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The model of creation of virtual museum geometric shapes divided into segments and the algorithm of geometric intersection of objects

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Abstract. The article tries to solve the problem of intersection with a plane by constructing their exact geometric dimensions using a new geometric model based on the creation of virtual images of original museum exhibits based on engineering geometry and computer graphics. The algorithm of intersection of three-dimensional shapes is described.

Keywords. Model, geometric modeling, 3D, multidimensional, computer graphics, exhibit.

Introduction.

In the world, on the basis of computer graphics and engineering geometry, he organizes the three-dimensional environment of virtual museums or the development of high-resolution video and photorealistic three-dimensional models of the structural structure of the museum, collections of all types of exhibits, the creation of a non-standard database and the formation of attributes. The main reasons for this are that visiting the museum and seeing all kinds of exhibits in real conditions, users' time, physical and financial resources are saved compared to remote viewing in a virtual environment. allows them to get interested in 3D software tools with the help of virtual simulation and videorealistic imaginations at their convenience. Instrumental tools, technologies for using virtual reality museum elements that respond to an integrated and modern, automated information system, methods of constructing relational algebra expressions of relationships on the database in the organization of the virtual environment, development of three-dimensional virtual museum software tools and conducting scientific research is one of the important tasks.Application of virtual reality elements based on engineering geometry and computer graphics in the museum system of our republic, application of methods and algorithms for visualization of three-dimensional models of objects for virtual environment, scientific research on the software information system of virtual museum process automation, mainly by A.Kh. Nishanov, J.Kh.Djumanov, F.M.Nuraliyev, A.Muhammadyev, Sh.A.Anarova, R.D.Aloyev, U.R.Khamdamov and others have been making their contributions. Currently, one of the urgent problems in the virtual world is that the digital collection fund of the museum in the virtual environment, the creation of 3D models of them and the development of the software tool, the integrated museum with automated information systems, the technologies of online visit to the virtual museum environment through the Internet are not sufficiently studied at the moment.[3]

After the independence of the Republic of Uzbekistan, a lot of work is being done to promote the rich spiritual and cultural heritage of our nation to the world. In this regard, according to the decree of the President of the Republic of Uzbekistan " On the radical improvement and improvement of the activities of museums"[1], through extensive exhibition activities in Uzbekistan and abroad, the rich history of our country, today's achievements will be introduced to the world public, and the unique exhibits stored in museums will be promoted on a global scale. tasks are presented. After all, the features that make a nation known to the world are its spirituality and culture. In the work of the first President of the Republic of Uzbekistan, I.A. Karimov, "Yuksak ma’naviyat – yengilmas kuch ", the concept of spirituality is broadly defined: "spirituality is the spiritual purification of a person, which invites him to

grow from the heart, the inner world of a person, strong will, "The incomparable power that completes his faith and awakens his conscience is the criterion of all his views" [2].

The idea of three-dimensional description of objects of national cultural heritage, museum collections and electronic documents is related to the extremely rapid development of real and abstract structures based on the sciences of engineering geometry and computer graphics of information technologies, and the museum is ahead of the field of digital modeling of objects. work, historical monuments, archeology and even purely humanitarian and other fields, aims to solve such issues as virtual existence.

A museum is a non-profit cultural institution created by the government to store, study and display museum objects and museum collections to the public, as well as to achieve other goals established by state laws [4].

Virtual museum is an interactive multimedia software product that displays museum collections and exhibits in electronic form.

The main criterion for including the software product in the concept of "Virtual Museum" is the implementation of the following known mechanisms of interaction between visitors and exhibitors:

- the mechanism of presentation of exposition; - the process of presenting the exhibition; - additional information provision structures; - increase the international index of the language and local exhibits; - indicator of the share of exhibition buildings displayed in the virtual museum format in the total number of museum exhibit buildings; - an indicator of the share of objects of the museum fund presented in the virtual museum format out of the total number of objects in the exhibition rooms displayed in the virtual museum format; - indicators of comfort for disabled, disabled and elderly people.

3D model is a unique feature of this model - a continuous representation of the three-dimensional environment by elements, in which many different objects, including different modeling methods, are used together . Thus, this model is a representation of a continuous sequence of real-world objects in the form of a set of discrete images of equal size on the plane, as a rule, in a square shape - pixels (depicting any simple polygonal shape), or in space - cube - consists of voxels (volume pixels). One cell of the model contains one value of the average characteristic of the elemental surface area (2D) or volume of free space (3D) of the object .

