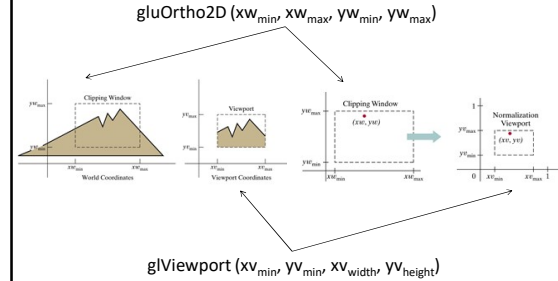


2D Viewing

- We specify a rectangular area (clipping window) in the **world coordinates** and a viewport in the **device coordinates** on the display
 - window defines what to appear
 - viewport defines where to display
- The mapping of the window (world coordinates) to viewport (device coordinates) is a 2D **viewing transformation**

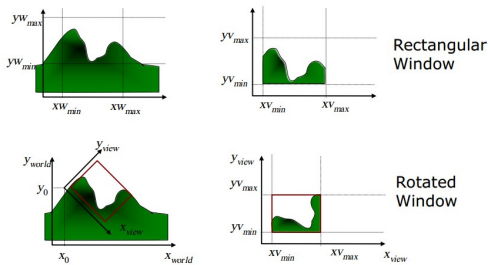
1

2D Viewing



2

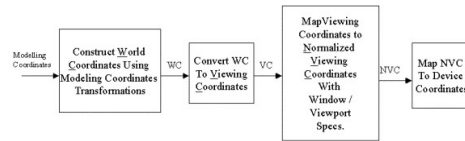
The clipping window



3

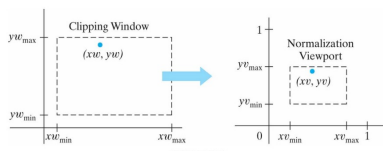
2D Viewing Pipeline

- 2D viewing pipeline
 - Construct world-coordinate scene using modeling-coordinate transformations
 - Convert world-coordinates to viewing coordinates
 - Transform viewing-coordinates to normalized-coordinates (ex: between 0 and 1, or between -1 and 1)
 - Map normalized-coordinates to device-coordinates.



4

Figure 8-6 A point (xw, yw) in a world-coordinate clipping window is mapped to viewport coordinates (xv, yv) , within a unit square, so that the relative positions of the two points in their respective rectangles are the same.



1. Scale the clipping window to the size of viewport using a fixed point (xw_{min}, yw_{min})

$$S = \begin{bmatrix} s_x & 0 & xw_{min}(1 - s_x) \\ 0 & s_y & yw_{min}(1 - s_y) \\ 0 & 0 & 1 \end{bmatrix}$$

2. Translate (xw_{min}, yw_{min}) to (xv_{min}, yv_{min})

$$T = \begin{bmatrix} 1 & 0 & xv_{min} - xw_{min} \\ 0 & 1 & yv_{min} - yw_{min} \\ 0 & 0 & 1 \end{bmatrix}$$

$$M = T \cdot S = \begin{bmatrix} s_x & 0 & xw_{max}xv_{min} - xw_{min}xv_{max} \\ 0 & s_y & yw_{max}yv_{min} - yw_{min}yv_{max} \\ 0 & 0 & 1 \end{bmatrix}$$

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OpenGL 2D viewing functions

- Projection mode
 - `glMatrixMode(GL_PROJECTION)`
 - `glLoadIdentity()`
- GLU Clipping window function
 - Orthogonal projection
 - `gluOrtho2D(xwmin, xwmax, ywmin, ywmax)`
 - If we do not specify a clipping window, the default coordinates are $(xw_{min}, yw_{min}) = (-1.0, -1.0)$ and $(xw_{max}, yw_{max}) = (1.0, 1.0)$

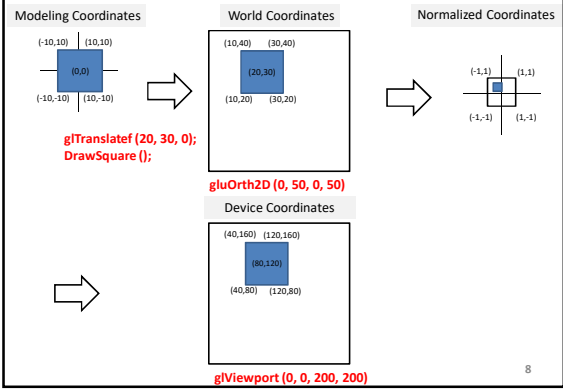
OpenGL 2D viewing functions

Viewport

- `glViewport (xV_min, yV_min, vP_width, vP_height)`
default is size of the display window
- ✦ $x_{V_{min}}$ and $y_{V_{min}}$ are the positions of the lower-left corner of the viewport
- ✦ vP_{width} vP_{height} are the pixel width and height of the viewport
- ✦ If we do not use `glViewport`, the default viewport size and position are the same as the display window

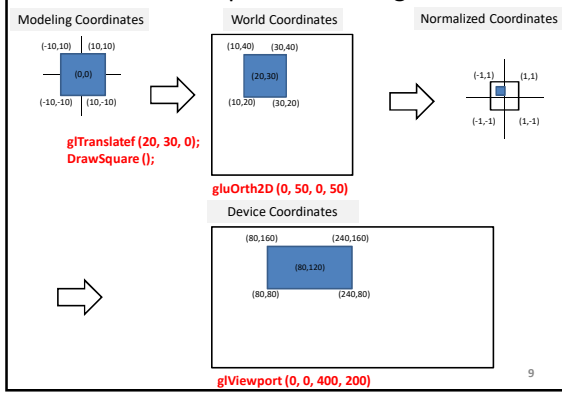
7

Example: 2D Viewing



8

Example: 2D Viewing



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