UNIT 7: 2D VIEWING

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7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Able to understand the procedures for displaying views a two-dimensional picture on an output device.
- Able to know about the clipping procedure which isused to identify those portions of a picture that are either inside or outside a specified region of space.

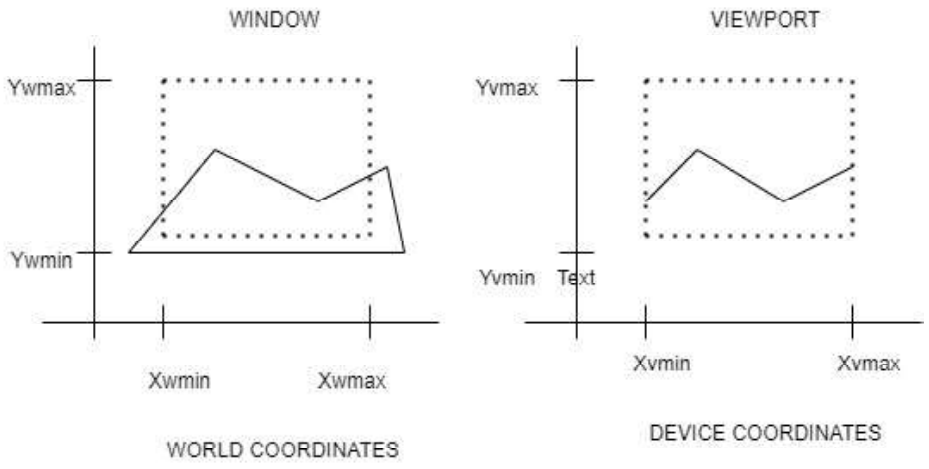
7.2 INTRODUCTION

A graphics package allows a user to specify where part of a defined picture is to be displayed and where that part is to be displayed on the

display device using clipping. Any conventional cartesian coordinate system, referred to as the world coordinate reference frame can be used to define the picture. For a 2D picture, a view is selected by specifying a subarea of the total sub-area.The transformation from world to device coordinates involves translation, rotation, and scaling operations as well as procedures for deleting those parts of the picture that are outside the limits of a selected display area.

7.3 BASIC CONCEPT OF VIEWING PIPELINE

7.3.1 Viewing Pipeline



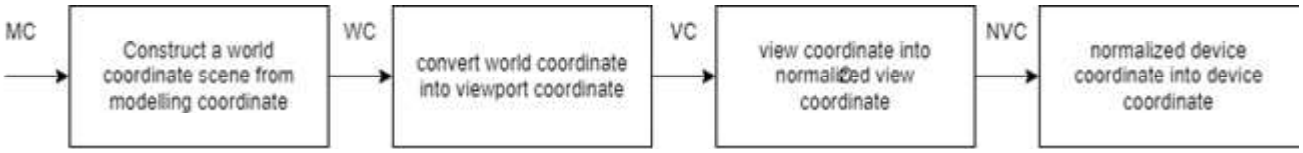
An image representing a view often becomes part of a larger image, like a photo on an album page, which model a computer monitor's display area. Since the monitor sizes differ from system to system, we want to introduce a device-independent tool to describe the display area. This tool is called a normalized device coordinate system (NDCS).

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. In simple terms, what is to be display is called window and where it is to be displayed is called a viewport.

Mapping of a part of a world coordinate scene to device coordinate is referred to as Viewing transformation.Sometimes,the 2-D viewing transformation is simply referred to as the window-to-viewport

transformationto the windowing transformation.

In graphics packages, generally, the window we select is the standard rectangular shape. For example, if our window is not a rectangle shape then we have to follow some steps. So the steps are

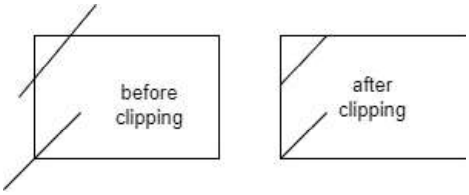


Viewing Pipeline

- Construct a world coordinate screen from modeling co-ordinate.
- Convert this world coordinate into our viewport co-ordinate.
- Once the viewport co-ordinate obtain,transform the description of the world coordinate into the viewport. It means view coordinates into normalized view coordinates.
- This normalized view coordinate is transformed into a device coordinate.

7.3.2 Clipping

The portion which lies outside the region of the window, in computer graphics, is called the clipped part and the process of displaying the image inside the region of the window is called clipping.



The clipping algorithm can be applied in both world coordinate and normalized device coordinates

In world coordinate system, only the contents of the window interior are mapped to device coordinates, world coordinate clipping removes those primitives outside the window from further consideration.

