US6538654 Claim Chart

PIXAR's
RenderMan

Pixar RenderMan

Disclaimer

The patent right(s) referenced in these materials are offered for acquisition through a sale as of the date of this publication. The patent owner may, at any time, in its sole discretion and without prior notice, modify, substitute or withdraw this offering, and may modify any and all terms and conditions related to the acquisition including, but not limited to, pricing. Neither these materials nor the patent-related information referred to in these materials is intended to constitute legal analysis, notice or accusation of infringement, or to claim or assert that any party has violated any intellectual property rights or law. Prospective purchasers must rely on their own examination and evaluation of the patent(s), including but not limited to review of associated patent applications, patent family members, file histories, and other relevant information, in determining the value or applicability of the patent(s) with respect to any activities, products, or services. Any purchase is to be made independent of these materials. Neither the patent owner nor Drakes Bay Company makes any representation or warranties regarding the patent(s), the information contained in or referred to in these materials, or any other information supplied in connection with this offering. The patent owner and Drakes Bay Company expressly disclaim any warranty of merchantability or fitness for a particular purpose in connection therewith. The patent owner, in its sole discretion, may reject any and all offers for any reason. No obligations or commitments, whether express, implied or otherwise, shall be enforceable against the patent owner unless and until a final, written agreement is executed by and between the patent owner and a prospective purchaser.

Contents

1
- Bibliographic Data

2
- Invention Overview

3
- Claim Elements

4
- Product Overview

5
- Product Mapping

Bibliographic Data

US6538654: System And Method For Optimizing 3D Animation And Textures

Issue Date: March 25, 2003

Filing Date: December 23, 1999

Priority Date: December 24, 1998

Inventors: Anthony Rose, Andrew D. Davie, Alexis Vuillemin.

Original Assignee: B3D Inc.

Current Assignee: B3D Inc.

Independent Claims: 9 (Claim #1, #6, #7, #8, #10, #11, #12, #14 and #15)

Total Claims: 15

Applications: The invention can be used in following application areas :

- 3D animation object development and rendering software
- Animation film making studios.

