Window to Viewport Transformation

The method of selecting and enlarging a portion of a drawing is called windowing. The area chosen for this display is called a window. The window is selected by world-coordinate.

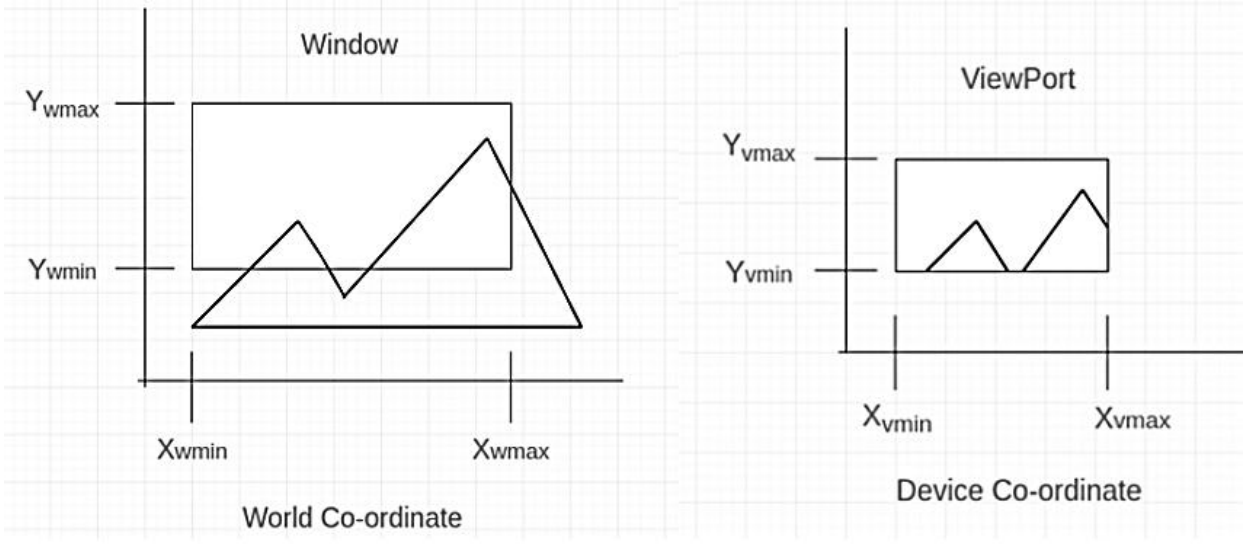
Sometimes we are interested in some portion of the object and not in full object. So, we will decide on an imaginary box. This box will enclose desired or interested area of the object. Such an imaginary box is called a window.

A window defines a rectangular area in world coordinates. You can define the window to be larger than, the same size as, or smaller than the actual range of data values, depending on whether you want to show all of the data or only part of the data.

Viewport: An area on display device to which a window is mapped [where it is to displayed]. A viewport defines in normalized coordinates a rectangular area on the display device where the image of the data appears.

Basically, the **window** is an area in object space. It encloses the object. After the user selects this, space is mapped on the whole area of the **viewport**. Almost all 2D and 3D graphics packages provide means of defining viewport size on the screen. It is possible to determine many viewports on different areas of display and view the same object in a different angle in each viewport.

Window to Viewport Transformation is the process of transforming 2D world-coordinate objects to device coordinates. Objects inside the world or clipping window are mapped to the viewport which is the area on the screen where world coordinates are mapped to be displayed.



General Terms:

- World coordinate – It is the Cartesian coordinate w.r.t which we define the diagram, like Xwmin, Xwmax, Ywmin, Ywmax
- Device Coordinate –It is the screen coordinate where the objects are to be displayed, like Xvmin, Xvmax, Yvmin, Yvmax
- Window –It is the area on the world coordinate selected for display.
- ViewPort –It is the area on the device coordinate where graphics is to be displayed.

Mathematical Calculation of Window to Viewport:

It may be possible that the size of the Viewport is much smaller or greater than the Window. In these cases, we have to increase or decrease the size of the Window according to the Viewport and for this, we need some mathematical calculations.

(xw, yw): A point on Window

(xv, yv): Corresponding point on Viewport

We have to calculate the point **(xv, yv)**

Normalized Point on Window $\left(\frac{X_w - X_{wmin}}{X_{wmax} - X_{wmin}}, \frac{Y_w - Y_{wmin}}{Y_{wmax} - Y_{wmin}} \right)$

Normalized Point on Viewport $\left(\frac{X_v - X_{vmin}}{X_{vmax} - X_{vmin}}, \frac{Y_v - Y_{vmin}}{Y_{vmax} - Y_{vmin}} \right)$

Now the relative position of the object in Window and Viewport are same.

For **x** coordinate:

$$\frac{X_w - X_{wmin}}{X_{wmax} - X_{wmin}} = \frac{X_v - X_{vmin}}{X_{vmax} - X_{vmin}}$$

For **y** coordinate:

$$\frac{Y_w - Y_{wmin}}{Y_{wmax} - Y_{wmin}} = \frac{Y_v - Y_{vmin}}{Y_{vmax} - Y_{vmin}}$$

So, after calculating for x and y coordinate, we get

$$X_V = X_{vmin} + (X_w - X_{wmin}) S_x$$

$$Y_V = Y_{vmin} + (Y_w - Y_{wmin}) S_y$$

Where sx is the scaling factor of x coordinate and sy is the scaling factor of y coordinate

$$S_X = \frac{X_{vmax} - X_{vmin}}{X_{wmax} - X_{wmin}}$$

$$S_y = \frac{Y_{vmax} - Y_{vmin}}{Y_{wmax} - Y_{wmin}}$$

Example: Let us assume:

- for window, Xwmin = 20, Xwmax = 80, Ywmin = 40, Ywmax = 80.
- for viewport, Xvmin = 30, Xvmax = 60, Yvmin = 40, Yvmax = 60.
- Now a point (Xw, Yw) be (30, 80) on the window. We have to calculate that point on the viewport i.e (Xv, Yv).
- First of all, calculate the scaling factor of x coordinate Sx and the scaling factor of y coordinate Sy using the above-mentioned formula.

Sx = (60 - 30) / (80 - 20) = 30 / 60

Sy = (60 - 40) / (80 - 40) = 20 / 40

- So, now calculate the point on the viewport (Xv, Yv).

Xv = 30 + (30 - 20) * (30 / 60) = 35

Yv = 40 + (80 - 40) * (20 / 40) = 60

- So, the point on window (Xw, Yw) = (30, 80) will be (Xv, Yv) = (35, 60) on viewport.