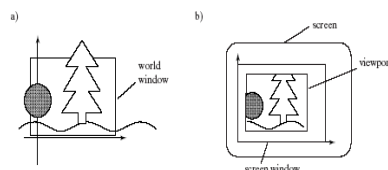


Computer Graphics

Drawing Tools

Window to Viewport Mapping

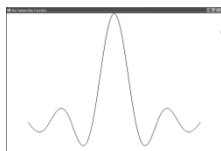
- <http://www.cs.mtsu.edu/~cen/4250/private/lectures/WinToView/WinToViewMap.html>



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Coordinate Systems Example

- We want to graph $\text{sinc}(x) = \frac{\sin(\pi x)}{\pi x}$
- $\text{Sinc}(0) = 1$ by definition. Interesting parts of the function are in $-4.0 \leq x \leq 4.0$.
- What should be the world coordinates?
- What should be the viewport?



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GL Functions To Create the Map

- World window:
`void gluOrtho2D(GLdouble left, GLdouble right,
GLdouble bottom, GLdouble top);`
- Viewport:
`void glViewport(GLint x, GLint y, GLint width,
GLint height);`

This sets the lower left corner of the viewport, along with its width and height.

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GL Functions To Create the Map

- Because OpenGL uses matrices to set up all its transformations, the call to `gluOrtho2D()` must be preceded by two setup functions:

```
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
```

```
gluOrtho2D(-10, 10, -6, 6);
glViewport(0, 0, 600, 400);
```

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setWindow and setViewport

- For a uniform set of parameters, the `setWindow` and `setViewport` functions can be defined:

```
void setWindow(GLdouble left, GLdouble right, GLdouble bottom, GLdouble top)
{
    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    gluOrtho2D(left, right, bottom, top);
}

void setViewport(GLint left, GLint right, GLint bottom, GLint top)
{
    glViewport(left, bottom, right - left, top - bottom);
}
```

- Calls: `setWindow(-5.0, 5.0, -0.3, 1.0);`
`setViewport(0, 640, 0, 480);`

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Scaling and Translating

Window to viewport
mapping :

$$x_v = s_x x_w + t_x$$

$$y_v = s_y y_w + t_y$$

Scaling factor :

$$s_x = \frac{x_{v \max} - x_{v \min}}{x_{w \max} - x_{w \min}}$$

$$s_y = \frac{y_{v \max} - y_{v \min}}{y_{w \max} - y_{w \min}}$$

Translation factor :

$$t_x = \frac{x_{w \max} x_{v \min} - x_{w \min} x_{v \max}}{x_{w \max} - x_{w \min}} = x_{v \min} - s_x * x_{w \min}$$

$$t_y = \frac{y_{w \max} y_{v \min} - y_{w \min} y_{v \max}}{y_{w \max} - y_{w \min}} = y_{v \min} - s_y * y_{w \min}$$

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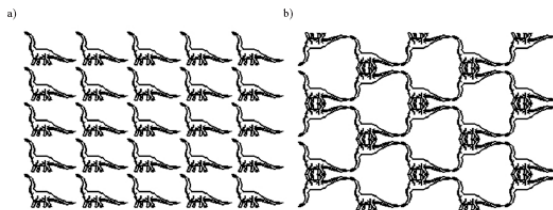
Window-to-Viewport Mapping

- Find the values for A, B, C, and D for the given setup
 - World Window (-10,10,-6,6)
 - Viewport (0,600,0,400)
 - (left, right, bottom, top)
 - Is the aspect ratio in the world preserved in the viewport?
 - Aspect ratio = width/height
- For a point (5, 2) in the world window, what are the corresponding coordinates (x_v , y_v) in the view window?

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Application: Tiling with Viewports

- With a draw function that draws one dinosaur, how to produce the following two tiling picture?



