Introduction

World Coordinate System (Object Space) : it is Space in which the application model is defined. It is the representation of an object is measured in some physical or abstract units. It is space in which the object geometry is defined.

Screen Coordinate System (Image Space): it is Space in which the image is displayed. Ex. 800x600 pixels.it is Usually measured in pixels but could use any units. This is Space in which the object's raster image is defined.

Window to viewport transformation

A world-coordinate area selected for display is called a window.

An area on a display device to which a window is mapped is called a viewport. The window defines *what* is to be viewed; the viewport defines *where* it is to be displayed.

The two-dimensional viewing transformation is simply referred

to as the ***window-to-viewport transformation*** or the ***windowing transformation.***

In general, viewing involves more than just the transformation from the window

to the viewport. Figure 6-1 illustrates the mapping of a pidure section that

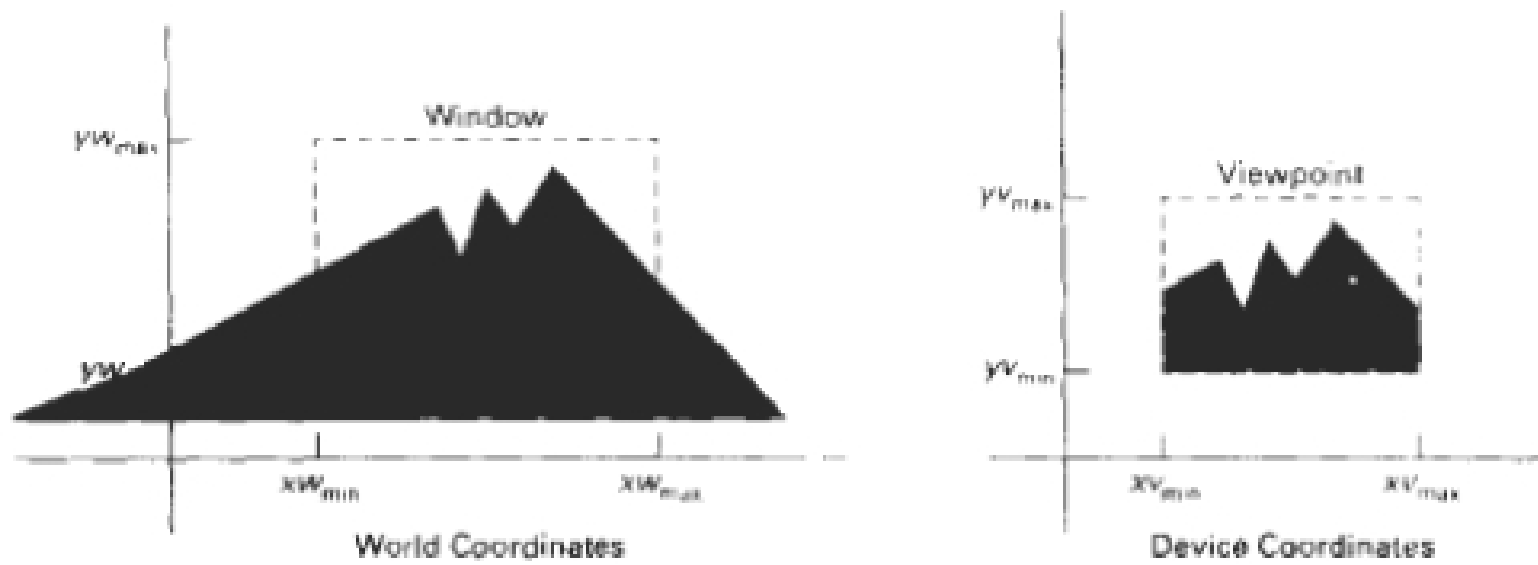falls within a rectangular window onto a designated rectangular viewport.

Figure 6-1
A viewing transformation using standard rectangles for the window and viewport.
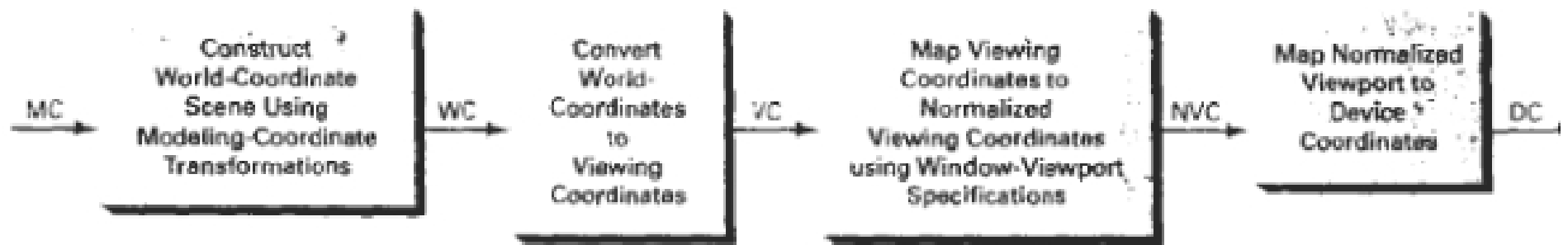
MC → **Construct World-Coordinate Scene Using Modeling-Coordinate Transformations** → WC → **Convert World-Coordinates to Viewing Coordinates** → VC → **Map Viewing Coordinates to Normalized Viewing Coordinates using Window-Viewport Specifications** → NVC → **Map Normalized Viewport to Device Coordinates** → DC

Figure 6-2
The two-dimensional viewing-transformation pipeline.

