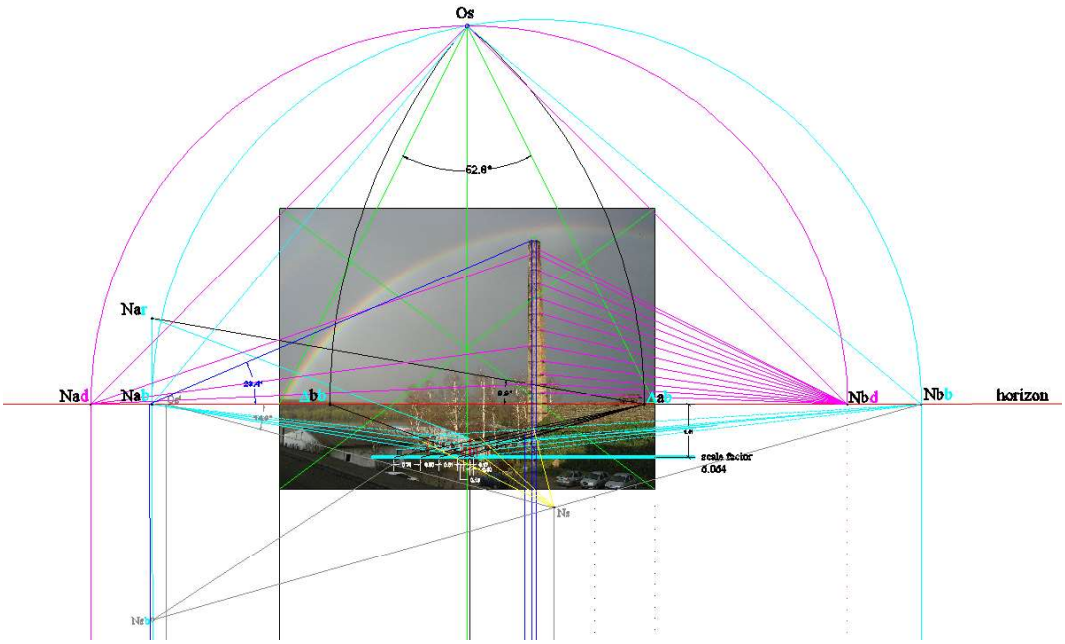

Fig. 5a Perspective restitution of the scene: Image restitution

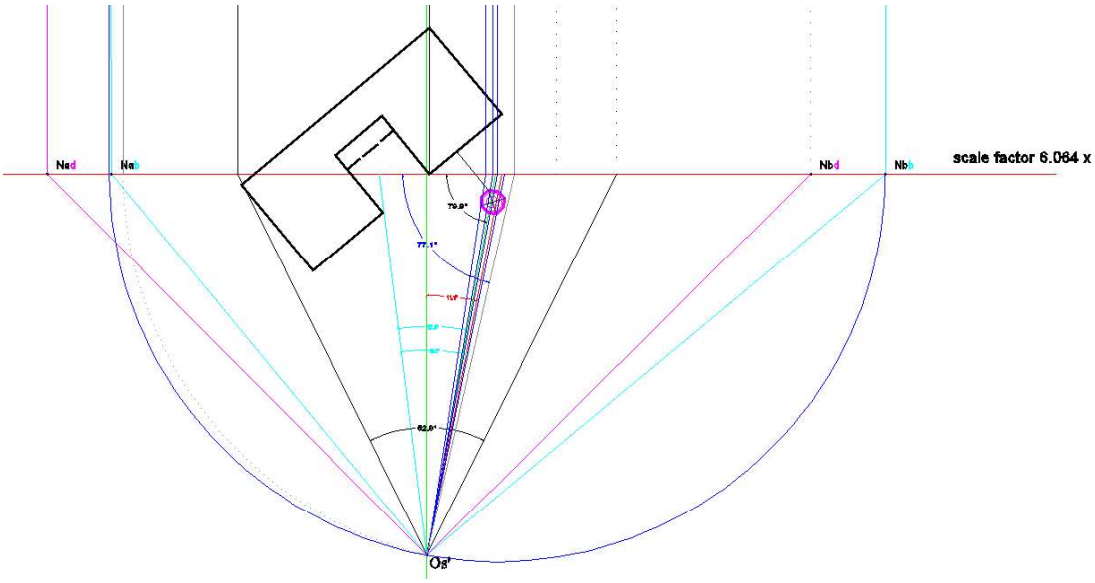

Fig. 5b Perspective restitution of the scene: Plan restitution

3D modeling procedure

3D modeling procedure needed certain geometric skills, not only in modeling procedure, but managing with "missing " data. Only a few points of outbuilding were recorded by precise instrument, while the others should have been reconstructed. In order to get as much realistic scene as possible, some details of outbuilding were presented: doors, windows, etc. as well as approximate terrain simulation (Fig. 6).

