Computer Graphics

Lecture 1

- Computer Graphics is the process of getting drawings using Computer.

	Computer graphics	Image processing	Computer vision
Input	description	Image	Image
output	Image	Image	description.

→ The Computer screen is divided into pixels. « rows, Columns »
→ A pixel is the intersection of every row and Column.

* Frame buffer is the region of memory that holds the Color data for the image displayed on the Computer screen.
- Example: 1024 X 768 X 1 → every pixel is stored in one bit, So the image will appear as black and white. « 0 or 1 »

- modern screens use 24 bit for every pixel. « 8 red, 8 green, 8 blue »

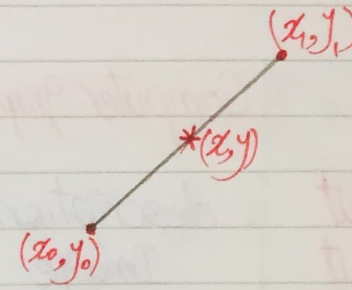
* In this Course, we will study:
  1) primitives.
  2) Transformations.
  3) Brightness.
  4) Colouring.

1) Primitives

- What is the problem for drawing a straight line mathematically?

→ mathematically:

$$\text{Slope} = \frac{y_1 - y_0}{x_1 - x_0} = \frac{y - y_1}{x - x_1}$$



$$\therefore y = y_1 + x\left(\frac{y_1 - y_0}{x_1 - x_0}\right) - x_1\left(\frac{y_1 - y_0}{x_1 - x_0}\right)$$

, y, x → unknown values.

$$\therefore y = Mx + B \longrightarrow \text{Equation of straight line.}$$

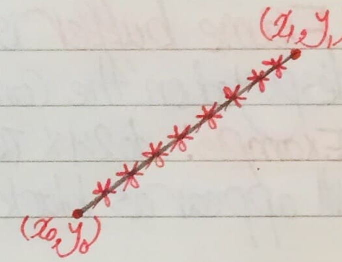
- This way is too slow and it needs approximation.

→ Parametric Form:

→ $x = x_0 + t(x_1 - x_0)$

→ $y = y_0 + t(y_1 - y_0)$

, where: $0 \le t \le 1$



- The problem is that the parametre t is float.

→ So, we have to use Algorithms for drawing a straight Line.

Algorithms

DDA	Bressenham's
digital differential equation	Line drawing algorithm

1) DDA: draw a straight line between the points: (2,3) , (12,8)

→ $dx = x_1 - x_0 = 12 - 2 = 10$
$dy = y_1 - y_0 = 8 - 3 = 5$

$\because dx > dy$
$\therefore$ number of steps $= dx = 10$

, $x_{increment} = \frac{dx}{\text{No. of steps}} = \frac{10}{10} = 1$

, $y_{increment} = \frac{dy}{\text{No. of steps}} = \frac{5}{10} = 0.5$

t	x	y	round(x)	round(y)
0	2	3	2	3
1	3	3.5	3	4
2	4	4	4	4
3	5	4.5	5	5
4	6	5	6	5
5	7	5.5	7	6
6	8	6	8	6
7	9	6.5	9	7
8	10	7	10	7
9	11	7.5	11	8
10	12	8	12	8

- The points (round(x), round(y)) will be drawn as a straight line.

2) Bressenham: draw a straight line between the points: (x_0, y_0), (x_1, y_1)

→ 1) Set (x_0, y_0)

2) $P_0 = 2dy - dx$

3) If $P_k < 0$ → y doesn't change, $P_{k+1} = P_k + 2dy$

, If $P_k \geq 0$ → y increases by 1, $P_{k+1} = P_k + 2dy - 2dx$

* Example: draw a straight line between the points: (2,3), (12,8)

→ $dx = 10$, $dy = 5$, $2dy = 10$, $2dy - 2dx = -10$

→ $P_0 = 2dy - dx = 10 - 10 = 0$

t	P_k	x_k	y_k
0	0	2	3
1	-10	3	4
2	0	4	4
3	-10	5	5
4	0	6	5
5	-10	7	6
6	0	8	6
7	-10	9	7
8	0	10	7
9	-10	11	8
10	0	12	8

- The points (x_k, y_k) will be drawn as a straight line.

* For all straight lines:

1) If |slope| > 1 → exchange y and x

2) If dy negative → decrease y values.

, If dx negative → decrease x values.

* Example: draw a straight line between the points: (3,48), (8,32)

→ $Slope = \frac{32-48}{8-3} = \frac{-16}{5} = -3\frac{1}{5}$

∵ |slope| > 1 , ∴ points: (48,3) , (32,8)

→ dx = 32 - 48 = -16 « decrease x values.»

dy = 8 - 3 = 5

2dy = 10 , 2dy - 2dx = -22 , P_0 = 2dy - dx = 10 - 16 = -6

t	P_k	x	y
0	-6	48	3
1	4	47	3
2	-18	46	4
3	-8	45	4
4	2	44	4
5	-20	43	5
6	-10	42	5
7	0	41	5
8	-22	40	6
9	-12	39	6
10	-2	38	6
11	8	37	6
12	-14	36	7
13	-4	35	7
14	6	34	7
15	-16	33	8
16	-6	32	8

x_{new}	y_{new}
3	48
3	47
4	46
4	45
4	44
5	43
5	42
5	41
6	40
6	39
6	38
6	37
7	36
7	35
7	34
8	33
8	32