08:12:2017

COMPUTER GRAPHICS

1. Survey of computer graphics :(or) Application of Graphics

* Graphics
* Animation
* Morphing

computer graphics is used in many fields education, medicine etc.

CAD : Computer Aided Design

It is used in designing building, models

Wireframe Displays :

We can see the internal parts using these wireframe displays.

Advantage - Interactive adjustment.
Personalized symbols.
To test the performance of vehicle.

Animations in CAD Application :

Animation - frame by frame

Animation used in Virtual Reality

- Virtual Reality Walk Through.

We can view the final view appearance.

2. PRESENTATION GRAPHICS :

* 35 mm slides
* It is used for financial, mathematical data and reports
* Ex: Bar chart, pie chart

3. COMPUTER ART :

* Fine Art and Commercial Art.

Fine Art - Paint Brush Programs.

* It is used to paint the pictures on the video monitor screen. Uses Stylus.

Animation : Frequently used in advertisement

* Television, Commercial etc.
* Animation is produced by frame by frame.
* Each frame will be having motion and given positions.
* Successive frames differ by position.
* Each frame should be saved as image file.
* Film or video buffer.
* For first time 24 frames
* For play back 30 frames.

4. ENTERTAINMENT :

* Used in Movies, film
* Computer graphics is used in making motion pictures, television shows etc.

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Education and training:

It is mainly used for pilot training, flight simulators

It helps to understand the performance in better way.

Input parameter - keyboards.

Visualization:

Large amount of data can be visualized to study the behaviour.

* Scientific Visualization
* Business Visualization

Effective visualization depends upon the characteristic of data.

Collection data has scalar values, vector values.

Visualization used by scientist and engineers.

Color Coding is one way to visualize the data set.

Image processing techniques are combined with comp graphic visualization

Image Processing:

Difference between image processing and computer graphic.

Computer Graphic is used to create a picture whereas in image processing is used to process the image or picture (applying the technique to modify or interrupt the picture).

Application:

Improving the image quality.

Machine Perception. of visual information used in Robo.

Steps to be followed for image processing :

1. Image should be digitalized
2. Should apply the image processing techniqu

Purpose :

We can rearrange the parts of the picture, improve the colour, or to improve the quality of the picture.

Ex: Satellite picture undergo image processing

Tomography is used in medical field where X-ray is used to view the cross sectional view (X-ray Tomography).

CT - Computed Tomography.

PET - Position Emission Tomography.

Used in the field of nuclear fields, medicine etc. surgery

Artificial limbs : Combining Image Processing + Computer Graphic.

8. Graphical User Interface:

Icon is a graphical symbol which is desigued to use the application

Advantage:

Less screen space.

Easier interpretation.

Window Manager - Allows to open multiple window.

essing :

ssing technique.

picture,

ove the

processing

l field

e cross

aphy.

medicine etc.
surgery

cessing +
Graphic.

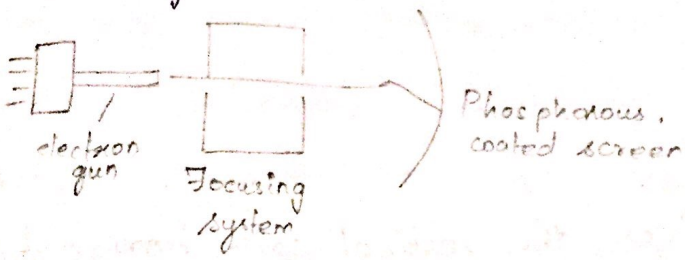
is designed

Hiple window.

VIDEO DISPLAY DEVICE: 8m.

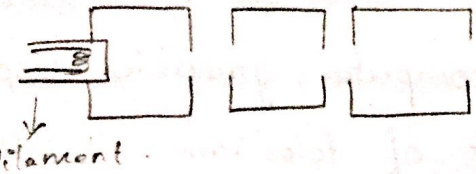
TV - Monitors - Picture Tube - CRT (Cathode Ray Tube).

Cathode Ray Tube:



2M / Refresh CRT - keeps the phosphorous glowing to redraw the picture.

Components of Electron Gun:



1. heated metal cathode are heated through filament.
2. Control Grid.

* Control grid is used to control the brightness of the picture.

