

Computer Graphics

Final Examination
Semester Spring 2022

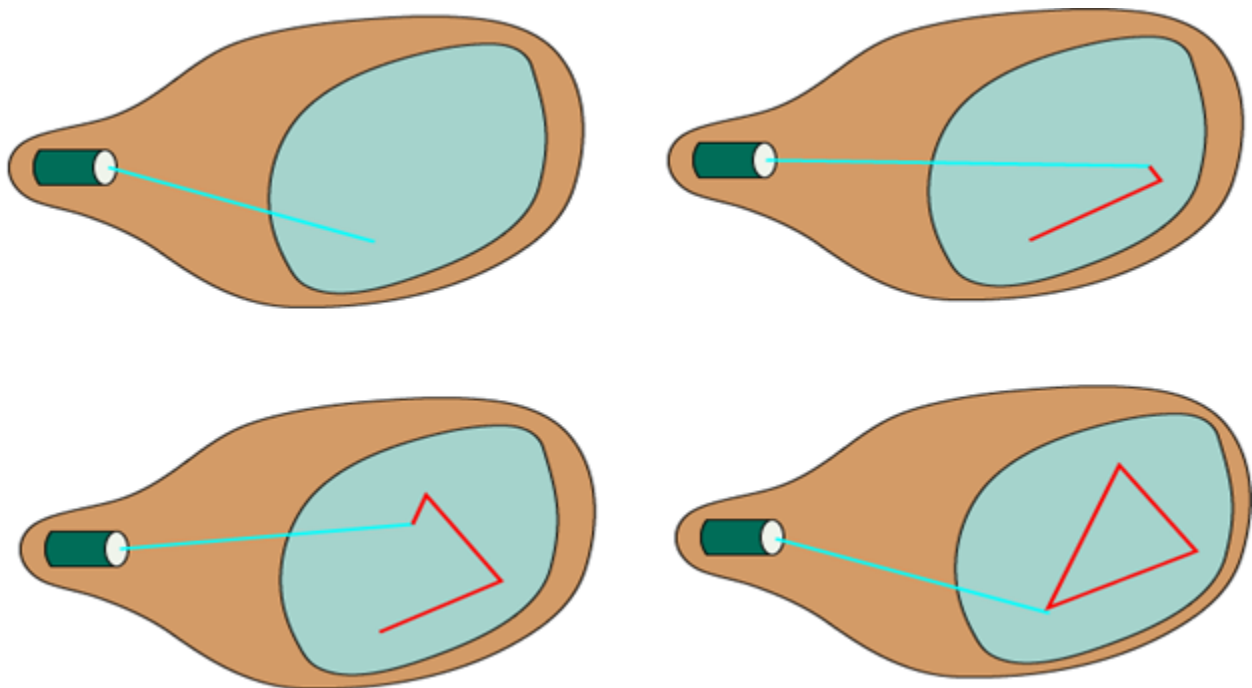
1. Differentiate between Vector scan display and Raster scan display

The main difference between vector and raster graphics is that **raster graphics are composed of pixels, while vector graphics are composed of paths**. A raster graphic, such as a gif or jpeg, is an array of pixels of various colors, which together form an image

Random Scan and Raster Scan Display:

Random Scan Display:

Random Scan System uses an electron beam which operates like a pencil to create a line image on the CRT screen. The picture is constructed out of a sequence of straight-line segments. Each line segment is drawn on the screen by directing the beam to move from one point on the screen to the next, where its x & y coordinates define each point. After drawing the picture. The system cycles back to the first line and design all the lines of the image 30 to 60 time each second. The process is shown in fig:



Random-scan monitors are also known as vector displays or stroke-writing displays or calligraphic displays.

Advantages:

1. A CRT has the electron beam directed only to the parts of the screen where an image is to be drawn.
2. Produce smooth line drawings.
3. High Resolution

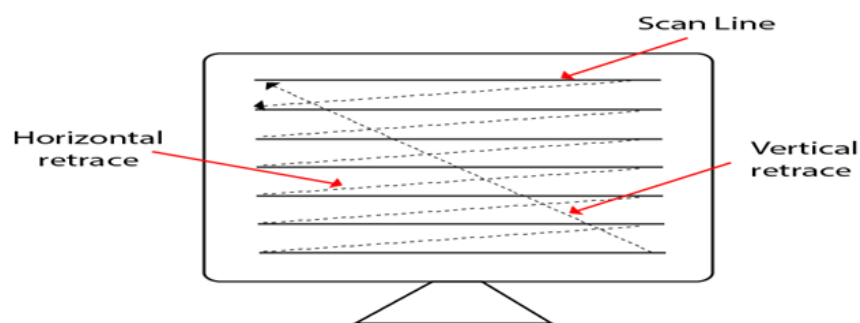
Disadvantages:

