3D Graphics

Lecture 12

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Outline

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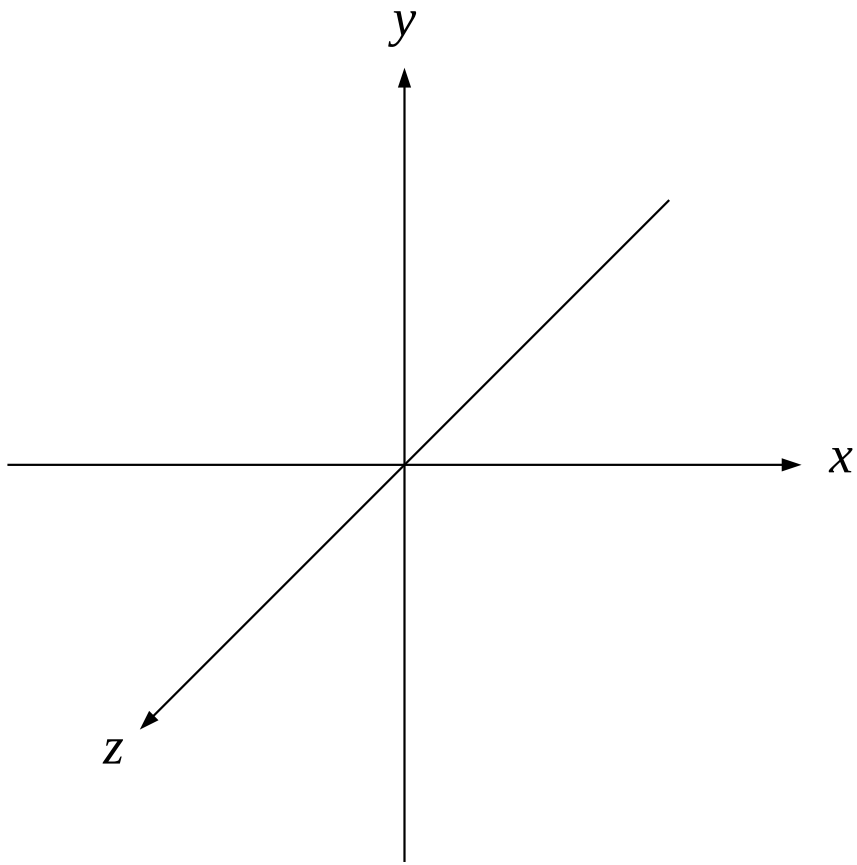
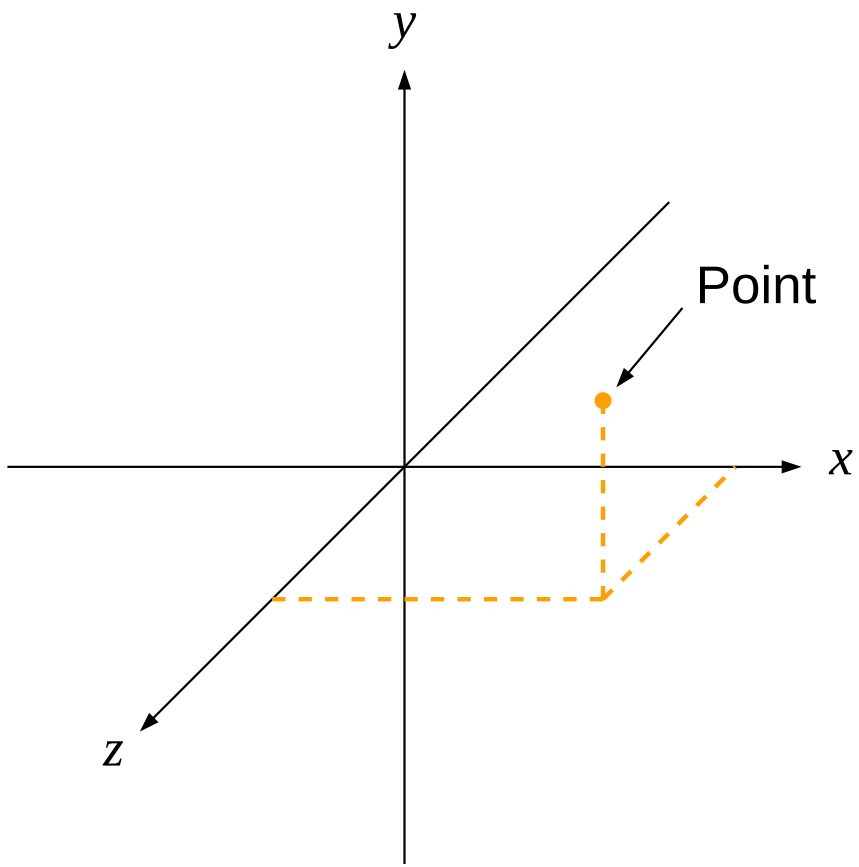
The 3D Coordinate System

- The 3-dimensional coordinate system has 3 axes.
  - The x-axis runs from left to right.
  - The y-axis runs from bottom to top.
  - The z-axis runs from back to front.
- They form a right-hand coordinate system.
- Vertices will consist of three **`floats`**, for x, y, and z.
- The fourth coordinate, w, should be set to `1.0`.