* Focusing system is needed to converge the electron.

* Electro static focusing system is used in television computer graphic control system.

Persistence: Even when the CRT is removen how long the phosphorous glows.

Low persistence phosphorous used to avoid flickering of picture.

High persistence phosphorous resistance used to display complex pictures.

RESOLUTION: 2M.

Maximum no. of pixels without overlapp displayed in the CRT is called resolution.

1280 x 1024

Aspect ratio:

This number gives the vertical with horizontal.

3/4.

RASTER SCAN DISPLAY

Rows in display screen are called as scan line.
Most common form of computer graphic display
Based on the concept of television.
It has illuminated spots.
The picture definition is stored in refresh buffer or storage buffer.

Each screen point (pixel) - picture element
in raster scan is used to give realistic displ

Example of raster scan display : TV

One bit per pixel: 0 - OFF
1 - ON

2M
- One bit per pixel in black & white system is called bit map.

2M Multiple bit per pixel in black and white system is called pix map.

While scanning, returning to the left of the line while refreshing horizontal replace.

Vertical replace. - returning to next scan line after refresh is called vertical replace.

Interlace and refresh procedure - If beam is crossing each scan line, if there is any left out in second pass (so that every line is scanned is called interface and refresh procedure).

It is effective technique to avoid flicker.

Random Scan Display (or) Vector display (or) Stroke Writting (or) Calligraphic Display :

Electron will be directed to the screen where the picture is to be drawn.

Components of random scan display.

Ex: Pen plotter.

Refresh Display file - Set of line drawing in refresh area.

2m. Difference between raster scan and random scan.

// Colour CRT monitor :

Deep penetration method

Shadow Masking method.

24 bits per pixel.

DVST - Direct View Storage Tube.

Non-emissive - LCD. //

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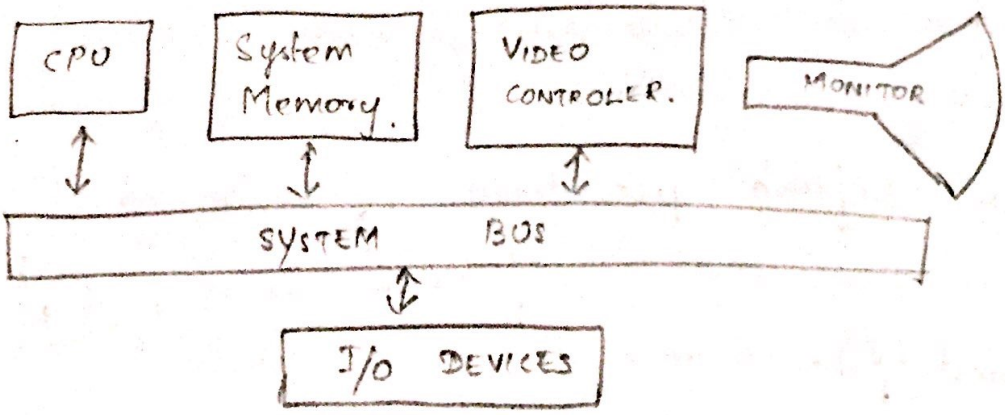
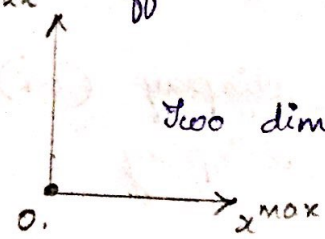
Raster Scan System:

ARCHITECTURE:



* Video controler - display controler.. to control display d
* Frame buffer can be anywhere in the system memo



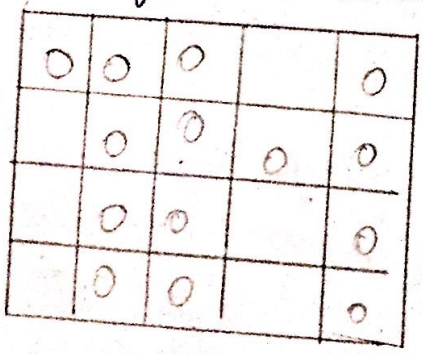
Scan line:

y^{max} to 0.
0 to x^{max}.

