

Introduction to OpenGL

Chaiwoot Boonyasiriwat

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What is OpenGL?

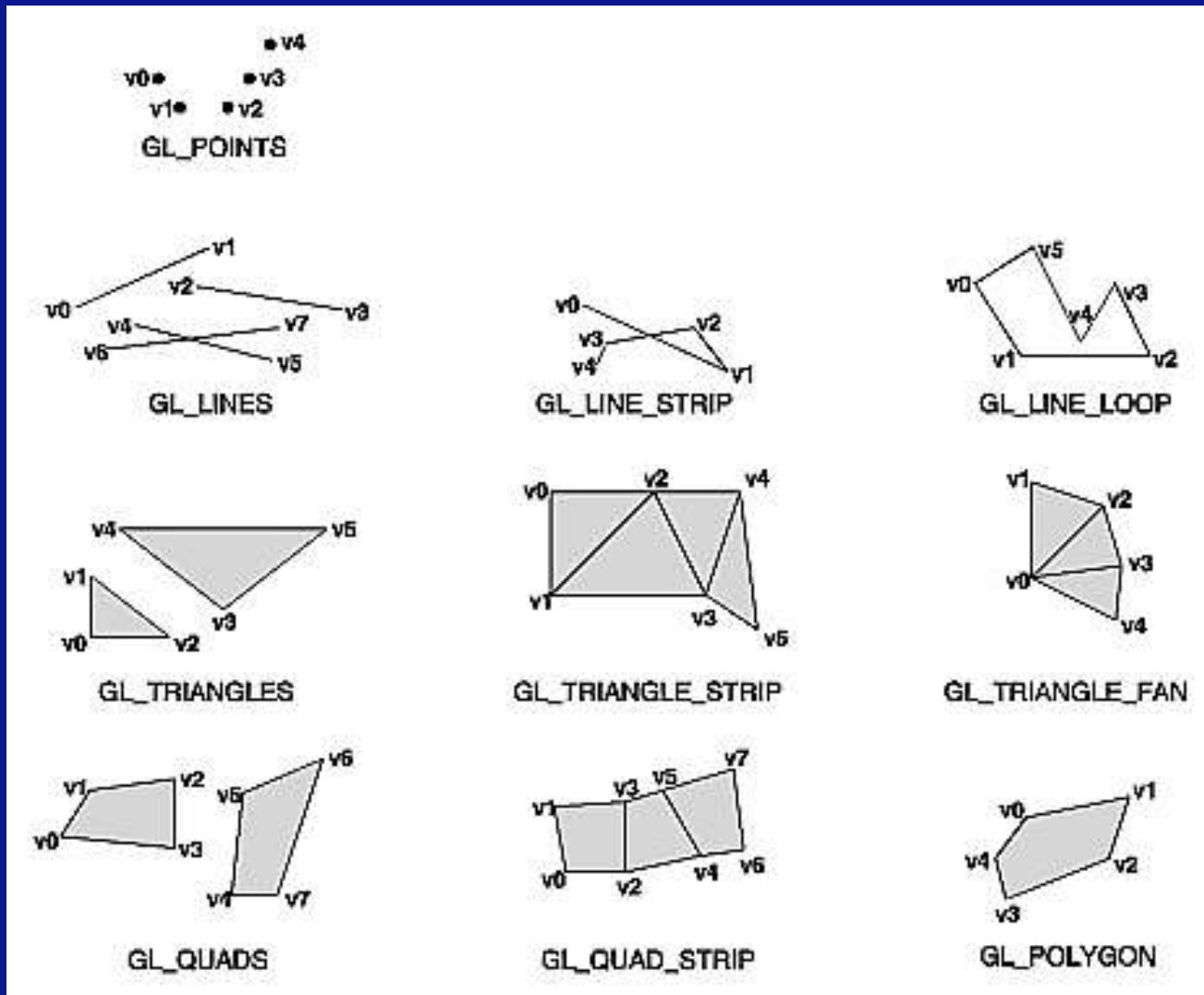
- OpenGL is a library that connects computer programs to graphics hardware.
- OpenGL contains many functions to use.
- Current OpenGL version 4.5.

OpenGL Libraries

- OpenGL Library (**GL**) provides primitive (low-level) set of rendering commands
- OpenGL Utility Library (**GLU**) contains several routines that lower-level OpenGL commands to perform high-level tasks such as setting up matrices for viewing orientations and projections, performing polygon tessellation, rendering surfaces
- OpenGL Utility Toolkit (**GLUT**) is a window-system-independent toolkit. GLUT also has commands for drawing 3D objects such as sphere, cone, torus, etc.

