Portfolio Milestone – Viewing Functions

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This small essay is part of Module 5 Portfolio Milestone – Colored Cube from CSC405: Graphics and Visualization at Colorado State University Global. It provides a light overview of viewing functions in computer graphics and focuses on using WebGL. The role of the viewing functions is to transform 3D scenes and project them onto a 2D plane such as a screen. Two types of projection are used: parallel projection and perspective projection see Table 1.

Table 1

Difference Between Parallel Projection and Perspective Projection

SR.NO	Parallel Projection	Perspective Projection
1	Parallel projection represents the object in a different way like telescope.	Perspective projection represents the object in three dimensional way.
2	In parallel projection, these effects are not created.	In perspective projection, objects that are far away appear smaller, and objects that are near appear bigger.
3	The distance of the object from the center of projection is infinite.	The distance of the object from the center of projection is finite.
4	Parallel projection can give the accurate view of object.	Perspective projection cannot give the accurate view of object.
5	The lines of parallel projection are parallel.	The lines of perspective projection are not parallel.
6	Projector in parallel projection is parallel.	Projector in perspective projection is not parallel.
7	Two types of parallel projection : 1.Orthographic, 2.Oblique	Three types of perspective projection: 1.one point perspective, 2.Two point perspective, 3. Three point perspective,
8	It does not form realistic view of object.	It forms a realistic view of object.

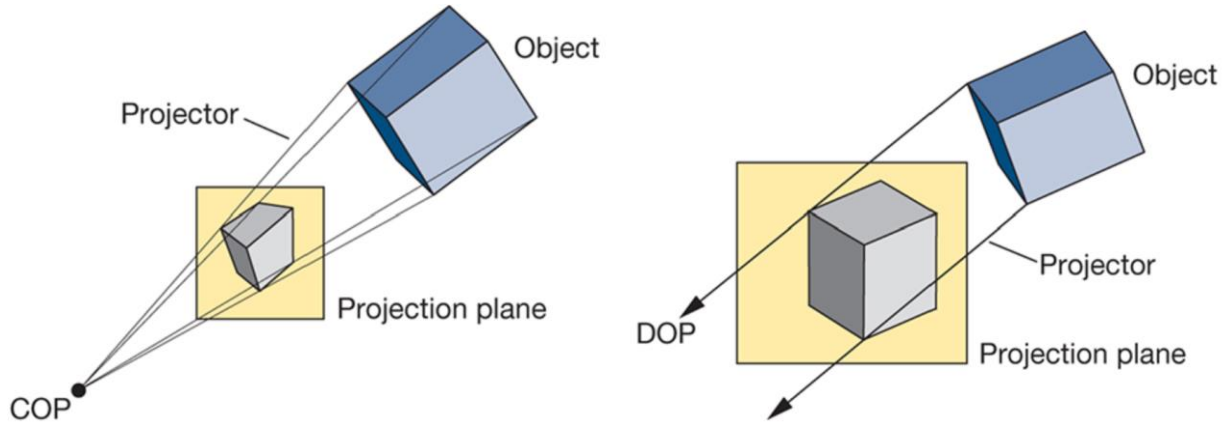
Note: From “Difference between Parallel and Perspective Projection in Computer Graphics” by Aware (2020).

The main difference between parallel and perspective projection is how 3D objects' sizes and depths are represented. That is how the 3D objects' dimensions are projected onto the 2D using

projected lines that can be parallel to the object in parallel projection, or onto a point in perspective projection, see Figure 1.

Figure 1

COP vs DOP



Note: The Center of Projection (COP) represents a Perspective Projection, and the Direction of Projection (DOP) represents the Parallel Projection. From Chapter 5: Viewing. Interactive computer graphics. 8th edition, p134, by Angel and Shreiner (2020).

Parallel projection preserves object sizes without perspective distortion regardless of how far objects are from the viewer. This makes the projection ideal for applications such as technical drawings and architectural designs where preserving the true dimension of an object is crucial. In computer graphics, it is well suited for applications such as Computer-Aided Design (CAD), engineering schematics, and architectural blueprints, where preserving the dimension of an object and precision is also crucial.

On the other hand, perspective projection does not preserve objects' dimensions, it distorts them. For example, objects closer to the viewer appear larger, while distant objects shrink. In other words, large, long objects' front dimensions appear to the viewer larger than their

back dimensions when they are not. Perspective projection is better suited for applications where preserving a realist view or a human view of the world is important. For example, it is used in video games, simulations, and animations to mimic the way human vision sees the world.

WebGL utilizes functions such as ‘mat4.ortho()’ that create an orthographic projection matrix, an orthographic projection is a type of parallel projection. The matrix is used by the vertex shader to compute how the objects are viewed on a screen see code below.

JavaScript

```
// Create the orthographic projection matrix
projectionMatrix = ortho(left, right, bottom, top, near, far);
```

- out: The matrix that will hold the result of the projection.left: The coordinate of the left clipping plane.
- right: the right clipping plane.
- bottom: the bottom clipping plane.
- top: the top clipping plane.
- near: near clipping plane (along the negative z-axis).
- far: far clipping plane (along the positive z-axis).

JavaScript

```
// Send the matrices to the shader
gl.uniformMatrix4fv(modelViewMatrixLoc, false, flatten(modelViewMatrix));
gl.uniformMatrix4fv(projectionMatrixLoc, false, flatten(projectionMatrix));
```

In the shader:

GLSL

```
In the shader
/*
Applies the projection and model-view transformations to the vertex position
It transforms the 3D vertex positions into 2D screen coordinates
by applying the model-view and projection matrices
It also passes the vertex color to the fragment shader
*/
gl_Position = uProjectionMatrix * uModelViewMatrix * aPosition;
```

‘aPosition’ is the position of each vertex of a 3D object in object space (or model space). WebGL also utilizes a similar function for perspective projection, ‘mat4.perspective()’, that creates a perspective projection matrix used by the vertex shader, as the orthographic projection matrix is used to compute how the objects are viewed on a screen see code below.

JavaScript

```
// Create the perspective projection matrix
projectionMatrix = mat4.perspective(fieldOfView, aspectRatio, near, far);

// Send the matrices to the shader
gl.uniformMatrix4fv(projectionMatrixLoc, false, flatten(projectionMatrix));
```

- fieldOfView: the scene viewed vertically.
- aspectRatioscene: used to scale horizontally.
- near: near clipping plane (along the negative z-axis).
- far: far clipping plane (along the positive z-axis).

In the shader:

GLSL

```
gl_Position = uProjectionMatrix * uModelViewMatrix * aPosition;
```

To summarize, in computer graphics, viewing is a term that refers to how 3D objects are projected onto a 2D plane such as a screen. Two types of projection are used: parallel projection and perspective projection where parallel projection preserves the dimension no matter how far the object is from the viewer. WebGL utilizes functions such as mat4.ortho() for orthographic projections and mat4.perspective() to compute 3D scenes into 2D representations.

References

Adware (2020, May 24). *Difference between parallel and perspective projection in computer graphics.* GeeksforGeeks. https://www.geeksforgeeks.org/difference-between-parallel-and-perspective-projection-in-computer-graphics/

Angel, E., & Shreiner, D. (2020). Chapter 5: Viewing. *Interactive computer graphics. 8th edition.* Pearson Education, Inc. ISBN: 9780135258262