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Paper (Computer graphics)

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BS(CS) 5<sup>th</sup> semester

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23/06/2020

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Question1 (a): what is “eight way symmetry “of a circle?

Answer:

The most important thing in drawn a circle is figuring out how the circle is drawn utilizing eight way symmetry. It depends on mirror reflection. In the event that we see right hand in the mirror we will see left hand, comparatively on the off chance that we see pixel (x,y) in mirror we will see (y,x).So, point p1(x,y) will become p2(y,x) after reflection.

Question1 (b): Write the eight coordinates for representing eight way symmetry in term of (x, y)?

**Answer:** Any circle follows 8-way symmetry. This means that for every point (x, y) 8 points can be plotted. These (x, y), (y, x), (-y, x), (-x, y), (-x,-y), (-y,-x), (y,-x), (x,-y).

For any point (x+a, y+b), points (x ± a, y ± b) and (y ± a, x ± b) also lie on the same circle. So it is sufficient to compute only 1/8 of a circle, and all the other points can be computed from it.

Question1 (c): How does it help minimize the calculations?

Answer:

$$x_1=1$$

$$x_2=5$$

$$y_1=1$$

$$y_2=3$$

$$D_x=4$$

$$D_y=2$$

The initial decision parameter and the minimize calculation has the value ;

$$P_k= 2\Delta y- \Delta x$$

$$P_k= 4-4=0$$

Question2 (a): What happens if refresh rate of display is too slow?  
Explain.

Answer:

Commonly a refresh rate of less than 60 Hz will produce recognizable Flicker, meaning you can tell the screen is being redrawn as opposed to seeing a constant picture. In the event that the refresh rate is too slow, this can be difficult for your eyes and may make them tire rapidly.

**Question2 (b): What happens if refresh rate of display is too fast?**

**Answer:**

On the off chance that you determine the refresh rate that is unreasonably high for your monitor, your screen may get unusable and your hardware might be damaged. Additionally not, a few monitors shudder at higher rates

Furthermore, a portion of the higher resolutions and color depths might be inaccessible at the higher frequencies. In my older monitor, it showed resolutions from 60 Hz to 200Hz.

**Question3 (a):**

**Answer:**

### 1) Bresenham Line Drawing Algorithm:

Bresenham's algorithm finds the closest integer coordinates to the actual line, using only integer math. Assuming that the slope is positive and less than 1, moving 1 step in the x direction, y either stays the same, or increases by 1. A decision function is required to resolve this choice.

Move across the x axis in unit intervals and at each step choose between two different y coordinates

For example, from position (2, 3) we have to choose between (3, 3) and (3, 4)

We would like the point that is closer to the original line

At sample position  $x_{k+1}$  the vertical separations from the mathematical line are labelled  $d_{upper}$  and  $d_{lower}$

The y coordinate on the mathematical line at  $x_{k+1}$  is:

$$Y=M(x_{k+1})+b$$

1. Input the two line end-points, storing the left end-point in  $(x_1, y_1)$  and plot this point.
2. Calculate the constants  $\Delta x$  i.e.  $dx$ ,  $\Delta y$  i.e.  $dy$ ,  $2\Delta y$  and  $2\Delta x$ , get the first value for the decision parameter as:

$$e=2\Delta y- \Delta x$$

3. At each  $X_k$  along the line, starting at  $k = 1$ , perform the following test:

$$\text{If } e < 0$$

then the next point to plot is

$$(x_k + 1, y_k)$$

and set

$$e = e + 2\Delta y$$

Otherwise, the next point to plot is  $(x_k + 1, y_k + 1)$  and:

$$e = e + 2\Delta y - 2\Delta x$$

4. Repeat step 3  $(\Delta x - 1)$  times.

For  $m > 1$ , we will find whether we will increment  $x$  while incrementing  $y$  each time.

After solving, the equation for decision parameter  $p_k$  will be very similar, just the  $x$  and  $y$  in the equation will get interchanged.

Example:

Let's have a go at this

Let's plot the line from  $(20, 10)$  to  $(30, 18)$

First off calculate all of the constants:

- $\Delta x$ : 10
- $\Delta y$ : 8
- $2\Delta y$ : 16
- $2\Delta y - 2\Delta x$ : -4

Calculate the initial decision parameter  $p_0$ :

- $p_0 = 2\Delta y - \Delta x = 6$

2) DDA Algorithm:

DDA abbreviated for digital differential analyzer has a very simple technique.

Find difference,  $dx$  and  $dy$  as:

$$dy = y_2 - y_1$$

$$dx = x_2 - x_1$$

if  $|dx| > |dy|$  then

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

else

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

Now very simple to say that  $\text{step}$  is the total number of pixels required for a line.

Next step is to find  $x$  Increment and  $y$  Increment:

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

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

Next a loop is required that will run 'step' times.

In the loop drawPixel and add xIncrement to x1 and yIncrement to y1.

