

CSE-301 Computer Graphics

Final Exam

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SEMESTER	BS(CS) 5TH
PAPER	COMPUTER GRAPHIC

Question #1 (15 Marks)

- a. What is 'Eight Way Symmetry' of a circle?

Answer:

Eight-Way Symmetry:

It is a simple circle drawing Algorithm.

The equation for a circle is:

$$x^2 + y^2 = r^2$$

where r is the radius of the circle So, we can write a simple circle drawing by solving the equation for y at unit x intervals using:

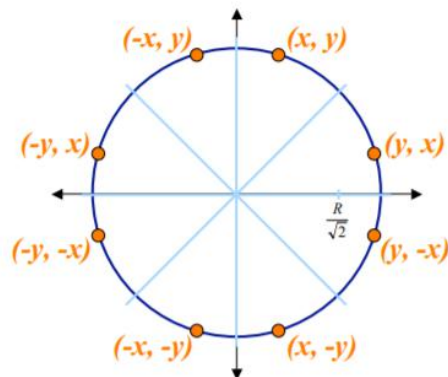
$$y = \pm\sqrt{r^2 - x^2}$$

The first thing we can keep in mind while drawing circle using this algorithm is that circles centered must be at origin (0, 0) in eight-way symmetry.

The 8 points can be plotted using these points: (x,y), (y,x), (y,-x), (x,-y), (-x,-y), (-y,-x), (-y,x), and (-x,y).

It is sufficient to compute only one point in these 8 points and all other points can be computed from it.

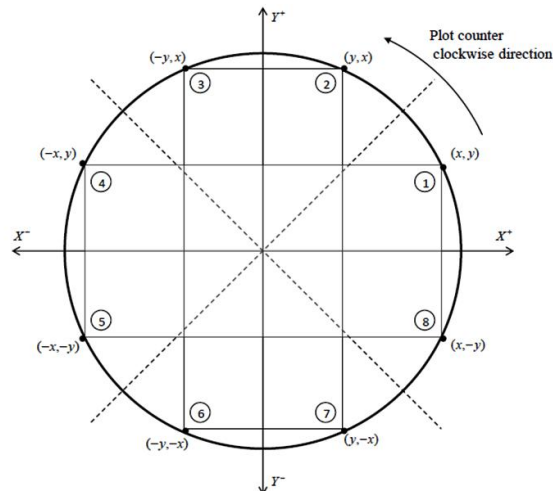
Below diagram shows the circle using eight-way symmetry:



- b. Write the 8 coordinates for representing 8-way symmetry in terms of (x, y) .

Answer:

The 8 points can be plotted using these points: (x,y) , (y,x) , $(y,-x)$, $(x,-y)$, $(-x,-y)$, $(-y,-x)$, $(-y,x)$, and $(-x,y)$.



- c. How does it help minimize the calculations?

Answer:

If we find or get only one point of this symmetry then the other seven points can be easily calculated using eight-way symmetry. The property of reflection will be used for this purpose to draw the whole circle or find all points that is seven using only 45° arc. In this why the repetitions of same calculations is avoided which minimize the calculations.

Question #2 (10 Marks)

- a. What happens if Refresh Rate of a display is too slow? Explain.

Answer:

The refresh rate is the number of times in a second that a display hardware updates its buffer.

The typical refresh rate for screen is less than 60HZ that produce visible flicker, meaning that we can tell the screen is being redrawn instead of seeing a constant image.

If this refresh rate is very/too slow, this flicker can be hard on our eyes and may cause them to exhaust quickly.

- b. What happens if Refresh Rate of a display is too fast? Explain.

Answer:

When the refresh rate of display screen is too fast, then we will notice less image flicker on the screen as we discuss it in above answer that less than 60 Hz refresh rate only produce noticeable flicker. In case of too fast refresh rate meaning, you can tell the screen is being redrawn instead of seeing a constant image.

Question #3 (10 Marks)

For plotting a line between two points, we can use algorithms such as

- Incremental Line Algorithm
- DDA Algorithm
- Midpoint Algorithm
- Bresenham's Algorithm

a. Explain the method used in and TWO of the above algorithms in your own words.

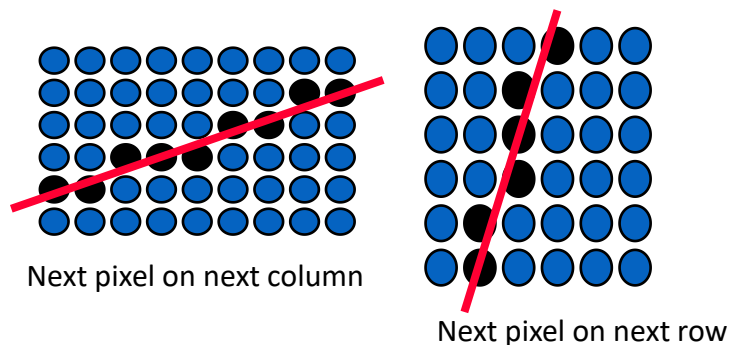
Answer:

- **Line:** A line is thin, (infinitely) long, straight geometrical object, i.e. a curve that is long and straight.
- A line may have three forms with respect to slope:
 - slope = 1
 - slope > 1
 - slope < 1

I. Incremental Line Algorithm:

- Incremental line Algorithm is one of the algorithms used to draw line. The steps involve in this is explain below:
- Let we have to compute/find one point based on previous point:

$$(x_0, y_0), (x_1, y_1), \dots, (x_k, y_k) \rightarrow (x_{k+1}, y_{k+1}) \dots$$



➤ **Method/ Algorithm Steps:**

The equation of straight line is given by:

$$y = m x + b$$

This algorithm achievement is to find simple line equation.

