

CS 405 Project 3: Scene Graph + Illumination

Implementation Report

Objective

The goal of the project was to implement and enhance a scene graph to simulate a solar system using WebGL. This involved:

1. Establishing hierarchical transformations (Task 1).
2. Implementing realistic illumination with diffuse and specular lighting (Task 2).
3. Adding Mars as a new object to the solar system and ensuring it functions correctly in the scene graph (Task 3).

Task 1: Implement the draw Method for the Scene Graph

Methodology

1. **Understand the Hierarchy:** Each node applies its transformation, which combines with the parent's transformations to form a global transformation.
2. **Combine Transformations:**
 - Used the `trs.getTransformationMatrix()` to fetch the node's local transformation.
 - Multiplied the local transformation with the parent's matrix using `MatrixMult`.
3. **Update Rendering Matrices:**
 - Propagated the updated model matrix to calculate `mvp`, `modelView`, and `normalMatrix` using helper functions.

4. Recursive Drawing:

- First, draw the current node by passing updated matrices to the meshDrawer.draw() method.
- Recursively called draw() for all child nodes

Task 2: Implement Diffuse and Specular Lighting

Methodology

1. Understand Lighting Models:

- **Diffuse Lighting:** Simulated light scattering with the surface by computing $\max(\text{dot}(\text{normal}, \text{lightDir}), 0.0)$
- **Specular Lighting:** Simulated light reflection using $\text{reflectDir} = \text{reflect}(-\text{lightDir}, \text{normal})$ and $\text{spec} = (\text{dot}(\text{viewDir}, \text{reflectDir}))^p$
- Combined with a constant ambient term for base illumination.

2. Update Shader:

- Used the varying variables vNormal, fragPos, and vPosition passed from the vertex shader.
- Calculated the diffuse and specular contributions in the fragment shader, adding them to the ambient term.

Task 3: Add Mars to the Solar System

Methodology

1. Define Mars Properties:

- Parent Node: sunNode.
- Position: Translated by -6 units on the X-axis relative to the Sun.
- Scale: Reduced to 0.35 to simulate Mars' smaller size.
- Rotation: Rotates at $1.5 \times \text{zRotation}$.

2. Texture Setup:

- Applied the texture using the image provided (<https://i.imgur.com/Mwsa16j.jpeg>).

3. Add to Scene Graph:

- Linked Mars as a child of the sunNode using the SceneNode constructor.

4. Update Rotation:

- Dynamically updated Mars' rotation in the renderLoop.