Lecture-7
NDU

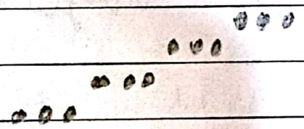
classmate
Date 07/02/18
Page

Scan conversion (rasterizing)
Assumption: raster display
How the scene is loaded?
- frame buffer
- pixel patterns

Point plotting
• Converting a single co-ordinate position furnished by an application program into appropriate operation for the output device in use.

Line plotting
• Calculating intermediate positions along the line path b/w two specified endpoints positions.
Vector pen plotter or random scan display: Linearly varying horizontal & vertical voltage intensities.

Line plotting: jaggies (aliasing/stairstep)



• Noticeable on systems with low resolution.
• Improve their appearance somewhat by displaying them on high resolution systems.
• More effective techniques for smoothing raster lines are based on adjusting pixel intensities along the line path.

Antialiasing
Aliasing: distortion of pixels due to low frequency sampling (undersampling).
Jagged or stairstep appearance.

Line drawing algorithms

$y = mx + c$ (Cartesian slope-intercept equation)
m ↓ slope, c ↓ intercept

Given two end point of a segment: (x_1, y_1), (x_2, y_2)

$$m = \frac{y_2 - y_1}{x_2 - x_1} \quad ; \quad b = y_1 - mx_1$$

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

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

$|m| < 1$

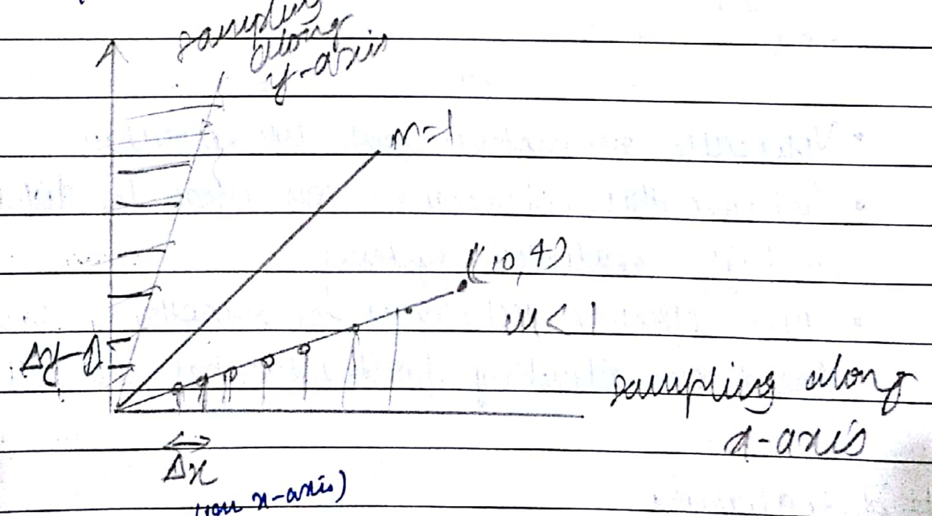
Δx can be set $\propto$ small hor. deflection voltage
$\Delta y \propto$ vertical deflection

$|m| > 1$

Δy can be set $\propto$ ~~small vertical~~ small horizontal deflection voltage
$\Delta x \propto$ vertical deflection

$|m| = 1$

$\Delta x = \Delta y$
horizontal and vertical deflection voltages are equal.



Sampling - Incrementing the value on x axis with Δx till we reach the end point.
↳ & corresponding y value is calculated using
$\Delta y = m \Delta x$
And vice-versa for other axis

DDA algorithm (Digital differential analyzer)

- Scan conversion line drawing algorithm based on either Δy or Δx.
- Sample the line at unit intervals in one co-ordinate & determine corresponding integer values nearest to the line path for the other coordinate.
- Consider the slope and $m \leq 1$; the line is from left endpoint to right end point.
  - sample at unit x-interval $\rightarrow \Delta x = 1$
  - to compute $y_{k+1} = y_k + m$
  - initially, $k=1$ increment 1 until final end pt. is reached
  - m can ~~also~~ be real no, y-value is approximated to nearest integer.

$$y_k = m x_k + b$$

$$y_{k+1} = m x_{k+1} + b$$

$$= m(x_k + 1) + b$$

$$\boxed{y_{k+1} - y_k = m}$$

- Consider the slope and $m > 1$, the line is from the left end point to right end point
  - The role is reversed $\rightarrow x_{k+1} = x_k + \frac{1}{m}$

$$y_k = m x_k + b$$

$$y_{k+1} = m x_{k+1} + b$$

$$y_k + 1 = m x_{k+1} + b$$

$$\Rightarrow m(x_{k+1} - x_k) = 1$$

$$\Rightarrow \boxed{x_{k+1} = x_k + \frac{1}{m}}$$

- $m <= 1$, +ve slope, $\Delta x = -1$
  $y_{k+1} = y_k - m$
- $m > 1$, +ve slope $\Delta y = -1$
  $x_{k+1} = x_k - 1/m$

} For right to left

Q. (2,3) (8,7)
Draw straight line from (2,3) to (8,7) using DDA algorithm.

$dx = 8-2 = 6$
$dy = 7-3 = 4$
$m <= 1$ but positive
$steps = dx = 6$

$y_{inc} = \frac{dy}{steps} = 0.67$

x_{old}	y_{old}	x_{new}	y_{new}	round(x)	round(y)
2	3	3	3.67	3	4
3	3.67	4	4.34	4	4
4	4.34	5	5.01	5	5
5	5.01	6	5.68	6	6
6	5.68	7	6.35	7	6
7	6.35	8	7.02	8	7

DDA : Pros and cons

- Faster algorithm
- Eliminates the multiplication by making use of raster characteristics
- Accumulation of round-off error. Calculated pixel position can drift away from true line.
- Rounding & floating point arithmetic are time consuming
- Improvement: by separating the increments m and 1/m into integer & fractional parts so that all calculations are reduced to integer operations.

classmate

Date
Page

Bresenham's algorithm

- Accurate & efficient raster

Q. Draw straightline from (2,3) to (12,8) using DDA

$dx = 12-2 = 10$

$dy = 8-3 = 5$

$m = \frac{dy}{dx} = 0.5$

$m <= 1$ true

Steps = 10

$y_{inc} = \frac{dy}{steps} = 0.5$

Xold	Yold	Xnew	Ynew	round(x)	round(y)
2	3	3	3.5	3	4
3	3.5	4	4	4	4
4	4	5	4.5	5	5
5	4.5	6	5	6	5
6	5	7	5.5	7	6
7	5.5	8	6	8	6
8	6.0	9	6.5	9	7
9	6.5	10	7	10	7
10	7	11	7.5	11	8
11	7.5	12	8	12	8