SJIF Impact Factor (2023): 8.574| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 8 | Issue: 2 | February 2023 - Peer Reviewed Journal

BICUBIC SPLINES IN COMPUTER SIMULATION

Rustam Qodirov
Lecturer of the Department Informatics and Management National institute of fine art and Design named after K.Behzod, Uzbekistan, Tashkent

ABSTRACT
This article discusses bicubic splines in computer simulation. Often displayed objects, especially natural ones, have a rather complex shape that does not allow for a universal analytical description as a whole. Their shape is given by a set of characteristic (reference) points belonging to the surface of the object. Reference points are obtained as a result of measurements on real objects, their scanning using 3D scanners, or assigned by developers.
KEYWORDS: *computer graphics, splines*

In the process of geometric modeling, the original surface must be restored with a given accuracy. It should pass as close as possible to the reference points, and preferably through them. In this case, the character (topology) of the original surface must be preserved. The simplest approach is to connect the control points with plane sections, that is, apply a polygonal model. However, to achieve realistic display of an object, its polygonal model must contain thousands and tens of thousands of polygons, which increases the requirements for memory and graphics system performance. The use of quadrics does not bring success either, since in this case the problem of their smooth joining into a single surface arises. Surfaces of non-analytical forms are represented by piecewise polynomial functions - splines.

The word "spline" (spline) came from shipbuilding. So at one time in England they called a long and thin metal ruler. She was pressed against the ribs (reference points) of the future vessel and, thanks to her elasticity, received the contours of the sides. In geometric modeling, splines are power functions of one or two variables, whose graphical representations are curved lines or curved surfaces. They serve, in particular, to solve the problem of interpolation, that is, to find intermediate points of a curved line or surface defined by reference points. Spline equations usually have a degree no higher than the third, since it is this degree that is the minimum necessary for smooth joining of curved sections.

A spline surface, unlike a curve, must pass through four points that are angular for it. The surface can be thought of as the result of a cubic curve moving parallel to itself. In this case, the end points of this curve slide along two other (lateral) cubic curves in the process of movement. The result is a surface that is described by a bicubic power polynomial. Each term of the polynomial includes two arguments, having various combinations of degrees from 0 to 3. There are many varieties of spline surfaces that have different properties and are formed using different conditions and geometric parameters.

Splines can be described using explicit, implicit and parametric forms. In computer graphics, a parametric description of splines is usually used. The explicit form of the description in the Cartesian coordinate system is rarely used for a number of reasons. First, the type of surface description in an explicit form depends on the chosen position of the coordinate system. Secondly, some parts of the

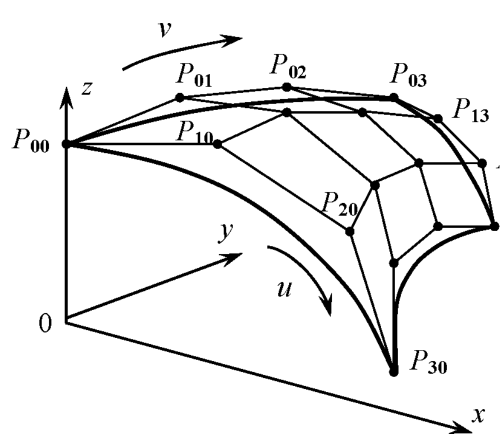
SJIF Impact Factor (2023): 8.574| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 8 | Issue: 2 | February 2023 - Peer Reviewed Journal

surface may have vertical tangent vectors with derivatives tending to infinity. In this case, it is impossible to set the conditions for docking surface compartments. Thirdly, the parametric representation, in contrast to the explicit form, describes the natural successive traversal of the surface sections in the process of its unfolding in time, which was explained by the example of quadrics. In the general case, the section of a spline surface is described by bicubic expressions of the form

The coefficients of polynomials are found by imposing restrictions on the shape of the surface section. Depending on the choice of constraints, the surface receives one or another form of description. For example, the restrictions for the Koons surface (a special case - the Hermite surface, the Ferguson surface) are the conditions for its passage through the given corner points, as well as the compliance with the given values of partial derivatives (i.e. slopes) at the corner points of the surface and mixed partial derivatives (i.e. torsion) at these points. The use of such restrictions is geometrically clear, but difficult to implement. In computer systems of geometric modeling, the repetition of the shape of a certain polyhedral reference surface (characteristic polyhedron) specified by sixteen reference points is usually used as a constraint by a spline. The surface must pass near the control points or through some of them, and changing their coordinates must lead to a change in the shape of the surface.

The values of the functions f- (u), fj (v) act as weight coefficients of the coordinates reference points, so these functions are called weight or mixing.