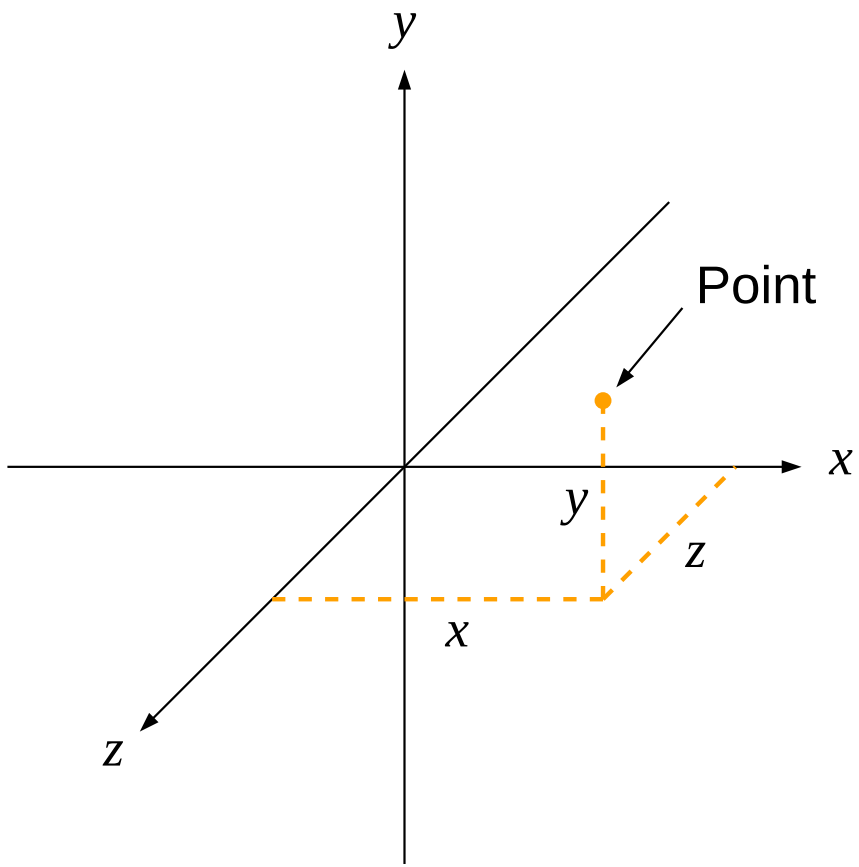
The Coordinate Axes



The Coordinate Axes



The Coordinate Axes



Outline

The Viewpoint

- In three dimensional graphics, we must establish a viewpoint, usually referred to as the eye or the camera position.
- We must also specify the look point, i.e., the point at which we are looking, usually the center of our scene.
- And we must specify the camera's orientation, usually straight up.
- The default values are
  - eye = (0, 0, 0), the origin.
  - look = (0, 0, -1), down the negative z-axis.
  - up = (0, 1, 0), up in the positive y-axis.

The `lookAt()` Function

The `lookAt()` Function

```
mat4 lookAt(vec3 eye, vec3 look, vec3 up);
```

- `eye` is the location of the eye point.
- `look` is the location of the look point.
- `up` is the up vector. It points in the "upward" direction with respect to the camera.
- The `lookAt()` function returns a 4×4 view matrix that represents the transformation of moving and reorienting the scene from the origin to the eye point.