Now sum-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|
```

```
    xIncrement = dx/step
```

```
    yIncrement = dy/step
```

```
    for counter = 1 to step
```

```
        drawPixel (x1, y1)
```

```
        x1 = x1 + xIncrement
```

```
        y1 = y1 + yIncrement
```

Question 3(b):

Answer:

1) Drawback of Bresenham Line Drawing Algorithm:

These are the Drawbacks of Incremental Line Algorithm.

- Though it improves the accuracy of generated points but still the resulted line is not smooth.
- This algorithm is for the basic line drawing.
- It cannot handle diminishing jaggiest.

2) Drawback of DDA algorithm:

The disadvantages of DDA Algorithm are-

- There is an extra overhead of using round off( ) function.

- Using round off( ) function increases time complexity of the algorithm.
- Resulted lines are not smooth because of round off( ) function.
- The points generated by this algorithm are not accurate.

Question #4 (15 Marks)

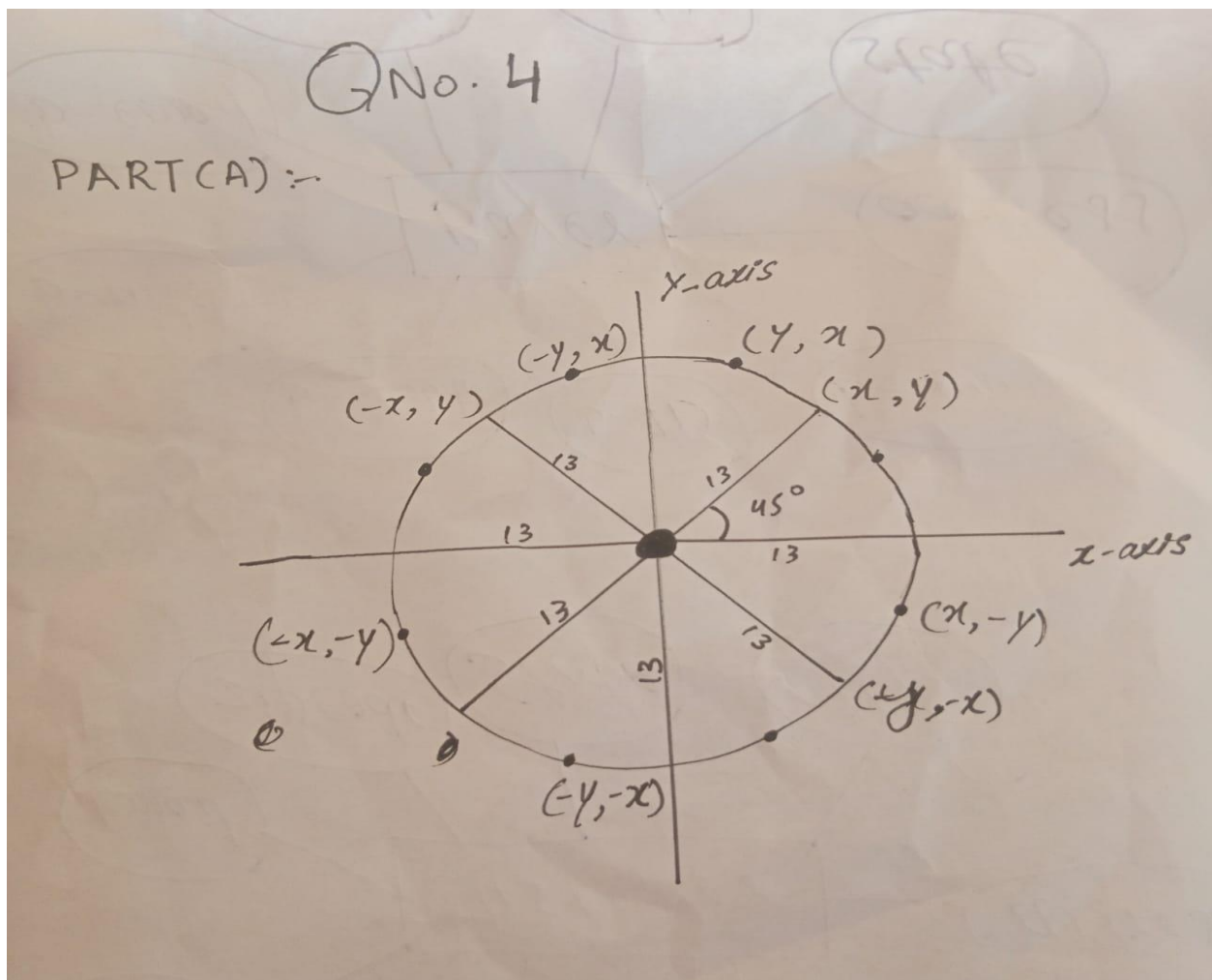
When plotting a circle, the convention is to draw the arc of first quadrant and then impose the same values in all the other 7 quadrants. To plot the arc in first quadrant, we just need the radius of the circle.

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

Convert the  $(x, y)$  values determined in part 'a' to the second quadrant.

Question 4(a):

Answer:



Question4 (b):

Answer:

Given data

$$r=13, (x, y)=(0,0)$$

if  $d > 0$  then  $(x+1, y-1)$

else  $(x+1, y)$

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

where  $d=3-(2*r)$  and  $x=0, y=r=13$

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

$$d=3-26$$

$$d=-23 < 0$$

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

now  $x < y$   $1 < 13$

so repeat above steps.

$$D=-23 < 0$$

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

$$D=-23+(4*1)+6$$

$$D=-23+10$$

$$D=-13 < 0$$

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

$$D=-13+(4*2)+6$$

$$D=-13+8+6$$

$$D=1 > 0$$

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

$X < y$  and  $d > 0$

So  $d = d + 4 * (x - y) + 10$

$D = 1 + 4(2 - 13) + 10$

$D = -29 < 0$

And  $(x, y - 1) = (3, 12)$

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

$D = -29 + (4 * 3) + 6 = -11 < 0$

$(X + 1, y) = (4, 12)$

$X < y$  and  $d < 0$  therefore

$D = -11 + (4 * 4) + 6 = 11$

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

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

$D = 11 + 4(5 - 11) + 10 = 19$

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

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

$D = 10 + 4(6 - 10) + 10 = 4$

$D = 4 > 0$

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

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

$D = 4 + 4(7 - 9) + 10$

$D = 6 > 0$

$(X + 1, y - 1) = (8, 8)$

Here  $x = y$  so program will be existed.