1. Random-Scan monitors cannot display realistic shades scenes.

Raster Scan Display:

A Raster Scan Display is based on intensity control of pixels in the form of a rectangular box called Raster on the screen. Information of on and off pixels is stored in refresh buffer or Frame buffer. Televisions in our house are based on Raster Scan Method. The raster scan system can store information of each pixel position, so it is suitable for realistic display of objects. Raster Scan provides a refresh rate of 60 to 80 frames per second.

Frame Buffer is also known as Raster or bit map. In Frame Buffer the positions are called picture elements or pixels. Beam refreshing is of two types. First is horizontal retrace and second is vertical retrace. When the beam starts from the top left corner and reaches the bottom right scale, it will again return to the top left side called at vertical retrace. Then it will again more horizontally from top to bottom call as horizontal retrace shown in fig:



Types of Scanning or travelling of beam in Raster Scan

1. Interlaced Scanning
2. Non-Interlaced Scanning

In Interlaced scanning, each horizontal line of the screen is traced from top to bottom. Due to which fading of display of object may occur. This problem can be solved by Non-Interlaced scanning. In this first of all odd numbered lines are traced or visited by an electron beam, then in the next circle, even number of lines are located.

For non-interlaced display refresh rate of 30 frames per second used. But it gives flickers. For interlaced display refresh rate of 60 frames per second is used.

Advantages:

1. Realistic image
2. Million Different colors to be generated
3. Shadow Scenes are possible.

Disadvantages:

1. Low Resolution
2. Expensive

Differentiate between Random and Raster Scan Display:

Random Scan	Raster Scan
1. It has high Resolution	1. Its resolution is low.
2. It is more expensive	2. It is less expensive
3. Any modification if needed is easy	3.Modification is tough
4. Solid pattern is tough to fill	4.Solid pattern is easy to fill
5. Refresh rate depends or resolution	5. Refresh rate does not depend on the picture.

6. Only screen with view on an area is displayed.	6. Whole screen is scanned.
7. Beam Penetration technology come under it.	7. Shadow mark technology came under this.
8. It does not use interlacing method.	8. It uses interlacing
9. It is restricted to line drawing applications	9. It is suitable for realistic display.

2 Define pixel and resolution.

Pixel

We have already defined a pixel in our tutorial of concept of pixel, in which we define a pixel as the smallest element of an image. We also defined that a pixel can store a value proportional to the light intensity at that particular location.

Now since we have defined a pixel, we are going to define what is resolution.

Resolution

The resolution can be defined in many ways. Such as pixel resolution, spatial resolution, temporal resolution, spectral resolution. Out of which we are going to discuss pixel resolution.

You have probably seen that in your own computer settings, you have monitor resolution of 800 x 600, 640 x 480 e.t.c

In pixel resolution, the term resolution refers to the total number of count of pixels in an digital image. For example. If an image has M rows and N columns, then its resolution can be defined as M X N.

If we define resolution as the total number of pixels, then pixel resolution can be defined with set of two numbers. The first number the width of the picture, or the pixels across columns, and the second number is height of the picture, or the pixels across its width.

We can say that the higher is the pixel resolution, the higher is the quality of the image.

We can define pixel resolution of an image as 4500 X 5500.

Megapixels

We can calculate mega pixels of a camera using pixel resolution.

Column pixels (width) X row pixels (height) / 1 Million.

The size of an image can be defined by its pixel resolution.

Size = pixel resolution X bpp (bits per pixel)

Calculating the mega pixels of the camera

Lets say we have an image of dimension: 2500 X 3192.

Its pixel resolution = 2500 * 3192 = 7982350 bytes.

Dividing it by 1 million = 7.9 = 8 mega pixel (approximately).

Aspect ratio

Another important concept with the pixel resolution is aspect ratio.