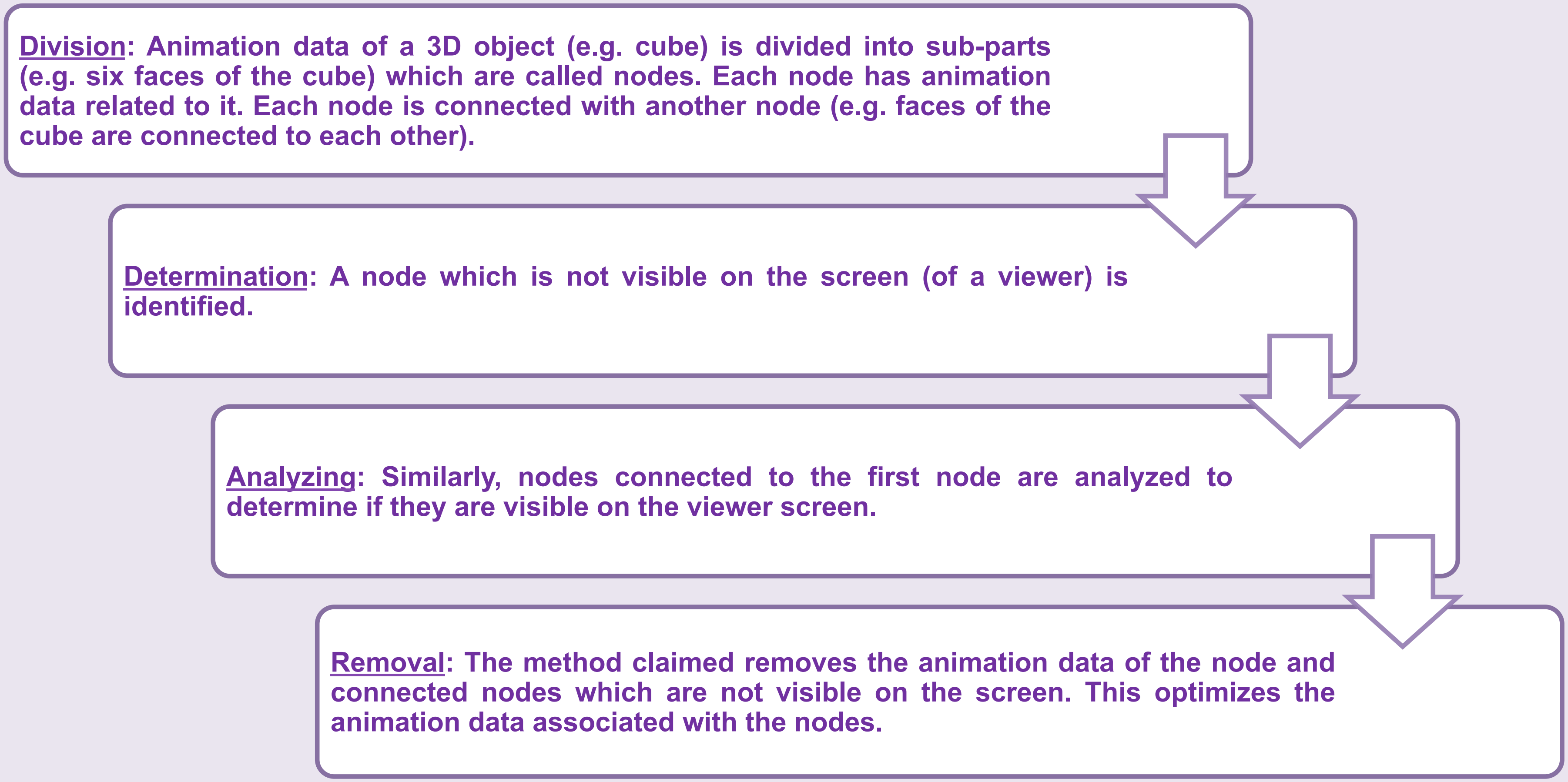
Summary: The subject patent relates to 3D animation software. It discloses a method for determining and removing the animation data of 3D objects which are outside the view frame.

U.S. Family Members: 5

Non-U.S. Family Members: 0

Invention Overview

Subject patent describes the process of creating the animation data for 3D objects (Actors, Props, Cubes etc.) in an optimized manner. Below is a flow chart illustrating the method in the claimed invention.



<u>Division</u>: Animation data of a 3D object (e.g. cube) is divided into sub-parts (e.g. six faces of the cube) which are called nodes. Each node has animation data related to it. Each node is connected with another node (e.g. faces of the cube are connected to each other).

<u>Determination</u>: A node which is not visible on the screen (of a viewer) is identified.

<u>Analyzing</u>: Similarly, nodes connected to the first node are analyzed to determine if they are visible on the viewer screen.

<u>Removal</u>: The method claimed removes the animation data of the node and connected nodes which are not visible on the screen. This optimizes the animation data associated with the nodes.

Note: Steps are provided by the analyst for better visualization of the claimed invention.

CLAIM ELEMENTS

This section presents the shortlisted claim used for mapping. It also provides an overview on what information has been identified and to what extent. Below is the color-coding used for this purpose –

- **Green** text represents a sub-element, relevant information for which is directly and explicitly available in the product.
- Blue text represents additional important information related to a topic/subtopic added by the analyst team.

Elements and Sub Elements of Claim 1

Preamble:

In a computer system for creating animation data for a 3D object appearing in a 3D animated content, the 3D object having a hierarchy of parent nodes and children nodes, each node being associated with animation data, a method for optimizing the animation data associated with each node comprising:

Clause 1:

determining if the node is outside a view frame;

Clause 2:

determining if any child node associated with the node is outside the view frame; and

Clause 3:

removing the animation data associated with the node if the node and any associated child node are outside the view frame.

PRODUCT OVERVIEW

This section provides an overview of the product mapped with the subject patent. This information is provided to aid understanding of the mapping by providing a glance at the product beforehand.

Purple text and boxes represent comments added by the analyst team to improve understanding.

