Nanyang Technological University
School of Computer Science and Engineering

Laboratory Report

CZ2003
Computer Graphics and Visualization

Lab 4
Implicit Solids

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Contents

1 Introduction

Figure 1 – Front View

Figure 2 – Back View

A shape comprising of implicit solids, inspired by the "Nintendo Switch Joy-Con", is created for the compulsory portion of this lab. Figure 1 illustrates the front/side view of the shape while Figure 2 illustrates the back view.

Figure 3 – Screen Shape

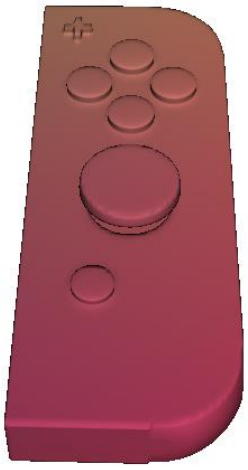


Figure 4 – Right Joy-Con Shape

Figure 5 – Nintendo Switch comprising of multiple transforms/shapes

Two additional shapes are also included as part of the optional portion of this lab, namely the "Screen" (Figure 3) and the "Right Joy-Con" (Figure 4). The shapes are wrapped in a Transform object such that the shapes may be translated along the X-axis. The "Left Joy-Con" (Figure 1) is translated to X = -1.4 while the "Right Joy-Con" (Figure 4) is translated to X = 1.4 to form the Nintendo Switch (Figure 5).

The individual, compulsory shape is defined in "Lab4_Joycon_Only.wrl" while the Nintendo Switch is defined in "Lab4.wrl".

Note 1: When running "Lab4.wrl", the screen is rendered first before the two joy-cons due to the simplicity of the shape. The two joy-cons will render after about 3 seconds. The individual shape renders after about 3 seconds as well, which fulfils the requirement of rendering below 5 seconds.

2 Left Joy-Con Shape Creation

This section briefly describes how individual geometries are created to form the left joy-con. Formulas for individual geometries have been omitted due to space constraints. Instead, a variable defined in the VRML files is provided as reference for each geometry. Reproduction of the geometries may be achieved by inserting a "return [variable_name]" call right after the variable declaration or assignment in the VRML file.

The left joy-con is defined with a resolution of 100 each and with a bounding box size of 0.6, 1.45, 0.6. The left joy-con is individually defined in "Lab4_Joycon_Only.wrl".

2A Diffused Colour

The material of the joy-con is defined using a FMaterial with the following formula:

- r = (u+1.25)/5
- g = (v+2.5)/5
- b = (w+2.5)/5

This gives the joy-con a colour gradient of teal (top) to blue (bottom).

2A Joy-Con Base

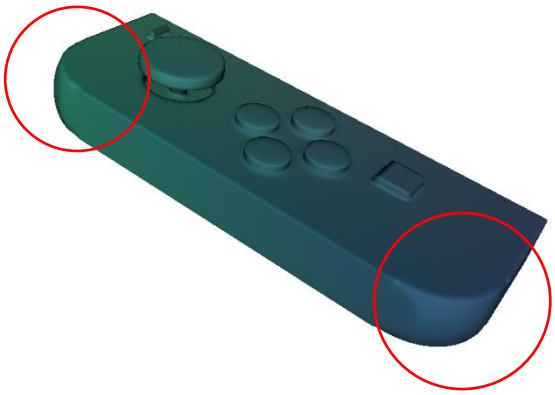
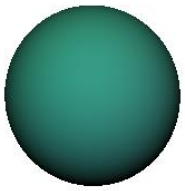
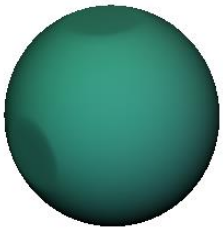
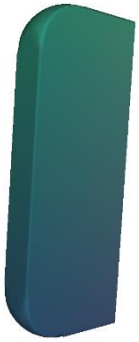


Figure 6 – Rounded edges circled in red

Two rounded-edge shapes are created for the joy-con, one for the top and one for the bottom of the joy-con (Figure 6). The edges are made with using a plane half-space, ellipsoid, and two plane surfaces.

	Figure A: A plane half-space is first defined. Variable: edgeSurface

	Figure B: An ellipsoid is then defined. Variable: edgeEllipsoid
	Figure C: The intersection of Figure A and B is obtained. Variable: edge1 & edge2
	Figure D: A surface, the base of the joy-con, is defined. Variable: surface
	Figure E: A cut version of the base is defined through the union of two shapes: • Variable: surface1 • Variable: surface2 • max(surface1, surface2) [defined in mainSurface1 variable assignment]
	Figure F: The final joy-con base is obtained through the intersection of 2 x Figure C (at different X and Y position) and Figure D each, union with Figure E: Variable: mainSurface1

2B Circle Pad Base

Figure 7 – Circle pad base circled in red

An indent is made in the joy-con as the base of the circle pad (Figure 7). The indent is made using a cylinder + plane surface and subtracting the intersection from the joy-con base.