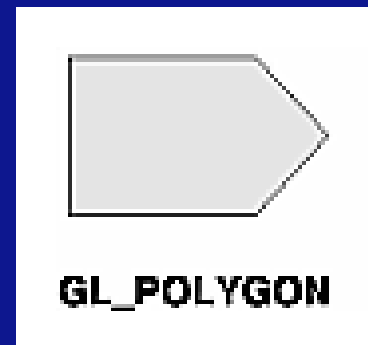
Drawing with OpenGL

You can draw primitive objects using OpenGL.



Example 1

```
glBegin(GL_POLYGON);  
    glColor3f(0.0, 1.0, 0.0);  
    glVertex2f(0.0, 0.0);  
    glVertex2f(0.0, 3.0);  
    glColor3f(1.0, 1.0, 0.0);  
    glVertex2f(4.0, 3.0);  
    glVertex2f(6.0, 1.5);  
    glVertex2f(4.0, 0.0);  
glEnd();
```



Drawing 3D Objects

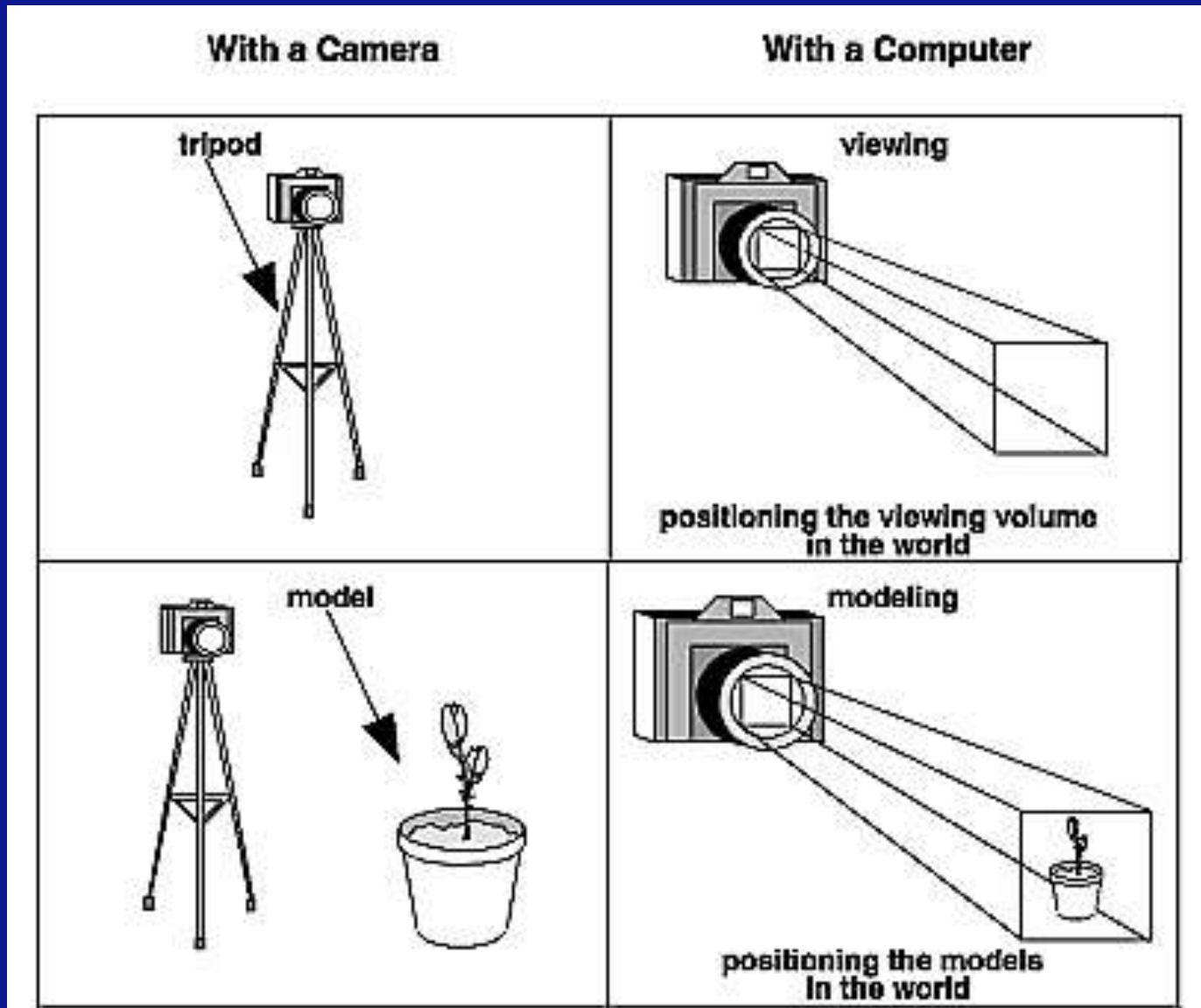
```
glutSolidCone(radius,height,slices,  
stacks);
```

```
glutSolidCube(size);
```