Company: Pixar
Product: RenderMan

RenderMan has been Pixar's core rendering technology for over 25 years, and has been developed to meet the challenges of **3D animation and visual effects**. RenderMan is capable of delivering high quality global illumination and physically based visual effects, while also offering multiple types of light transport for unparalleled creative flexibility and artistic control.

Source 1

PhotoRealistic RenderMan is designed and optimized for creating very realistic images of visually complex scenes. Renderers often try to take advantage of this fact by completely discarding the parts of that object where the interior surface faces the viewer (e.g., the back wall of the cube).

Source 2

Analyst Comment: RenderMan is 3D animation software developed by Pixar to create 3D animation films. Its optimization feature removes data which is outside the field of view so that output is optimized.

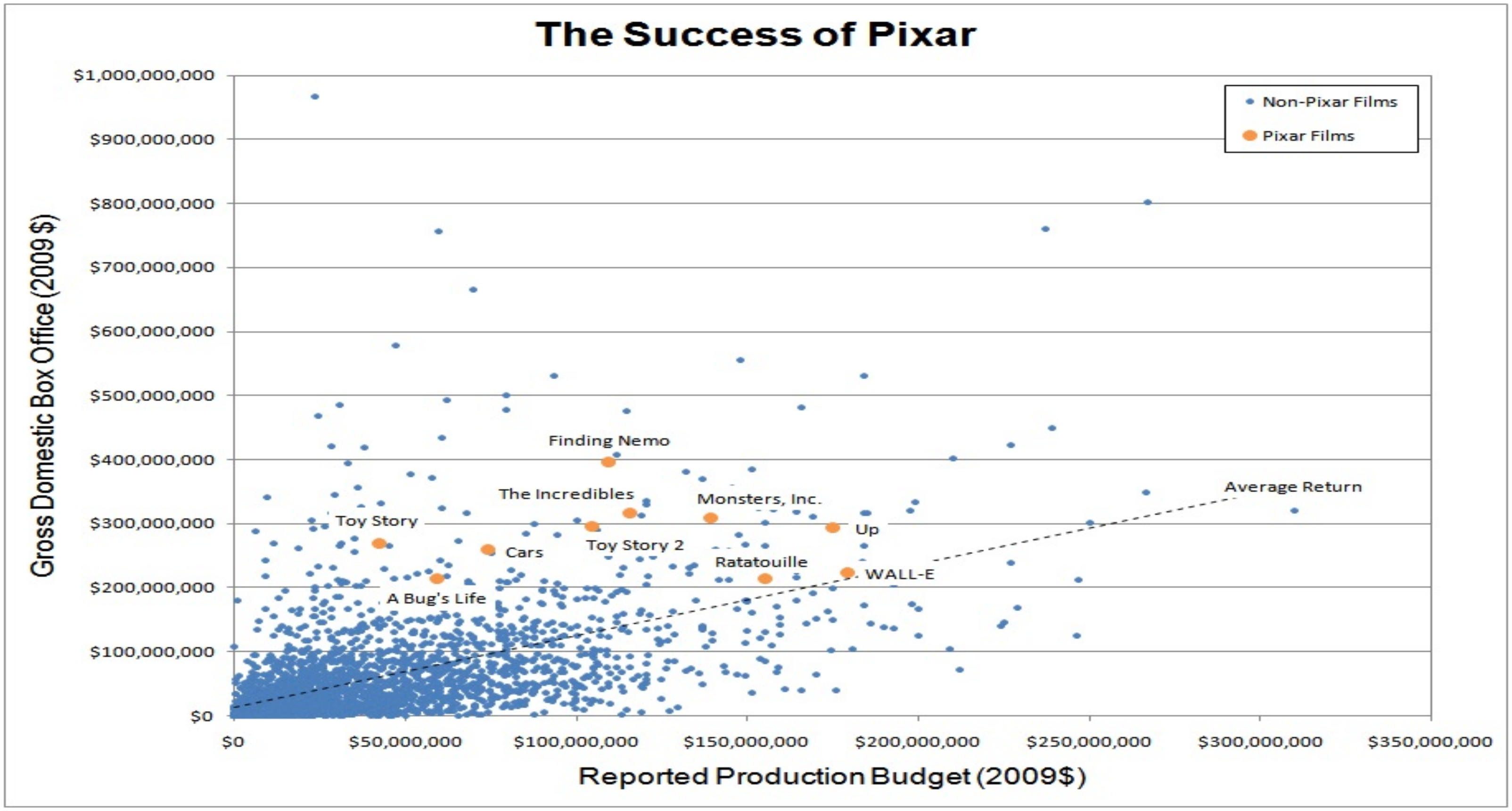
Source 1: http://renderman.pixar.com/view/p-renderman

