CYLINDRICAL AND POLYHEDRAL PANORAMAS - RESEMBLANCES AND DIFFERENCES

Jolanta DŹWIERZYŃSKA

Rzeszow University of Technology,
Department of Architectural Design and Engineering Graphics
al. Powstańców Warszawy 12, 35-959 Rzeszów, Poland
email:joladz@prz.edu.pl

Abstract. The subject of the paper refers to the author's earlier considerations dealing with construction of cylindrical and conical panoramas, as well as panoramas when their backgrounds are approximated by right polyhedra. The paper discusses resemblances and differences in geometrical aspects of constructing both kinds of panoramas, as well as their mappings received on the unreeled background. It focuses on presentation of the way of forming analytical algorithms for computer aided drawing panoramas on cylindrical and polyhedral backgrounds, and discusses influence of their structure on the graphical mapping panoramic images. The aim of the paper is to assess possibility and accuracy of the panorama image in the case of approximation of the panorama background by polyhedral one, as well as, presentation of the optimal way of composition of the panorama image.

Keywords: panoramic projecting, cylindrical perspective, approximation of panorama, analytical algorithms, CAD

Introduction

In the previous works [1,2,3,4] the method of the direct construction of panorama images on cylindrical and polyhedral backgrounds was introduced. In that method, as in the typical vertical perspective projection with a flat background, the image of the given point F is a pair of points $\{F^S, F^{O,SR}\}$ (Fig.1).

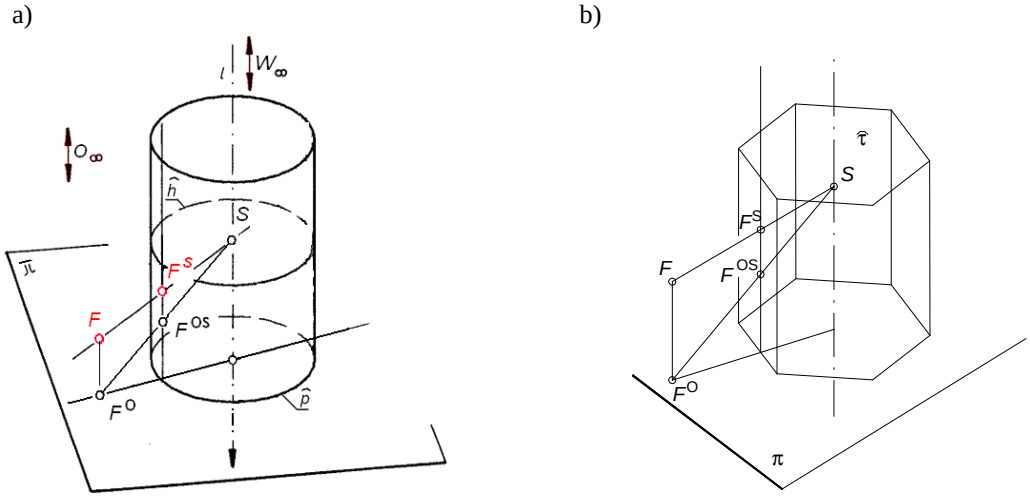

Figure1: The image of the point in panoramic projection: a): on a cylindrical background, b): on a polyhedral background

The effects of the panoramic projection are received on the unreeled, flat surface of the panorama background. For that reason, all images contained in the background $\hat{\tau}$ are

transformed to their counterparts on the unreeled background. This problem has been discussed by the author in the previous publications [1,4].

1 Resemblances and differences in mapping and forming algorithms for computer aided drawing panoramas

In general, panoramic images for cylindrical and polyhedral surfaces should be different. That is due to the fact that, in case of the cylindrical panorama the image of the straight line is a curved line, whereas, in case of the polyhedral panorama it is a broken line (Figs.2a,2b).

a) b)

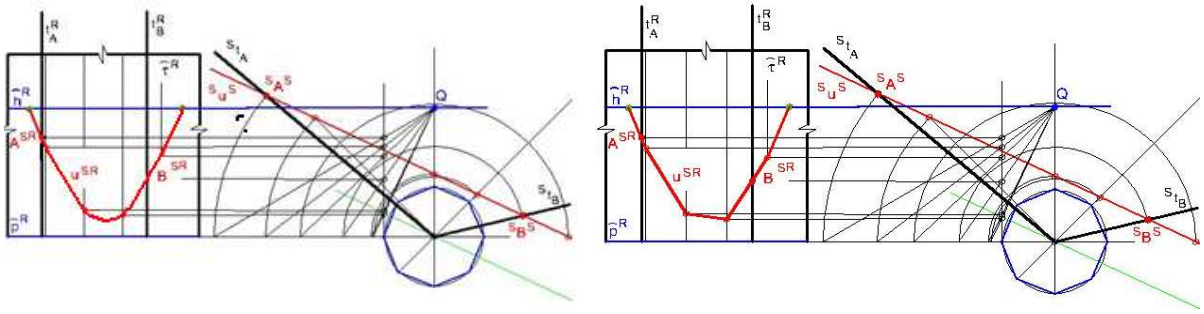

Figure 2: Mapping the straight line: a) in cylindrical panorama, b) in polyhedral panorama

The way of forming analytical algorithms for computer aided drawing the cylindrical panorama was shown in [1]. To form analytical algorithms for creation the polyhedral panorama in any CAD system similar strategy can be used. That is due to the fact that, the polyhedral background can be treated as the cylindrical one with the changeable value of the radius r_F of the base circle $\mathcal{O}$ (Fig.1a).

