Computer Graphics and Virtual Reality   Prof Mrs Agbo

Graphics — Pictorial representation of Data

Definitions of Computer Graphics

1) Computer graphics include anything on computer that is not text or sound

2) Drawing pictures on computers (rendering) and those drawings can be photographs, movies, simulations

3) Generation of graphs, tables, static or moving images by computer systems. usually on cathode ray tubes. Vector tubes → Produces line images. Raster / Stroke tubes Raster tubes Scan tubes. They are both types of cathode ray tubes

Raster ⟹ Beaming of electron beam on the screen of a monitor in the fusion of rows and columns

Screens consist of collection of data called pixel grids Pixels, grids, frames. They can vary in colour by brightness

4) _____ provides a set of tools to create pictures and to interact with them. The tools consist of hardware and software which enable programmers to produce pictures with strong graphics capabilities

5) _____ is a technology in which pictures are generated, acquired, pre-processed, managed, displayed, stored in an application oriented manner by means of a computer with which pictures are correlated with non graphical application data.

Graphics are synchronized with text and sound.

Audio - Visual

) Implies computer aided integration and handling of pictures synchronized with other data types e.g. video audio, text or multimedia systems and the advanced dialogue techniques associated with these types

) Is regarded as a branch of computer science that deals with the theory of and technology of computerized image synthesis.

) I seen as the basic technology for accomplishing visualization and implementing interactive graphics dialogue

Use it to design an engineering Application such as Computer Aided Design (CAD)

for printing, publishing office application

for research to medical sciences.

Media and Visual Communication

Geographical Information systems (GIS)

Architecture & Civil Engineering

Is seen as the key technology for enabling
important trends in Computer Science and IT for the
Development of new Paradigms
Distributed multimedia and cooperative apps
Computer supported works & apps
Development of computer generated environment
(Virtual Reality)
Analysis & simulation of complex (Information Global Information
Realization of complex graphics intelligic information
Systems

$\vee$ Information

(Global Information
Visualization)

Geometric Conceive an image
⇒ Mathematical definition & understanding
⇒ Transformation into a Continuum space
⇒ Convert to discrete pixel
(Scan Conversion)

Distortion sets in while carrying out Conversion
Aliasing effect ⇒ Process to fill of distortion
Anti Aliasing ⇒ Process of removing distortion

Distortion - e.g when the quality of the image
generated is not good enough

Hidden Surface Removal

Representing 3d shape on a 2d
Projection method.   plane

2 Types of Computer Images

= Object Oriented (Vector Graphics)
- Raster Graphics

Vector Graphics makes uses of dots (point) &
lines, geometrical primitives to represent images
Pros

=> No effect on image quality on resize
=> Vector image size are small insize i.e small storage
requirement   Cons
of the Computer
=> The higher resolution   the   sharp the image
=> Poor Job of translating to

Raster Graphics

Rows by columns, intensifying of pixels in differents ms
and columns to for image
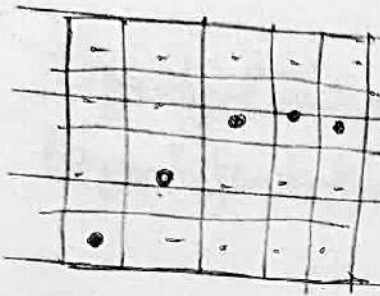
→ more intensity on certain pixels

Images are produced and in independently controlled dots arranged in rows and columns.

Raster technology Raster treats images as a collection of dots/pixels nearer to machine readable formats but not outrightly.

Pros	Assignment
⇒ Image distort on resizing	Look at C.G System elements
	-Graphic input devices
	Physical & logical devices
	- Graphical output devices

A digital image discrete pixel or picture elements. Pixels are arranged in rows & columns to for a rectangular picture area referred to as a raster

To calculate the total no of pixel of an image you have to look at the row & the column sizes

The total no of pixel, in an image is the function of the size of the image and the number of pixes per unit length on the horizontal & vertical directions.

number of pixel per unit length is Called Resolution of an image - e.g. 3 by 2 inch image at a res of 300 pixel per unit (length)

3×300 pixel $\quad \times \quad 2 \times 300$ pixel

900 pixels $\quad \times \quad$ 600 pixel

540, 000 pixels

Aspect Ratio = Image width / Image height

$$= \frac{3}{2} \quad \text{or} \quad 3 : 2$$

Colour Models

Colour Complex and it is an inter disciplinary subject.

$\Rightarrow$ RGB $-$ Colour Model $\qquad$ Primary Colours
$\qquad$ Red, Green, Blue

$\Rightarrow$ CMY $-$ Cyan, Mangeta, Yellow

2^n, $\quad n =$ total no of bits per Colour
$\qquad$ if one Colour is assigned

$\qquad$ 3 bits

then $2^9 =$ total no of states

String

Direct Coding

Look up table

Direct Coding

Pixel value & pixel colour

R	G	B
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Increasing the no of bits to for different colour Combinations Causes the storage requirements increases.