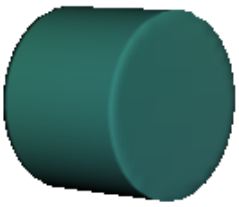
	Figure A: A surface is defined. Variable: indentSurface
	Figure B: A cylinder is defined. Variable: indentCylinder
	Figure C: The intersection of Figure A and B is obtained: Variable: indent

	Figure D: Figure C is subtracted from the joy-con base from the previous section: Variable: mainSurface

2C Circle Pad

Figure 8 – Circle pad circled in red

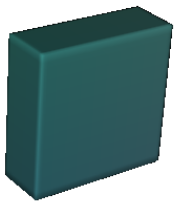
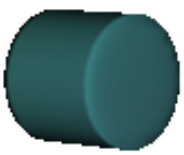
The circle pad (Figure 8) is then created by attaching a cone and ellipsoid + surface onto the circle pad base.

	Figure A: An ellipsoid surface is defined using an ellipsoid and a plane surface: Variable: circlePadSurface
	Figure B: A cone is defined. Variable: circlePadCone
	Figure C:; A union of Figures A and B is obtained. Variable: circlePad

2D Round Buttons

Figures 9 and 10 – Round buttons circled in red

The round buttons are created using a similar method as the Circle Pad Base (section 2B), the only difference being the shape is unionised with the joy-cone base instead of subtracting it.

	Figure A: A surface is defined. Variable: dPadSurface / buttonSurface
	Figure B: A cylinder is defined. Variable: dPadCylinder / buttonCylinder
	Figure C: The intersection of Figures A and B is obtained. Variable: dPad[Up/Down/Left/Right] / unlockButton

2E Miscellaneous Buttons

Figure 11 – Miscellaneous buttons circled in red

	The bottom button is defined using a cube. Variable: circleButton
	The top button is defined using a surface. Variable: minusButton

2F Back Button

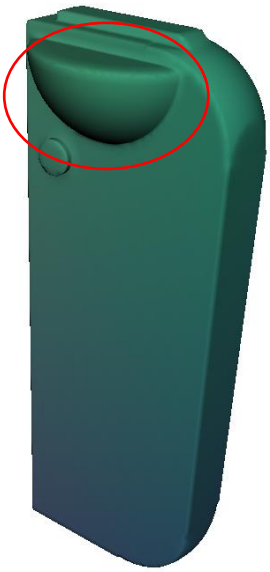
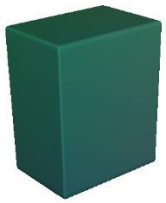
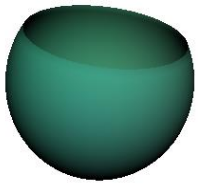
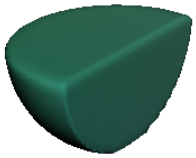


Figure 12 – Back button circled in red

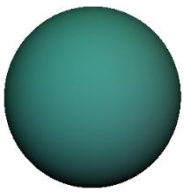
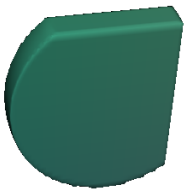
The back button is obtained similarly to how the rounded edges are obtained in section 2A, through the intersection of a surface and an ellipsoid.

	Figure A: A surface is defined. Variable: backSurface
	Figure B: An ellipsoid is defined, bounded by the bounding box (big Y position). Variable: backEllipsoid
	Figure C: An intersection of Figures A and B is obtained, with Figure B defined with a different Z axis value. Variable: backButton

2G Top Button

Figure 13 – Top button circled in red

The top button is obtained using the same method as the Back Button (section 2F).

	Figure A: A surface is defined (smaller Z axis values compared to the Back Button). Variable: topSurface
	Figure B: An ellipsoid is defined. Variable: topEllipsoid
	Figure C: An intersection of Figures A and B is obtained. Variable: topButton

2H Unionising Individual Shapes

The individual shapes defined from section 2B to 2G are unionised to form the joy-con. The corresponding variable in the VRML file is “controller”, which is a series of nested max functions.

3 Right Joy-Con

The right joy-con is defined by mirroring the X axis values of the left joy-con. The material of the joy-con is defined using a FMaterial with the following formula:

- r = (u+4)/5
- g = (v+2)/5
- b = (w+2)/5

This gives the joy-con a colour gradient of orange (top) to red (bottom).