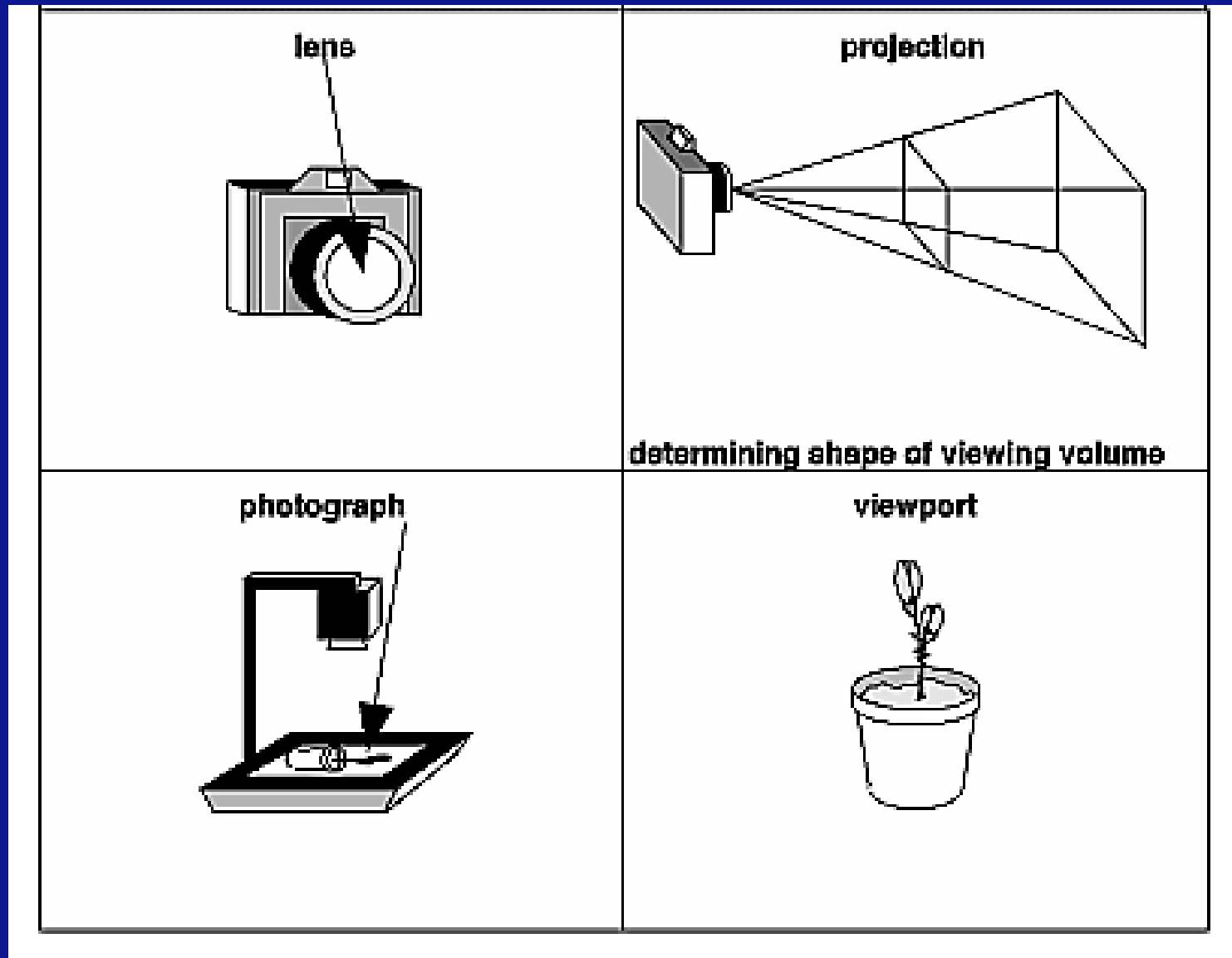
```
glutSolidSphere(radius,slices,stacks);
```

```
glutSolidTorus(innerRadius,outerRadius,  
nsides, rings);
```

