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# Coursework Report

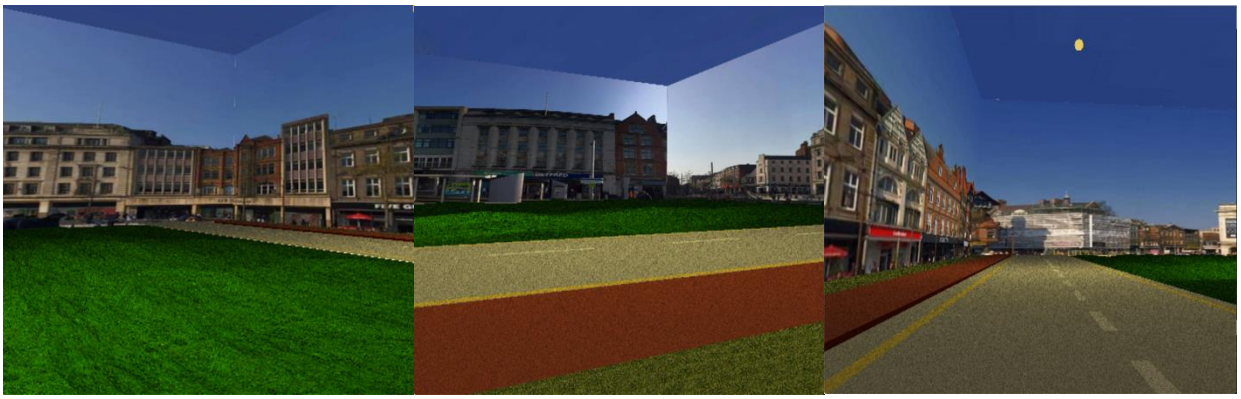
In this project, I model a scene of a robot walking to a bus stop. The 3D objects in my scene include robot, bus stand, pole displaying information about the bus stop, street lamp, wooden chair, tree, flower, sun, and the environment which includes grass, road, and sidewalk. There are three animated things in my project: a robot walking, advertisements sliding up on the display of the bus shelter, and a display of bus schedules running horizontally.

*screenshots showing an overview of the scene from different angles*

## The Environment

The environment is set in a city. One of the things that I found the most challenging is making the skybox look realistic. I took a panorama of the Nottingham town hall and took crops of the panorama as my images for the skybox. I resize the images into the same dimension and tried to make the images of each side connect as smoothly as I can. I have the most trouble with the connection between the top and the other side as shown by the second image below.

*screenshots showing the environment from different angles*



Apart from the skybox, I also draw a terrain of grass as shown most clearly in the first image above. The terrain has ups and downs, which resemble real life grass terrain more than just a flat surface. I draw it using subdivision and textured the smallest square with an image of a grass. I start with a square and continuously subdivide it into smaller squares defined by the midpoint of each side and the midpoint of the square. However, the y-coordinate of the midpoint of the square is changed by plus or minus a small constant. In addition to the grass terrain, the environment also includes the sidewalk, the road, the yellow strips and the white road divide which I draw using the floor class with a slight modification and the texture of an image called “road.bmp”. The floor class takes an index and a range parameter. The range parameter control the length of the floor, which is helpful in drawing the white road divide. The index indicates which color to use. Sidewalk is red, road is grey, and road divide is white.

**Tree**

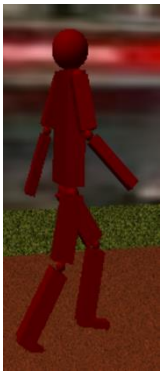
I build on the tree class from the lab. I use a different image for texture and different color. The main thing I changed about the tree is the initial string sequence and the string sequence to make the branch shape look more realistic in my opinion. I create three trees on each side of the road and use two string sequences to add more variety to my scene.

**Wooden Chair**


The chair consists of four legs, a leaning back, a horizontal seat, and a support frame around the legs. The seat and the leaning back is drawn using multiple long pieces of rectangular cube. Figuring out how much to translate to draw each part of the chair was a challenge as there a lot of polygonal component to model. Each cuboid is textured with an image called “wood.bmp”.