* Two register is used : X register is said to 0
  y register is set to y^{max}.
* X register is incremented by 1 when we measu
  next pixel on the scan line. On reaching
  the last line again x register is said
  to 0 and y - register is decremented by

Cross Mechanism for real time animation:

Character defined as rectangular grid of pixel positio



Or Curve section.

Raster Scan Display Processor (or) Graphic controler (or) Display Core Processor.

To free CPU from graphic

2M / A major task of the display processor is digitizing the picture definition in a given program into a pixel intensity value for storage in the frame buffer. This digitalization process is called scan conversion. //

line styles:

Solid ——————

Dotted .....

Dash — — — —

In an effort to reduce the memory requirements, methods used are link list and encoding.

One coay, to do this is to store each scan line as a set of integer pairs. One number of each pair intensity value and second number specifies no. of adjacent pixels of the scan line that are to have the intensity. This techniqie is called

2M RUN-LENGTH ENCODING. It is used to reduce. storage space. It is used to construct pictures of long runs of single color each. similar

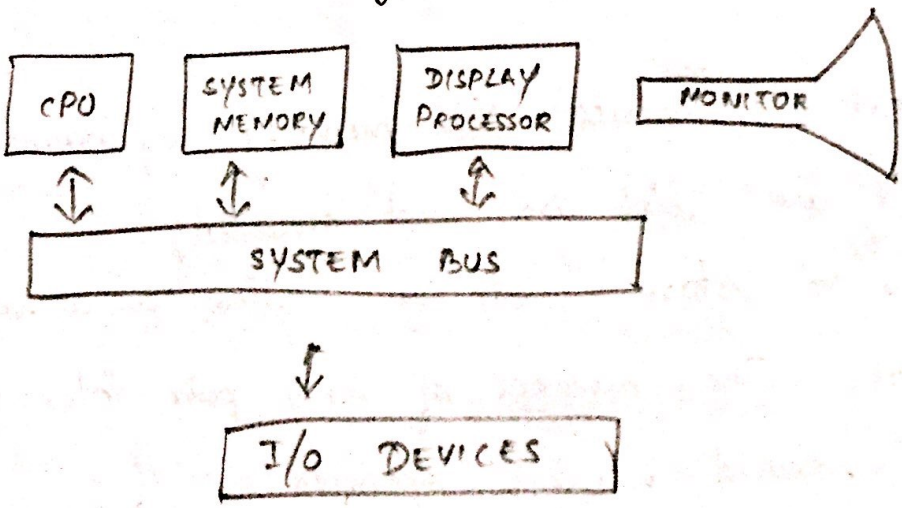
approach can be taken if the pixel intensity changes linearly.

Another approach is to encode raster as a set of rectangular area is called CELL ENCODING.

Disadvantage of run-length encoding :

Intensity changes are difficult, to make and storage requirements actually increase as the length of runs decreases. It is difficult for the display controller to process the raster when many short runs are involved.

Random Scan System :



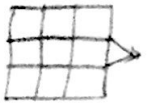
Display processing unit or graphic controller. It is used to process the output and displays it

20·12·2017.

WORKING OF RANDOM SCAN SYSTEM:

Application program → Input is stored in system memory along with the graphic package → Display processor processes the graphic command → Displays the out on the monitor.

Directing the electron beam along the lines of the picture.

Mediawall - Multiscreen system.  Mullions.

Used in passenger terminal, museums etc.

INPUT DEVICES: 8m. (no diagram needed)

Keyboard - Alphanumeric keyboard - Used for non-graphical data - Cursor control keys - Function keys.

Ergonomic - User should feel comfortable.
Ergonomic designed keyboards were developed.

Mouse - Handheld device. → Controlling the cursor movement
Z-mouse will be used in virtual reality - CADD - Animation.
Top - standard ball.
bottom - Mouse ball

Track ball - It will move, operated using the palm - 2D
Space ball - It will not move. but operates same as track ball. - 3D.

Strain Guage - It is used to measure the pressure applied.

Joystick: Used to control the screen cursor.
Isometric Joystick: Pressure sensitive Joystick.

Data glove : Grasping virtual objects - Used to det the movement of finger and hand position. It has reciever and transmitting antenna's. Consist of sensors.

Digitizers : Common devices used for drawing, painting , 2D - input , 3D - input. One type of digitizer ~~stylus~~ graphic Tablet. (Stylus base

Types:
Electro magnetic pulses
Accoustic Tablets.