Aspect ratio is the ratio between width of an image and the height of an image. It is commonly explained as two numbers separated by a colon (8:9). This ratio differs in different images, and in different screens. The common aspect ratios are:

1.33:1, 1.37:1, 1.43:1, 1.50:1, 1.56:1, 1.66:1, 1.75:1, 1.78:1, 1.85:1, 2.00:1, e.t.c

Advantage

Aspect ratio maintains a balance between the appearance of an image on the screen, means it maintains a ratio between horizontal and vertical pixels. It does not let the image to get distorted when aspect ratio is increased.

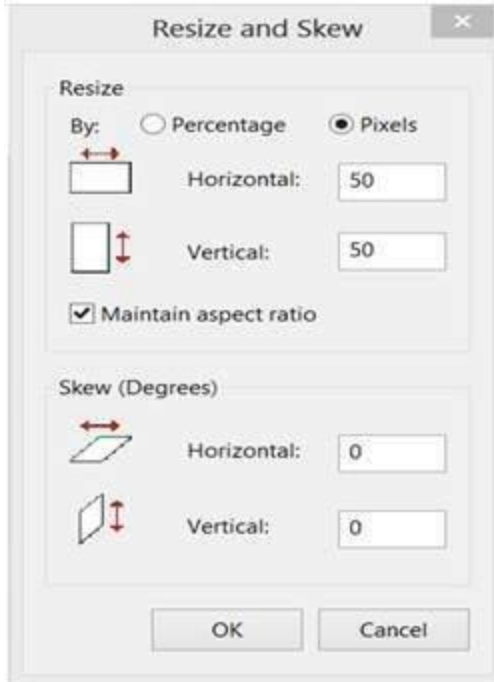
For example

This is a sample image, which has 100 rows and 100 columns. If we wish to make is smaller, and the condition is that the quality remains the same or in other way the image does not get distorted, here how it happens.

Original image



Changing the rows and columns by maintain the aspect ratio in MS Paint.



Result



Smaller image, but with same balance.

You have probably seen aspect ratios in the video players, where you can adjust the video according to your screen resolution.

Finding the dimensions of the image from aspect ratio:

Aspect ratio tells us many things. With the aspect ratio, you can calculate the dimensions of the image along with the size of the image.

For example

If you are given an image with aspect ratio of 6:2 of an image of pixel resolution of 480000 pixels given the image is an gray scale image.

And you are asked to calculate two things.

- Resolve pixel resolution to calculate the dimensions of image
- Calculate the size of the image

Solution:

Given:

Aspect ratio: $c:r = 6:2$

Pixel resolution: $c * r = 480000$

Bits per pixel: grayscale image = 8bpp

Find:

Number of rows = ?

Number of cols = ?

Solving first part:

$$\text{Equation 1. } c:r = 6:2 \rightarrow c = 6r/2$$

$$\text{Equation 2. } c = 480000/r$$

$$\text{Comparing both equations } \rightarrow \frac{6r}{2} = \frac{480000}{r}$$

$$r^2 = \sqrt{\frac{480000 * 2}{6}}$$

$$\text{That gives } r = 400.$$

$$\text{Put } r \text{ in equation 1, we get } \rightarrow c = 1200.$$

So rows = 400 cols = 1200.

3. List areas of applications of computer graphics

Answer

Applications of Computer Graphics

- Difficulty Level : [Basic](#)
- Last Updated : 30 Jul, 2019

[Computer graphics](#) deals with creation, manipulation and storage of different type of images and objects.

Some of the applications of computer graphics are:

1. **Computer Art:**

Using computer graphics we can create fine and commercial art which include animation packages, paint packages. These packages provide facilities for designing object shapes and specifying object motion. Cartoon drawing, paintings, logo design can also be done.

2. **Computer Aided Drawing:**

Designing of buildings, automobile, aircraft is done with the help of computer aided drawing, this helps in providing minute details to the drawing and producing more accurate and sharp drawings with better specifications.

3. **Presentation Graphics:**

For the preparation of reports or summarising the financial, statistical, mathematical, scientific, economic data for research reports, managerial reports, moreover creation of bar graphs, pie charts, time chart, can be done using the tools present in computer graphics.

4. **Entertainment:**

Computer graphics finds a major part of its utility in the movie industry and game industry. Used for creating motion pictures, music video, television shows, cartoon animation films. In the game industry where focus and interactivity are the key players, computer graphics helps in providing such features in the efficient way.

5. **Education:**

Computer generated models are extremely useful for teaching huge number of concepts and fundamentals in an easy to understand and learn

manner. Using computer graphics many educational models can be created through which more interest can be generated among the students regarding the subject.

