Project 2

Points: 90 (+5 +15 BONUS)

Purpose

Learn how to use affine transformations to position objects in 3-space and illuminate them

Resources

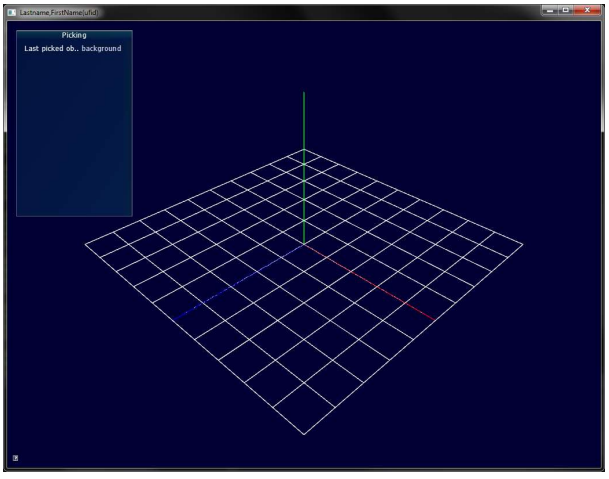
- OpenGL Transformations and Matrices - Moving/scaling/rotating objects
- OpenGL Shading - Lighting up the scene
- GLFW Input Handling - adding keyboard inputs
- GLM - Convenient OpenGL Mathematics library
- GLSL Data Types - Useful to know for shader programming

Set Up

- Use this code base.
  (note: no webGL code base; bonus)
- The object loader (modified source files) placed into TUT/common will help. (always backup original files: rebuild may break other tutorials)

Task 1: Grid

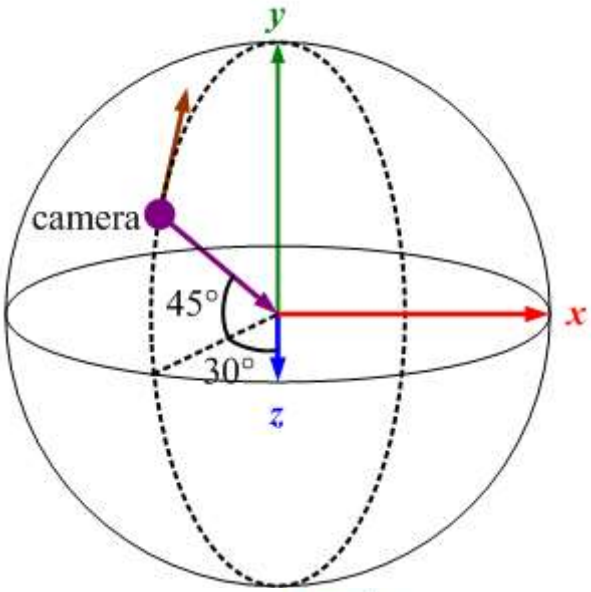
Points: 5

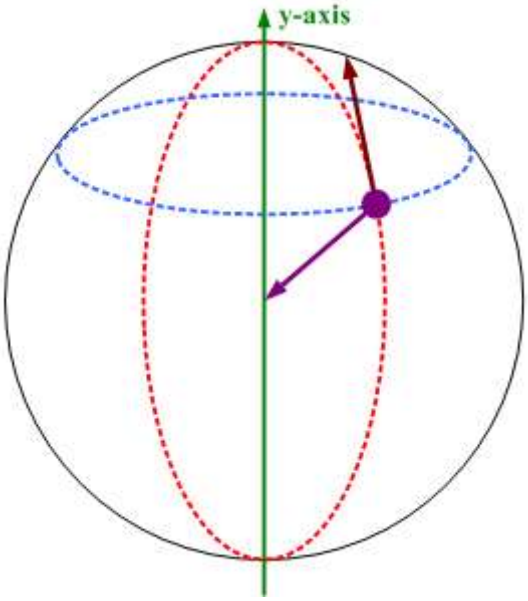


Draw an integer grid on the Y=0-plane for the rectangle (-5,0,-5) to (+5,0,+5). Draw the positive X axis in red, the Y axis in green and the Z axis in blue. Only draw the positive portion of each axis, of length 5.

Task 2: Camera Rotations

Points: 5





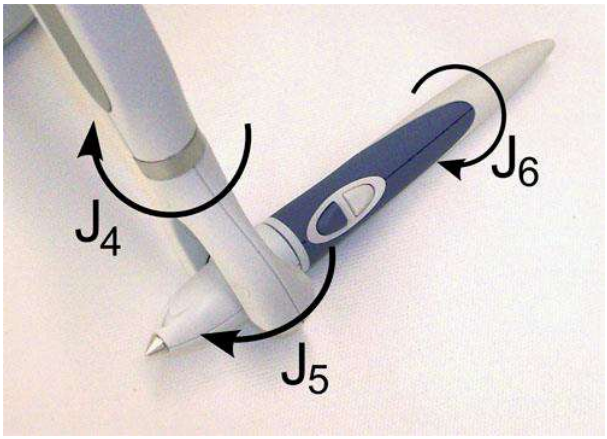
- Use **Perspective** projection
- Place the camera so you can see the whole scene: use glm::LookAt to generate the View matrix.
- Key C selects the camera.
- Keys ← and → move the camera along the blue circle parallel to the equator.
- Keys ↑ and ↓ rotate the camera along the red circle orthogonal to the equator.
- Choose the "up" direction so the camera always points to the origin.