In computer graphics, a description of a spline in matrix form is usually used. Splines are characterized by a number of useful properties. It has already been mentioned that the shape of the spline compartment follows the shape of the characteristic polyhedron. If all its reference points lie in the same plane, then all current points of the spline also lie in this plane. The characteristic polyhedron is circumscribed around a spline surface, therefore, whether this surface falls into a certain volume (for example, the observer's visibility volume) is easily checked using sixteen points. In addition, splines are invariant under affine transformations. This means that if you need to shear, rotate, scale, and mirror the spline, you do not need to subject all current points of the compartment to these transformations.
It is enough to perform transformations only on control points, and then simply apply the spline expansion algorithm on these transformed control points. In geometric modeling, a bicubic Bezier surface is often used. The limitations in constructing this surface are its passage through the corner points of the characteristic polyhedron and the slopes of the tangents given on its boundaries in the u, v directions.
The figure shows a bicubic Bézier surface and its characteristic polyhedron.



The surface is placed in its local Cartesian coordinate system. The main task when using spline primitives in geometric modeling of spatial objects is the placement of reference points. In the case of a Bezier spline, the four corner points of the primitive are easy to find: they belong to the surface of the object. The rest of the points must be chosen in such a way as to ensure smooth joining of the primitive with its neighbors. It is easy to figure out that there will be eight such neighboring primitives: four will be in contact with this primitive by edges and four by corner points.

The dashes show the straight lines on which the extreme control points of neighboring primitives lie.

The mathematical conditions for smooth joining will be the equality of partial derivatives taken in the appropriate directions for the spline functions that describe neighboring primitives. For the diagonal direction, the mixed derivative is taken. When constructing a mathematical model of a complex surface, you need to know what these partial derivatives will be, and the designer has only this surface itself or its characteristic points at its disposal. To simplify the process of describing the surface, they resort to interactive systems of geometric modeling. They have ready-made spline primitives, the shape of which can be changed in real time. This is done by moving ("dragging") the anchor points. Corner points are attached to the surface being modeled, and the position of intermediate points is interactively set in such a way that the primitive receives the desired configuration. One of the well-known geometric modeling systems is 3DMAX.

In addition to Bezier splines, basic splines, or L-splines (“bi-splines”), are widely used in computer graphics. The use of L-splines simplifies the process of modeling complex surfaces. Any 16 characteristic points of the surface, forming a quadrilateral 4*4 points, can be taken as reference points of the L-splice primitive.

The use of multiple control points improves the quality of modeling complex surfaces, although it significantly increases the consumption of computing resources of the graphic system. Rational bicubic splines have wide visual possibilities. In computer graphics, non-uniform Rational B-Splines (NURBS) are usually used.

Computer modeling is essentially the digital successor to the art of frame-by-frame animation of 3D models and frame-by-frame animation of 2D illustration. For 3D modeling, objects (models) are created (modeled) on a computer monitor, and 3D figures are equipped with a virtual skeleton. For 2D animation of figures, individual objects (illustrations) and individual transparent layers, layers with or without a virtual skeleton are used. The form of the above expressions shows that the modeling of surfaces based on rational splines requires large computational costs. NURBS drawing macros are available in modern graphics libraries.

BIBLIOGRAPHY

1. *ZUNNUNOVA UMIDA GULOMOVNA, Development Trends of the Organization of Information Processing at the Enterprise, INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY, 2020, V 7, 2*
2. *Umida Zunnunova, KINDS OF INNOVATION STRATEGY AND RISKS OF INNOVATIVE ACTIVITY, "Мировая наука", 2019, V 22,1*
3. *Mukhamedov Umar, Umirzokov Rakhmatilla, Advantages of using computer graphics in the field of design, International Journal on Integrated Education, 2020, V3, 1*

4. *Umida Gulomovna Zunnunova Sayyora Abdulhakovna Zakirova, Lelia Rus Pîrvan, CHALLENGES AND PROSPECTS IN ART HIGHER EDUCATION OF UZBEKISTAN AND ROMANIA, European Journal of Research and Reflection in Educational Sciences (EJRRES), 2020,V 8, 10*
5. *Turabek Raufovich Fayziyev Umida Gulomovna Zunnunova , Sayyora Abdulhakovna Zakirova, ACADEMIC AND ORGANIZATIONAL ASPECTS OF ENTREPRENEURSHIP EDUCATION IN ART UNIVERSITIES OF UZBEKISTAN, JOURNAL OF CRITICAL REVIEWS, 2020, V 7, 19*
6. *Sayyora Abdulhakovna Zakirova, COMPUTER GRAPHICS AS A TOOL FOR THE DEVELOPMENT OF STUDENTS' CREATIVE AND INTELLECTUAL ABILITIES IN CLASSES ON THE BASICS OF INFORMATION TECHNOLOGY, ACADEMICIA An International Multidisciplinary Research Journal (Double Blind Refereed & Reviewed International Journal), 2020, V 10, 6*
7. *Zakirova Sayyora Abdulhakovna, The Role of IT-Management in the Development of Information Technologies, International Journal of Advanced Research in Science, Engineering and Technology, India, National Institute of Science Communication and Information Resources, 2020, V 7,2*