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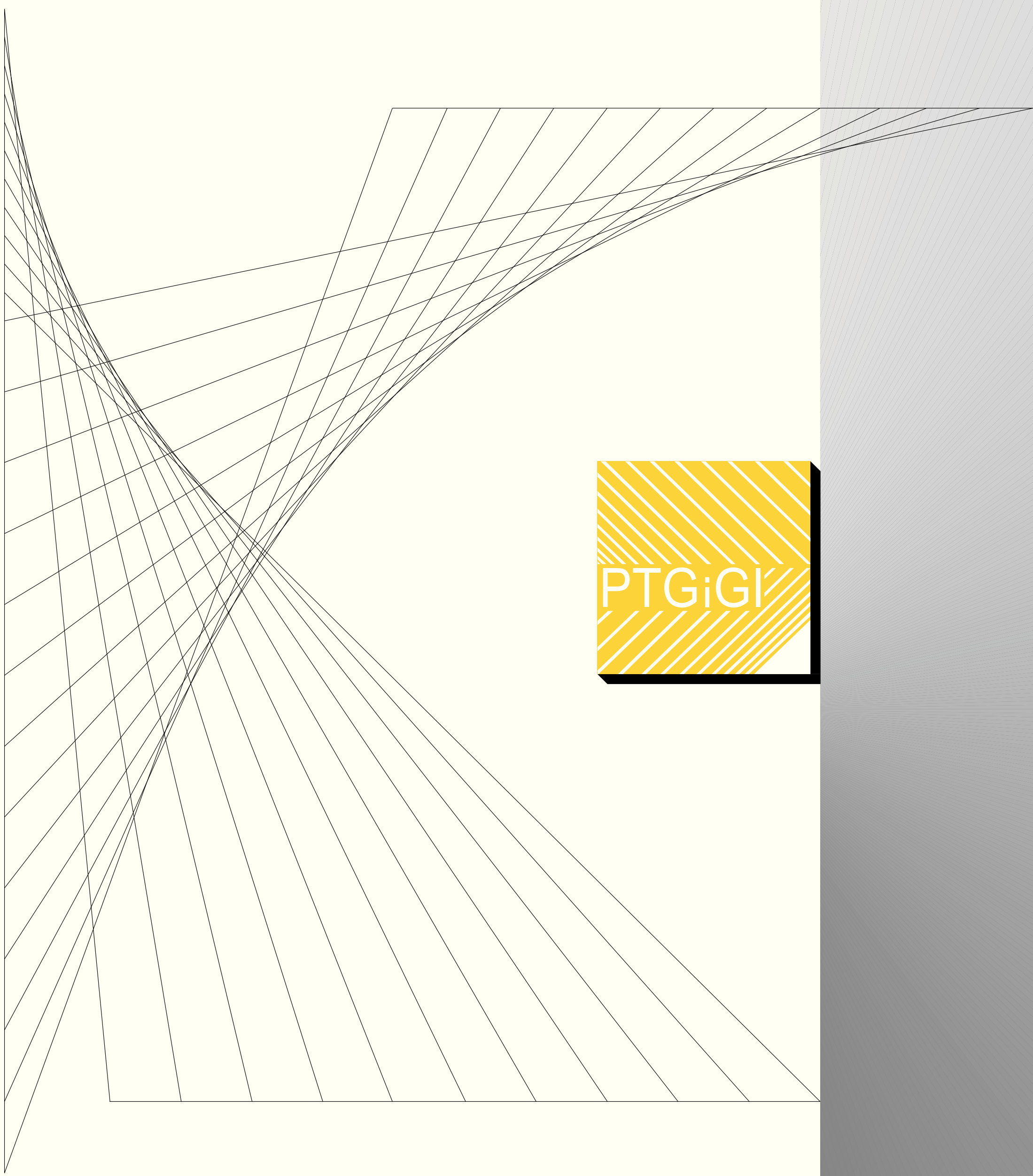

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A DIRECT DESCRIPTIVE CONSTRUCTION OF AN INVERSE PANORAMIC IMAGE

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Abstract. The aim of the study is to introduce a descriptive method of an inverse panoramic image construction. The paper discusses an inverse panoramic projection being a kind of a cylindrical panoramic projection is which the center/centers of the projection are located outside a projection surface. Moreover, presented projection is a multicenter projection from the centers dispersed on a circle. Such an approach gives maximum approximation of the received projections to real perception one experiences observing a panoramic image. The paper disuses projective and graphical connections between projections displayed on the cylindrical projection surface and their counterparts received on an unrolled, flat projection surface. The graphical mapping effects of the representation is realized directly on the unrolled cylindrical surface in a descriptive way. The representation presented in the paper, as well as the method of the direct construction of the inverse panoramic image on the flat surface can find practical application in advertisement and different artistic presentations. It can be also a base for the more effective constructions of inverse panoramic images with computer aid.

