Andrew Holden
Student Number: 97242455

Assignment 1
Alien Invasion

1.0 – Description

1.1 – Setting the scene

Aliens have invaded Earth! They have taken over an old fortress in the middle of nowhere. The aliens have landed in their space ship in the centre of the fortress and built a small wooden hangar around it. The hangar opens from the top, so they can leave at short notice whenever they feel it necessary. The fortress is still in pretty good shape, with a working cannon outside a fully functional draw bridge and no visible damage. It also has a marble tile floor which the aliens have polished so that it reflects everything above it. The aliens have deployed an invisible light source that constantly revolves around the sky casting shadows in different directions. The aliens have set up 8 robots to patrol the area, so they can leave in a hurry when a threat has been spotted. 2 robots are circling the fortress clockwise and another 2 are circling anti-clockwise. The other 4 robots have been placed one on top of each wall with a spotlight attached to their head, so they can better see the approach of any threats, they patrol along the wall at regular intervals. The aliens can at any time take off in their ship to get a better view of the fortress from above.

1.2 – Technical Description

This Scene was built inside of a skybox, however because the floor is quite large it slowed the scene down too much, so I had to make much larger quads for the outlying area that was not used. I then built a fortress with towers, each made from 2 custom made triangle strip extrusions, one for the roof and one for the body of the tower. The walls were made using quads, both for the wall itself, the battlements and the gate each with a texture applied. The gate can be raised and lowered using the 'l' and 'o' keys. Inside the fortress the floor is slightly transparent and has a marble tile texture to reflect the objects above it. The hangar in the middle of the fortress is made from gates which were transformed to be big enough to encompass the space ship and its orbiting orbs, it opens from the top when the space ship is launched using the 's' key and closes automatically when the space ship lands again. The space ship is made from a rotating triangle strip with a parabolic hull, triangles make up the fins and cylinders represent the engines. It changes colours constantly and has several orbiting orbs, which are always the opposite colour to the ship. The robots are made of glut solid objects, including cylinders, a sphere, cubes, and torus. The cannon is the same as the one from the labs, it fires a cannon ball with the 'c' key which bounces a few times getting less altitude with each bounce. The main light source rotates around the scene constantly to show off the fact that literally everything has a shadow. The robots on the walls even have 2 shadows, one on the wall and one on the ground as with their reflections. The camera can be moved left and right with the left and right keys, it can also be moved up and down with the page up and page down keys, so the camera can move in any direction. It cannot go through the fortress or the hangar in the middle, however if the gate is completely lowered it can go through the front gate. The camera is also limited to a certain area so it cannot get too close to the skybox.

2.0 – Extra Features
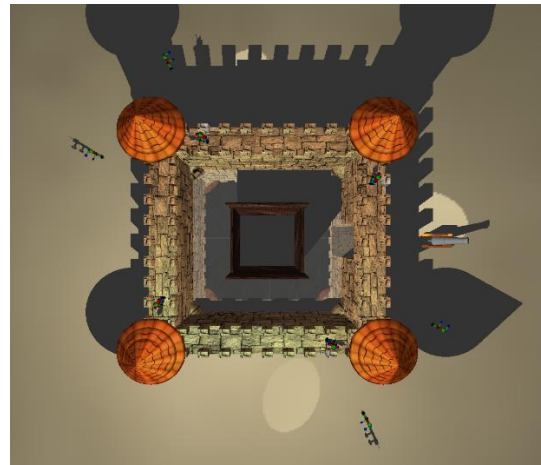

FIG 2.1 – REFLECTION IN THE FORTRESS FLOOR

FIG 2.2 – VIEW FROM THE SPACESHIP CAMERA

FIG 2.3 – SHADOWS INCLUDING THE SPACECRAFT

2.1 – Planar Shadows

Seen in Fig 2.3 above, I have cast planar shadows from every object in the scene. The fortress, robots (both on the walls and ground), space ship, cannon and hangar all have shadows on the ground surface with the robots on the walls also casting a shadow on top of the wall as well, I have also made the light source revolve around the scene to show this feature off better.

One difficulty I had with this was that I had nested a few functions to make the code more readable as it was growing at an exponential rate. In the end I decided to pass in a Boolean to each function in which colours and or textures were used so that the appropriate changes could be made if the object was intended to be a shadow.