In normalized device coordinate system, mapping is fully done from world to the normalized device. Clipping will reduce calculations by allowing concatenation of viewing and geometric transformation matrices.

7.3.3 Clipping Algorithms

Algorithms have been developed for clipping for the following primitive types:

- Point Clipping.
- Line Clipping (straight-line segments)
- Area Clipping (polygons)
- Curve Clipping
- Text Clipping.

7.3.4 Application of Clipping

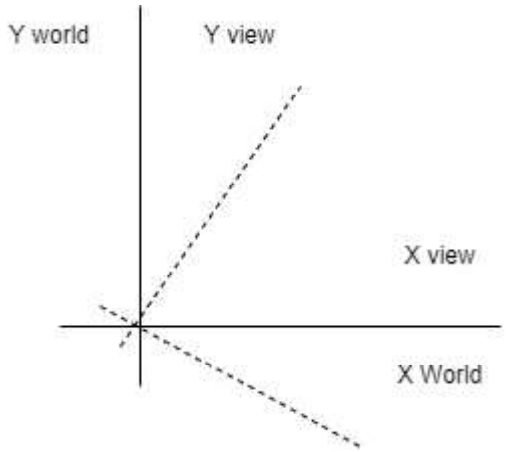
- Extracting part of defined scene for viewing.
- Identifying visible surfaces in three-dimensional views.
- Anti-aliasing line segments or object boundaries.
- Creating objects using solid-modeling procedures.
- Displaying a multiwindow environment.
- Drawing and painting operations that allow parts of picture to be selected for copying, moving,
- Erasing, or duplication.

7.4 VIEWING COORDINATE REFERENCE FRAME

We will have the matrix for converting world coordinate positions to viewing coordinates as a two-step composite transformation

First, the viewing origin is translated to the world origin, then we rotate to align the two coordinate reference frames.The composite 2D transformation to convert world coordinates to viewing coordinatesis where T is the translation matrix that takes the viewing origin point P to the world

origin, and R is therotation matrix that aligns the axes of the two reference frames.



Viewing coordinate reference frame

7.5 WINDOW TO VIEWPORT COORDINATE TRANSFORMATION

A window is specified by four coordinates: wxmin, wxmax, wymin, wymax. Similarly a viewport is described by four coordinates: vxmin, vxmax, vymin, vymax.The objective of window-to-viewport mapping is to convert the world coordinates(wx,wy) of any point to its corresponding normalized device coordinates(vx,vy). In order to maintain relative changes of the point in the viewport as in the window, we require:

$$\frac{wx_{min} - wx_{max}}{wx_{max} - wx_{min}} = \frac{vx - vx_{min}}{vx_{max} - vx_{min}}$$

and

$$\frac{wy - wy_{min}}{wy_{max} - wy_{min}} = \frac{vy - vy_{min}}{vy_{max} - vy_{min}}$$

From the above two equations we have:

$$vx = \frac{vx_{max} - vx_{min}}{wx_{max} - wx_{min}} \left[wx - wx_{min} \right] + vx_{min}$$

$$vy = \frac{vy_{max} - vy_{min}}{wy_{max} - wy_{min}} \left[wy - wy_{min} \right] + vy_{min}$$

Question 1.

Find the workstation transformation that maps the normalized device screen onto a physical device whose x extent is 0 to 199 and y extent is 0 to 639 where the origin is located at the (a) lower left corner.

Solution:

(a)The window parameters are $wx_{min}=0$,$wx_{max}=1$,wy min=0 and $wy_{max}=1$.

The viewport parameters are vxmin=0,$vx_{max}=199$, $vy_{min}=0$ and$vy_{max}=639$.

Then sx=199, s y= 639 and

$$W = \begin{bmatrix} 199 & 0 & 0 \\ 0 & 639 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



CHECK YOUR PROGRESS

Q 1: Express window-to-viewport mapping in the form of a composite transformation matrix.

$$S_x = \frac{vx_{max} - vx_{min}}{wx_{max} - wx_{min}} \quad \text{and} \quad \frac{vy_{max} - vy_{min}}{wy_{max} - wy_{min}}$$

Q 2: Show that for a viewing transformation, S_x and S_y if and only if $a_w = a_v$, where a w is the aspect ratio of the window and a v the aspect ratio of the viewport.