Keywords: cylindrical perspective, panoramic projection, descriptive geometry, inverse panorama

Introduction

The greater and greater interest in panoramic presentations is mainly initiated by the development of the digital panoramic techniques as simple digital camera stitching methods and high-level panorama scanning [1,2].The fast developing field recently is the creation of the inverse panorama. One can find some examples of an inverse panorama construction in Internet [5,6].The paper proposes a geometrical approach to the construction of this panorama. This approach is the extension of the author's previous considerations dealing with panoramic projections onto cylindrical and conical rotary surfaces, as well as a direct way of mapping them on an unrolled surface [4]. In [3] the theory of the panoramic presentation was developed in two directions distinguishing a single center panorama and a multicenter panorama. This idea is continued in the paper as it discusses a central projection from dispersed centers (multicenter panorama) onto a cylindrical rotary surface. However, the centers of the projection, contrary to the previous study, are located not inside the cylindrical surface but outside of it. Such a panorama is called an inverse panorama.

The use of the moving center of the representation aims at better approximation of the received projections of the given figures to the real images experienced while watching panorama.

Basic information

Like in the case of linear perspective on a flat projection plane, the representation considered in the paper is a two projective partly compound representation. Therefore, the mapping of

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any figure is composed of two projections: the *main* one and the *auxiliary* one. Moreover, it has the property, that the given figure and additionally the image of this figure got earlier in the auxiliary projection are represented in the main projection [3,4].

The changeable center (view point) S_A of the inverse panoramic projection is attributed to the given point A by cutting the vision circle $\widehat{s}$ by a half-plane determined by the axis l and the point A, see Fig.1. Due to this fact, the image of any point A, in general, is a pair (A^S, $A^{O,S}$) of two projections included in the ruling t_A of the cylindrical surface. The point A^S is a main central projection from the centre S_A onto a cylindrical background $\widehat{\tau}$. Whereas, the point $A^{O,S}$ is an auxiliary projection. It is received by submitting the point A^O (the orthogonal projection of the point A onto the projection plane π) to the main projection from the centre S_A onto cylindrical background $\widehat{\tau}$ (Fig.1).

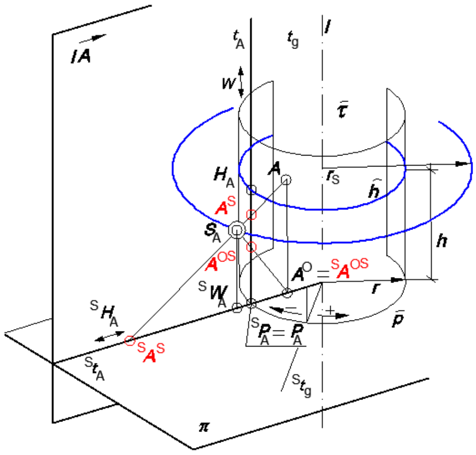

Figure 1: The projection of the straight line t_A with the series t_A(P_A, H_A, W_A....) of points for realization of the transformation

The image of the straight line depends on its location towards the projection surface. In the case of the vertical line its inverse panoramic image is a vertical line (Fig.2a). In the case of the horizontal line located on the level on horizon its main projection is a semicircle (Fig.2). In other cases, the image of the straight line is a curved line difficult to determine.

a) b)

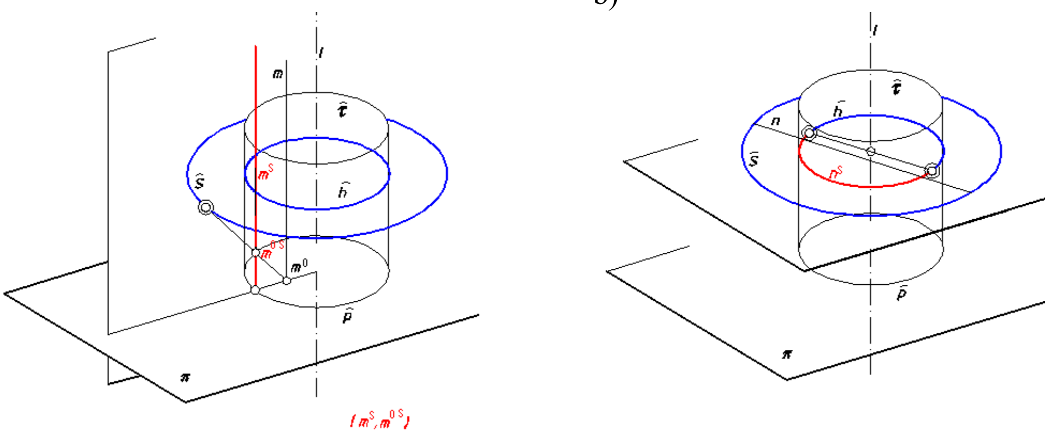

Figure 2: Mapping of straight lines of the special position: vertical m and horizontal n

