MODULE 2

Graphics Primitives

Points and Lines

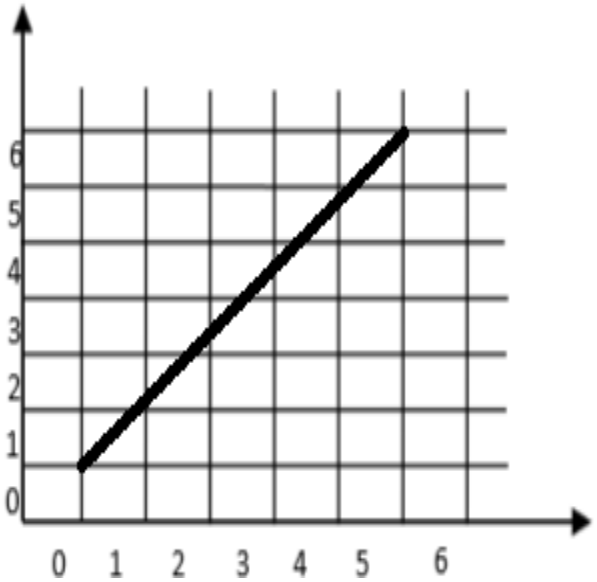
- Point plotting is done by converting a single coordinate position furnished by an application program into appropriate operations for the output device in use.
- Line drawing is done by calculating intermediate positions along the line path between two specified endpoint positions.
- The output device is then directed to fill in those positions between the end points with some color.
- For some device such as a pen plotter or random scan display, a straight line can be drawn smoothly from one end point to other.
- Digital devices display a straight line segment by plotting discrete points between the two endpoints.
- Discrete coordinate positions along the line path are calculated from the equation of the line.
- For a raster video display, the line intensity is loaded in frame buffer at the corresponding pixel positions.
- Reading from the frame buffer, the video controller then plots the screen pixels.

- Screen locations are referenced with integer values, so plotted positions may only approximate actual line positions between two specified endpoints.
- For example line position of $(12.36, 23.87)$ would be converted to pixel position $(12, 24)$.
- This rounding of coordinate values to integers causes lines to be displayed with a stair step appearance ("the jaggies"), as represented in fig 2.1.

Fig. 2.1: - Stair step effect produced when line is generated as a series of pixel positions.

- The stair step shape is noticeable in low resolution system, and we can improve their appearance somewhat by displaying them on high resolution system.
- More effective techniques for smoothing raster lines are based on adjusting pixel intensities along the line paths.

- For raster graphics device-level algorithms discuss here, object positions are specified directly in integer device coordinates.
- Pixel position will referenced according to scan-line number and column number which is illustrated by following figure.



Graphics Primitives

- Line Drawing algorithms
  - DDA
  - Bresenham's Line drawing Algorithm
- Circle Generating Algorithm
  - Midpoint circle generating Algorithm
  - Bresenham's circle generating Algorithm
- Polygon fill algorithm
  - Scan Line Polygon fill algorithm

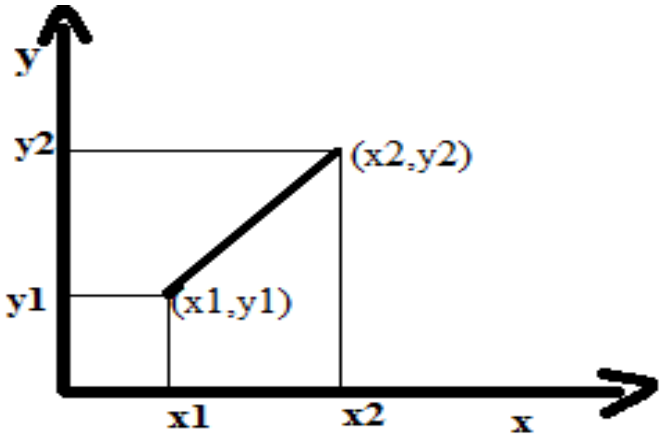
DDA Algorithm

- Digital Differential Analyzer Algorithm
- Scan conversion line drawing algorithm based on calculating either $\triangle x$ or $\triangle y$.
- Basic incremental algorithm.
- We have a line with end points (x_1, y_1) and (x_2, y_2).
- In order to draw a line (x_1, y_1) to (x_2, y_2), we have to find all the intermediate points between (x_1, y_1) and (x_2, y_2).
- Equation for straight line is

  $y = mx + b$,where "m" is the slope.
- Slope is calculated as

  $m = (y_2-y_1)/(x_2- x_1)$ or

  $m = (yk+1 - yk)/(xk+1 - xk)$



DDA Algorithm cntd..

- In DDA algorithm, we find all the intermediate points from starting point to end point.
- First, we plot initial(x, y) points & whenever we find the last point (x, y) we will end the algorithm.
- Depending upon the slope m, we have 3 cases.

Case 1 (m<1)

•x coordinate changes in unit interval.

$x_{k+1} = x_k + 1$

$x_{k+1} - x_k = 1$

$m = (y_2-y_1)/(x_2- x_1)$

$y_{k+1} = y_k + m$

Case 2 (m>1)

•y coordinate changes in unit interval.

$y_{k+1} = y_k + 1$

$y_{k+1} - y_k = 1$

$m = (y_2-y_1)/(x_2- x_1)$

$x_{k+1} = x_k + 1/m$

Case 3 (m=1)

•x and y coordinates changes in unit interval.

$x_{k+1} = x_k + 1$

$y_{k+1} = y_k + 1$

DDA Algorithm cntd..

- **Algorithm**
  1. Calculate slope m
  2. If m<1
     - X changes in unit interval
     - Y moves with deviation
     - New points (xk+1, yk+1) = (xk +1, yk +m)
  3. If m>1
     - x moves with deviation
     - y changes in unit interval
     - New points (xk+1, yk+1) = (xk +1/m, yk +1)
  4. If m=1
     - x and y moves in unit interval.
     - New points (xk+1, yk+1) = (xk +1, yk +1)
  5. Continue until we reach end points

DDA Algorithm cntd..

Q. The end points of a line is given : (0, 0) & (4, 5). Find all the intermediate points.

DDA Algorithm cntd..

Q. The end points of a line is given : (0, 0) & (4, 5). Find all the intermediate points.

$m = (y_{k+1} - y_k)/(x_{k+1} - x_k)$

$m = (5-0)/(4-0) = 5/4 > 1$

Hence $m>1$.

Then,

$y_{k+1} = y_k + 1$

$y_{k+1} - y_k = 1$

$x_{k+1} = x_k + 1/m$

$1/m = 4/5 = 0.8$

DDA Algorithm cntd..

Q. The end points of a line is given : (0, 0) & (4, 5). Find all the intermediate points.

x	y	x plotted on graph	y plotted on graph	(x, y)

DDA Algorithm cntd..

Q. The end points of a line is given : (0, 0) & (4, 5). Find all the intermediate points.

x	y	x plotted on graph	y plotted on graph	(x, y)
0	0	0	0	(0, 0)
0.8	1	1	1	(1, 1)
1.6	2	2	2	(2, 2)
2.4	3	2	3	(2, 3)
3.2	4	3	4	(3, 4)
4	5	4	5	(4, 5)

DDA Algorithm cntd..

Q2. The end points of a line is given : (2, 3) & (12, 8).
Find all the intermediate points.