**Robot Walking**

The robot in my project is a just slight modification from the one I modelled for the second assignment. I changed the proportion of the length, the width, and the thickness of the polygonal component to make the robot look more realistic. The animation of the robot walking is based on the same concept as the animation of the horse in the lab. The animation is divided into 8 stages.



In each one, the angle of rotation for each part of the legs and the arms are well calculated to get coordination right. It was challenging, but I think the movement turns out quite well. I also allow for changes in the direction of the translation and orientation of the robot based on the user's input. Here are the list of keyboard inputs and what they do to the robot.

- "i", "j", "k", and "l" for going forward, left, back, right
- "+" and "-" for increasing the speed and decreasing the speed of the walk respectively
- "p" and spacebar for sitting down and standing still respectively.

**Bus Stand Pole**

The bus stand pole consists of two cylindrical poles of different radius, a flag banner, a rectangular cuboid that displays information about the next buses, and a "house" displaying bus schedule on each of the four sides. I use the cylinder from the lab and specify the material properties as specular and shininess add more sense of realism to the pole. Between the two cylinders, I draw a connecting "cone" using the vertices on the two circles alternatively and GL_TRIANGLE_STRIP. The flag banner is drawn within a rectangular frame and textured. I also draw two short cylinders around the long cylinders at the height of the top and at the bottom of the frame to give an impression that the banner is attached to the pole. The "house" consists of a half octahedron and four rectangular frames. I textured each side using images I took personally from a bus stand. For the information display, I use two static textured rectangle and one animated sprite sheet at the bottom, which I will elaborate below.

**Bus Shelter**


The bus shelter consists of the left door, the roof, the back part, a red seat, and the right door. The roof is a rectangular cuboid with each side except the top and the bottom textured with an image that says "University Park Hill". The left, the right, and the back frame are drawn using long rectangular cube. As I was short on time, I did not draw mirrors within each frame. The middle part is drawn by a scaled solid cube with a textured rectangle displaying bus map/schedule. The right door is a display of two advertisements alternatively using sprite sheet animation. The seat is drawn using three rectangular solid cubes.

**Sprite Sheet Animation**

The main highlight of my scene is the animation of an advertisement sliding up to change into another display of another advertisement, and the bus schedule display on the pole changing. It

was challenging to think of the a way for a smooth transition between the two parts of the image. I increase the number of spriteWidth and update the coordinate of the texel by spriteWidth/2, so that as the animation time increases, it would seem as if the advertisement is sliding up into another display of advertisement. I also subtract a certain amount from the animation time when the sprite frame equals spriteWidth/2 or spriteWidth, so that the display shows the advertisement much longer than the changing time.

**Lamp Post**

The lamp post consists of the cylindrical parts, the head of the lamp, a textured rectangle of a traffic sign, a textured half cylinder displaying the number of the lamp. The cylinders and the connecting cone is the same as the ones used in the bus stand pole except that it is textured instead of colored. The head of the lamp is drawn using two cuboid, one green and one white. The textured half cylinder was the most challenging part as unlike the case of the tree where each small rectangular part of the cylinder was textured with the whole image, I have to the textured half of the cylinder with an image. I drew inspiration from the sprite sheet animation and move the texels coordinates along with the circle of the cylinder. I create three lamp post and place them along the sidewalk.

**Lighting**

For lighting, I use the sun class from the lecture demo and I also use spot lights for the lighting of each lamp. My program allows the user to turn off the sun light and enable the street light, and to turn on the sun light and disable the street light by pressing ‘n’. For each lamp post, I place one spot light below the head lamp facing down and another facing up so that the head lamp will also have a shiny yellow color. The skybox would also become darker to make the scene more realistic. I also specify the specular and the shininess properties of the lamp post and the bus stand pole to add more sense of realism. I also specify the emissive property of the bus schedule display on the pole so that it will shine even without light hitting it.

**Viewing**

I utilize the framework and so my program inherit a lot of properties of viewing. I use perspective viewing with a view angle of 60° and far clipping plane of 35000. I increase the speed of the camera movement to 100, and set the eye coordinate behind the robot looking in the same direction as the robot. I also add several more keyboard inputs that change the eye position: ‘1’ and ‘2’move the eye position up and down by 50 respectively; ‘3’, ‘4’ move the eye position in a circle that let the user see the whole scene from a bird eye’s point of view (inspired by the lab).