Mapping inverse panorama directly on unrolled background

For the graphical mapping effects of the representation on the flat, unrolled surface it is applied a similar approach as presented in [4]. Therefore, the images contained in the cylindrical projection surface $\widehat{\tau}$ are transformed to their counterparts located on the unrolled projection surface $\widehat{\tau}^R$. It is realized by the projecting each ruling t_A of any point A from the center S_A onto the base plane π, as well as establishing projective relations between points of the ruling ${}^St_A$ after that projection, and their counterparts on unrolled surface $\widehat{\tau}^R$.

Mapping of a point

The geometrical action which permits to find the inverse panoramic projections on the unrolled surface looks in a following way. First, the apparatus of the representation should be defined with an accuracy of isometry. Next so-called a base ruling t_g and the ruling t_A containing a pair of projections of the point A are distinguished in the cylindrical surface (Fig.1). Moreover, the positive circulation for measuring angles ξ_i of the rotation transforming the ruling t_g to the ruling t_i is established. Next, it is drawn the fragment of the unrolled surface $\widehat{\tau}^R$ with distinguished developments of a base ruling t_g^R, the ruling t_F^R, a base circle $\widehat{p}^R$ and a horizon circle $\widehat{h}^R$. The image $\widehat{\tau}^R$ of the unrolled surface $\widehat{\tau}$ is placed towards the base circle $\widehat{p}$ in the manner shown in the Figure 3.

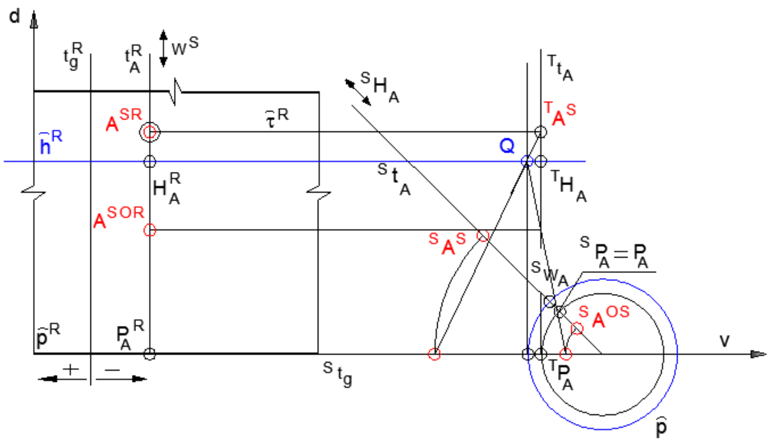

Figure 3: The way of the assignation of the homologous points of the series $t_A^R(W^R, P^R, H^R\ldots)$ to the series ${}^St_A$ $({}^SW_A, {}^SP_A, {}^SH_A\ldots,)$

The series $t_A(P_A, H_A, W_\infty, F^S, F^{O,S}, \ldots)$ of points belonging to the ruling t_A is distinguished; where the point P_A is included in the base circle $\widehat{p}$, the point H_A is included in the horizon circle $\widehat{h}$ and the point W_∞ is a vertex of the surface (Fig.1). Next, the ruling t_A with the series of points established earlier, is projected from the center S_A onto the base plane π. As a result of that projection the series ${}^St_A({}^SP_A, {}^SH_A, {}^SW, {}^SF^S, {}^SF^{O,S}, \ldots)$ of points is obtained in the ruling ${}^St_A$. Then, the ruling ${}^St_A$ with the series ${}^St_A({}^SP_A, {}^SH_A, {}^SW, {}^SF^S, {}^SF^{O,S}, \ldots)$ is turned around the centre of the base circle to the position it overlaps with the unrolled base circle $\widehat{p}^R$ (Fig.3). In a row, the ruling t_A^R matching the t_A one with distinguished series $t_A^R(P_A^R, H_A^R, W_\infty^R, \ldots)$ of points is translated to the position of the straight line ${}^Tt_A$. That geometrical action points out that series of points obtained after the rotation and included in the ruling ${}^St_g$ and series of points obtained as a result of translation and included in the straight line ${}^Tt_F$ are projective. As they have also united homologous points they are perspective ones. It gives graphical connection between the image of the point got in the additional projection from the centre S_A onto the projection plane π with its counterpart got in the unrolled background $\widehat{\tau}^R$, and on the contrary. It is worth noting that for the point A included in the projection plane π is as follows: $A^S = A^{O,S}$ and $A = {}^SA^S = {}^SA^{O,S}$.