Source 2: https://renderman.pixar.com/resources/RMS_3/index.html?url=baking3d.html (Topic: Modeling for Efficient Rendering)

DRAKES BAY COMPANY

Company: Pixar
Product: RenderMan

Market information:



Note: Market information is taken from unofficial sources as the same is not available on official website of Pixar.

Information on Next Slide

Source: http://boxofficequant.com/

Company: Pixar
Product: RenderMan

Market information:

The 3D animation market is estimated to grow from $21.06 billion in 2014 to $40.78 billion in 2019 at a Compound Annual Growth Rate (CAGR) of 14.1% from 2014 to 2019. On geographical grounds, North America (NA) is forecasted to be the biggest market for 3D animation technology while other regions such as Middle-East and Africa (MEA), Asia Pacific (APAC) and Latin America (LA) are forecasted to experience a rise in this market with high CAGRs in the due course.

Analyst Comment: Pixar is clearly a major player, given the growth of the 3D animation industry and the success of Pixar in terms of revenue generated from its animation films.

Information on Previous Slide

Note: Market information is taken from unofficial sources as the same is not available on official website of Pixar.

Source: http://www.marketsandmarkets.com/PressReleases/3d-animation.asp

PRODUCT MAPPING

This section provides element-by-element mapping of the subject claim with the product identified. Below is the color-coding used for this purpose –

- **Green** text represents a sub-element for which relevant information is explicitly available.
- **Purple** text represents comments and notes added by the analyst team to improve understanding.
- **Blue box** represents the claim element that is being mapped with the product.

Note: To explicitly show presence of some claim elements, we have used references/ text which are not from official website of Pixar.

Claim 1 (Preamble) (I)

In a computer system for creating animation data for a 3D object appearing in a 3D animated content, the 3D object having a hierarchy of parent nodes and children nodes, each node being associated with animation data, a method for optimizing the animation data associated with each node comprising:

This article won't just look at the major advances like the release of **RenderMan, Pixar's in house animation software used to create all their pictures from Toy Story to Monsters University**, but the little programs that add detail to anything put on the screen, programs such as Open VDB, a Dreamworks creation responsible for some of the jaw dropping graphics in films like The Croods and Rise of the Guardians.

3D Animated Content

Source 1

Minimum System Requirements

The following operating systems are supported for this release:

Linux with one of the following gcc/glibc packages installed:

gcc 4.0.2/glibc 2.3.4

gcc 4.1.0/glibc 2.4

Macintosh OS X 10.7.x or higher

Windows Vista or 7

Additionally, RenderMan Pro Server requires SSE2-compliant processors. Macintosh support is limited to Intel chipsets only; PowerPC is no longer supported.

Computer System

Source 2

Analyst Comment: RenderMan is 3D animation software used to create 3D animation content such as Toy Story, Monsters University, etc. RenderMan runs on a computer system running Windows, Macintosh or Linux operating systems.