The level of detail (accuracy) of the model compared to the original is determined by the size of voxels and ultimately their number (Fig. 1.4). If the resolution of the voxel model is high enough, then when the model is displayed on the screen, there may be a situation where the voxel size is equal to or smaller than the display pixel size, and in turn, they are indistinguishable in the final image. In this case, the model is perceived as smooth, visible, that is, more realistic. Image enhancement techniques completely hide the underlying cuboidal structure of the voxel model, but similarly, these processes hide the structure of the polygonal surface model.

We express the analytical view of the geometric model in the form of a third-order polynomial of the $Y(x) = y_i(x)$ function in each section [xi-1, xi] (i=1,2,…,N):

$$y_i(x) = a_i + b_i(x - x_i) + c_i(x - x_i)^2 + d_i(x - x_i)^3 \quad (1)$$

$$x_{i-1} \le x \le x_i \quad , (i=0,1,2,\ldots,N)$$

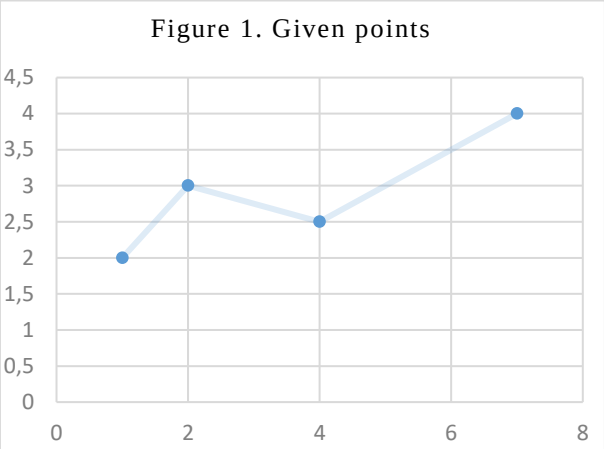
where a, b, c, d are coefficients, these coefficients are found by taking derivatives from formula (1):

Given the following points (table 1):

Table 1. Given points.

№	x	y
0	1	2
1	2	3
2	4	2.5

3	7	4



We interpolate through these points using formula (1). We write down the formulas for the three-part polynomial

$$\begin{cases} y_0 = a_0 + b_0(x - x_0) + c_0(x - x_0)^2 + d_0(x - x_0)^3 \\ y_1 = a_1 + b_1(x - x_1) + c_1(x - x_1)^2 + d_1(x - x_1)^3 \\ y_2 = a_2 + b_2(x - x_2) + c_2(x - x_2)^2 + d_2(x - x \end{cases}$$

After entering the appropriate coordinates, it will look like this:

$$\begin{cases} y_0 = a_0 + b_0(x - 1) + c_0(x - 1)^2 + d_0(x - 1)^3 \\ y_1 = a_1 + b_1(x - 2) + c_1(x - 2)^2 + d_1(x - 2)^3 \\ y_2 = a_2 + b_2(x - 4) + c_2(x - 4)^2 + d_2(x - 4)^3 \end{cases}$$

(2)

In order for a polynomial line passing through each point to be smooth, the attempts to enter and exit the curve must overlap. for this

$$y_0' = y_1', y_0'' = y_1'' , y_1' = y_2' , y_1'' = y_2''$$

(3)

We determine the property of polynomials at the initial and final points. We give zero curvature to polynomials.

$$y_0'' = 0,\ y_2'' = 0,\ x_0=1,\ y_0=2,\ x_3=7,\ y_3=4$$

(4)

We calculate the values of the function with a step of 0.1 by replacing the coefficients in table 4-b-c-d to the functions in formula (2) defined for each segment.