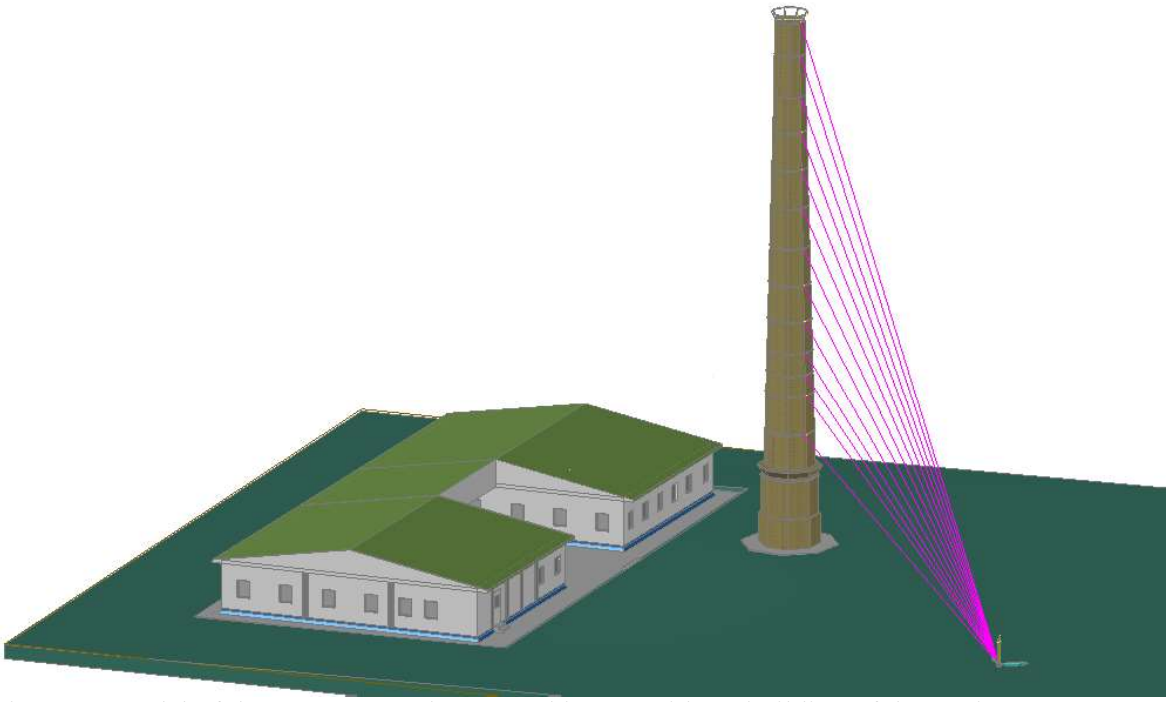

Fig. 6 3D model of the reconstructed scene - chimney with outbuilding of the Institute (view point of the instrument with virtual laser rays - coordinate origin)

CONCLUSION

Project which preliminary task was to explore possibility of efficient and non-expensive solution for 3D scene reconstruction, achieved several results in various fields and disciplines: cultural heritage, 3D technology application, technical documenting, affirmation of descriptive geometry principles, information, etc.

It can be stated that the importance of cultural heritage protection directs several aspects:

- Beside application of new technologies, protection of classical knowledge;
- Respect of old culture and architecture (monuments and characteristic objects) and their transformation in contemporary streamline [3];
- Cultivation of skills aided by 3D technologies;
- Stimulating creative experiments and ideas, regardless their costs [4];
- Association of compatible disciplines and experts;
- Cultivation of beauty in any sense.

It is certain that the chimney of the destroyed brick factory could be utilized in several functional purposes: one of characteristic landscape viewpoints which Belgrade and Zemun offer; orientation point in the network of similar objects in the city; witness of the certain past

time in touristic cultural heritage guide; attractive object for inspiring architectural renovation, etc.
The results of the investigation, 3D model of the scene, with proper materialization could be inserted in 3D map of the city, and hence give a small contribution of ongoing 3D digitization process.

REFERENCES

[1] A. Čučaković, M. Dragović, M. Pejić, M. Srećković, J. Pandžić (2016) *The possibilities of application of 3D digital models in cultural heritage objects' protection and reconstruction,* Proc. of Int. Conf. MoNGeometrija 2016, Belgrade, Serbia, June 23-26, 2016. pp. 434-443.
[2] J. Maksimović, M. Mirković, Lj. Brajović, G. Todorović (2016) *Application of geometry in geodetic instruments and measurement techniques,* Proc. of Int. Conf. MoNGeometrija 2016, Belgrade, Serbia, June 2016. pp. 434-443.
[3] P. Pejić, S. Krasić, H. Krstić, M. Dragović, Y. Akbiyik (2017) *The 3D virtual modeling of existing objects by terrestrial photogrammetric methods - case study of Barutana.* Tehnički vjesnik, 24 (supplement 1) pp. 233-239
[4] J. Reznicek, K. Pavelka (2008) *New low cost 3D scanning techniques for cultural heritage documentation,* The Int. Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol XXXVIII. Part B5, Beijing, pp.237–240.
[5] V. Stojaković (2008) *3D modeling based on photographic data,* Novi Sad J. Math. , Vol.38, No.3, pp.65-72.