Source 1: http://www.cinesyn.com/new-worlds-software-gets/

Source 2 : http://renderman.pixar.com/resources/current/rps/install.html

Claim 1 (Preamble) (II)

In a computer system for creating animation data for a 3D object appearing in a 3D animated content, **the 3D object having a hierarchy of parent nodes and children nodes**, each node being associated with animation data, a method for optimizing the animation data associated with each node comprising:

*Description of **"the 3D object having a hierarchy of parent nodes and children nodes"** from the subject patent.*

> **Actors and props (collectively referred to as actors) are composed of a hierarchy of nodes.** The hierarchy begins with a root node and proceeds down to other nodes**, each node being associated with a discrete piece of 3D geometry (group of polygons) making up the 3D object. Each node is further identified by a node name. For example, a node representing an object's head might be named a "head" node.**
>
> **Each node has zero or more parent and child nodes, with the restriction that the linkages cannot form a loop. Thus, a trunk node may have a leg node as one of its children, and a head node as one of its parents.**

Analyst Comment: According to the subject patent, a 3D object e.g. an actor, is made up of various 3D geometries and each 3D geometry is associated with a unique node. A node has other nodes connected to it, called parent and child nodes. For example, a trunk node may have a head node as a parent and a leg node as a child connected to it.

Source: http://patentimages.storage.googleapis.com/pdfs/US6538654.pdf (Column 5, Line 58)

Claim 1 (Preamble) (III)

In a computer system for creating animation data for a 3D object appearing in a 3D animated content, **the 3D object having a hierarchy of parent nodes and children nodes**, each node being associated with animation data, a method for optimizing the animation data associated with each node comprising:

> **It is very rare for an object in the real world to be modeled by a single patch or polygon. Usually there are large numbers of patches or polygons, and they are quite often connected in some regular pattern.** Patches are often parts of spline surfaces, with an underlying rectangular grid. Polygons are often parts of polyhedra, and share most of their vertices with other polygons. **RenderMan has compact, efficient versions of patch and polygon primitives for these situations known as PatchMesh and PointsPolygons.**

Analyst Comment: Similar to what is described in the subject patent (see slide 14), 3D objects in Pixar RenderMan are comprised of polygons (geometry). Hence, we have shown the presence of 3D geometry. The connection of the patches or polygons indicates the concept of nodes is used in the product (see example below).

> If very complex models are being used more than once in an image, or the same complex model is being used repeatedly in multiple frames, it can often be very beneficial to place the geometric primitives for that model in a **RenderMan object**. This entire model can then be referred to by its identification tag, rather than re-specifying all of the geometric data for every use. **For example, the patch meshes which make up the body of a car might be made into an object.**

Geometry forming parent and child nodes

Analyst Comment: In the example above, a car is an object made up of various patch meshes. Patch meshes are the 3D geometries that are synonymous to the hierarchy of parent and child nodes.

Source: https://renderman.pixar.com/resources/RMS_3/index.html?url=baking3d.html (Topic: Modeling for Efficient Rendering)

Claim 1 (Preamble) (IV)

In a computer system for creating animation data for a 3D object appearing in a 3D animated content, the 3D object having a hierarchy of parent nodes and children nodes, **each node being associated with animation data**, a method for optimizing the animation data associated with each node comprising:

It is very rare for an object in the real world to be modeled by a single patch or polygon. Usually there are large numbers of patches or polygons, and they are quite often connected in some regular pattern.

Source 1

When you look at Monsters University, you'll notice **effects like the flag swaying in the wind**. But you'll also notice the **blades of grass in the plaza, the swaying of the trees**, the large numbers of student monsters roaming all over the school, and the lighting and shadows everywhere.

Source 2

Animation Data

Analyst Comment: The 3D objects and their nodes in the Pixar movie "Monsters University" are animated with effects like flag swaying and student monsters roaming the school.

Source 1: https://renderman.pixar.com/resources/RMS_3/index.html?url=baking3d.html

Source 2: http://venturebeat.com/2013/04/24/the-making-of-pixars-latest-technological-marvel-monsters-university/

Claim 1 (Preamble) (V)

In a computer system for creating animation data for a 3D object appearing in a 3D animated content, the 3D object having a hierarchy of parent nodes and children nodes, each node being associated with animation data, **a method for optimizing the animation data associated with each node** comprising:

Description from the subject patent.

> **the animation and texture data of the 3D animation content is optimized to reduce the size of the animation data to be streamed over the Internet.** The system and method according to this second aspect of the invention gathers statistical information about the nodes and textures being utilized in each frame of the animated content. In doing so, **the system and method determines if a particular node and any of its children nodes are outside the view frame. If they are, then the animation data associated with the node is removed.**

Analyst Comment: According to the subject patent, optimization of animation data includes removing the data associated with a node which is outside the field of view.