6. Training:

Specialised system for training like simulators can be used for training the candidates in a way that can be grasped in a short span of time with better understanding. Creation of training modules using computer graphics is simple and very useful.

7. Visualisation:

Today the need of visualise things have increased drastically, the need of visualisation can be seen in many advance technologies , data visualisation helps in finding insights of the data , to check and study the behaviour of processes around us we need appropriate visualisation which can be achieved through proper usage of computer graphics

8. Image Processing:

Various kinds of photographs or images require editing in order to be used in different places. Processing of existing images into refined ones for better interpretation is one of the many applications of computer graphics.

9. Machine Drawing:

Computer graphics is very frequently used for designing, modifying and creation of various parts of machine and the whole machine itself, the main reason behind using computer graphics for this purpose is the precision and clarity we get from such drawing is ultimate and extremely desired for the safe manufacturing of machine using these drawings.

10. Graphical User Interface:

The use of pictures, images, icons, pop-up menus, graphical objects helps in creating a user friendly environment where working is easy and pleasant, using computer graphics we can create such an atmosphere where everything can be automated and anyone can get the desired action performed in an easy fashion.

These are some of the applications of computer graphics due to which it's popularity has increased to a huge extend and will keep on increasing with the progress in technology.

4. Discuss the working methodology of plasma panel in brief. How it is better than LED?

For most of the early 2000s, plasma and Liquid Crystal Display (LCD) TVs were competing to earn the market share in TV sales. Each type used its own technology to display an image, and each had its own pros and cons. By 2007, LCD TVs dominated the TV market because they cost less and were readily available, and although Panasonic, LG, and Samsung all stopped producing plasma TVs by 2014, many people may still have their old plasmas.

This article explains how each TV technology displays an image and the differences between them. You can learn about it in more detail [here](#).



Plasma TV - Samsung N5300



LED TV - LG LN5400

Plasma

Plasma screens contain tiny pockets of gas that get excited when voltage is applied to them, turning them into a state of plasma. In that state, the voltage then strikes electrons of mercury, turning them into ultraviolet (UV) light, which isn't visible to the human eye. The UV light then passes through phosphor cells; each pixel contains red, green, and blue phosphor cells. Thanks to these phosphor cells, the TV can turn the UV light into colors that are visible on the light spectrum. Essentially, plasma TVs don't require a light, and each pixel is self-emissive, so how one pixel displays itself is independent of the next pixel.

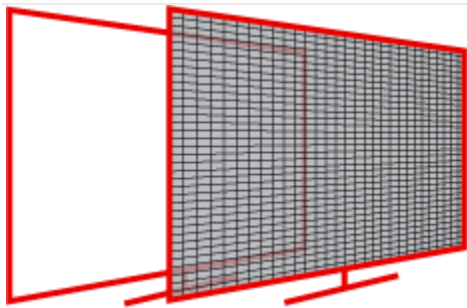
Since each pixel emits its own light, blacks are really deep. When the television wants to display black, it simply emits no light at all for the selected pixels. However, these aren't perfect blacks because each pixel retains a bit of voltage, leaving a bit of light to pass through. Each pixel emits light in all directions, creating wide [viewing angles](#), so the image remains accurate when viewing from the side.

The pixels aren't excited continuously, but in short pulses, and some plasma TVs can pulse up to 600 times every second. The naked eye perceives this as flickering, and some people are very sensitive to this. There can also be some advantages to this; since each pixel

holds a certain charge, it's ready to turn on and off as needed, resulting in minimal [motion blur](#). This means that fast-moving content, like in sports or video games, appears smooth. One of the downsides of plasmas was how they suffered from occasional [image retention](#) if they displayed the same image for a long period. So if you watched the news for about an hour, with all of its static displays, then switch channels, you'd still see the outline of the static elements. Eventually, they disappeared, but it could have been particularly annoying. Also, after several years in use, plasmas suffered from [permanent burn-in](#). This happened when the phosphor cells simply stayed stuck in one color and couldn't display any colors. Unfortunately, there was no way to avoid eventual burn-in, and almost every plasma TV suffered from it.

OLED TVs have similar characteristics to plasmas with their infinite contrast ratio, wide viewing angles, near-instant response time, and to a lesser extent, the risk of permanent burn-in. Since 2012, they've replaced plasma as a competitor to LCD TVs, and to learn more about OLEDs and how they differ from LCD TVs, see [here](#).

