

# Splitting of Meshes in Image-Space

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zur Erlangung des akademischen Grades

**Bachelor of Science**

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BACHELOR'S THESIS

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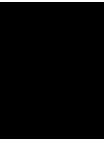


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# Introduction

The main purpose of 3D computergraphics is to represent image data. To make these data examinable, user interaction becomes an important part. Hence, the user should be able to translate, rotate and scale the 3D object. With the complexity of the object, the desire to examine just parts of it rises. The examination of the objects' inner structures can also be of interest. That leads to the first problem that needs to be solved: How can we reveal the inner structures? By simply removing the outer structures, the context would also get lost that could be important for scientific findings. Hence, the idea is to reveal the point of interest whilst keeping the context. Therefore, several scientific approaches exist. One idea is to simply raise the opacity of the outer structures. For example to reveal a brain, the approach would be to simply raise the opacity of the skull and the skin respectively for making the parts of secondary interest semi-transparent. Another approach is to cut the object so that no information would get lost and still the inside would be fully visible. So called explosion views unfold the inside by breaking the outer structures into multiple parts and shifting those apart whilst keeping the point of interest in the center.

This paper will examine several approaches to reveal inner structures of complex 3D models retaining the context to be able to examine the object regarding its surroundings.  
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## **Analysis of existing approaches**

**2.1 Literature studies**

**2.2 Analysis**

**2.3 Comparison and summary of existing approaches**



# KAPITEL 3

## Methodology

- 3.1 Volumeshop**
- 3.2 Creating a plug-in with Volumeshop**
- 3.3 Concepts and languages**



## Suggested implementation

In this section a step by step approach to reveal inner structures of a mesh will be discussed. First a plane needs to be defined that represents the position of the cut. To retain interactivity, several parameters in the Volumeshop interface can be set to translate, rotate and scale the plane. The color and opacity of the plane should also be adaptable to not conceal parts of the mesh. For the splitting we define an offset that indicates how far the two halves of the mesh shall be apart from the plane. The larger the gap the better can be gained an insight into the model. The splitting itself is no real translation of the two halves, but the model is rendered twice at different positions in space parallel to the plane. The final step is shading of the models' surface as well as the back facing vertices. The latter will be shaded with another color, but with the same amount of different lights to create the illusion of depth.

### 4.1 Definition of the plane

A plane in this context is a square of infinite size. It is used as a visual help to define where the mesh will be cut.

To be able to intervene with the Volumeshop, it is necessary to provide properties to set the translation, rotation, and scale vectors as well as the color. Each property requires a name and a type.

This would be a property named „Plane Translation Vector“ of the type Vector (in this case vec3):

```
GetPlugin().GetProperty("Plane Translation Vector").require(
    Variant::TypeVector(Vector(0.0f, 0.0f, 0.0f)));
```

To apply changes made in the interface immediately, an observer for the property has to be added:

```
GetPlugin().GetProperty("Plane Translation Vector").addObserver(
    &m_modVariantObserver);
```

To draw the plane, the Viewing Transformation Matrix has to be loaded. This matrix is for transforming the coordinates from world space into viewing space.[BOOK: Hearn, Baker] Then the plane is being adjusted by its affine transformations. All handed parameters are of the type 'float' and taken from the user input.

The commands in OpenGL:

```
glTranslatef(vecPlaneTranslation.GetX(), vecPlaneTranslation.
    GetY(), vecPlaneTranslation.GetZ());
glRotatef(vecPlaneRotationAngle, vecPlaneRotationVector.GetX(),
    vecPlaneRotationVector.GetY(), vecPlaneRotationVector.GetZ
    ());
glScalef(vecPlaneScaling.GetX(), vecPlaneScaling.GetY(),
    vecPlaneScaling.GetZ()); //'z' acts as a dummy as the plane
    is in 2D
```

The color of the plane has to be handed over normalized from the interface to the renderer. In Volumeshop, this can be easily achieved by calling the function 'GetNormalized<Color>'.

```
glColor4f(vecPlaneColor.GetNormalizedRed(), vecPlaneColor.
    GetNormalizedGreen(), vecPlaneColor.GetNormalizedBlue(),
    vecPlaneColor.GetNormalizedAlpha());
```

OpenGL supports several basic graphics primitives by default. For a plane a quad is needed that looks like the following [BOOK hill, p70]:

```
glBegin(GL_QUADS);
    glNormal3f(0, 0, 1);
    glVertex3f(-1, -1, 0);
    glVertex3f( 1, -1, 0);
    glVertex3f( 1, 1, 0);
    glVertex3f(-1, 1, 0);
glEnd();
```

As stated above our plane will be indefinite, but for the purpose as a visual helper it is displayed from -1 to 1 as a default. Note that it is also scaleable for bigger meshes.

The result should look like [FIGURE].

## 4.2 Splitting the mesh

The splitting offset is again implemented as a interface parameter. If the parameter is set to '0.0f' the mesh does not seem to be split. The larger the value of the offset the bigger the distance between the two parts of the mesh.

```
GetPlugin().GetProperty("Offset").require(Variant::TypeFloat
    (0.5f));
```



Note that of course an observer needs to be added as well.

The normal of the plane has been defined with '(0.0, 0.0, 1.0)', but regarding that the normal vector is still located in the object space of the plane, it needs to be transformed into the same space as the mesh, which would be the modelview space. This is being done by rotating the normal by the same amount as the plane is rotated in the interface.

The following code reveals the rotation matrix regarding the interface inputs.

```
glLoadIdentity();
glRotatef(vecPlaneRotationAngle, vecPlaneRotationVector.GetX(),
        vecPlaneRotationVector.GetY(), vecPlaneRotationVector.GetZ
        ());
```

Of course, the rotation matrix could also be calculated using the generally known formulas [BOOK hill p 217]:

x-roll:

$$R_x(\beta) = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\beta) & -\sin(\beta) & 0 \\ 0 & \sin(\beta) & \cos(\beta) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad (4.1)$$

y-roll:

$$R_y(\beta) = \begin{pmatrix} \cos(\beta) & 0 & \sin(\beta) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\beta) & 0 & \cos(\beta) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad (4.2)$$

z-roll:

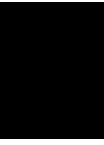
$$R_z(\beta) = \begin{pmatrix} \cos(\beta) & -\sin(\beta) & 0 & 0 \\ \sin(\beta) & \cos(\beta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad (4.3)$$

However, it should be considered that 3D rotation matrices do not commute [BOOK hill p220], so the order of multiplication matters.

### 4.3 Shading the mesh



# KAPITEL 5



## Critical reflection



# KAPITEL 6

## Summary



# Bibliography

## 7.1 Literature Search

Information on online libraries and literature search, e.g., interesting magazines, journals, conferences, and organizations may be found at <http://www.big.tuwien.ac.at/teaching/info.html>.

## 7.2 BibTeX

BibTeX should be used for referencing.

The  $\LaTeX$ source document of this pdf document provides you with different samples for references to journals [3], conference papers [6], books [2], book chapters [7], electronic standards [5], dissertations [8], masters' theses [4], and web sites [1]. The respective BibTeX entries may be found in the file `references.bib`. For administration of the BibTeX references we recommend <http://www.citeulike.org> or JabRef for offline administration, respectively.





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