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Machine Graphics that Create Axonometric Images Recommended Mechanisms Based on Construction

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Abstract:

This article presents a number of options for mechanisms recommended for the basis of machine graphics construction that constructs axonometric images of spatial objects.

Keywords: *cartesian coordinate system, computer graphics, axonometric images, graphic tables, two-dimensional space, barycentric coordinate system, three-dimensional space.*

Mechanization and automation of the laborious process related to drawing (graphics), which has taken a significant place in the structure of engineering design activities, has been rapidly developing in two different directions, mainly since the second half of the last century. The first direction: creating the desired drawing on the computer display using one of the specially developed electronic graphic editing programs, transferring the result to paper using a printing device. Nowadays, this direction is called computer graphics [1].

The second direction: creating and using "robot"-mechanisms with an automatically controlled drawing brush (pen), which draws the desired drawing directly on the paper itself. This direction was named machine graphics [2], [3], [4], today it is developing as one of the automation of design (CAD) systems.

All processes that visualize geometric information on a page of paper (or screen) by means of lines in an automated or mechanical way are designed based on the classical rules of drawing that have been developed in the sciences of drawing and drawing geometry for centuries. According to these rules, the object to be drawn is placed in the I octant of the rectangular Cartesian coordinate system with three ***x, y, z dimensions:*** three times in the direction parallel to each of the ***x, y, z axes: xy (H),*** are projected onto ***xz (V), yz (W) planes.*** When placing an object in a three-dimensional rectangular Cartesian coordinate system, it is of particular importance that as many of the straight lines and planes involved in the formation of the object as possible are located either parallel or perpendicular to one of the projection planes or to one of the coordinate axes. When this is done, the so-called horizontal, frontal and profile projections of the object on the surface of the paper consist of a drawing visualized by means of lines in horizontal and vertical position (fig. 1). Projections created in this way are called rational images.

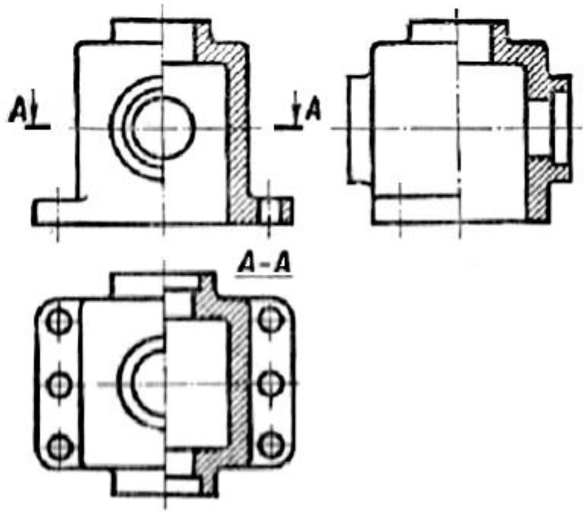


Figure 1.

Is not too complicated for computer graphics equipment or machine graphics equipment (fig. 2) . Complexity occurs when visualizing the lines of the drawing (fig. 3) resulting from the projection of the three-dimensional rectangular Cartesian coordinate apparatus in a perpendicular direction (it can be at an oblique angle) onto the drawing paper, which is neither parallel to any of its coordinate axes nor parallel to any of its projection planes. begins to show itself.

A drawing like the one in Figure 3 is called an axonometry in engineering graphics. In axonometry, the lengths of straight line sections of an object, the angle between two intersecting (or non-meeting) lines, the surfaces of planes, etc., are not projected onto the image field in real size. Therefore, such projections are called irrational images. Knowledge of axonometry has a significant place in the science of drawing geometry. It is necessary to take such cases into account both when creating electronic graphic editing programs and when developing mechanisms for drawing axonometric images.

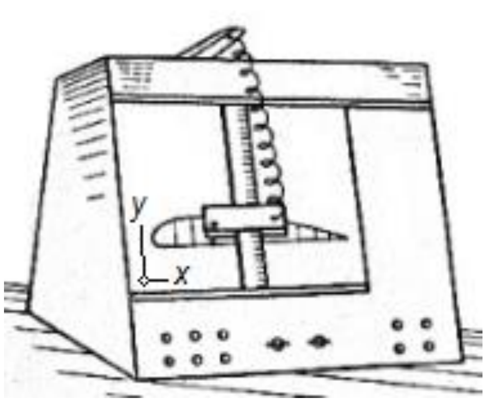


Figure 2.

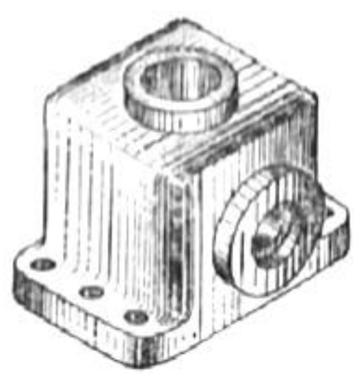


Figure 3.

The theoretical foundations of the transformation of rational images into irrational images and irrational images into rational images have been comprehensively developed by applied and drawing geometry sciences [5]. Such scientific developments are effectively used in the creation of electronic graphic editing programs related to drawing axonometric images and in the development of mechanisms that draw axonometric images.