Using formula (1), (3), (4), we draw a curve on the surface of the object

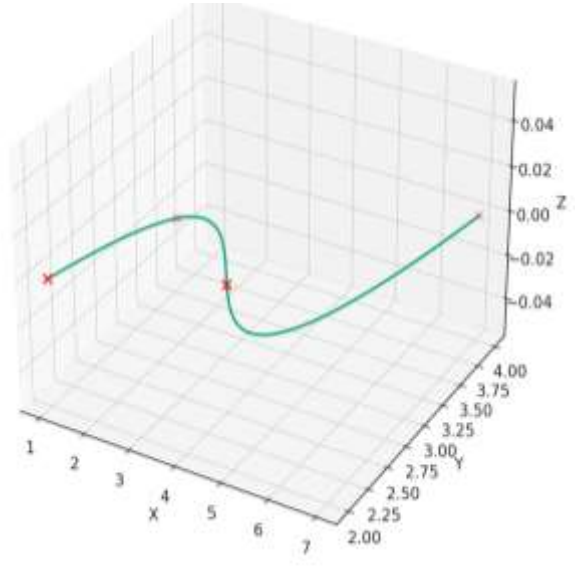


Figure 1. A curve drawn on the surface of the object using formulas (1), (3), (4).

Turn the curve 360 degrees around the x-axis and fill the trajectory with points (Fig. 2).

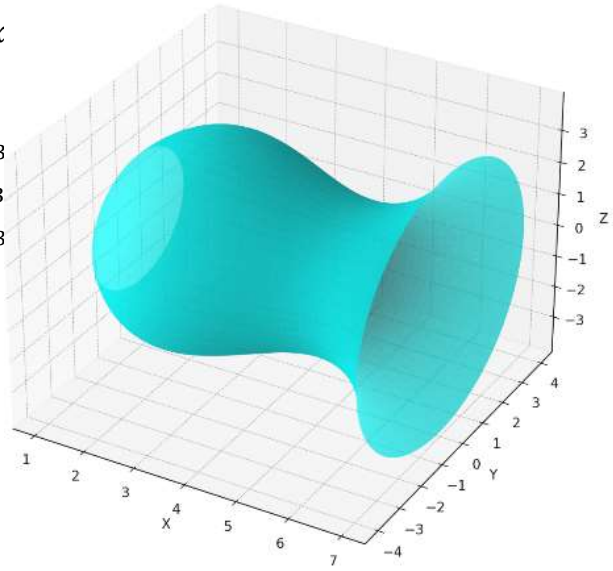
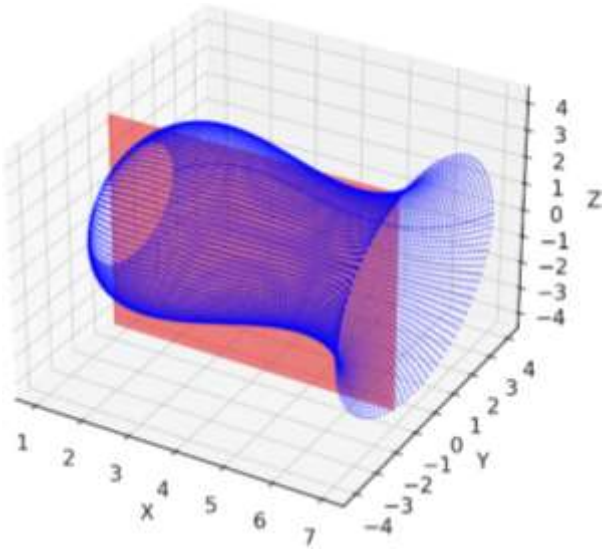
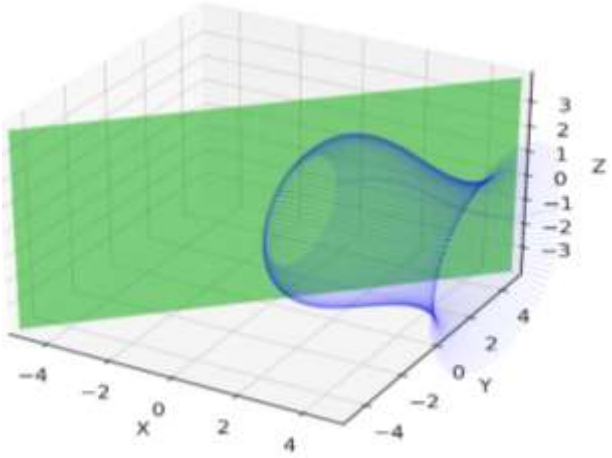


Figure 2. A model generated by a 3rd degree polynomial represented by the given points above.