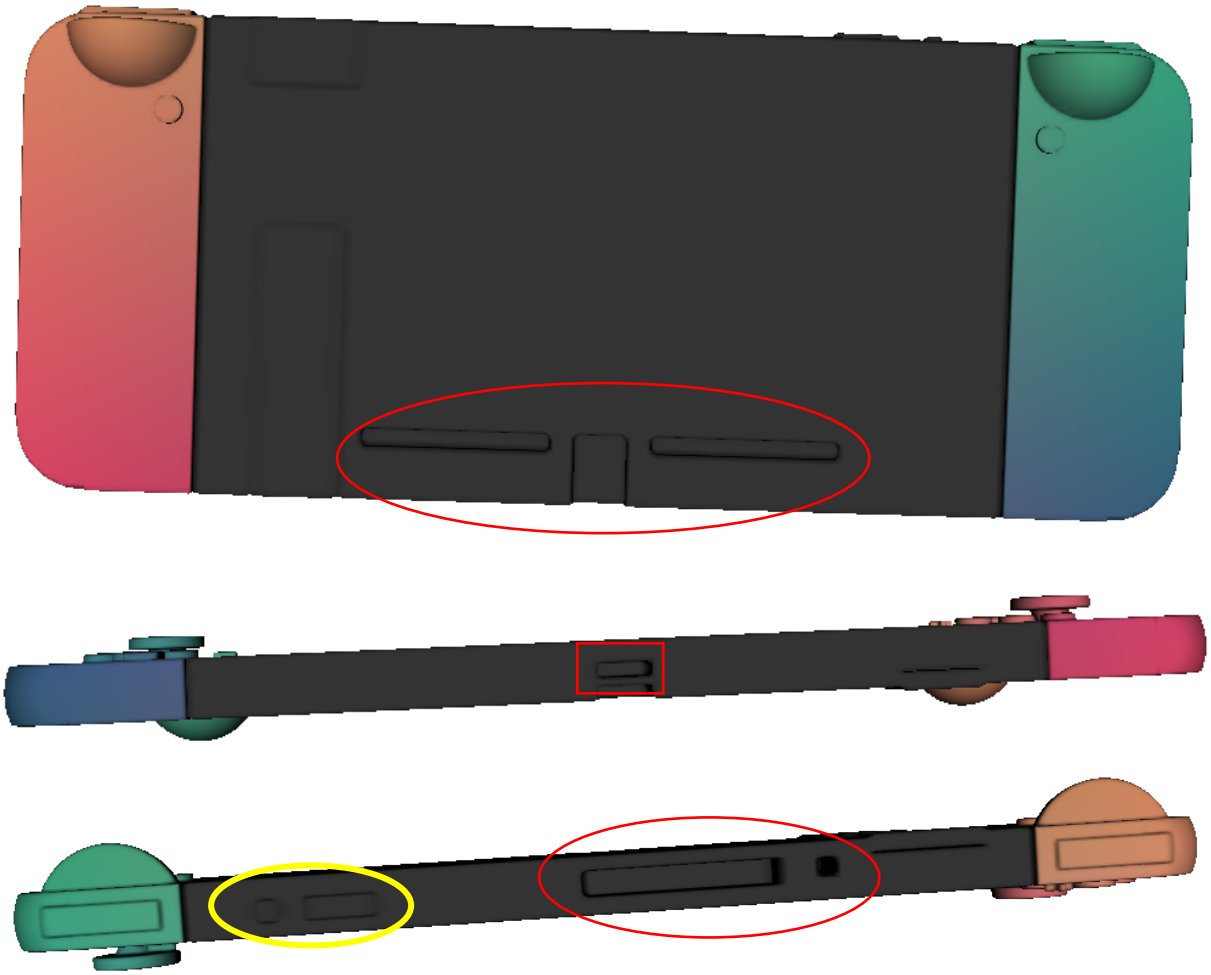
The right joy-con is defined with a resolution of 100 each and with a bounding box size of 0.6, 1.45, 0.6.

4 Screen

The screen is defined using a large surface with numerous indents and buttons using additional surfaces.

The colour of the screen is defined using an if-else clause in the FMaterial declaration of the shape as it is not bounded by the lab requirements:

```
if (z < 0.07) {
      r = 0.2;
      g = 0.2;
      b = 0.2;
} else {
      if ((abs(x) >= 1.07 || y >= 0.61 || y <= -0.66)) {
            r = 0.2;
            g = 0.2;
            b = 0.2;
      } else if ((abs(x) >= 0.92 || (y >= 0.53 || y <= -0.58))) {
            r = 0.1;
            g = 0.1;
            b = 0.1;
      } else {
            r = 0.5;
            g = 0.5;
            b = 0.5;
      }
}
```



Figures 14, 15 and 16 – Indents circled in red and buttons circled in yellow

The screen comprises several indents to represent the charging port, air-vents, speakers, and ear-jack port, and several buttons representing the power button and volume buttons.

These indents and buttons are created using additional simple surfaces and performing subtraction and union respectively on the screen shape.

5 Conclusion

A Nintendo Switch has been created in VRML using three different shapes for this lab. The left joy-con of the switch is made in accordance with the lab requirements as the compulsory part of the lab. The screen and right joy-con is defined separately as optional parts without conforming to the lab requirements. The three shapes are created using intersection and union functions on various geometries defined implicitly, with each shape wrapped in a Transform object to define translations along the X axis to form the Switch object as a whole.