2.2 – Spot Lights

I have placed 4 spotlights in the scene, one on the head of each of the robots manning the walls. They move and rotate at regular intervals along with the robots which can be clearly seen on both the ground and the fortress walls/towers.

This I found very difficult to implement at first as when I added a second light source it played havoc with my first light source. At first, I managed to fix this by placing the light source at the origin first and then moving it to the required location. I have no idea why this fixed it and stumbled on the solution by accident. I found a more permanent solution however when I started adding animations. It seems that the light is only different in the initial render of the scene and after the first glutPostRedisplay it fixes itself. So as soon as I added animations that were present from the start the error went away.

2.3 – Additional Animated System Inside the Fortress

I added a draw bridge to the front of the fortress that can be controlled using the 'l' and 'o' keys complete with shadows etc. It sits above the ground when down so as to be realistic.

I also added a hangar as an additional animated system, with doors that open before the spaceship takes off and close when it lands.

Seen in Fig 2.1 above, I also added Reflections to the floor inside the fortress, these include the hangar, fortress, robots, spaceship and the top of the skybox.

2.4 – Two camera modes

Seen in Fig 2.2 above, I reasonably easily implemented an extra camera mode, which just swaps over using a Boolean trigger when rendering the scene, that way the position of the original camera is not affected and can be returned to. The altitude of the space ship is used as the altitude of the camera too which means it goes up and down as the ship does.

2.5 – Physics Models

The physics model I have used was for the trajectory of the cannonball which bounces with a dampener so that it behaves similar to in real life.
The formula I used to calculate this was the following:

$$height = 30 \left| \sin\left(\frac{distance}{20} + 6.5\right) \right| e^{-\frac{0.19 distance}{20}}$$

This I found extremely difficult to figure out, as I input the dampening constant by guessing as I went and seeing what looked good in my model.

2.6 – Custom Built Sweep Surfaces

I have 3 of these in my scene, the tower has 2 of these in the body and the roof of the tower, and the space ship's body is also a custom-built sweep surface. All of these were extrusions made with triangle strips which I found to look the best for the objects I was making.

The only problem I had with these was that they would grow over time because they were not reset after each time they were rendered. This was easily fixed.

2.7 – A Surface Shape Generated Using a Mathematical Formula

The Space ship's body is the surface I chose for this feature, using the equation:

$$x - coord = -\left(\frac{(y - 10)\sqrt{5}}{10}\right)^2 + 5$$

Which I used in the range $0 \leq x \leq 20$ which made a nice football like object.

2.8 – Collision Detection

I used collision detection quite heavily with my camera movement. I made it so the camera cannot move too far away from the centre of the scene and it also cannot go through the fortress walls, towers, or the hanger. I made it possible however to move through the gate portal only if the gate was fully lowered.

2.9 – Sky Box

The skybox I used took its texture from one of the textures provided in the labs. The walls and the ceiling all use GL_REPLACE whilst the floor uses GL_MODULATE so the spotlights etc work properly. I shrank the height of the skybox to make it look better, however it's still pretty obvious where the sides meet the floor.

This I found incredibly easy to implement at first however incredibly difficult to make it look good. I had to play with it a lot in order to get it to the standard I have at the moment.

3.0 – Controls

Key	Function
Up	Move the camera forwards
Down	Move the camera backwards
Left	Turn the camera left
Right	Turn the camera right
Page Up	Turn the camera upward
Page Down	Turn the camera downward
C	Fire the cannon
S	Launch the space ship
O	Raise the drawbridge 1 degree
L	Lower the drawbridge 1 degree

Appendix – References

Textures:

http://seamless-pixels.blogspot.com/2015/04/stoney-dirt-ground-texture.html

https://www.123rf.com/photo_46098525_old-gray-stone-wall-seamless-background-photo-texture.html

https://www.sketchuptextureclub.com/textures/architecture/roofings/clay-roofs

https://www.tryfoto.com/photo/3673/wooden-texture

https://www.sketchuptextureclub.com/textures/architecture/tiles-interior/marble-tiles/white/rhino-marble-floor-tile-texture-seamless-14849

Image conversion to TGA:

https://image.online-convert.com/convert-to-tga