The intersection of the resulting object (Fig. 2) with the plane y = - 1 and y = x is depicted in Fig. 3.



a)



b)

Figure 3. Graph of intersection of the object in Fig. 2 with planes a) y = - 1 b) y = x

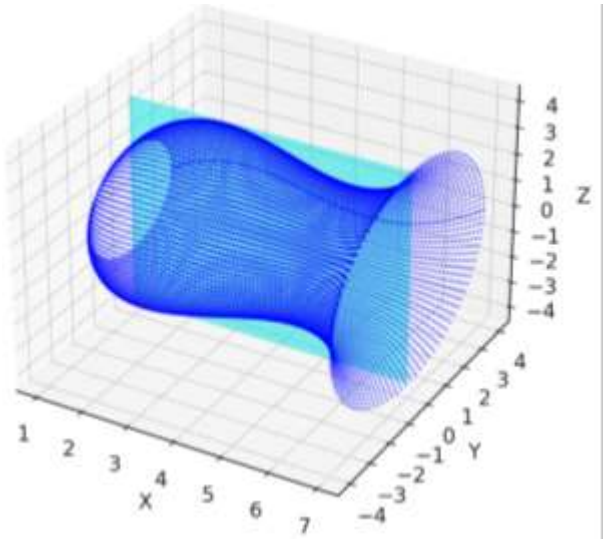


Figure 4. Intersection of the object in Fig. 2 with the plane y = 0

After rotating the given points (1,2,0), (2,3,0), (4,2.5,0), (7,4,0) around the X-axis of the object generated using a polynomial To find an analytical solution for the part where y > 0, we first consider the mathematical expression of this object. In this case, we need the exact cubic spline function and its expression after rotation about the X-axis.

1. **Polynomial function**

$$Y(x)=a_i+b_i(x-x_i)+c_i(x-x_i)^2+d_i(x-x_i)^3$$

2. **Rotate around the X axis**

After rotating around the x-axis, the new y' and z' coordinates are:

$$y' = y\cos(\alpha)-z\sin(\alpha)$$

$$z' = y\sin(\alpha)+z\cos(\alpha)$$

But since z=0, it looks like below:

$$y' = y\cos(\alpha)$$

$$y' = y\sin(\alpha)$$

3. **Cutting the object**

We use the condition y′>0 for cutting. Based on this condition, we need to consider the part of the cubic spline function y(t) where y>0. For values of y=y(t), y′=y(t)cos(a)>0, which holds for all a for which cos(a)>0.

4. **Solution**

To write the analytical solution directly, we need an exact representation of the function y(t), but use the given points to calculate the coefficients ai, bi, ci, and di of the polynomial. Based on the given points, it is possible to calculate these coefficients and then analytically express the cut section based on the condition y′>0, but since the calculated values are a large amount of data, its program code is presented and the result is illustrated in Figure 5:

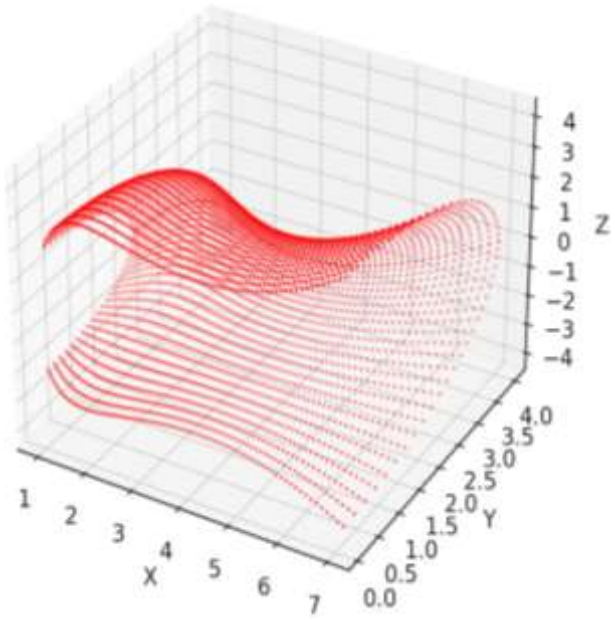


Figure 5. The model created by intersecting the created model with the y = 0 plane.