Look up table

Using indices to look for Colour value on a table

Storage requirement is minimal in Look up table. The index is the pixel

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Ohanna outline

Monochromatic & Colour Display Monitor pg 10

monochromatic

=> Control Electrode helps direct or control the path of the beam

=> Horizontal plates help deflect beams from the left to right. The vertical plates control the beam to go from top to bottom

Colour

The colour display has three electron guns, the screen is coated with three different types g phosphor

Printer

A printer deposits colour pigments onto a print media at different intensity.

Techniques

1) Halftoning - Variably increases the intensity of pixel pigment dots at an angle 45° with the screen.

2) Halftone Approximation: uses pixel grid patterns.

Bi-level means rows and columns must be the same e.g 3×3, 4 by 4.

When printing, the previous level's output would be carried into the next level

Halftone grid pattern are also referred to as dither patterns.

Dither matrix is the technique used to determine where to print.

Dither matrix pattern e.g $\begin{bmatrix} 1 & 2 \\ 0 & 3 \end{bmatrix}$
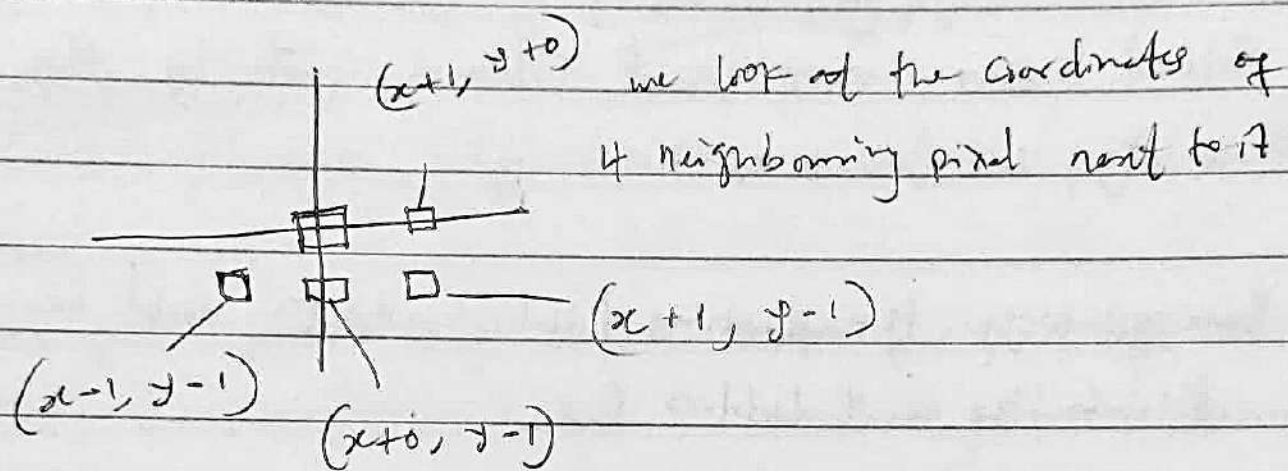
we start from the least index till $n - 1$

This matrix pattern is used to avoid symmetry.

3) Dithering: Technique that provides a matrix (x, y) and an intensity level about a $n \times n$ matrix

$x \bmod n - i$ if the sum of the values of

$y \bmod n = j$ $i + j$ is less than the value of

the intensity value, you print on the

cell or location (x, y)

4) Error Diffusion: The printer prints erroneously on a cell close to it.

$(x+1, y+0)$ we look at the coordinates of 4 neighbouring pixel next to A

$(x+1, y-1)$

$(x-1, y-1)$

$(x+0, y-1)$

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Setting The Colour Attributes of Pixels

SetPixel (x, y, rgb) —   Direct Coding

SetPixel (x, y, i) —   Lookup Table

x, y $\Rightarrow$ pixel coordinates

$rgb \Rightarrow$ 3 element array where $rgb[0] = r$

$$rgb[1] = g$$

$$rgb[2] = b$$

$i \Rightarrow$ index of the address containing the (r, g, b) value in a lookup table.

In one protocol the application provides both coordinate information simultaneously.

SetEntry (i, rgb) can be used to set the value from the lookup table whose address is i.

GetEntry is used to obtain the colour value in the entry i through the array parameter rgb

Scan Conversion

Refers to the process of converting geometric shapes or objects defined in terms of mathematical representation into pixel values that can be displayed on a screen.

