Course slides
Computer Graphics

Lec 1

- Computer Graphics: is the science & art of communicating visually via a computer's display & its interaction devices.
- visual aspect of communication is usually in the computer-to-human direction.
- in the human-to-computer direction is beginning to change visual data is beginning to flow back to computer.

- Building a graphics application:
  1. UI work
  2. Some amount of modeling: representation of shapes
  3. Rendering: making a picture of shapes.
- fields play important role in Computer Graphics.
  1. Physics: modeling the way light interacts.
  2. Mathematics: Describing shape & other things.
  3. Human perception: understanding the visual system
  4. Human-Computer interaction: " How people interact with pc.
  5. Engineering: understanding & applying the constraints of bandwidth, mem
  6. Graphic Design: shares graphics' aim of communication.

* Graphics Area:
  1. modeling: deals with mathematical specification of shapes & appearance properties in a way that can be stored to pc.
  2. Rendering: the creation of 3D models & shaded images
  3. Animation: create motion through sequences of images.
  4. User interaction: interface between input devices & other sensory feedback.

5. virtual reality:- immerse the user into a 3D virtual world.

6. visualization:- gives users insight into complex information via visual display.

7. image processing:- manipulation of 2D images → graphics / vision

8. 3D scanning:- uses range-finding technology to create measured 3D Models.

* Applications of Computer Graphics:-

1. video games: 3D models & rendering Algorithms.
2. Cartoons: 3D Models
3. visual effects & animated films: use all Computer graphics tech.
4. CAM / CAD:

Computer-aided manufacturing ← → Computer-aided design.

OUTPUT

* Simulation: used to simulate different systems providing design requirements. ← → detecting faults

* Images:-

- every image & figure displayed on any screen is made up of a group of small dots termed as pixel.

- imaging can be 2D or 3D

- Images captured by 3 ways

optical objects | Natural objects | digital image

Goal

two types

- digital images is a pictorial representation of a 2D image in binary format (sequence of ones & zeros).

① vector

- are created with vector soft-ware and are common for images that will be applied onto a physical product
- used in CAD, engineering, 3D graphics.

② Raster

- are created with pixel-based programs or captured with a camera or a scanner
- more common
- jpg, gif, png → used in web

① vector displays (vector graphic)

- show images as a list of the geometric shapes [lines, circles, triangles, rectangles]

1. image composed as shapes
2. flicker when the number of primitives in the image become too large.
3. Scan conversion isn't required.
4. Draw continious & smoth lines
5. Cost is higher
6. occupy less space
7. SVG, Eps, pdf, DXF

② Raster displays (Raster graphics)

- show images as rectangular arrays of pixels.

[flat panel computer or television]

1. image composed as pixels
2. Refresh process is independent of the complexity of the image.
3. specified end-points and must be scan converted into px
4. Can draw curves, polygons, ... only by pixel approximation
5. less cost
6. occupy more space → quality
7. BMP, Tif, gif, JPG

* Pixels & Coordinates :-

- is a single point in a raster image.
- are normally arranged in a regular 2D grid & are often represented using dots or squares.
- identified by a pair integers giving column number & row number (C, r)

from left to right (0) — top to bottom / bottom to top (openGL)

* Rows & Columns numbers identify a pixel, not a point.
* pixel contains many points.

→ The intensity of each pixel is variable in color systems. each pixel has red, blue, green.

→ The resolution of a picture is based on the pixel counts of that image

How Can we Compute the Coordinate of pixels from real Coordinates of objects?

for XY Coordinate system are XL, XR, YT & YB (left, Right, Top, bottom)

" " " " " PXL, PXR, PYT, PYB

$$* \; PX1 = PXL + \left(\frac{X_1 - XL}{XR - XL}\right) * (PXR - PXL)$$

$$* \; PX2 = PYT + \left(\frac{Y_1 - YT}{YB - YT}\right) * (PYB - PYT)$$

ex

Suppose that you want to transform the point (3,5) from XY Coordinates to the pixel Coordinates given that, the horizontal & vertical limits :- L R T B

* For the pixel Coordinates are: 0, 800, 0 & 600
* for the XY Coordinates are : 0, 50, 0 & 40

$X_1 = 3 \quad y_1 = 5$

$pxL = 0 \quad pXR = 800 \quad pYT = 0 \quad pyB = 600$

$XL = 0 \quad XR = 50 \quad YT = 0 \quad YB = 40$

$$px_1 = pxL + \left(\frac{X_1 - XL}{XR - XL}\right) * (pXR - pxL)$$

$$= 0 + \left(\frac{3-0}{50-0}\right) * (800-0) = \boxed{48}$$

$$px_2 = pyT + \left(\frac{y_1 - YT}{YB - YT}\right) * (pyB - pyT)$$

$$= 0 + \left(\frac{50-0}{40-0}\right) * (600-0) = \boxed{75}$$

$$(px_1, px_2) = (48, 75)$$