Source: https://patentimages.storage.googleapis.com/pdfs/US6538654.pdf (Column 3, Line 17)

Claim 1 (Preamble) (VI)

In a computer system for creating animation data for a 3D object appearing in a 3D animated content, the 3D object having a hierarchy of parent nodes and children nodes, each node being associated with animation data, **a method for optimizing the animation data associated with each node comprising:**

> Most models contain objects that enclose space. That is, objects which have a distinct interior with no holes to the outside; for example, a sphere or a cube. Unlike a sheet of paper or an open cylinder, it is easy to recognize that on such closed objects, it is impossible to see the interior surface. **Renderers often try to take advantage of this fact by completely discarding the parts of that object where the interior surface faces the viewer (e.g., the back wall of the cube). This process is often called backface culling, and is enabled in RenderMan by setting the RiSides(1) flag.**

Optimizing the animation data

Analyst Comment: RenderMan software optimizes the animation data by removing (culling) the data associated with a node which is outside the field of view (backface).

Source: https://renderman.pixar.com/resources/RMS_3/index.html?url=baking3d.html (Topic: Modeling for Efficient Rendering)

Claim 1 (Clause 1) (I)

determining if the node is outside a **view frame;**

*Description of “**view frame**” from the subject patent.*

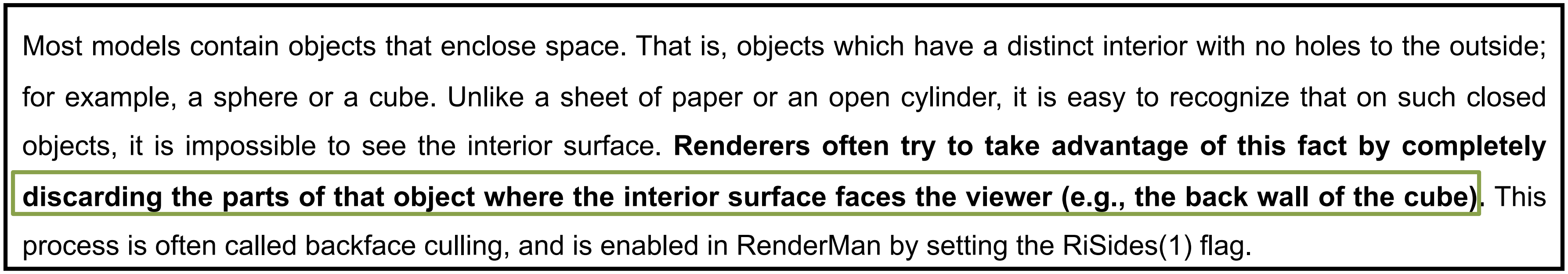
> The animation inaccuracy of the child node does not affect the quality of the 3D movie if the child node is **not visible (i.e. outside the view frame).**

Analyst Comment: According to the subject patent, view frame refers to the field of view in which the node is visible and is not obscured by the other nodes.

Source: http://patentimages.storage.googleapis.com/pdfs/US6538654.pdf (Column 65, Line 52)

Claim 1 (Clause 1) (II)

determining if the node is outside a view frame;



Most models contain objects that enclose space. That is, objects which have a distinct interior with no holes to the outside; for example, a sphere or a cube. Unlike a sheet of paper or an open cylinder, it is easy to recognize that on such closed objects, it is impossible to see the interior surface. **Renderers often try to take advantage of this fact by completely discarding the parts of that object where the interior surface faces the viewer (e.g., the back wall of the cube)**. This process is often called backface culling, and is enabled in RenderMan by setting the RiSides(1) flag.

Analyst Comment: RenderMan discards the parts of the object (nodes) which are outside the view frame i.e. determination of nodes outside the view frame is done.

Source : https://renderman.pixar.com/resources/RMS_3/index.html?url=baking3d.html (Topic: Modeling for Efficient Rendering)

Claim 1 (Clause 2) (I)

determining if any child node associated with the node is outside the view frame; and

Description from the subject patent.

