COSC363 Assignment 1

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1 Scene Description

This scene depicts a small set of aliens in the desert, gathering materials from a factory and moving them to a UFO prepping for takeoff. When the spacebar is pressed the aliens will stop in their path and the UFO will begin floating into the air with its engine exhaust blowing downwards onto the aliens below.
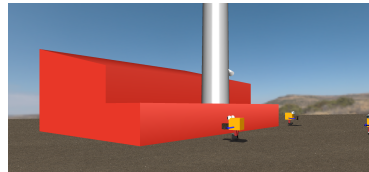

Figure 1: Aliens working hard

2 Extra Features

- Planar shadows: these are cast by both the UFO object as well as the aliens in the scene. There is some z-fighting on these shadows due to the fact that the models are not entirely convex and thus some parts of the models are casting shadows twice.

- A Sky dome using a glut quadric surface.

- Custom sweep surface: the main body of the ufo is being drawn using a sweep surface with its points defined in the UFO class.

- Surface shape defined by mathematical formula: Both the dome of the UFO and it's antenna dish are defined by mathematical formulae see 3 for more details on this process

- Spaceship liftoff

(a) The canopy with an alien inside

(b) The antenna for phoning home

(c) A happy little alien

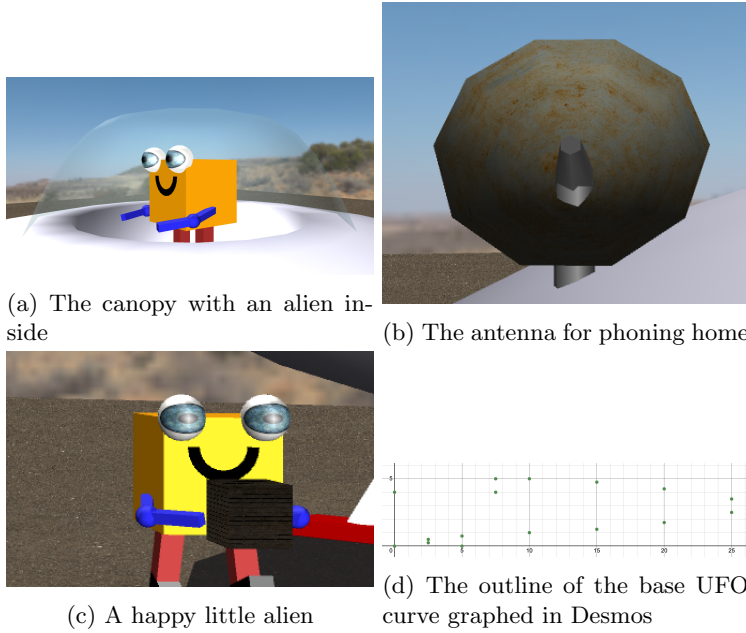(d) The outline of the base UFO curve graphed in Desmos

Figure 2: All of the equation defined and revolved surfaces in the scene

- Particle systems: When the spaceship takes off it's engine leave behind an exhaust plume constructed using a particle system.

- I have theoretically added a spotlight moving with a cone on the side of the factory's smoke stack however due to a bug in the MacOS implementation of OpenGL, I cannot test this without major graphical issues occurring. Un-commenting lines 119 and 120 in `factory.cpp` should re-enable this feature however again it is relatively untested so may not work.

3 Designs

There are three shapes in this scene which are defined by mathematical equations, they are:

- The canopy of the UFO which is defined by:

$$f(x) = -x^4 + 1$$

and then scaled by factors of $(3, 2, 3)$ along the X, Y, and Z axis. The results can be seen in 2a

- The antenna dish on the UFO which is defined by:

$$f(x) = 0.5x^2$$

Which is then scaled down by a factor of 0.6 on all axis. The results can be seen in 2b

- The smile on the alien models which uses the equation

$$x(a) = \cos(a) y(a) = \sin(a)$$

Where a is an angle in the range $[0, 180]$ and $x(a), y(a)$ determines the x and y coordinates of each vertex. The results can be seen in 2c

The UFO is a revolved custom line with some scaling applied which can be seen above in 2d.

Every other object in the scene is defined with either a combination of GLUT objects, and quads.

4   Equations

Some of the equations used in this scene are:

1. The takeoff position of the UFO is defined by:

$$f(\text{keyframe}, \text{scale}) = \frac{(\frac{\text{keyframe}}{\text{scale}})^2}{6.433}$$

Where the scale is just a separate variable to scale the function across the X-axis

2. The alien idle animation and walk cycle are defined by the equation:

$$g(\text{keyframe}, \text{animPhase}) = 20 * \sin(\frac{0.2 * keyframe}{\pi} + animPhase)$$

the animPhase material is an additional parameter which offsets the phase of the sin wave and allows the aliens' animations to display out of sync and appear more natural.

5   Controls

- Up/Down Arrow Keys: Move camera forwards/backwards through scene
- Left/Right Arrow Keys: Turn camera left/right in scene
- A/Z: Adjust camera up/down
- Spacebar: Begin takeoff sequence
- Escape: exit program

6 Build Commands

to build this project run the make.sh script with the clean argument like so from the base directory:

```
./make.sh --clean
```

Which will clean any previous CMake caches and build from a clean directory. After this has finished, the executable can be found in:

```
./bin/Assignment1
```

7 Student Declaration

I declare that this assignment submission represents my own work (except for allowed material provided in the course), and that ideas or extracts from other sources are properly acknowledged in the report. I have not allowed anyone to copy my work with the intention of passing it off as their own work.
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Date: 26/3/24

8 External Resources

All textures were taken from polyhaven, and the class labs.
All models were made by me or taken from in class labs (factory model).