LCD



A backlight is behind an LCD screen

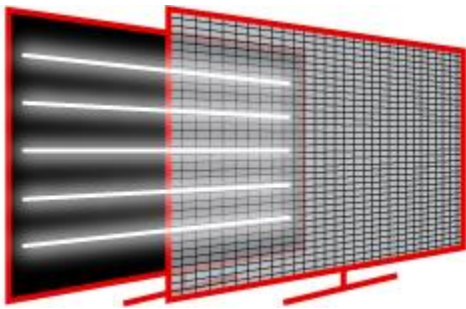
An LCD screen is composed of two parts: the actual liquid crystal display and a light source at the back of the screen (called backlight). A light diffuser is placed between the backlight and the LCD screen to make the source of light uniform across the screen.

The LCD panel doesn't emit light by itself, and this is why it needs a backlight; it only acts as a filter to block the light on a per-pixel basis. The backlight is always on, and the pixels in the display rotate to allow light through, creating the colors needed for the image. If the screen wants to display black, the LCD pixels rotate to try to block the light completely. If it wants to display white, it lets all light through. Since the display is only a filter, the blacks will not be as deep as with a plasma screen because an LCD panel will always let a small portion of light through.

There are different types of LCD panels, each with its unique characteristics. Vertical Alignment (VA) panels generally have a high contrast ratio and narrow viewing angles, while In-Plane Switching (IPS) panels have a low contrast ratio with wide viewing angles. You can read about their differences [here](#).

By using a backlight, LCD TVs use much less power than plasmas, which you can read about [here](#). Also, LCD TVs tend to get much brighter than plasmas, making them more suitable for well-lit rooms. There are two main types of backlights used in LCD screens: CCFL and LEDs.

CCFL



Conventional LCD backlight

When someone refers to an LCD TV, they usually mean a Cold-Cathode Fluorescent Lamp (CCFL) backlit LCD screen. The first LCD TVs were lit by CCFLs, but they're extremely rare as of the start of the 2020s. The backlight is a series of light tubes placed behind the screen. These tubes are very similar to fluorescent lamps used in buildings but smaller.

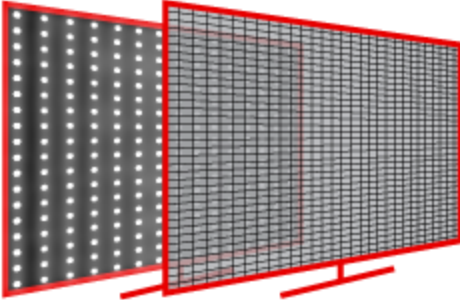
CCFL-backlit LCD TVs were eventually replaced by LED TVs because they cost less, were made thinner, and required less power. Also, LED TVs have more control over their backlight, resulting in vivid colors and better picture quality.

LED

An LED (Light-Emitting Diode) screen is an LCD screen, but instead of having a normal CCFL backlight, it uses LEDs as the source of light behind the screen. Companies label their TVs as LED, even though they're technically LCD; it can be confusing at times, but if you see an LED TV, you know it has an LCD panel. These TVs are more energy-efficient and a lot smaller than CCFLs, enabling a thinner television screen.

There are three main configurations of LED as backlights for television screens: full-array, edge-lit, and direct-lit.

Full-Array

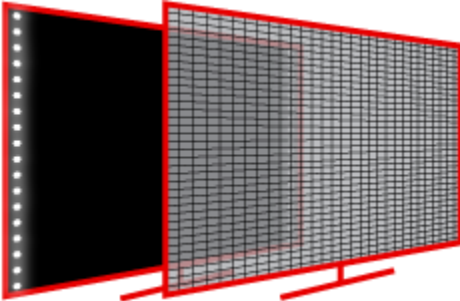


Full array LED backlight

This method is considered the best LED backlight type and is usually found on higher-end models, but as of 2020, some mid-range models have it too.

In a full-array LED screen, the LEDs are distributed evenly behind the entire screen. This produces a more uniform backlight and provides more effective use of [local dimming](#), where it can turn off and dim complete zones of LEDs.