Image Scanners:

Optical Scanning Mechanism → Text are scanned and stored in devices.

Touch Pannel:

Allows to display object using finger touch. Mainly used for selecting processing option. Input can be recorded by

* Optical - LED - light detectors
* Electrical - Transparent plates? < conducting material / resistance material
* Acoustical - Sound waves will be generated along the glass plates.

Waves will be emitted from the fingers to display. Transmission of each wave and ~~Received~~ reflection to the emitter.

Light Pens : It is also used to select the screen positions. (Pencil shape) Based on the lightpring, reading will be different.

Disadvantage : Light screen only can be seen. Prolong usage results in hand pain.

VOICE SYSTEM :

Storing the common words in the system. Advantage is there is no need of input commands, does not requires much attention.

It requires dictionary, voice recognizing pattern, microphone, headphones.

HARDCOPY DEVICES : 2m

PRINTER :

Pictures on the paper can be printed by plotter or printer.

Dot size - No. of dots per inch. or lines per inch.

Printers produce output either by impact method or non impact method.

Impact — Type writter
Ex : Line Printer

Non impact — by passing light
Ex : Plotters

Non. impact method uses laser technique, ink Jet spray, Xerographic process.

Electrostatic Method and electro thermal methods are also used by non. impact printers

(* all methods should be explained in detail)

Impact printer - color output is limited.

Non-impact printer uses three color pigments (crayon, magenta, yellow.)

Graphic layouts will be generated by pen pl

GRAPHIC SOFTWARE:

General programming Packages

Special purpose application packages.

General purpose programming packages → high level languages → It will be using GL

GL - Graphic library.

Basic functions - Straight line, color, polygon, circ intensity transformation. (To generate picture components selecting views.

Application Graphic image designed for users who are not computer professionals or programmers

Ex: CADD app, medical app.

User should be able to use the s/w in his own forms.

Co-ordinate representation: 2M

Cartesian co-ordinate: x-y co-ordinates.

We can construct the shape of individual objects, such as trees, furnitures in

a scene within a single frame called modelling co-ordinates local co-ordinates or master co-ordinates.

Once individual objects shape have been specified we can place the object into appropriate position within the scene using reference frame called world co-ordinate. Finally the world co-ordinate description of the scene is transferred to one - or more output device reference frames for displaying. These display co-ordinate systems are referred to as device co-ordinates or screen coordinates incase of video monitor.

Graphic system first converts world co-ordinates position to normalized device co-ordinates in the range 0 to 1. Before final conversions to specific device coordinates, this makes the system independant of various devices that might be used at a particular work station.

$$(xmc \cdot ymc) \rightarrow (xwc : ywc) \Rightarrow (xnc , ymc) \Rightarrow (xdc : ydc).$$

Basic building blocks for pictures are referred to as output primitives. They include character string, geometric entities such as points, straight line, curved lines, filled areas (polygon, circle) and shapes defined

with array of color points. Routines for output primitives provide the basic tool for constructing pictures.

22:12:2017 OUTPUT PRIMITIVES:

Attributes are the properties of the output primitives. An attributes displays describes how a particular primitive should be displayed. They include intensity, colour specifications, line styles, text styles and area building patterns.
filling

We change the size, position or orientation of an object within a scene using geometric transformation. Viewing transformation are used to specify the view (i.e) to be presented and the portion of output displayed, that is area. to be used.

Pictures can be subdivided into component parts subject or segments or objects.

Input function are used to control and process the data flow from the interactive devices.

Software Standards:

Primary goal of standardized software is portability. When packages are designed with

std graphic functions software can be easily moved from one organisation to another. and used hardware system in different implementations and Applications. Without standards programs designed for one hardware system often cannot be transferred to another system. without extensive recoritting of the program.

GRAPHIC STANDARDS:

Graphical kernal System - This is the first graphic software standard adopted by ISO (International Standard Organisation) and ANSI (American National Standard Institute).

GKS was originally designed as 2D graphic package. GKS+ is developed for 3D graphic package.

Programmers Hierarchical Interactive Graphic Standards (PHIGS): it is an extension of GKS. and PHIGS+ is an extension of GKS+.

There is no standard methoddogy for displaying output.