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Applications (continued)

- Tiling A was set up by the following code:

```
// set a fixed window
setWindow(0, 640.0, 0, 440.0);
for (int i = 0; i < 5; i++)    // for each column
    for (int j = 0; j < 5; j++)
    {
        // for each row
        glViewport (i*128, j*88, 128, 88);

        // set the next viewport
        drawPolylineFile("dino.dat"); // draw it again
    }
```



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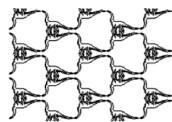
Applications (continued)

- Tiling B requires more effort: you can only turn a world window upside down, not a viewport.

```
for (int i = 0; i < 5; i++)
    for (int j = 0; j < 5; j++)
    {
        // for each row
        if ((i + j) % 2 == 1)
            setWindow(0.0, 640.0, 0.0, 440.0);
        else
            setWindow(0.0, 640.0, 440.0, 0.0); // upside-down

        glViewport (i*128, j*88, 128, 88);

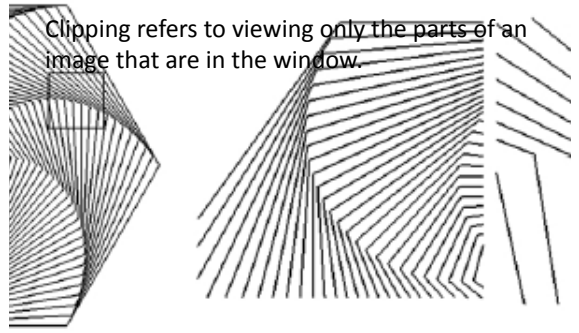
        // no distortion
        drawPolylineFile("dino.dat");
    }
```



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Application: Clip, Zoom and Pan

Clipping refers to viewing only the parts of an image that are in the window.



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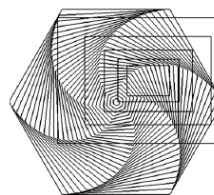
Application (continued)

- The figure is a collection of concentric hexagons of various sizes, each rotated slightly with respect to the previous one. It is drawn by a function called `hexSwirl ()`;
- The figure showed 2 choices of world windows.
- We can also use world windows for zooming and roaming (panning).
- How would you change the windows to zoom?
- How would you change the windows to pan?

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Zooming and Panning

- To zoom, we pick a concentric set of windows of decreasing size and display them from outside in.



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Zooming and Roaming

- The animation of the zoom will probably not be very smooth.
- We want to look at one drawing while the next one is drawn
 - then switch to the new drawing.
- We use `glutInitDisplayMode (GLUT_DOUBLE | GLUT_RGB)`;
 - gives us 2 buffers, one to look at and one to draw in
- We add `glutSwapBuffers()`; after the call to `hexSwirl ()`; // change to the new drawing

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Roaming (Panning)

- To roam, or pan, we move a viewport through various portions of the world. This is easily accomplished by translating the window to a new position.
- How would you ensure the effect looked the same on different computers?

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Resizing the Screen Window

- Users are free to alter the size and aspect ratio of the screen window.
- You may want GL to handle this event so that your drawing does not get distorted.
- Register the reshape function:


```
glutReshapeFunc (myReshape);
```
- `void myReshape (GLsizei W, GLsizei H);`
collects the new width and height for the window.
 - Should you modify the window or viewport?

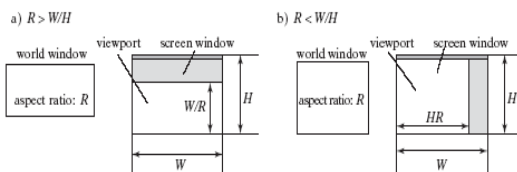
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Preserving Aspect Ratio

- We want the largest viewport which preserves the aspect ratio **R of the world window**.
- Suppose the screen window has width W and height H:
 - If $R > W/H$, the viewport should be width W and height W/R
 - If $R < W/H$, the viewport should be width $H \cdot R$ and height H
 - What happens if $R = W/H$?

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Automatic Aspect Ratio Preservation for Viewports



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