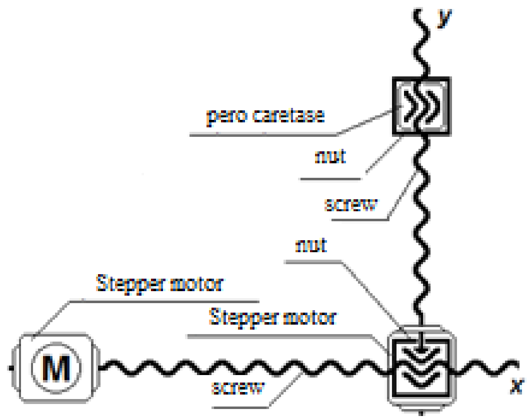
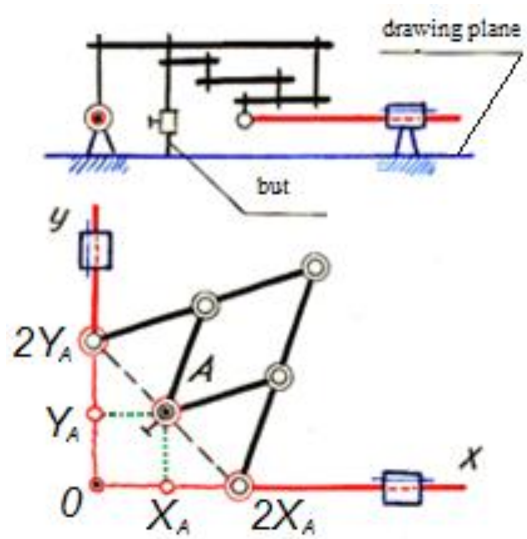


Figure 4.

Below, we would like to briefly comment on how the construction of mechanisms that draw axonometric images takes place in our experiments. One of the important functions of the imaging device is to control the movement of the pen (a tip that leaves a mark in the form of a line on the drawing paper with the ink leaking from the inside) along the surface of the drawing paper. In most imaging devices, the control mechanism takes the form of two “screw-nut” pairs provided by linear digital control programs (fig. 4). Here, the “screw” rotates according to the “fast-slow”, “right-left” commands given by the digital program. Along the “screw” acting as a coordinate axis, the “nut” assigns the necessary positions for the corresponding parts of the drawing mechanism attached to it, along with the positions specified in the program.



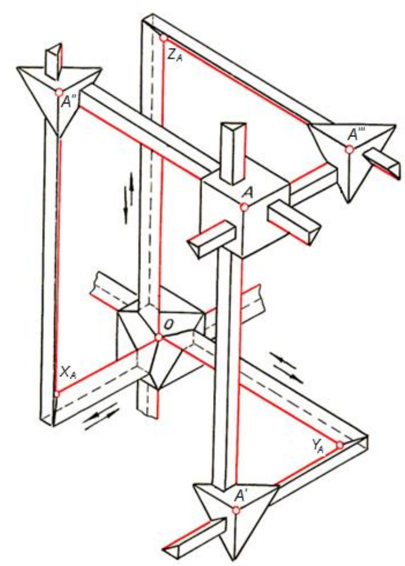


Figure 5. **Figure 6.**

In principle, it is possible to draw axonometries as shown in figure 3 with the diagram shown in figure 4. But some kind of complexities in the mathematical field create many difficulties when creating linear-numerical programs for drawing such drawings.

The use of barycentric coordinates based on Möbius, while maintaining the structure of the Cartesian coordinate system, achieves great efficiency in the creation of linear numerical control programs for imagers that draw axonometries. Barycentric coordinates are double (fig. 6).

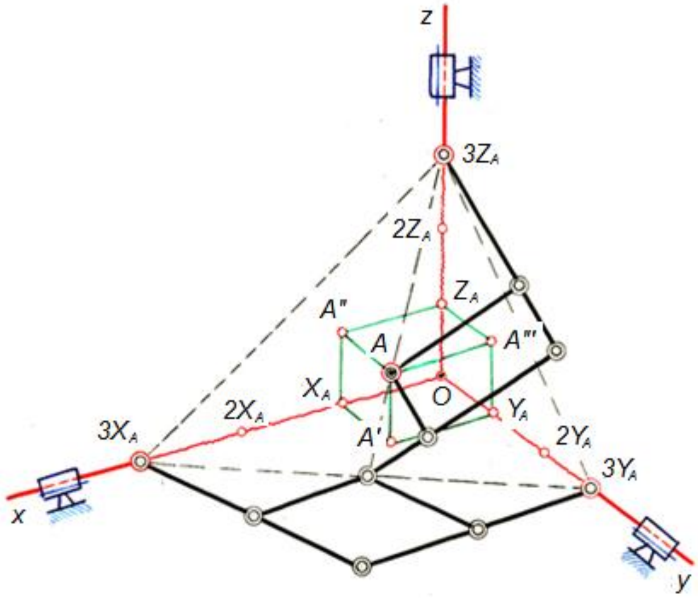


Figure 7.

5) Cartesian coordinates for a point on axes in a 2-dimensional spatial coordinate system, and tripled (fig. 7) Cartesian coordinates for a point on axes in a 3-dimensional spatial coordinate system.

In two-dimensional space, the center of gravity (center) of the section (2-simplex) connecting the barycentric coordinates of the point overlaps with the position constructed using the Cartesian coordinates of this point (fig. 5). The center of gravity of the triangle (3-simplex) connecting the barycentric coordinates of the point in the three-dimensional space (crossing point of the medians) coincides with the location of this point constructed using the Cartesian coordinates (fig. 7). This rule remains valid even in coordinate systems of more than 3-dimensional spaces [6], [7].

Figure 6 presents a hypothetical construction of a three-dimensional space axonograph.

One of the obvious advantages of the combined use of the barycentric coordinate system and the Cartesian coordinate system is the presence of mechanisms that can be assembled from pantographs that find the center of gravity of the simplexes formed by combining barycentric coordinate projections on the drawing paper (fig. 5 and 7).

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