Interface Output device Standards:

Standardization for device interface method is given in computer graphic interface (CGI).

CGM (Computer Graphic Metafaces) system specifies standard for archiving and transporting pictures

WORK STATION:

Work station refers to a computer system with a combination of input and output devices which is designed for a single us

POINTS & LINES:

OUTPUT PRIMITIVES:

Graphic programming packages provides function to describe a scene interms of basic geometric structures referred to as output primitives.

Points and straight line segments are the simplest geometric components of pictures. Additional output primitives that can be used to construct a picture can include circles and other ~~coding~~ conic sections, quadric surfaces, spline curves and surfaces, polygon color areas and character strings.

Point plotting is accomplished by converting a single co-ordinate position furnished by single an application program into appropriate operations for the output device in use. With a CRT monitor for example. Electron beam is turned on to illuminate the screen phosphorous at the selected location, how the electron beam is positioned depends upon the display technology.

Random scan (vector) system stores point-plotting instructions in the display list and co-ordinate values in these instructions are converted to deflection voltages that position the electron beam at a screen location to be plotted during each refresh cycle.

For a black & white Raster system, a point is plotted by setting the bit value corresponding to a specified screen position within the screen buffer 2-1. Then as the electron beam swipes across each horizontal scan line, it emits a brusts of electrons (plots a point) whenever a value of one is encountered in the frame buffer.

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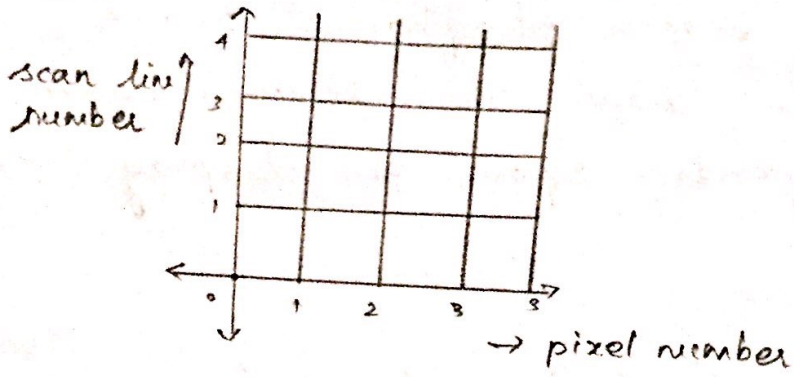
LINE DRAWING:

Calculating the intermediate (points) to draw a line path. For analog device such as pen, plotter to draw the lines.



Line drawing algorithm:

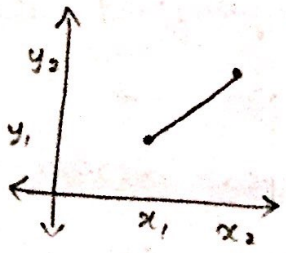
Equation of straight line ⇒ $y = mx + b$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$b = y - mx$$

$$\boxed{\Delta y = m \Delta x.}$$

Line path between end point position



DDA ALGORITHM V. IMP Algorithm is must.
(Digital Differential Analyzer):

It is scan line conversion algorithm based on calculating Δx or Δy

$$\Delta y = m \Delta x$$

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

For lines with +ve slope:

$$\Delta x = 1 \Rightarrow \Delta y = m$$

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

$$\boxed{y_{k+1} = y_k + m} \rightarrow (1)$$

k can take values from 1 to until reaches the end point. m takes +ve integer between 0 and 1.

For lines with +ve slope more than 1:

$$\Delta y = 1$$

$$\Delta x = \frac{1}{m}$$

$$\boxed{x_{k+1} = x_k + 1/m} \rightarrow (2)$$

Based on equation (1) & (2) the lines are represented from left endpoint to right end point.

If the process are reversed,

$$\Delta x = -1$$

$$\Delta y = -m$$

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

$$\boxed{y_{k+1} = y_k - m} \rightarrow (3)$$

when $\Delta y = -1$

$$\Delta x = -1/m$$

$$\boxed{x_{k+1} = x_k - 1/m} \rightarrow (4)$$

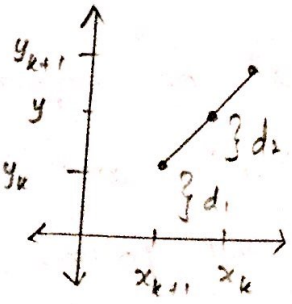
Procedure line DDA (xa, ya, xb, yb ; integer)
Var dx, dy, steps, k : integer ;
.
.
.
end line DDA //

DDA algorithm is mainly used for calculating pixel position, Rounding off error successive addi floating point is a problem.