It is possible to create an exhibit model in the 3Ds MAX program, by drawing a curve, turning the resulting curve 360 degrees around the z axis, and choosing a color. Based on the created model, we get the following results (Figure 6):

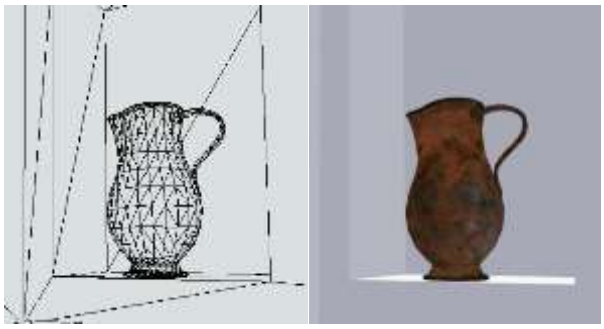


Figure 6. Fragments of virtual view of exhibits

Fragments of virtual views and sections of several exhibits in the museum based on the above geometric model developed (Figures 7).

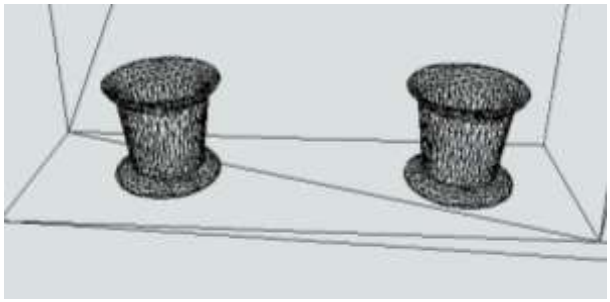




Figure 7. Fragments of virtual view of exhibits

Summary

Despite significant progress in the production of three-dimensional models of cultural heritage objects in recent years, there is still no automated technology that allows mass production of stable and reliable results. Development of new methods and models of virtual representation of virtual museum exhibits is one of the urgent issues. Based on the developed geometric model, it is possible to achieve a high-precision result in the virtual representation of exhibits. Virtual visitors can rotate, zoom, and view the exhibits. This, in turn, increases the number of visitors to this museum

References

[1] O‘zbekiston Respublikasi Prezidentining 2018-yil-26 avgustdagi "O‘zbekiston Respublikasida madaniyat va san’at sohasini innovatsion rivojlantirish chora-tadbirlari to‘g‘risida”gi PQ -3920 son Qarori

[2] Karimov I.A. Yuksak ma’naviyat – yengilmas kuch. – Toshkent:Ma’naviyat, 2008. – 176 б

[3] Djumanov J.X., Xudayberganov T.R., Sobirov B.I., Raximov R.R. “Principles of creation of the virtual museum "dorul hikmat and maorif”. // Electronic journal of actual problems of modern science, education and training. ISSN 2181-9750, Urgench. 2023. № 4. 65-73 pp.

[4] Xudayberganov T.R., Xojiboyev J.M., Boltayev R.Sh. Autodesk 3Ds MAX dasturida modellashtirish. // Высшая школа Научно-практический журнал. Россия. 2018. №14-св3. 36-38 стр.

[5] Xudayberganov T.R., Raximov R.R., Djep-parova E.R. Virtual muzeylarning an’anaviy muzeylardan avfzalligi. // European Journal of science archives conferences series. Ger-many. 2022. 2022/7. p 68-70.

[6] Голованов Н.Н. Геометрическое моделирование. / М.: Издательсий центр “Академия”, 2011

[7] Роджерс Д. Алгоритмические основы машинной графики: Пер. с англ. – М.: Мир, 1989. – 512 с., ил. ISBN -03-00076-9

[8] Djumanov J.X., Xudayberganov T.R.. Muzey eksponatlarini “aylana” tortishish usuli asosida virtual tasvirlash «Problems of application of advanced technologies in the field of agriculture» regional scientific and technical conference on. Nukus. 2023

[9] Xudayberganov T.R., Yusupov F., Shomuratova I.I., Allaberganova M.R., Otamuratov H.Q. Method of Applying the Program 3ds Max on the Topic of the Use of Global Illumination.// International Journal of Innovative Technology and Exploring Engineering. India. 2020. №9(8). p. 207-209

[10] Xudayberganov T.R., Adinayev X.S., Turdiyev T.T., Axmedov E.Yu., Eshchanov U.K. Technique for Using 3D Computer Graphics in the Educational Process. // Annals of the Romanian Society for Cell Biology. Romaniya. Aprel 2021. P 11509-11512