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Research on Geometric Stereo based on Art Picture

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Abstract: How to display images of geometric art, puts forward the research application of stereo image art based on geometry. Through the defect of dealing effectively with the traditional method of image three-dimensional improvement. Through the experimental test results show that the research is more effective and has more practical value.

Keywords: Practical value; Dimensional; Picture

1. Introduction

On the CAGD international conference held in Utath University, 1974, the subdivision method of Chaikin generated curves had attracted the attention of CAGD community[1]. Then Riesenfeld and Forrest proved that this limit curve to be the uniform quadratic B-spline curve.Later Catmull, Clark, Doo and Sabin respectively proposed to popularize double three and double quadratic B-spline surfaces to arbitrary topology surface[2]. In 1987, Loop in his master's thesis presented a approximated segmentation Loop based triangular mesh, which popularizes four triangular box spline to arbitrary triangular mesh. But the description of the above method and theory almost entirely focused on the uniform and stable subdivision. CAGD researchers achieved good results in the non-uniform pattern, non-static mode, nonlinear mode, Hermite subdivision patterns etc., providing a new way of thinking for geometric modeling [3-5].

This paper's goal is the four order geometric partial differential equations, including surface diffusion flow, the proposed surface diffusion flow and uses Willmore flow boundary conditions to complete the G1 surface design, adopts mixed finite element method to discrete these equations based on Catmull-Clark subdivision limit form . This paper mainly makes expanding and innovative work in the following areas:

(1)Geometric Partial Differential Equations is a powerful technique for structural quality surfaces. Tessellation has been active in the field of CAD due to its flexibility for topology since it appeared. In this paper these two kinds of different ways are combined in a unified framework to efficiently and satisfactorily design geometric partial differential equations subdivision surfaces with G1 boundary conditions. Considering the three four order geometric partial differential equations for the surface diffusion flow, the proposed surface diffusion flow and Willmore flow, these equations use the mixed finite element method to seek solution, and successfully designed the finite element method for four order geometric partial differential equations based on quadrilateral Catmull-Clark subdivision.

(2)To further validate the correctness and validity of the proposed geometric flow methodology and tessellation method's combining, this paper uses several numerical examples to illustrate the different effects of QSDF, SDF and WF surface evolution, and how to use them to solve some surfaces design problems. The experimental results showed that: this method successfully constructed finite element method of four order geometric partial differential equations based on Catmull-Clark quadrilateral surfaces subdivision.

As we all know, three-dimensional data sampling techniques and hardware devices rapidly develop, such as laser range scanning, object's initial mesh can be easily generated on the computer; more importantly, because the graphics industry's demand for smooth surface modeling of arbitrary topology is increasingly urgent, the traditional Bézier, B-spline methods cannot meet the requirements any more, they have serious limitations in design of arbitrary shaped boundaries and surfaces of arbitrary topology, while tessellation is able to provide a simple and efficient algorithm to characterize arbitrary topology free-form surfaces, and has a certain order of smoothness. In 1974, Chaikin first proposed the concept of discrete segments [1]. In 1978, Doo Catmull etc., put forward subdivision rules of biquadratic and Bi-cubic tensor product B-spline surfaces based on quadrilateral meshes[2-3]. Loop in 1987 proposed approximation subdivision rules of triangular surface mesh based on four box spline, and triangle mesh's interpolating subdivision scheme (called butterfly format) is given by Dyn and so on [5]. Geometric modeling using tessellation method has been widely and deeply studied. Because of its many advantages it is widely used, and achieved good results, such as scattered data surface reconstruction, finite element analysis of shell structures, as well as many surface modeling problems (surface polishing, stitching and N-sided hole filling, etc.) [4-5].

Proposed surface diffusion flow

$$\begin{cases} \dfrac{\partial x}{\partial t} = -\Delta_s^2 x,\ S(0) = S_0 \\ \partial S(t) = \Gamma \end{cases} \quad (1)$$

This paper adopts mixed finite element method to solve these three four order geometric flows, control vertexes on the surface are the unknown quantity need to be determined , the average surface curvature and mean curvature vector are also treated as unknown quantities. Specific steps are as follows: First, the fourth-order equations are written in two second-order equations coupled system; Then create this coupled system variationalform (weak form), then conduct the discretization of finite element , exporting a linear system; finally use iterative method to solve the linear system to obtain approximate solutions.