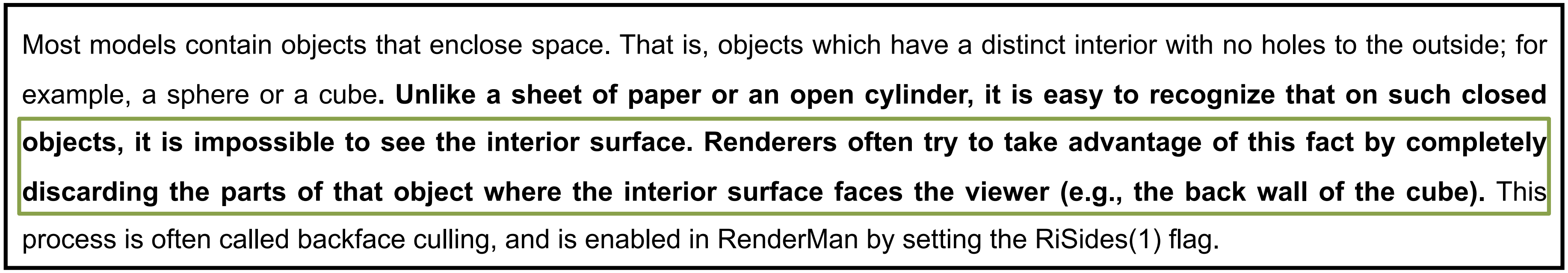
> Thus, removal of a parent node's animation data negatively affects the accuracy of the animation of a child node. **The animation inaccuracy of the child node does not affect the quality of the 3D movie if the child node is not visible (i.e. outside the view frame). However, if the child node is within the view frame, the inaccurate animation of the child node deteriorates the overall quality of the 3D movie.**

Analyst Comment: According to the subject patent, the animation of a child node may affect the quality of the 3D movie so it is critical to determine if the child node lies outside the view frame.

Source: https://patentimages.storage.googleapis.com/pdfs/US6538654.pdf (Column 15, Line 60)

Claim 1 (Clause 2) (II)

determining if any child node associated with the node is outside the view frame; and



Most models contain objects that enclose space. That is, objects which have a distinct interior with no holes to the outside; for example, a sphere or a cube**. Unlike a sheet of paper or an open cylinder, it is easy to recognize that on such closed objects, it is impossible to see the interior surface. Renderers often try to take advantage of this fact by completely discarding the parts of that object where the interior surface faces the viewer (e.g., the back wall of the cube).** This process is often called backface culling, and is enabled in RenderMan by setting the RiSides(1) flag.

Analyst Comment: In RenderMan, backface culling takes place for the nodes present outside the view frame. This means identification of child nodes outside the view frame is necessary.

Source : https://renderman.pixar.com/resources/RMS_3/index.html?url=baking3d.html (Topic: Modeling for Efficient Rendering)

Claim 1 (Clause 3)

removing the animation data associated with the node if the node and any associated child node are outside the view frame.

Most models contain objects that enclose space. That is, objects which have a distinct interior with no holes to the outside; for example, a sphere or a cube. Unlike a sheet of paper or an open cylinder, it is easy to recognize that on such closed objects, it is impossible to see the interior surface. **Renderers often try to take advantage of this fact by completely discarding the parts of that object where the interior surface faces the viewer (e.g., the back wall of the cube). This process is often called backface culling, and is enabled in RenderMan by setting the RiSides(1) flag.**

Removing the animation data

Analyst Comment: Renderman removes the parts of the object (nodes) outside the view frame using a technique called backface culling. Removing the nodes also removes the associated animation data.

Source: https://renderman.pixar.com/resources/RMS_3/index.html?url=baking3d.html (Topic: Modeling for Efficient Rendering)

For additional information, please contact:

- Joseph W. Jennings
  - 1-415-927-2716
  - jjennings@drakesbaycompany.com

- Marisa Bracoloni
  - 1-415-927-2716
  - mbracoloni@drakesbaycompany.com