BRESENHAM ALGORITHM: 8M. & IMP.

It is accurate and efficient algorithm for drawing raster line.

$x_k + 1$



Considering the scan line conversion process,

$$y = m(x_k + 1) + b \rightarrow (1)$$

$$d_1 = y - y_k$$

$$d_1 = m(x_k + 1) + b - y_k$$

$$d_2 = (y_{k+1}) - y$$

$$d_2 = y_k + 1 - m(x_k + 1) - b$$

$$d_1 - d_2 = 2m(x_k+1) - 2y_k + 2b - 1 \rightarrow (2)$$

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

$$P_k = \Delta x (d_1 - d_2)$$

$$P_k = 2\Delta y \cdot x_k - 2\Delta x \cdot y_k + c \rightarrow (3).$$

$$\Delta x (2m(x_k+1) - 2y_k + 2b - 1)$$

$$= \Delta x\, 2m x_k + 2m\Delta x - 2y_k\Delta x + 2b\Delta x - \Delta x$$

$$= \Delta x \times \frac{\Delta y}{\Delta x} 2x_k + 2\frac{\Delta y}{\Delta x}\Delta x \cdot 2y_k\Delta x + 2b\Delta x - \Delta x$$

$$= 2\Delta y\, x_k + 2\Delta y - 2\Delta x\, y_k + 2b\Delta x - \Delta x$$

$$= 2\Delta y\, x_k - 2\Delta x\, y_k + c$$

$$\boxed{c = 2\Delta y + 2b\Delta x - \Delta x}$$

$$P_{k+1} = 2\Delta y\, x_{k+1} - 2\Delta x\, y_{k+1} + c$$

$$P_{k+1} - P_k = 2\Delta y (x_{k+1} - x_k) - 2\Delta x (y_{k+1} - y_k)$$

$$= 2\Delta y (x_k + 1 - x_k) - 2\Delta x (y_{k+1} - y_k)$$

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

$$P_{k+1} - P_k = 2\Delta y - 2\Delta x (y_{k+1} - y_k)$$

$$P_{k+1} = P_k + 2\Delta y - 2\Delta x (y_{k+1} - y_k)$$

($y_{k+1} - y_k$ will be 0 or 1 based on parameter P_k).

Substitute (x_0, y_0) in eq (3)

$$P_0 = 2\Delta y - \Delta x$$

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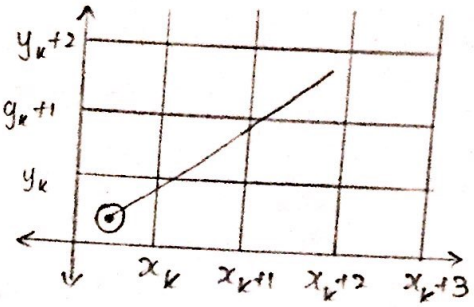
$$P_k = 2\Delta y x_k + 2\Delta y - 2\Delta x y_k + 2\Delta x b - \Delta x$$ (constant (so left out))

Put (x_0, y_0)

$$\boxed{P_0 = 2\Delta y - \Delta x} \leftarrow (x_k+1, y_k).$$

$$P_{k+1} = P_k + 2\Delta y$$



It is used for display circles and other curves Breshenham Algorithm must

To Illustrate the algorithm line with end points (20,10) (30, 18), slope = 0.8 with $\Delta x = 10$, $\Delta y = 8$. Find initial decision parameter P_0, k, P_k (x_{k+1}, y_{k+1}).

$P_0 = 2\Delta y - \Delta x.$

$P_0 = 2(8) - 10$

$P_0 = 16 - 10$

$P_0 = 6.$

k	P_k	(x_{k+1}, y_{k+1})
0	6	(21, 11)
1	2	(22, 12)
2	−2	(23, 12)
3	14	(24, 13)
4	10	(25, 10)

If $k = 0$, $P_k = 6$ $(\because P_0 = 2\Delta y - \Delta x)$.