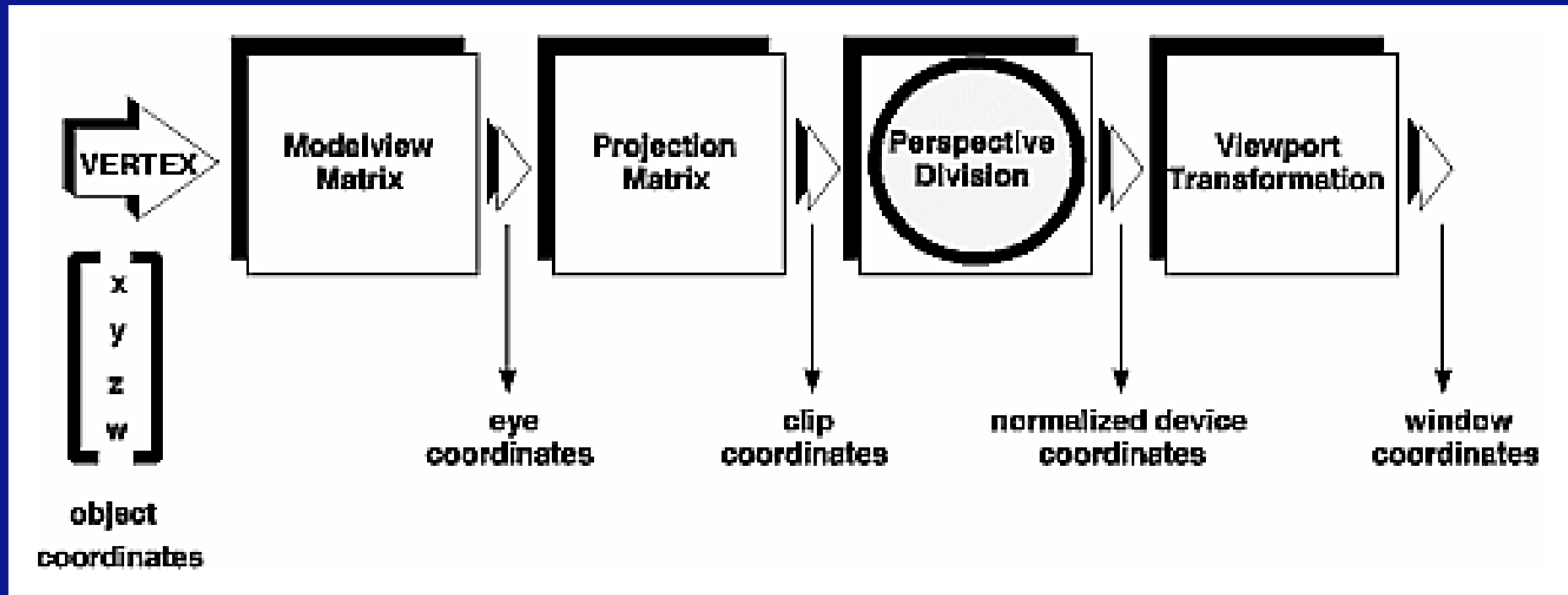
Viewing: Camera Analogy



Viewing: Camera Analogy



Vertex Transformation



Vector transformation: $v' = Mv$ where M is a 4×4 transformation matrix and $v = (x, y, z, w)$, with $w = 1$. The 4th dimension is for translation.

Viewing: cube.c

- This code shows an example to how to set viewing/modeling matrices, and projection matrix.
- **glLoadIdentity()** is used to set the current matrix to the identity matrix.
- **gluLookAt()** is used to set the camera position and its orientation.
- **glScalef()** is the modeling transformation for enlarging/shrinking objects.
- **glViewport()** is used to set the dimension of the screen space.

Viewing: cube.c (continued)

- **glMatrixMode()** is used to specify the transformation matrix to be modified: modelview or projection.
- **glFrustum()** is used for perspective projection.
- To use orthographic projection, **glOrtho()** is used instead.
- Modeling transformations include
 - `glTranslatef(x,y,z)`
 - `glRotatef(angle,x,y,z)`
 - `glScalef(x,y,z)`