The `lookAt()` Function

The `lookAt()` Function

```
GLuint view_loc = glGetUniformLocation(program, "view");

vec3 eye(5.0f, 4.0f, 3.0f);
vec3 look(0.0f, 0.0f, 0.0f);
vec3 up(0.0f, 1.0f, 0.0f);
mat4 view = lookAt(eye, look, up);
glUniformMatrix4fv(view_loc, 1, GL_FALSE, view);
```

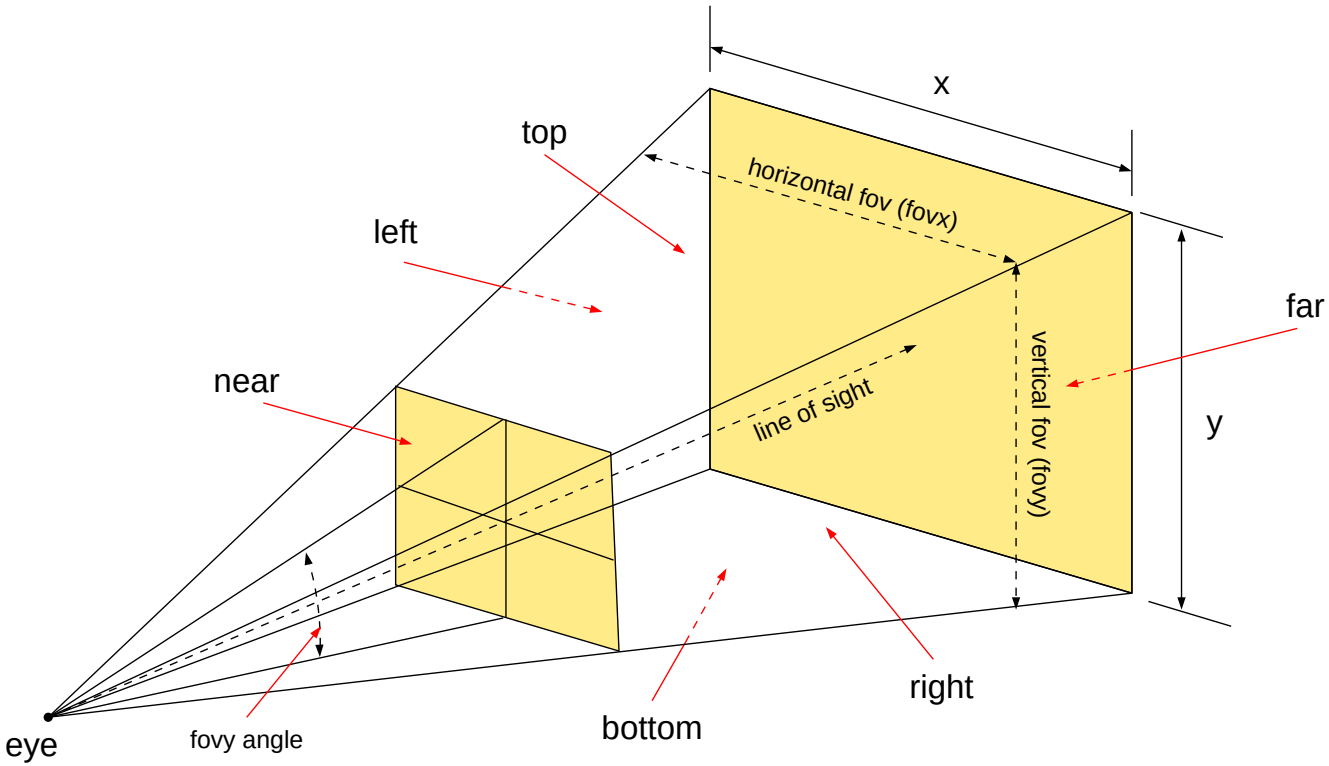
- We need to pass the view matrix to the vertex shader.
- Because it will be the same matrix for all vertices, we should pass it as a uniform parameter.

Outline

The View Frustum

- A frustum is a truncated pyramid.
- The view frustum encloses the part of the scene that will be rendered.
- The vertex (of the untruncated pyramid) is located at the eye point.
- We may think of the base of the view frustum as the plane onto which the scene is projected.

The View Frustum



The `perspective()` Function

The `perspective()` Function

```
mat4 perspective(GLfloat fovy, GLfloat aspect,
    GLfloat near, GLfloat far);
```

- `fovy` is the vertical angle of the field of view.
- `aspect` is the aspect ratio (width/height).
- `near` is the distance from the eye to the near plane.
- `far` is the distance from the eye to the far plane.
- The `perspective()` function returns a 4×4 projection matrix that represents the transformation of creating the perspective view of the scene.

The `perspective()` Function

The `perspective()` Function

```
GLuint proj_loc = glGetUniformLocation(program, "proj");

mat4 proj = perspective(60.0f, 16.0f/9.0f, 0.1f, 100.0f);
glUniformMatrix4fv(proj_loc, 1, GL_FALSE, proj);
```

- We need to pass the projection matrix to the vertex shader.
- Because it will be the same matrix for all vertices, we should pass it as a uniform parameter.

Outline

Assignment

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- Read pp. 217 - 220, Perspective projection.
- Also, read the `perspective()` and `lookAt()` functions in `vmath.h`.