$(x_{k+1}, y_{k+1}) = (20+1, 10+1)$

$(x_{k+1}, y_{k+1}) = (21, 11).$

If $k = 1$, $P_k = 2$ $(x_{k+1}, y_{k+1}) = (22, 12).$

$P_1 = 2.$

If $P_k < 0$, then $P_{k+1} = P_k + 2\Delta y$ $\therefore (x_{k+1}, y_k)$

If $P_k > 0$, then $P_{k+1} = P_k + 2\Delta y - 2\Delta x$.

(x_{k+1}, y_{k+1})

since $P_0 = 6 > 0$, $P_{k+1} = P_k + 2\Delta y - 2\Delta x$

$= 2$.

since $P_1 = 2 > 0$ $P_{k+1} = P_k + 2\Delta y - 2\Delta x$.

$= 2 + 2(8) - 2(10)$

$= 18 - 20$

$P_{k+1} = -2$.

since $P_2 < 0$, $P_{k+1} = P_k + 2\Delta y$.

$= -2 + 2(8)$

$= -2 + 16$

$= 14$.

since $P_3 > 0$ $P_{k+1} = P_k + 2\Delta y - 2\Delta x$.

$= 14 + 2(8) - 2(10)$

$= 14 + 16 - 20$.

$= 30 - 20$

$= 10$.

since $P_4 > 0$ $P_{k+1} = P_k + 2\Delta y - 2\Delta x$.

$= 10 + 16 - 20$.

$= 26 - 20$

$= 6$.

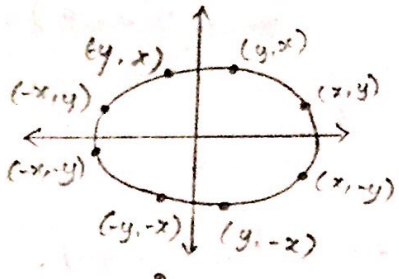
$k = 9$

CIRCLE GENERATING ALGORITHM: 13 mark. V. IMP

Equation of circle is $(x-x_c)^2 + (y-y_c)^2 = r^2$
(cartesian co-ordinates)

Equation of circle: $x = x_c + r\cos\theta$ (in polar co-ordin
$y = y_c + r\sin\theta$.

Midpoint circle Algorithm:



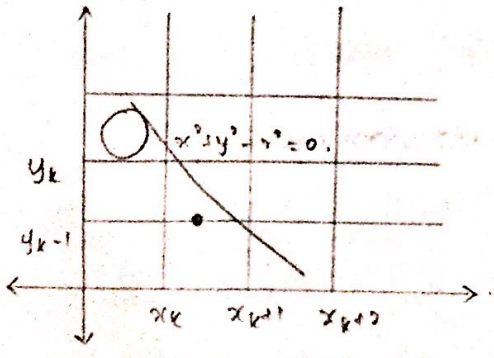
Symmetry of circle (diagram).

Circle equation, $f_{circle}(x,y) = x^2+y^2-r^2 \rightarrow (1)$

Any point (x,y) on the boundary of circle with radius r satisfies the equation,

$$f_{circle}(x,y) = 0.$$

$$f_{circle}(x,y) = \begin{cases} <0 & \text{if } (x,y) \text{ is inside the circle boundary} \\ =0 & \text{if } (x,y) \text{ is on the circle boundary} \\ >0 & \text{if } (x,y) \text{ is outside the circle bound} \end{cases}$$



Midpoint between candidate pixels and sampling position x_{k+1} along a circular path

Assuming that we have just plotted the pixel at (x_k, y_k), we next need to determine whether the pixel at position (x_{k+1}, y_k) or one at the position $(x_{k+1}, y_k - 1)$ is closer to the circle.

Our decision parameter is the circle function evaluated at a midpoint between these two pixels.

Mid point of (x_{k+1}, y_k) and $(x_{k+1}, y_k - 1)$ is $(x_{k+1}, y_k - 1/2)$.

$$P_k = f_{circle}(x_{k+1}, y_k - 1/2)$$

$$f_{circle}(x_{k+1}, y_k - 1/2) = (x_k + 1)^2 + (y_k - 1/2)^2 - r^2$$

$$x_k^2 + 2x_k + 1 + y_k^2 - y_k + 1/4 - r^2$$

If $P_k < 0$, this midpoint is inside the circle. and the pixel on scan line, y_k is closer to the circle boundary. otherwise ($P_k \geq 0$) is the midpoint is outside or on the circle boundary, we select the pixel on scan line $y_k - 1$.