Mapping of a straight line

In the case of the straight line not particularly situated towards the projection surface both its projections the main one and the auxiliary one are curved lines. They are the common part of the conoid and the cylindrical surface, possible to achieve in an approximate way. Moreover, for the graphical mapping images of figures defined by their measuring properties, like in the case of linear perspective onto a flat surface, the regulation for drawing: parallel straight lines and perpendicular horizontal straight lines, can be defined [4]. The Figure 4 shows an example of the inverse panoramic image of the pyramid <*ABCDW*> dawn in the descriptive way. The square base <*ABCD*> of the pyramid is contained in the plane π and its edge *BW* is perpendicular to the base <*ABCD*>. The measure of square's edge equals ***a*** whereas the measure of the edge *BW* equals 2***a***. Due to the fact that the edge *BW* is vertical and included in the projection surface $\widehat{\tau}$ its measure does not change during projection, see Fig.4.

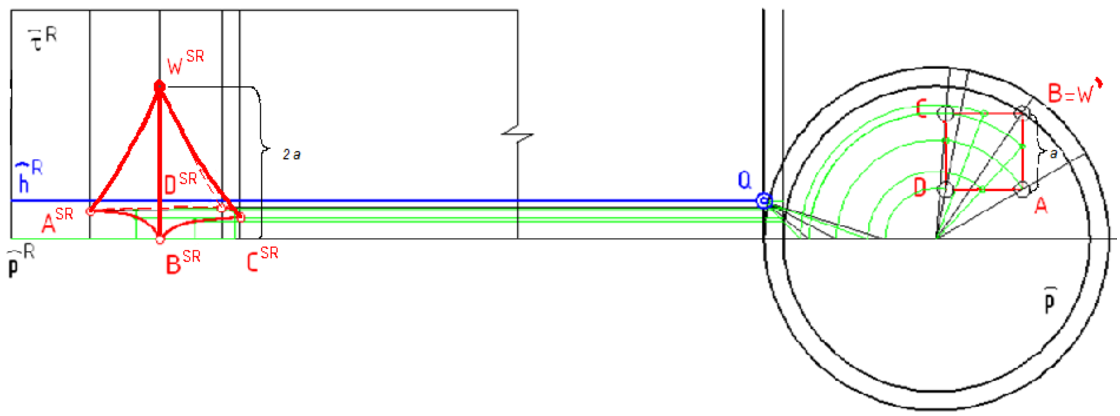

Figure 4: The inverse panoramic image of the pyramid <*ABCDW*>

Conclusions

In this paper a new way of the direct construction of the inverse panorama is presented. The use of the moving center of the panoramic representation aims at better approximation received projections of the given figures to the real images experienced while watching panorama. The method of creating inverse panorama on a flat unrolled background can be applied in advertising and different artistic presentations. For the significant improvement in drawing panorama computer aid should be implemented. However, presented approach of the descriptive construction of the inverse panoramic image can be a good base for it.

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BEZPOŚREDNIA WYKREŚLNA KONSTRUKCJA OBRAZU PANORAMY ZEWNĘTRZNEJ

Temat artykułu nawiązuje do wcześniejszych rozważań autorki dotyczących bezpośredniej konstrukcji panoram walcowych i stożkowych na rozwiniętych płaskich tłach. Rozszerzając tę koncepcję autorka analizuje odwzorowanie środkowe na obrotowej cylindrycznej powierzchni (lub fragmencie tej powierzchni), w którym środek rzutowania leży nie tak jak w typowej panoramie „wewnątrz” powierzchni, ale „na zewnątrz” niej. Powyższy rodzaj panoramy jest nazywany zewnętrzną panoramą walcową. Rozważane odwzorowanie panoramiczne bazuje na rzutowaniu wieloośrodkowym ze środków rozproszonych na okręgu, co powoduje maksymalne przybliżenie uzyskanych rezultatów rzutowań do naturalnie postrzeganych obrazów panoramicznych. W artykule pokazuje się geometryczne zależności umożliwiające wykreślną i bezpośrednią konstrukcję panoramy zewnętrznej.