Edge-Lit

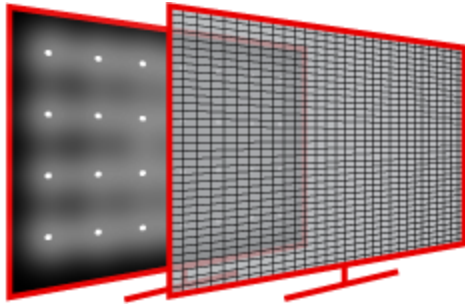


Many lower-end TVs and most monitors use this backlight type.

With an edge-lit LED screen, the LEDs are placed at the edges of the screen. Depending on the display, it can be all around the screen, on the left and right sides, or at the top and bottom. This allows the screen to be very thin.

However, it can cause some spots on the screen to be brighter than others, like the edges. This problem is called [flashlighting](#) or clouding. It can be seen when watching a dark scene in a dark environment. Also, edge-lit screens usually don't result in good local dimming as they don't have control over the dimming zones.

Direct-Lit



Direct-LED TVs are similar to full-array, but generally don't have a local dimming feature; this is found on lower-to-mid-range TVs.

Like the full-array method, the LEDs are directly behind the screen. However, there are very few of them, and they can't be controlled separately to match the luminosity of the picture.

These TVs aren't very thin because of the space required behind the screen to add the LEDs.

THE FUTURE: MINI AND MICRO LED?

As TV companies attempt to improve their technology, a new type of LED backlighting has emerged: Mini LED. It uses the same traditional LED backlighting behind an LCD panel, except the LED lights are even smaller. This allows for more lights, creating a brighter image and more control over local dimming. Only a handful of Mini LED TVs were produced before 2021, but it now seems that manufacturers are starting to use the technology more often. The [Samsung QN90A QLED](#) is an example of a Mini LED TV.

Another technology, Micro LED, is only in its initial phases of development. This doesn't even have an LCD panel as each LED pixel is self-emissive, similar to OLEDs, but without the burn-in risk. Currently, there aren't any Micro LED TVs available at the consumer level; Samsung has produced large Micro LED TVs (over 100 inches), and they're very expensive. However, we may begin to see Micro LED technology in the consumer TV market soon.

Conclusion

Plasma and LCD each present advantages and disadvantages when it comes to picture quality. Plasma TVs generally offer better contrast, wider viewing angles, and improved response times, while LCD TVs get much brighter and have better reflection handling. LCDs also cost less and can be much thinner, which are two of the main reasons why they took over the market share from plasmas in the mid-2000s. Plasma TVs are now extinct, and although OLEDs share many of the same characteristics, LED-backlight LCD TVs are now the norm, and it's likely your next TV purchase will have an LCD panel.

5. Write down the algorithm to fill the polygon?

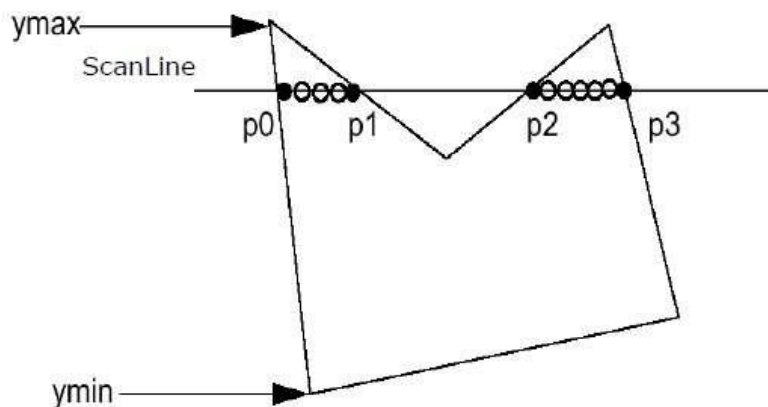
Polygon is an ordered list of vertices as shown in the following figure. For filling polygons with particular colors, you need to determine the pixels falling on the border of the polygon and those which fall inside the polygon. In this chapter, we will see how we can fill polygons using different techniques.



Scan Line Algorithm

This algorithm works by intersecting scanline with polygon edges and fills the polygon between pairs of intersections. The following steps depict how this algorithm works.

Step 1 – Find out the Ymin and Ymax from the given polygon.



Step 2 – ScanLine intersects with each edge of the polygon from Ymin to Ymax. Name each intersection point of the polygon. As per the figure shown above, they are named as p0, p1, p2, p3.

Step 3 – Sort the intersection point in the increasing order of X coordinate i.e. p0,p1, p1,p2, and p2,p3.