We obtain a recursive expression for the next decision parameter by evaluating the circle function at sampling position

$$x_{k+1} + 1 = x_k + 2.$$

$$P_{k+1} = f_{circle}(x_{k+1} + 1, y_{k+1} - 1/2)$$

$$P_{k+1} = (x_{k+1} + 1)^2 + (y_{k+1} - 1/2)^2 - r^2$$

$$P_{k+1} = (x_{k+1})^2 + 2x_{k+1} + 1 + (y_{k+1})^2 - y_{k+1} + 1/4 - r^2$$

$$P_k = x_k^2 + 2x_k + 1 + y_k^2 - y_k + 1/4 - r^2$$

$$P_{k+1} - P_k = 2(x_k + 1) + (y_{k+1}^2 - y_k^2) - (y_{k+1} - y_k)$$

$$(x_k + 1)^2 + 2x_{k+1} - x_k^2 - 2x_k = x_k^2 + 2x_k + 1 + 2x_{k+1} - x_k^2 - 2x_k$$
$$= 2x_k + 2 = 2(x_k + 1)$$

$$P_{k+1} = P_k + 2(x_k + 1) + (y_{k+1}^2 - y_k^2) - (y_{k+1} - y_k)$$

Increments for obtaining P_{k+1} are either $(2x_{k+1}$ if $P_k < 0$ (or) $2x_{k+1} + 1 - 2y_{k+1}$. Evaluation of terms $2x_{k+1}$, $2y_{k+1}$ can also be done incrementally $2x_{k+1} = 2x_k + 2$. At start position $(0, r)$ these two terms have values 0 and $2r$ respectively. Each successive value is obtained by adding 2 to the previous value of $2x$ and subtracting 2 from the previous value of $2y$.

$$2x_{k+1} = 2x_k + 2$$

$$2y_{k+1} = 2y_k - 2$$

Initial decision parameter is obtained by evaluating the circle function at the start posit

$$(x_0, y_0) = (0, r).$$

$$P_k = f_{circle}(x_{k+1}, y_k - 1/2).$$

At $(0, r)$

$$P_0 = f_{circle}(1, r - 1/2)$$

$$P_0 = 1 + (r - 1/2)^2 - r^2)$$

$$= 1 + r^2 - r + \frac{1}{4} - r^2$$

$$P_0 = \frac{5}{4} - r.$$

$$= 5/4 - r.$$

$$\boxed{P_0 = 1 - r.}$$

$$\frac{5}{4} \approx 1$$

Algorithm:

set Pixel.

⋮

end. //

03:01:2018

Radius $r = 10$, midpoint circle algorithm along the circle in the 1st quadrant $x = 0$, $x = y$.

The value of the decision parameter

$$P_0 = 1 - r$$

$$P_0 = 1 - 10$$

$$P_0 = -9$$

Then for the circle centered on coordinate origin, $(x_0, y_0) = (0, 10)$ and initial increment terms for calculating decision parameters are

$$2x_0 = 0 \qquad 2y_0 = 20.$$

Successive decision parameter values and the position along the circle path are calculated using the midpoint method as

k	P_k	(x_{k+1}, y_{k+1})	$2x_{k+1}$	$2y_{k+1}$
0	-9	(1, 10)	2	20
1	-6	(2, 10)	4	20
2	-1	(3, 10)	6	20
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
6	5	(7, 7)	14	14

// not for theory only for lab

Ellipse generating Algorithm:

An ellipse is elongated circle, therefore eliptical curves can be generated by modifying circle drawing procedures to taken into account. Different dimensions of an ellipse along major and minor axes.

General equation

$$ax^2 + by^2 + cxy + dx + ey + f = 0.$$

where coefficients

a, b, c, d, e, f are evaluated in terms of focal coordinates and dimensions of major and minor axis of the ellipse.

Major axis is the straight line segment extending from one side of the ellipse to the other through the foci.