Partial cutting method of the 3D geometric model

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***Abstract*--A research on 3D shape model mock cutting technology has recently been conducted actively. Game industry has also developed 3D mock cutting module, however, even though it is optimized to repeat mock cutting in real time, there is a problem in a complex model that the object is also to be cut other than the scope of cutting. Therefore, in this paper, it was improved to only cut the designated scope to overcome such problem.**

I. INTRODUCTION

If the objects are covered from each other through the mock cutting technology, the internal structure can be examined thoroughly. Therefore the mock cutting technology has been applying to various fields such as natural science and process technology.

Model cutting is a classic problem in computer graphics,and there are many algorithms. But these algorithms also have a lot of shortcomings, whose real-time performance are very bad, so they cannot be used for real-time operation in games [1].

This work is widely used to reconstruct meshes from 3D data Mesh simplification, hierarchical detail model, geometric compression and transmission, interactive editing, texture mapping, mesh subdivision, geometric deformation, the establishment of correspondence between animation, local area parameterization, and spline surface reconstruction in reverse engineering At research work.

At the same time, the local geometric topology saliency of the 3D mesh model is also an effective index for the retrieval of the 3D mesh model.

Games, especially 2D smart phone games, are also applied with real-time cutting technology utilizing 2D image. Since 'Fruit Ninja' and 'iSlash' were released in the smart phone game market, similar games had been releasing continuously. With this, we can learn that people like an intuitive interactive game method. However, 3D games only create a scene of cutting, not using the actual mock cutting. The cases applied with such technology are extremely rare especially in 3D RPG game area.

Therefore, it is predicted that introducing the real-time mock cutting technology in 3D shape to games will be able to provide a rather more realistic game environment favorable by users.

II. 3D SHAPE MODEL PARTIAL CUTTING WORK PROCEDURE

Mock cutting work is a process that deals with 3D objects created after modeling the actual object data. In the field of computer graphics, various mock cutting algorithms have been developed on the basis of Volume rendering and Surface rendering models [2]. Of these, the recent games commonly use a method based on the surface rendering model.

The basic process of a mock cutting algorithm based on surface rendering model suggested by D.Bruyns [3] is to be dealt with in the following process.

1. Definition of the cut path,
2. Primitive removal and re-meshing,
3. Number of new primitives created,
4. When re-meshing is performed, and
5. Representation of the cutting tool.

However, the above processes cannot only cut the designated scope, therefore it was handled in the following processes for cutting the designated scope in this paper.

1.Designation of cutting target
2.Definition of cutting route
3.Creation of cutting surface
4.Cutting on Triangle Mesh
5.Reconstitution of model

III. REALIZATION OF PARTIAL CUTTING TECHNOLOGY

Unity Engine, used in this paper, is an engine which is often used in divers areas such as game development and virtual simulation. It allows Dynamic Preview so to facilitate editing of detail attributes and development. The Unity engine was initially defined as a multi-platform, high-end, large-scale game development engine. It is highly optimized for DirectX and OpenGL graphics rendering pipelines, enabling low-end hardware to run smoothly on roaming displays, virtual simulations, interactive animations, etc., and can create high-quality 3D simulation systems and realistic visual effects.The Unity engine makes it easy to export up to 28 platforms such as iOS, Android, Windows, MacOS X, Linux, Xbox, PS, and Web.

In this paper, a partial cutting module was developed by expanding part of contents of TurboSlicer Tool Kit which was realized in Unity engine.

A mock cutting algorithm used in TurboSlicer Tool Kit is based on the principle of BSP-Tree creation suggested by John Ratcliff. Through BSP-Tree creation, it searches the apex of each triangle mesh of cutting targets and creates an infinite plane on the cutting route by the flat equation And then it decides if each triangle mesh is at the front or back of the plane or if the plane is penetrating the triangle mesh. If the plane is penetrating the triangle mesh, the triangle mesh is to be separated into two polygons for the one to be at the front and the other to be at the back.

This algorithm divides the cutting object into two parts; front and back, through BSP-Tree creation. Since it cuts on the basis of infinite plane, there is a limit of cutting the surrounding matters and objects of background together. Therefore, to allow cutting work to be performed only on the definite area, a definite cutting plane was set as follows. Two apexes A and B form four sides of an infinite cutting plane and the apex C is to be designated as Figure 1 to set the height of the infinite cutting plane.

Partial cutting is to be made after only splitting the triangle mesh of a model inside the cutting scope.

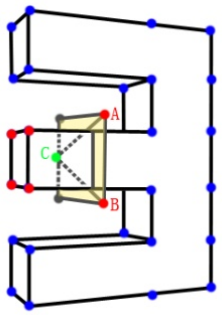

Fig. 1. Cutting scope

Remeshing is a form to remove the excessive thickness created by the regularized formulation and to ensure that dissipation is limited to a realistic region, without requiring crack path determination [4].

After the mesh has been split by the mock cutting,The clone of the original cut object after the grid segmentation is stored as two objects respectively, so that the cloned object obtains the basic information such as the position of the original cut object object, scaling, and rotation.

Removes the original model, add a collider and other necessary components to the newly created object makes newly created model have the attributes of the re-cuttable model.

A result of the partial cutting made in the process changed this way can be known by comparing (b) with (c) of Figure 2. We can see that other area was also cut than the scope designate as an infinite plane in (b) and that only the designated scope of area was cut in (c).

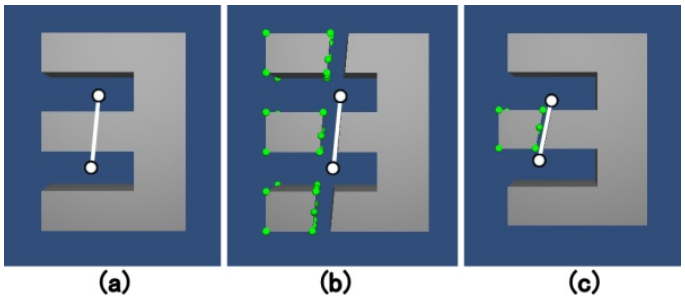

Fig. 2. (a)Marked cutting route; (b) A result of mock cutting with infinite plane; (c) A result of partial cutting.

IV. CONCLUSION

This paper has suggested a way to partially cut 3D shape model. To apply partial cutting, a cutting plane of infinite size was designated and 3D shape model data managed by BSP-Tree was calculated and then a new apex and mesh on the cutting plane were created for the procedure. The cutting technology developed in this research is expected to be usefully utilized in functional games, engineering simulation fields and many other areas in the future.

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