WINDOW-TO-VIEWPORT COORDINATE TRANSFORMATION

A point at position
(xw,yw) in the window 1s mapped into position **(xv, yv)** in the associated viewport.
To maintain the same relative placement in the viewport as in the window,we q u i r e that

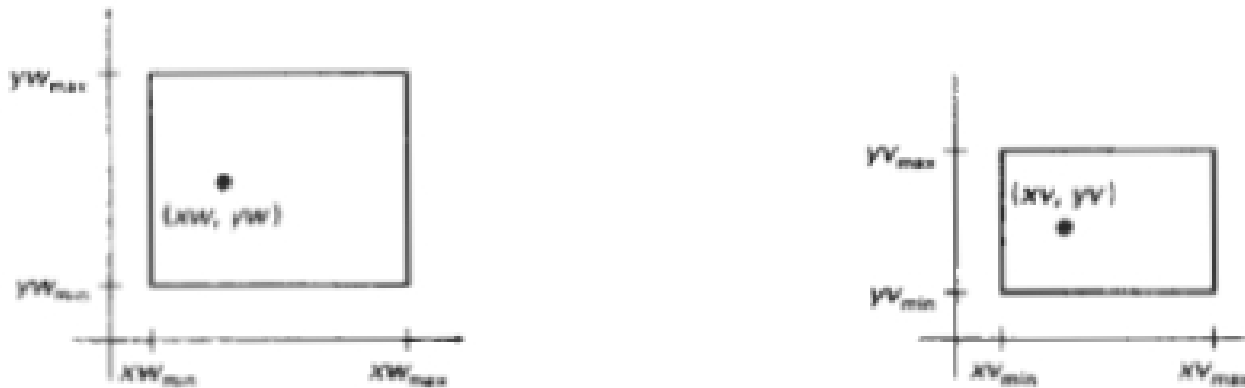*Figure 6-5*
A point at position (xw, yw) in a designated window is mapped to viewport coordinates (xv, yv) so that relative positions in the two areas are the same.

$$\frac{xv - xv_{min}}{xv_{max} - xv_{min}} = \frac{xw - xw_{min}}{xw_{max} - xw_{min}}$$

$$\frac{yv - yv_{min}}{yv_{max} - yv_{min}} = \frac{yw - yw_{min}}{yw_{max} - yw_{min}}$$

Solving these expressions for the viewport position (xv, yv), we have

$$xv = xv_{min} + (xw - xw_{min})sx$$

$$yv = yv_{min} + (yw - yw_{min})sy$$

where the scaling factors are

$$sx = \frac{xv_{max} - xv_{min}}{xw_{max} - xw_{min}}$$

$$sy = \frac{yv_{max} - yv_{min}}{yw_{max} - yw_{min}}$$

$$\begin{cases} vx = \dfrac{vx_{max} - vx_{min}}{wx_{max} - wx_{min}} (wx - wx_{min}) + vx_{min} \\[4mm] vy = \dfrac{vy_{max} - vy_{min}}{wy_{max} - wy_{min}} (wy - wy_{min}) + vy_{min} \end{cases}$$

Since the eight coordinate values that define the window and the view port are just constants, we express these two
formulas for computing (vx,vy) from (wx,wy) in terms of a
translate –scale - translate transformation N.

$$\begin{bmatrix} vx \\ vy \\ 1 \end{bmatrix} = N . \begin{bmatrix} wx \\ wy \\ 1 \end{bmatrix}$$

Where,

$$N = \begin{bmatrix} 1 & 0 & vx_{min} \\ 0 & 1 & vy_{min} \\ 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} \dfrac{vx_{max} - vx_{min}}{wx_{max} - wx_{min}} & 0 & 0 \\ 0 & \dfrac{vy_{max} - vy_{min}}{wy_{max} - wx_{min}} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -wx_{min} \\ 0 & 1 & -wy_{min} \\ 0 & 0 & 1 \end{bmatrix}$$

Application

SAI is a lightweight painting application program for Microsoft Windows developed by SYSTEMAX.

The user interface allows multiple documents to be opened at the same time. The drawing canvas can be both zoomed and rotated using the sliders on the navigator or the hotkeys configured on the keyboard. The toolbar on the top part of the screen also includes a button to mirror the drawing view without mirroring the actual drawing. It is also possible to open multiple viewports to the same document. An application-wide scratchpad (which can be used as a color mixing panel) is provided, which is saved between sessions. Colors can be stored in the swatches panel.