7.6 VIEWING FUNCTION

In a PHIGS application program ,following are the viewing function:

- evaluateViewOrientationMatrix (x0,y0,xv,yverror,viewMatrix)
  where x0,y0 are coordinates of viewing originxv,yvis the world coordinate positions for the view up vector.
- valuateview Mapping Matrix (xwmin, xwmax, ywmin, ywmax, xvmin, yvmax, error view Mapping Matrix)
  The window limits in viewing coordinates are chosen with parameters xwmin, xwmax, ywmin, ywmax and the viewport limits are set with the normalized coordinate positions xvmin,xvmax,yvmin, yvmax.
- set View Representation(ws, viewindex, view Matrix, view Mapping Matrix, xclipmin, xclipmax, yclipmin, yclipmax, clipxy)
  where parameter ws designate the output device(workstation) and parameter viewindex sets an integer identifier for this particular This allows us to turnoff clipping if we want to view the scene outside the viewport.

7.6.1 Opengl 2d Viewing Function

- To transform from world coordinate to screen coordinates, the appropriate matrix mode must be chosen
  glMatrixMode (GL_PROJECTION); glLoadIdentity( );
- To define a 2D clipping window, we use OpenGL Utility function:
  gluOrtho2D(xwmin, xwmax, ywmin, ywmax);
  This function also perform normalization (NDC)
- To specify the viewport parameters in OpenGL, we use function
  glViewport(xvmin, yvmin, vpWidth, vpHeight);



7.7 LET US SUM UP

- Four Cartesian co-ordinates systems in computer Graphics.
  1. Modeling co-ordinates
  2. World co-ordinates

3. Normalized device co-ordinates

4. Device co-ordinates

- Modeling Coordinates are also known as local coordinates, where the individual object in a scene is within separate coordinate reference frames. Each object has an origin (0,0)
- World Co-ordinates: World coordinate system describes the relative positions and orientations of every generated object.The scene has an origin (0,0). The object in thescene is placed with reference to the scenes origin. The world co-ordinate scale may be the same as the modeling co-ordinate scale or it may be different.
- Normalized Device Co-ordinates. Output devices have their own coordinates. Co-ordinates values: The x and y axis range from 0 to 1. All the x and y coordinates are floating-point numbers in the range of 0 to 1.This makes the system independent of the various device coordinates. This is handled internally by graphic system without user awareness.
- Device Co-ordinates: Specific co-ordinates used by a device.
- When we interested to display certain portion of the drawing, enlarge the portion, windowing technique is used.
- Technique for not showing the part of the drawing which one is not interested is called clipping
- An area on the device (ex. Screen) onto which the window will be mapped is called viewport.
- Window defines what to be displayed.
- A viewport defines where it is to be displayed.
- Most of the time, windows and viewports are usually rectangles in standard position(i.e aligned with the x and y axes). In some application, others such as general polygon shape and circles are also available



7.8 FURTHER READINGS

1) Schaum's Outline of Computer Graphics 2/E by Zhigang Xiang and Roy A Plastock

2) Computer Graphics By Donald Hearn and M. Pauline Baker

7.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1:

$$N = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -wx_{min} & -wy_{min} & 1 \end{bmatrix} \begin{bmatrix} Sx & 0 & 0 \\ 0 & Sy & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ vx_{min} & vymin & 1 \end{bmatrix}$$

Ans to Q No 1: if $S_x = S_y$ then

$$\frac{vx_{max} - vx_{min}}{wx_{max} - wx_{min}} = \frac{vy_{max} - vy_{min}}{wy_{max} - wy_{min}}$$

or

$$\frac{wy_{max} - wy_{min}}{wx_{max} - wx_{min}} = \frac{vy_{max} - vy_{min}}{vx_{max} - vx_{min}}$$

7.10 MODEL QUESTIONS

Short Questions (Answer each question in around 150 words).

Q 1: What do you mean by window-to-viewport mapping? Explain.

Q 2: What are the different viewing functions available in PHIGS?

Q 3: What is Clipping? What are different types of clipping available.

Q 4: Define window, viewport.

Q 5: Why window to viewport mapping required?

Q 6: Find the normalization transformation that maps a window whose lower left corner is at (1,1) and upper right corner is at (3,5) onto

(a) A viewport that is the entire normalized device screen

(b) A viewport that has lower left corner at (0,0) and upper right corner (1/2,1/2).

Q 7: Find the normalization transformation which uses a circle of radius five units and center(1,1) as a window and a circle of radius ½ and center (1/2,1/2) as a viewport.

Q 8: Explain modeling coordinates and device coordinates with example.

Q 9: What is the condition to be satisfied for a point to be inside the window?

Q 10: What are viewing functions available in OPENGL?

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