The following are their weak forms, let the trial function ϕ , $\forall \phi \in R^I(S)$,then formula (2) (3) weak forms as follows: find $\forall \varphi \in R^I(S)$,which makes

$$\begin{cases} \int_s \dfrac{\partial x}{\partial t}\phi dA + 2\int_s [\phi \varnothing R - n(\nabla_s \phi)^T \nabla_s R] dA = 0, \\ \forall \phi \in R^I(S) \\ \int sR\varphi dA - \dfrac{1}{2}\int_s tr(\varnothing x)\varphi dA = 0, \forall \varphi \in R^I(S) \end{cases} \quad (2)$$

And

$$\begin{cases} \int_s \dfrac{\partial x}{\partial t}\phi dA + \int_s [\phi \varnothing R - n(\nabla_s \phi)^T \nabla_s R] dA + \\ \int_s 2n(R^2 - K)\phi R dA = 0, \forall \phi \in R^I(S) \\ \int_s R\varphi dA - \dfrac{1}{2}\int_s tr(\varnothing x)\varphi dA = 0, \forall \varphi \in R^I(S) \end{cases} \quad (3)$$

Weak form of formula (4) is as: find $\forall \varphi \in R^I(S)$,which makes

$$\begin{aligned} &\int_s \frac{\partial x}{\partial t}\phi dA - 2\int_s \nabla sR \nabla s\phi dA = 0, \forall \phi \in R^I(S) \\ &\int_s R\varphi dA + \frac{1}{2}\int_s (\nabla sx)^T \nabla s\varphi dA = 0, \forall \varphi \in R^I(S) \end{aligned} \quad (4)$$

2. Simulation and Analysis

This section presents several numerical examples to illustrate QSDF, SDF and WF'S different surface evolution effects, and how to use them to solve some problems of surface design.

3. Blending Surfaces

Given a set of boundary surface mesh, it needs to construct a smooth transition surface to stitch together the given surface and has G_1 continuity at the stitching boundary. In Figure 1, the surfaces to be spliced are cylinders of three mutually perpendicular surfaces , as shown in Figure 1, Figure 1 shows an initial mosaic surface with smooth G_0 , Figure 1 shows the result of the evolution through QSDF; Figure 1 shows the results of evolution through SDF; Figure 1 shows the result of evolution through WF. Except the first line model in Figure 1, all other images are the results after 100 iterations, the time step is taken to be 0.0113. Due to the QSDF area reduction effect, further iteration will be singular, first line model in Figure 1 is the result after 64 iterations. These figures clearly show the G_1 smoothness at the splicing boundaries and the difference between the effect of evolution. QSDF Surface is more contracted than SDF surface, while WF surface is more expanded than SDF surface. This effect is consistent with Figure 1. In Figure 1, the three cylinders of the second line model are thicker than that of the first line model. It can be known that SDF has volume-preserving properties, WF has a swelling effect, while QSDF is area-reducing. Therefore, when the area to be filled is large, the effects of these geometric flows will be clearly reflected (like the first row models in Figure 1);

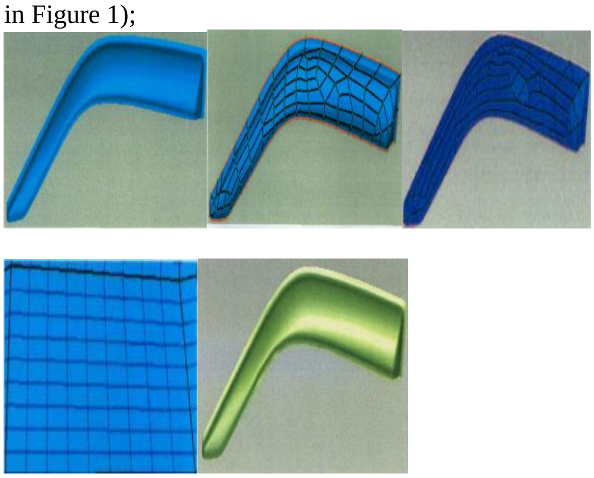

Figure 1. Blending Surfaces

4. Conclusion

Tessellation technology provides a simple and efficient way to construct arbitrary topology and at the same time has a certain order of smoothness of the surface. Geometric method is a powerful technology for constructing high-quality surfaces. This article organically combines the two together and give full play to the advantages of both, in a unified framework it solves some surface design problems such as surface blending, N side fill holes and others which meet G_1 boundary conditions. This paper has successfully constructed the finite element method for surfaces of four order geometric partial differential equations based on quadrilateral Catmull-Clark subdivision.

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