For each regular polygon with n sides we can derive the following formulas (Fig. 3):

$$a = 2 \cdot \frac{\pi}{n}, \quad \frac{r_F}{\sin\gamma} = \frac{t_F}{\sin\alpha_F} \quad \text{and} \quad \frac{r_F}{\sin\gamma} = \frac{b - t_F}{\sin(\alpha - \alpha_F)}.$$

Finally:

$$r_F = \frac{b \cdot \sin^2\gamma}{\sin\gamma \cdot [\sin(\alpha - \alpha_F) + \sin\alpha_F]}. \qquad (1)$$

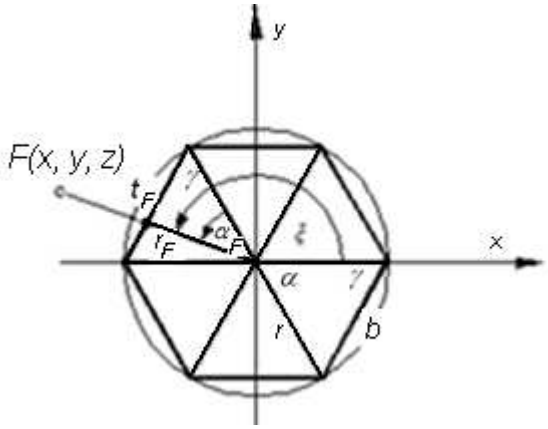

Figure 3: The scheme for establishing analytical relations occurring for a regular polygon

Replacing an unchanging value r of the radius of the base circle [1] with a changeable r_F one derived above, we can receive the algorithm for drawing the straight line in panorama

with polyhedral background. According to (1) the algorithm is much more complicated and changes periodically appropriately to the value of the angle α.

Let as not describe both algorithms (for cylindrical and polyhedral panoramas) in detail, but show the results of their work after their implementation in Mathcad 2000 Professional program. The algorithms enable quick drawing panorama image of any spatial figure shaped using lines in panorama with approximated and not approximated background. Whereas, the results received in the Mathcad software enable us to perform quick analysis of the differences and resemblances in mapping both kinds of panoramas.

As it was outlined in [1,4], the image of the straight line is the wave of the sine curve in the cylindrical panorama. However, in the case of the panorama with polyhedral surface it is a broken line. For a horizontal straight line the ends of the wave and the broken line belong to the horizon line. The size of the amplitude of the wave depends on the height of the straight line in reference to the base plane. The closer the straight line is situated towards the level of the horizon circle, the smaller the amplitude of the wave (Figs. 4a,4b).

a) b)

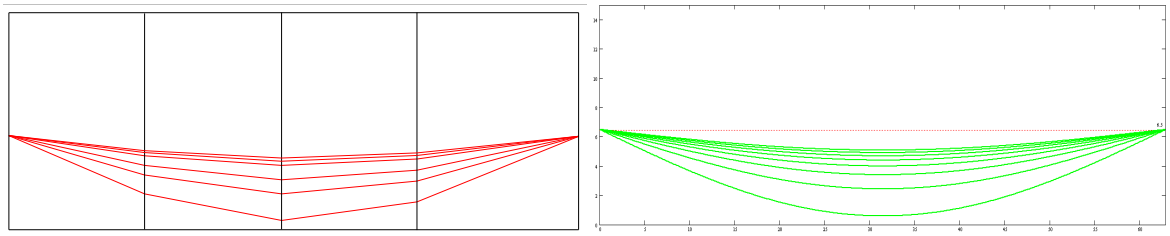

Figure 4: The amplitude of the horizontal straight line in relation to its location towards the base plane in: a) cylindrical panorama, b) polyhedral panorama

The amplitude of the sine wave depends also on the distance between the line and the background. The greater the distance of the straight line from the background, the smaller the amplitude (Fig.5).