The steps involve in this algorithm is given below:

Step 1: Get two points X, Y find their differences Dx, Dy and start at the pixel for the left-hand side.

Step 2: Now we have to calculate the slope m and b values using formulas:

$$m = dy / dx$$

and

$$b = y - m x$$

Step 3: Now we have to find step and its comparison with 1.

$$|m| < 1$$

Step 4: Now if

$$|m| < 1$$

Then step along the pixel horizontally $x = x + 1$

Whereas $y = m x + b$

Step 5: else

step along the pixel vertically $y = y + 1$

Whereas $y = m x + b$

➤ **Example:**

I. Suppose a line has points

p1 (10, 10) - p2 (20, 18)

$$dy = y_2 - y_1 = 18 - 10 = 8$$

$$dx = x_2 - x_1 = 20 - 10 = 10$$

This means that there will be 10 pixels on the line in which for x-axis there will be distance of 1 between each pixel and for y-axis the distance will be 0.8.

II. Now consider the reverse case

Suppose a line has points

p1 (10, 10) , p2 (16, 20)

$$dy = y_2 - y_1 = 20 - 10 = 10$$

$$dx = x_2 - x_1 = 16 - 10 = 6$$

This means that there will be 10 pixels on the line in which for x-axis there will be distance of 0.6 between each pixel and for y-axis the distance will be 1.

III. The algorithm will take two points P1 and P2 and draw line between them whereas each point consists of x,y coordinates.

$$dx = p_2.x - p_1.x$$

$$dy = p_2.y - p_1.y$$

$$m = dy / dx$$

$$x = p1.x$$

$$y = p1.y$$

$$b = y - m * x$$

IV. if $|m| < 1$

for counter = p1.x to p2.x

drawPixel (x, y)

$$x = x + 1$$

$$y = m * x + b$$

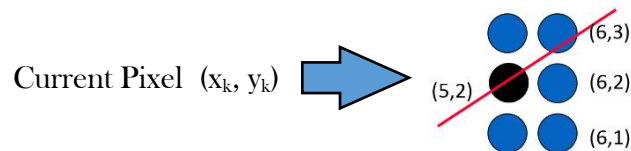
else

V. for counter = p1.y to p2.y

drawPixel (x, y)

$$y = y + 1$$

$$x = (y - b) / m$$



II. DDA Algorithm:

- DDA is the simpler and fine algorithm that works in all direction and remove the drawbacks of line increment algorithm, avoid too much calculations.
- DDA abbreviated for digital differential analyzer is a simple line generation algorithm which is explained step by step below:

➤ Method/ Algorithm Steps:

I. Get any two points and find difference between these points, dx and dy as:

$$dy = y2 - y1$$

$$dx = x2 - x1$$

II. Now we need to identify the number of steps to put pixels
if $|dx| > |dy|$ then

$$\text{step} = |dx|$$

else

$$\text{step} = |dy|$$

III. Now we have to calculate in x coordinate and y coordinate that is actually the increments:

$$X \text{ Increment} = dx/step$$

$$Y \text{ Increment} = dy/step$$

IV. A loop is required that will run up to 'step' times.

We have to put the pixels in the coordinates according to the increments in X and Y and complete the drawing of line.

V. Now Add-up all above in the algorithm:

DDA_Line (Point p1, Point p2)

$$dx = p2.x - p1.x$$

$$dy = p2.y - p1.y$$

$$x1 = p1.x$$

$$y1 = p1.y$$

if $|dx| > |dy|$ then

$$step = |dx|$$

else

$$step = |dy|$$

$$x \text{ Increment} = dx/step$$

$$y \text{ Increment} = dy/step$$

for counter = 1 to step

draw Pixel (x1, y1)

$$x1 = x1 + x \text{ Increment}$$

$$y1 = y1 + y \text{ Increment}$$

b. Explain the drawbacks of these algorithms.

➤ **Drawbacks of these algorithms:**

I. Incremental Line Algorithm Drawbacks:

- This algorithm requires a lot of calculations for a single image which is time consuming and monotonous work, may cause errors.
- Also, the end point accuracy is poor.
- Incrementation in X point so that the next pixel is to be set in next column, this approach will not be valid if the slop of the line is large.

