XI'AN JIAOTONG-LIVERPOOL UNIVERSITY

COURSEWORK SUBMISSION

Name (ID Number)	Jeongyeong Park (2032801)
Programme	BSc Information and Computing Science
Module Title	Computer Graphics
Module Code	CPT205
Assignment Title	CPT205 Assessment 1-2D Modelling Project
Submission Deadline	7 November 2021
Lecturer Responsible	Yong Yue

1. Design Overview

The greeting card was created to celebrate the 15th anniversary of XJTLU. It contains the central building of XJTLU, trees, clouds, balloons, texts, moon, stars, and a celebration message. The card contains three views which are day scene, night scene, and celebration message display. They will be mentioned in more detail later. Since it is the greeting card that people will see on the screen, there are several moving objects which are balloons, clouds, and stars. Window size is set as width = 1000 and height = 600 and since it is a 2-dimensional greeting card, gluOrtho2D function is used to set up a two-dimensional orthographic viewing region. In this greeting card, there are two viewing regions. One is for the part where the central building is displayed and the other is for the celebration message. For the central building display which is the main part of this greeting card, the value 'right' of gluOrtho2D function is set as 1000 and value 'top' of it is set as 600 in order to create the objects easily later. Since only the first quadrant(x:0 to 1000, y:0 to 600) will be displayed, there is no need to consider negative values when the objects are created. For celebration message display, the value 'left' is set as -1000 and value 'bottom' of it is set as -600. Therefore, it will show the third quadrant(x:0 to -1000, y:0 to -600) on the window. Colour values used in this program are obtained from the picture on (*Colour Theory*, n.d.).

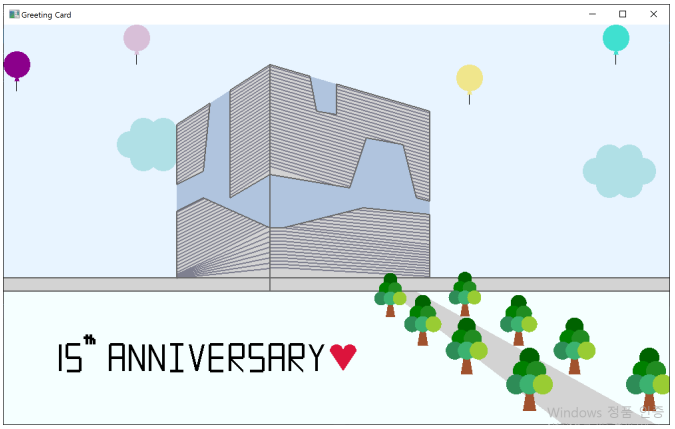

Figure 1. The Greeting Card - Day View Version

2. Features

2-1. Simplified Central Building

The Central Building of XJTLU was selected as a key feature since it is the building that represents XJTLU very well. In order to simplify the central building, the picture from the official school website was used. In order to draw a line on the photo of the building, PhotoShop was used. After obtaining a simplified building drawn with multiple lines, the building was moved on the coordinate plane which is the same as the window size as can be seen on the figure 3.

Figure 2. Central Building with Lines

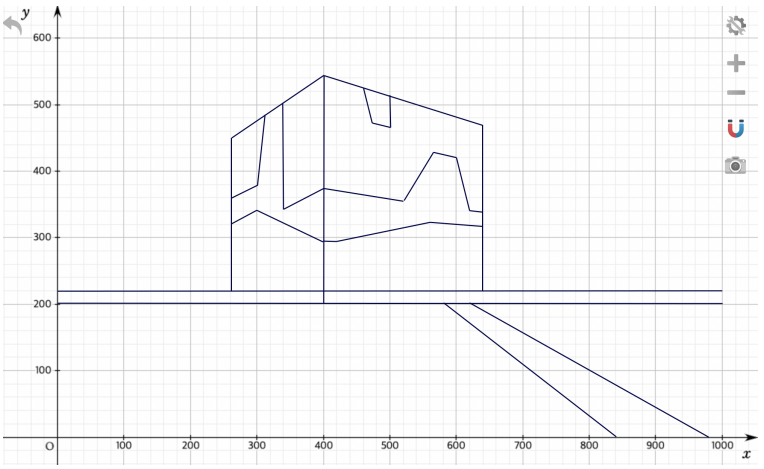

Figure 3. Simplified Central Building on the Coordinate Plane

The central building is created with GL_POLYGON, GL_LINES, and GL_TRIANGLES. For the specific values of vertices, figure 4 was used. A vertex whose coordinates are not known exactly was obtained by finding a linear equation. The stripes of the building were also generated by calculating the slope of each linear equation and doing the vertical transition for every line.

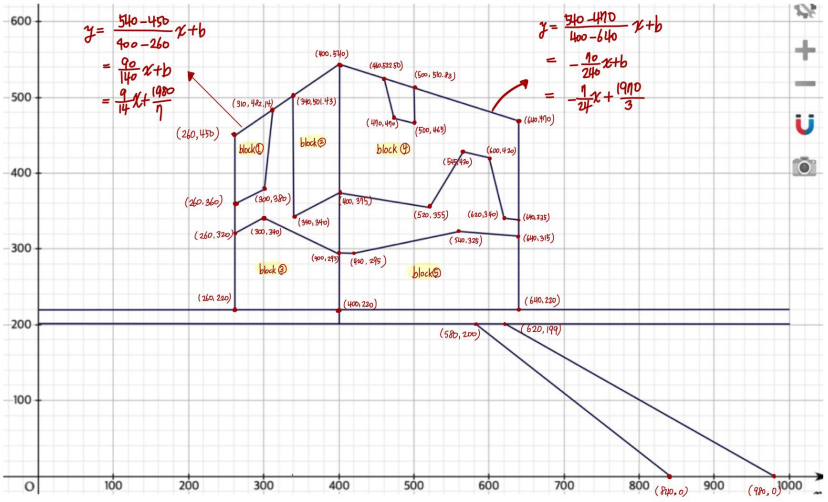

Figure 4. Coordinates of the Central Building

2-2 Trees

Trees are generated with the Tree() function for the trunk of a tree and circle_Tree() function for its leaves. In order to create different sizes of the trees, geometric transformations are used. The size of the tree is adjusted with glScalef() and the location of the tree is adjusted with glTranslatef(). As the size is changed, the location is also changed, so glTranslatef() is done after glScalef() in order to obtain objects in the exact position.