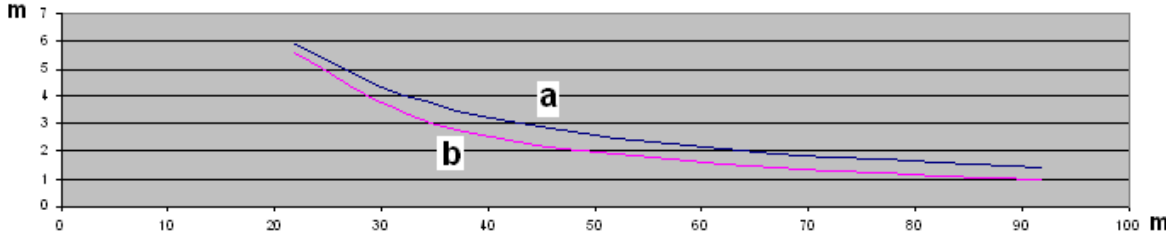

Figure 5: The amplitude of the horizontal straight line in relation to its distance from the background in: a) cylindrical panorama, b) polyhedral panorama

The same relation is true in the case of the panorama with polyhedral background. Due to this fact, the best approximation of the sine wave by the broken line can be achieved, when the straight lines are located close to the level of the viewer's eye, as well as for the straight lines located rather far from the background.

2 Approximation of the cylindrical background by the polyhedral one

The main factor deciding on accuracy of the approximation of the panoramic image is the number of walls of the polyhedron approximating the cylindrical background (Figs.6a,6b).

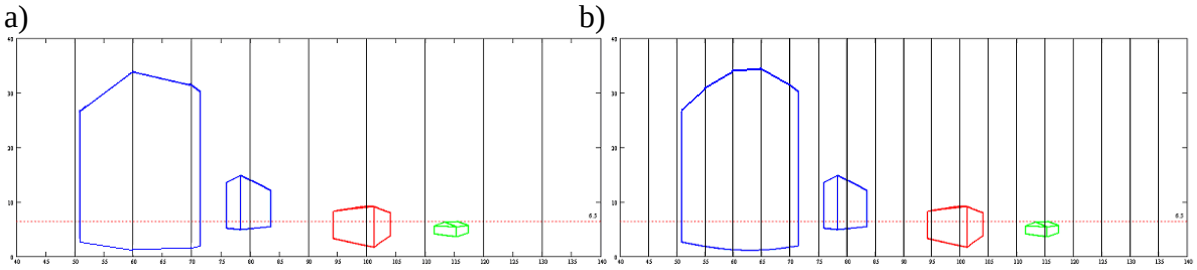

Figure 6: Mapping model objects in polyhedral panorama with: a) 10 wall- background, b) 20- wall background

We can compare two resulting panoramic images with two types of the background applied: one, which has been approximated by an n-prism and the other which is of a cylindrical shape (Fig.7). It is also possible to estimate the optimal number of walls of the prism which approaches the best the cylindrical background. However, very often the results of mapping panoramas in both cases are the same. That is due to the fact that, in perspective projection received images of objects are much smaller than in reality. Moreover, in the perspective presentation, in general, we deal with small segments of straight lines only (not with long lines), so the difference in shape between the curve and broken line is not big.

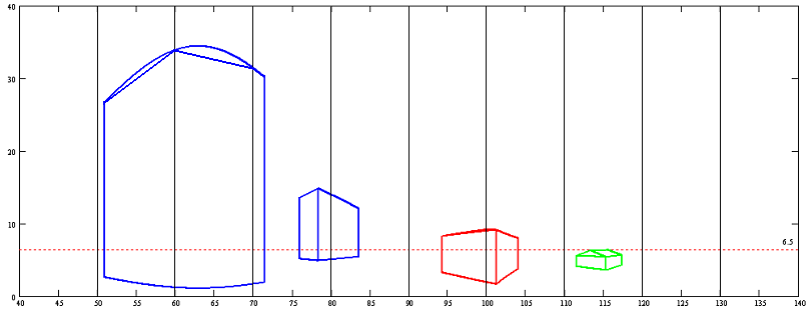

Figure 7: The comparison between cylindrical and polyhedral panoramas of the model objects

Conclusions

The formation of analytical algorithms for computer aided drawing cylindrical and polyhedral panoramas enable easy comparison between their images. Similarities between mapping both kinds of panoramas permit us to approximate a cylindrical panorama by a polyhedral one with satisfying accuracy.

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CYLINDRYCZNE I WIELOŚCIENNE PANORAMY- PODOBIEŃSTWA I RÓŻNICE

Temat artykułu nawiązuje do wcześniejszych rozważań autora dotyczących konstrukcji panoram cylindrycznych i stożkowych, jak również panoram o tłach aproksymowanych przez odpowiednie wielościany. W pracy rozważa się podobieństwa i różnice geometrycznych aspektów konstrukcji i zapisu powyższych panoram. Koncentruje się na prezentacji sposobu formułowania analitycznych algorytmów dla zapisu panoram przy wspomaganiu komputerowym, jak również analizuje wpływ ich struktury na zapis cylindrycznych i wielościennych panoram. Celem pracy jest ocena możliwości i dokładności przedstawień panoramowych w przypadku aproksymacji tła panoramy przez wielościan, jak również prezentacja optymalnego sposobu kompozycji obrazu panoramicznego.

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