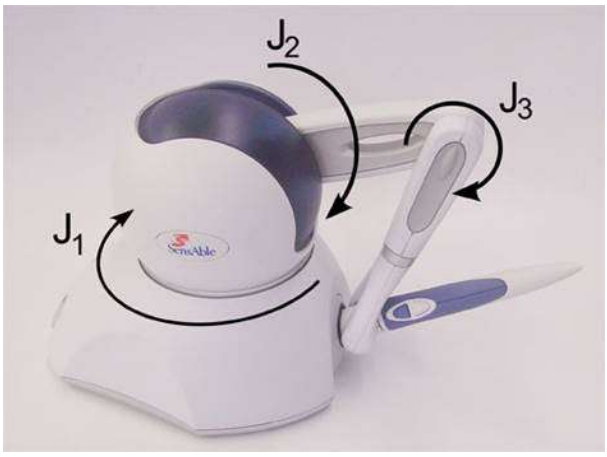
Task 3: Draw the robot arm

Points: 25

The robot arm consists of the following parts:

- **Base**:





  truncated tetrahedron placed on the x-z-plane
  - **Top**: icosahedron placed on top of and slightly penetrating the Base.
  - **Arm1**: rectangular box emmanating from Top and hinged at the center of Top.
  - **Joint**: dodecahedron of appropriate radius at the other end of Arm1.
  - **Arm2**: cylinder connected to the center of Joint.
  - **Pen**: truncated octahedron connected to the other end of Arm2.
  - **Button**: a small box on Pen.
- Create triangulated objects in the .obj format, e.g. by using Blender. Hint: generate correct normals for later use.
- To load .obj files exported with Blender: tinyobjloader (usage best learned by looking at the examples on github) or the supplied `void loadObject(char* file, glm::vec4 color, Vertex * &out_Vertices, GLushort* &out_Indices, int ObjectId)` function to load your objects.
- Call `void createVAOs(Vertex Vertices[], unsigned short Indices[], int ObjectId)` or find alternative online

Task 4: Keyboard interaction

Points: 5+5+5+5+15

Write the code to move the robot arm, rotate the top, rotate the arms and the pen, and twist the pen using the keyboard, as explained below:

- **Pen**: Select the pen using key p. The pen should *rotate* when the arrow keys are pressed. ←, →, ↑ and ↓ are longitude (J4) and latitude (J5) rotations. (Note that one end is always connected to *arm2*). shift+← and shift+→ should twist the pen around its axis (J6) (including buttons).
- **Base**: Select the base using key b. The whole model should *slide* on the XZ plane according to the arrow keys.
- **Top** : Select the top using key t. The top, arms and pen should *rotate* about the Y direction when pressing the left or right arrow keys (J1).
- **Arm1**: Select arm1 using key 1. The arm (and the other connected arm and pen) should *rotate* up and down when using the arrow keys (one end is fixed at the center of the *top* green cylinder) (J2).
- **Arm2**: Select *Arm2* using key 2. The arm (and pen) should *rotate* up and down when using the arrow keys (one end is fixed at the center of the *joint*) (J3).

Indicate the selected part by drawing it in a brighter color.

Task 5: Light up the scene

Points: 10

- Add two lights to the scene.

For each light, supply position, diffuse color, ambient color and specular color.
Position the lights near the camera so that one light comes from the left and another one from the right.
You are free to choose any light colors and positions as long as the scene looks good.

- Set diffuse and ambient material of the objects to the color of the object. Set specular as a multiple (eg one tenth) of the diffuse color.

Task 6: Teleporting

Points: 10

- When s is pressed have a Platonic solid exit the tip of the stylus, with tangent equal to the stylus axis and derivative in length equal to the stylus length
- The solid follows an arc according to Newton's law under gravity until it hits the grid. (Hint: use the BB-form of degree 2)
- Animate the projectile and, on impact, move the robot arm to the impact location.

BONUS Picking

Points: 5

Implement **picking** for selecting the parts of the robot arm. Use your knowledge acquired in Project 1. You might also find the original tutorial on picking helpful.

BONUS webGL

Points: 15

Implement the project in webGL instead of openGL

WHAT TO SUBMIT

- Your **modified source files** (.cpp's, shaders, etc)
- A **link** to a screen capture of your running program showcasing the implementation of all of the tasks using recordit (Mac, Win) or similar software.
- Filepaths to load models must be relative to the source directory (no absolute paths specific to your computer). Use a "models" folder within the top-most level of the source repo ("ogl-master"). If you need to deviate specify the location in the readme file.