2-3 Clouds

Clouds are generated by a function called circle_Cloud which is drawing one circle. Since OpenGL does not have a function of drawing a circle, it makes it look like a circle by drawing a polygon with very many sides. A point on a circle with radius 'r' can be expressed in (r $sin\theta$, r $cin\theta$), therefore trigonometric functions are used to find the vertex of this polygon with many sides. Since trigonometric functions only take radian not degree, degree is converted into radian. Two clouds are geometrically transformed(translation) by time since they are moving along the x-axis. For the geometric transformation, point p0 is set as {0,0}, and in this case, only the value of p0.x is changing by a certain value and time(The incremental step is 10 and the time interval is 800ms) in the OnTimer() function.

2-4 Balloons

A balloon consists of 3 parts and they are generated by a function called circl_Ballon, GL_TRIANGLES, and GL_LINES. The circl_Ballon function draws one circle exactly like circle_Cloud. Since balloons are moving up along the y-axis, they are geometrically transformed(translation) and the value of p0.y is changing by time in the OnTimer() function.

2-5 Texts(15th ANNIVERSARY) and Heart

Texts are created with multiple lines generated by GL_LINES and GL_LINE_STRIP. Heart is generated with the circle_Heart() function for two upper half circles and GL_TRIANGLES for the bottom part of the heart. Since the half part of the circle is needed, the angle reaches 180° instead of 360°.

2-6 Moon

Moon is drawn by the moon() function. In this function, two circles are generated overlapping in order to create a crescent moon. Moon appears in the night version of the card.

2-7 Stars

Star is generated with star() function. First, a star that has vertices that can be found easily on the coordinate plane is generated within the star() function. Then that star is geometrically transformed when actual stars on the card are generated. Geometric transformations are done with glScalef() and glTranslatef() just like when trees are generated. In the star() function, the size of stars is reduced and uniformly set by glScalef(). And for the position of each star, it is set with glTranslatef() when each star is drawn within the display() function. In addition, there are other geometric transformations for stars, which is rotation. In order to show stars moving round in the sky, their positions change at a constant angle over time. The angle for the rotation is set as 0 first(In this program, spin = 0) and it is changing by the time(Share the same value with other moving objects, incremental step is 10 and time interval is 800ms). Stars appear in the night version of the card.

2-8 Celebration Message, Smiley Face, and Sine Waves

A Celebration message, smiley face, and sine waves are shown in the celebration message display part of the card. A celebration message is generated with the celebrate() function. In the celebrate() function, texts are generated by GL_POLYGON,text() function which is drawing a line, and GL_LINE_STRIP(). Smiley Face is drawn with GL_POLYGON, and a half circle. Since a lower half circle is needed, the angle reaches 180° instead of 360° and angle is divided by -180 instead of 180 when the degree is converted to radian. For the points following the sine waves, the wave is vertically transformed -200 and -350. Also, geometry transformation is done by a certain value and time. Since each point is on the sine wave, applying a horizontal transformation to the sine wave by a certain value by a certain time shows that points are waving. Incremental step is 10 and time interval is 800ms such as other moving objectives. These features will be shown in the celebration message display.

3. A Brief Instruction to Run this Program Effectively

3-1 Interaction with Mouse

In this program, the viewer can interact with the card with both the left button and the right button. When the left button is clicked, the night view version of the card will be shown as Figure4. If the left button is clicked(GLUT_UP), the boolean flag1 is set to true, the night view will be drawn.
For the right button, if it is clicked(GLUT_UP), the boolean flag2 is set to true, the celebration message will be displayed. In this case, as mentioned earlier, the viewing region will be changed to gluOrtho2D(-1000, 0, -600, 0) from gluOrtho2D(0, 1000, 0, 600) so the celebration message drawn on the third quadrant can be shown.

Figure 5 The Night View Version of the Greeting Card

Figure 6 The Celebration Message Display

3-2 Interaction with Keyboard

In this program, the viewer can interact with the card with keyboard key ‘q’&’Q’ from quit, ‘c’&’C’ from change, ‘s’&’S’ from stop, and ‘r’&’R’ from resume. The keyboard keys and their corresponding functions are set to make people intuitively guess their usages. If a user presses ‘q’ or ‘Q’, the user will exit the program. ‘c’ or ‘C’ are pressed, the direction of moving objects will be changed. In order to stop the movement of all objects, ‘s’ or ‘S’ should be pressed. If the user wants to restart the movement then one can press ‘r’ or ‘R’. This interaction can be done in the situation for example the viewer wants to screenshot for the specific moment of the greeting card. One can pause all the movements by pressing ‘s’ or ‘S’.

4. Reference

1. S. (2010, November 23). *Colour Theory*. Sler - Web Multimedia. https://sler.wordpress.com/2010/11/07/399/amp/
2. *XJTLU Central Building*. (n.d.). [Photograph]. XJTLU Central Building. https://www.xjtlu.edu.cn/en/assets/image-cache/images/campus/campus-globe.3d9462b2.jpg