

## PROBLEMS OF BUILDING MODELS WITH COMPUTER GRAPHICS OF SPECIAL CURVED LINES LYING ON A CURVED SURFACE

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### ANNOTATION

This scientific paper discusses the use of special curves lying on a curved surface in the construction of molds to create thin-walled spatial coverings with curved surfaces using computer graphics modeling methods and the use of special curves lying on the surface in the repair of architectural monuments.

**Keywords:** *sphere, cylinder, model, Viviana curve, parameterization, axonometric, radius, geometry, coordinate, horizontal, frontal, projection, graphics.*

### INTRODUCTION

When repairing architectural monuments, special lines lying on the surface are used. This scientific article discusses the problem of finding the intersection line of a straight circular cylindrical surface with a diameter equal to the surface of the sphere and its radius in the method of computer geometry and computer graphics. A spherical surface of a sphere of radius  $R$  and a straight circular cylindrical surface with radius  $R/2$  of the base are set in a right-angled coordinate system. In this case, the centers of the bases of the cylindrical surfaces are shifted from the center of the sphere along one of its axes, at a distance  $R/2$ .

Logic 1:

- Horizontal and frontal projections of a sphere of radius  $R$  lying at the point  $O(x, y, z)$  are constructed.
- Horizontal and frontal projections of a cylinder with height  $h$  and radius  $R/2$  of the base are constructed.
- The line of intersection of spherical and cylindrical surfaces in the above-mentioned situation is found by the method of intersecting planes of descriptive geometry.

Logic 2:

- To solve this problem by the method of computer graphics, we move from the model of descriptive geometry to the model of computer geometry. To do this, we write the equation of a spherical surface in the following form:

$$(x-a)^2 + (y-b)^2 + (z-c)^2 = R_c^2 \quad (1)$$

We write the equation of a straight circular cylinder as follows:

$$(x-a)^2 + (y-a)^2 - R_y = 0 \quad (2)$$

If the spherical and right circular cylindrical surfaces are calculated from the origin, their equations are written as follows:

$$\begin{cases} x^2 + y^2 + z^2 = R_c^2 \\ x^2 + y^2 - R_y = 0 \end{cases} \quad (3)$$

To form the parametric equation of the curve formed by the intersection of the surfaces, we write the equation of a straight circular cylinder in the following form:

$$\left(x - \frac{R}{2}\right)^2 + y^2 = \left(\frac{R}{2}\right)^2 \quad (4)$$

henceforth,

$$x^2 + y^2 = R_y$$

we find, then we enter the notation  $x - R/2 = R/2 * \cos t$ . In that case,

$$y = R/2 * \sin t.$$

If we add the values of x and o to the equation of the sphere, the following equation is obtained:

$$\frac{R^2}{4}(1 + \cos t)^2 + \frac{R^2}{4}\sin^2 t + z^2 = R^2$$

where  $z = R * \sin t / 2$ . This equation is the equation of the Viviana curve lying on the surface of the sphere and we write it as follows:

$$\begin{cases} x = \frac{R}{2}(1 + \cos t), \\ y = \frac{R}{2}\sin t, \\ z = R \sin \frac{t}{2}. \end{cases}$$

Here t is a free parameter that can take an arbitrary value. The Viviana line is reminiscent of the number eight. Its rings are located on different sides of the xOy plane. In the repair of architectural monuments using this line, the forms of molds are made in a spherical shape and used. If,  $t = 0$  to  $t = \pi$ , the upper part of the curve, if  $t = 2\pi$  to  $t = 4\pi$ , the lower part of the curve can be determined:

If we say that  $t / 2 = u$ , new parametric equations of that curve are formed:

$$\begin{cases} x = a \cos^2 u, \\ y = a \sin u \cos u, \\ z = a \sin u. \end{cases}$$

Using a 3D-studio program, we define the intersection of these surfaces in the style of computer graphics as follows:

- from the library of surfaces find the surface of a given parametric sphere and a straight circular cylinder.
- a cutting axiomatic relationship is established between the surface of the sphere and the surface of a straight circular cylinder.
- Enter the values in the computer memory software of the radius of the spherical surface R and the radius of the right circular cylinder R / 2, and create the line of intersection of the intersecting, spherical and right circular cylinders along the Viviana line (Figure 1).