How can we scan convert a point
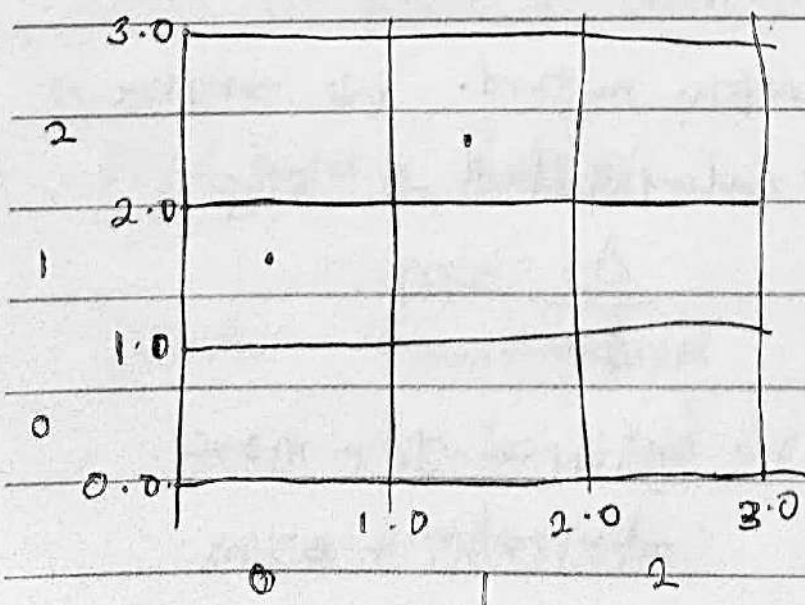
$P_1 =$

$P'_1 =$

$P_2 =$

$P'_2 =$

Direct use of the line equation
DDA Algorithm (Digital differential analyser)
Bresenham's line

Direct use of line equation

Two endpoints must be established before drawing a line

$$y = mx + b$$

$$m = \frac{y'_2 - y_1}{x'_2 - x_1}$$

$$b = y'_1 - mx'_1$$

DDA (Digital differential analyser)

Incremental scan Conversion method. We assume if a certain step we have calculated that step

$$\frac{\Delta y}{\Delta x} = m$$

$$\Delta y = y_{i+1} - y_i$$

$$\Delta x = x_{i+1} - x_i$$

$$y_{i+1} = y_i + m\Delta x$$

$$x_{i+1} = x_i + \Delta y/m$$

Bresenham's Line Algorithm

circle equation has three
but two others are inefficient

Use Bresenham's line to calculate circle equation

Use Bresenham's Algorithm to Scan Convert a circle

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Computer Graphics

Scan - Converting A Rectangle

The sides of a rectangle are parallel

Region filling

The process of "Coloring" a definite image area or region

Pixel level - Raster

Exterior - Boundary pixel

Boundary filled Algorithm - used to fill a boundary pixel

Interior - flood-fill algorithm

Geometric level

4- Connected vs 8- Connected

Boundary - fill Algorithm - Exterior
is a recursive algorithm that begins with a
starting Pixel, called a seed inside the region.

Flood - fill Algorithm - Interior
Also begins with a seed (starting pixel)

Scan - line Algorithm

This handles polygonal region that are
geometrically defined by the coordinates of their vertices
Horizontal edges are ignored since the pixels are
automatically filled during scan conversion.

Scan - Convert a Character

Bitmap font - Raster approach
Outline font - Vector approach

Types of Anti - Aliasing (Distortion)

Staircase   —   Jagged or staircase

Unequal Brightness — Slanted lines appear dimmer than horizontal or vertical.

— distance between horizontal or vertical lines are one 1 unit.

— slanted lines difference is 1 - 414 units

— Picket fence Problem.

4/7/2024 | System of Transformation.

Transformation type dimension:
- Rotation
- Reflection

Transformation is the process of introducing change in the shape, size and orientation of the object using scaling, rotation, shearing translation e.t. c.

Translation is the process of changing the position of an object in a straight line path from one coordinate location to another. Every point (x, y) in the object must undergo a displacement to x', y'. x becomes $x' = x + t_x$ while y' becomes $y' = y + t_y$

Rotation: A two dimensional rotation is done by repositioning the coordinate along a circular path, on the x, y pla

by making an angle with the axis. The trans
is now given by x' from x, y axis so

$$x' = r\cos(\theta + \varphi)$$
$$y' = r\sin(\theta + \varphi)$$

Scaling (Rigid objects (check)) - Objects that
the shape doesn't change no matter the trans

Scaling : The Scaling transformation chang
the shape of an object and can be carri
by multiplying each vertex x, y by scal
factor (S_x, S_y) where S_x is the scaling fact
x and S_y is the scaling factor of y

Shearing : The shearing transformation actuall
slants the object along the x direction
direction as required

Reflection Reflection is the transformation t
produce a mirror image of an object

Showing is not a form of Transformation.

Re-occuring question

- Techniques to get multiple Intensity in a printer
- Illustrative explanation of monochromatic display and Colour monitor display
- Two methods of Colour Image representation
- Diff b/w Image processing and Computer graphics
- Loading Image file /encoding of Image file
- Scan conversion of rectangular objects and polygonal objects
- How to prove the formulas for calculating decision Variable in BreBanham's algorithm
- Rotation
- region filling, boundary-fil and flood-fill algorithms
- 2d and 3 d transformation
- Input devices
- Clipping, Southerland - Hodgman, Cohan - Sutherla
- Concept of Computer graphics in digital image processing and human Computer Interaction
- Description of how to draw an object on a white piece of paper and using computing tool to produce the same effect

- Scan Converting a character
- Aliasing effect