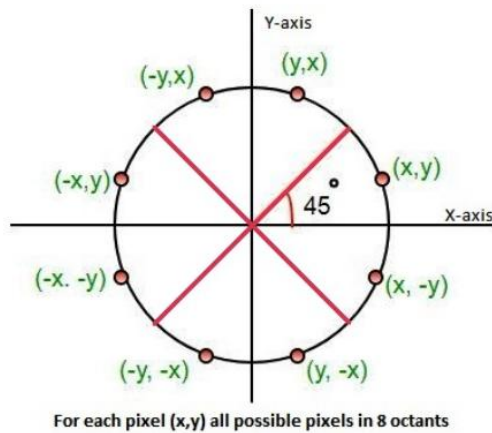
II. DDA Algorithm Drawbacks:

- The end point accuracy of DDA algorithm is poor.
 - Time consuming while in Round-Off state.
 - The arithmetic of floating point is also time consuming.
 - Cause the calculation pixel position to drift away from true line path for long line segment.
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Question #4 (15 Marks)

When plotting a circle, the convention is to draw the arc of first quadrant and then impose the same values in all the other 7 quadrants. To plot the arc in first quadrant, we just need the radius of the circle.

- a. Draw the first arc of the circle centered at $(0, 0)$ and radius $r = 13$. (10 Marks)

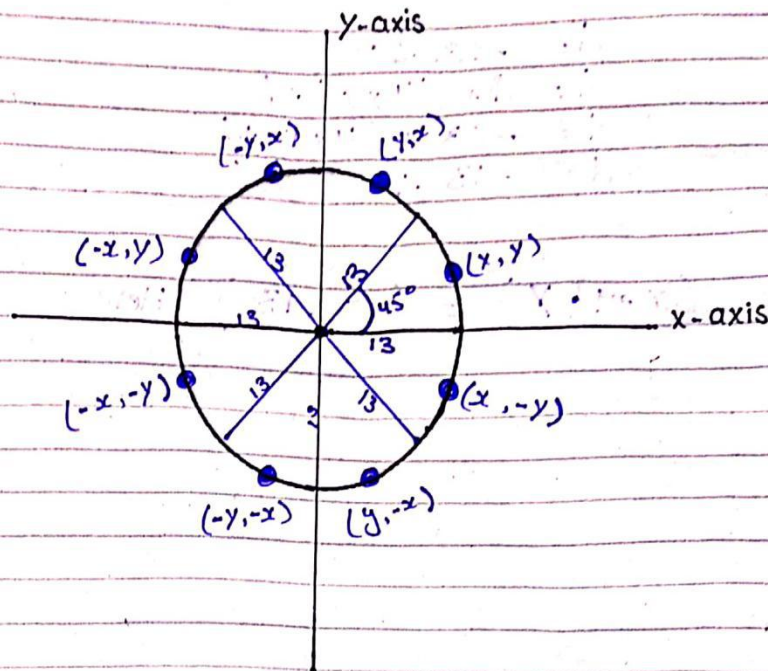


- b. Convert the (x, y) values determined in part 'a' to the second quadrant. (5 Mark)

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PART No (A) Question No 4



PART No B :-

Given $r = 13$, $(x, y) = (0, 0)$
if $d > 0$ then $(x+1)(y+1)$

initially $(x, y) = (0, 13)$
where

$$d = (3 - (2 \times r)) \text{ and } x=0, y=r=13$$

$$d = 3 - (2(13))$$

$$d = 3 - 26$$

$$d = -23 < 0$$

$$\text{So } (x+1, y) = (1, 13)$$

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Now $x < y$ $1 < 13$ so repeat above step

$$d = -23 < 0 \text{ So}$$

$$d = d + (4x) + 6$$

$$d = -23 + (4 \times 1) + 6$$

$$d = -13 < 0$$

So $(x+1, y) = (2, 13)$ Here $x < y$

$$d = -13 + (4 \times 2) + 6$$

$$d = -13 + 8 + 6$$

$$d = 1 > 0$$

$$(x+1, y) = (3, 13)$$

$x < y$ and $d > 0$ So

$$d = d + 4x \cdot (x - y) + 10$$

$$d = 1 + 4 \times (3 - 13) + 10$$

$$d = -29 < 0$$

$$\text{and } (x, y-1) = (3, 12)$$

$x < y$ and $d < 0$ therefore

$$d = -29 + (4 \times 3) + 6 = -11 < 0$$

$$\text{So } (x+1, y) = (4, 12)$$

$x < y$ and $d < 0$ therefore

$$d = -11 + (4 \times 4) + 6 = 11$$

$$(x+1, y-1) = (5, 11)$$

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$x < y$ and $d > 0$ therefore

$$d = 11 + 4(5 + 11) + 10$$

$$d = 19$$

So

$$(x+1, y-1) = (6, 10)$$

$x < y$ and $d > 0$ therefore

$$d = 10 + 4 \times (6 - 10) + 10$$

$$d = 4 > 0$$

So

$$(x+1, y-1) = (7, 9)$$

$x < y$ and $d > 0$ therefore

$$d = 4 + 4 \times (7 - 9) + 10$$

$$d = 6 > 0$$

So $(x+1, y-1) = (8, 8)$

Here $x = y$ So exit the program.