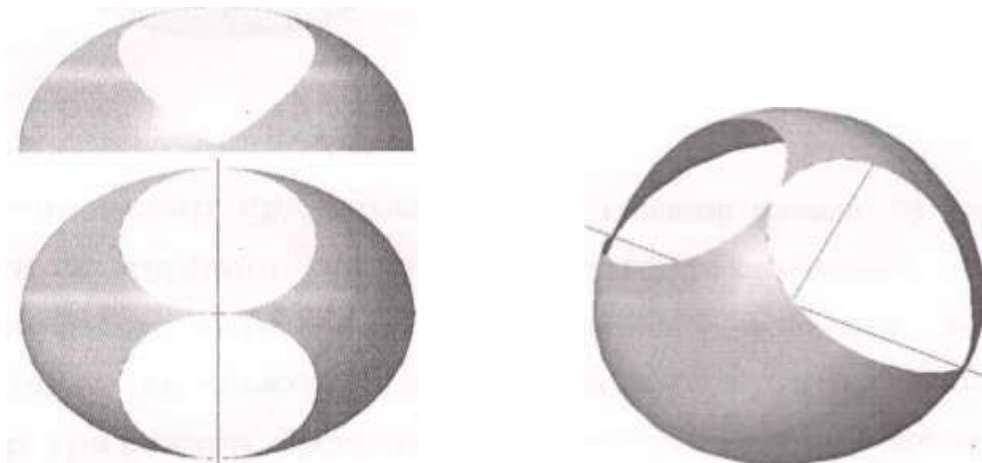


Figure 1.

- by inserting a rotary motion into the position of a straight circular cylinder, we create different variants of the Viviana line on the surface of the sphere.

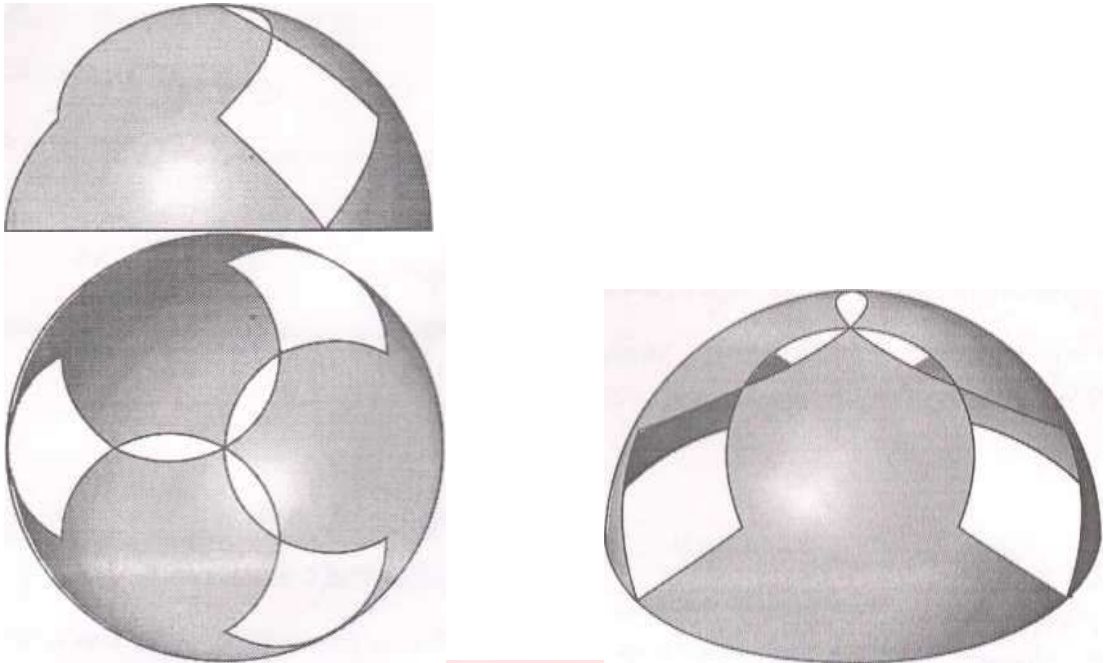


Figure 2

- the motion parameters that change the position of the spherical surface and the straight circular cylinder are entered.

- We create variants of intersection lines of different views (Figure 2).

Spherical molds are made using these lines. This is the computer information for the repair of architectural monuments<sup>1</sup> [1].

The authors have created more than 20 models of axiomatic relations of surfaces using computer graphics in the scientific direction of computer information creation (Figure 3).

You can get acquainted with the programs of these models at the Department of "Engineering Graphics and Computer Design.



Figure 3

<sup>1</sup> М.Е.Липницкий и др. "Железобетонные пространственные покрытия зданий". – М. 1965 г. 79 – 101 стр.

From what has been considered by the above authors, it can be concluded that the use of special lines lying on the surface in the repair of architectural monuments and the mathematical description of the options for creating different versions of the Viviana line on the surface of the sphere.

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