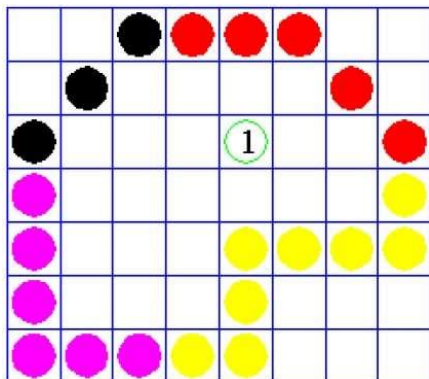
Step 4 – Fill all those pair of coordinates that are inside polygons and ignore the alternate pairs.

Flood Fill Algorithm

Sometimes we come across an object where we want to fill the area and its boundary with different colors. We can paint such objects with a specified interior color instead of searching for particular boundary color as in boundary filling algorithm.

Instead of relying on the boundary of the object, it relies on the fill color. In other words, it replaces the interior color of the object with the fill color. When no more pixels of the original interior color exist, the algorithm is completed.

Once again, this algorithm relies on the Four-connect or Eight-connect method of filling in the pixels. But instead of looking for the boundary color, it is looking for all adjacent pixels that are a part of the interior.



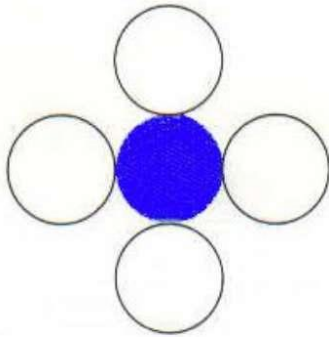
Boundary Fill Algorithm

The boundary fill algorithm works as its name. This algorithm picks a point inside an object and starts to fill until it hits the boundary of the object. The color of the boundary and the color that we fill should be different for this algorithm to work.

In this algorithm, we assume that color of the boundary is same for the entire object. The boundary fill algorithm can be implemented by 4-connected pixels or 8-connected pixels.

4-Connected Polygon

In this technique 4-connected pixels are used as shown in the figure. We are putting the pixels above, below, to the right, and to the left side of the current pixels and this process will continue until we find a boundary with different color.



Algorithm

Step 1 – Initialize the value of seed point $seedx, seedy, fcolor$ and $dcol$.

Step 2 – Define the boundary values of the polygon.

Step 3 – Check if the current seed point is of default color, then repeat the steps 4 and 5 till the boundary pixels reached.

```
If getpixel(x, y) = dcol then repeat step 4 and 5
```

Step 4 – Change the default color with the fill color at the seed point.

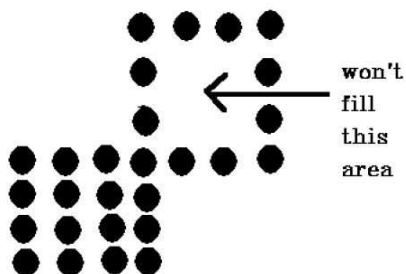
```
setPixel(seedx, seedy, fcol)
```

Step 5 – Recursively follow the procedure with four neighborhood points.

```
FloodFill (seedx - 1, seedy, fcol, dcol)  
FloodFill (seedx + 1, seedy, fcol, dcol)  
FloodFill (seedx, seedy - 1, fcol, dcol)  
FloodFill (seedx, seedy + 1, fcol, dcol)
```

Step 6 – Exit

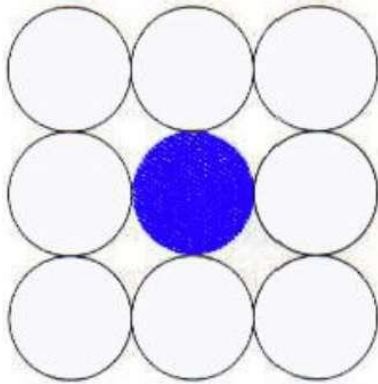
There is a problem with this technique. Consider the case as shown below where we tried to fill the entire region. Here, the image is filled only partially. In such cases, 4-connected pixels technique cannot be used.



8-Connected Polygon

In this technique 8-connected pixels are used as shown in the figure. We are putting pixels above, below, right and left side of the current pixels as we were doing in 4-connected technique.

In addition to this, we are also putting pixels in diagonals so that entire area of the current pixel is covered. This process will continue until we find a boundary with different color.



Algorithm

Step 1 – Initialize the value of seed point $seedx, seedy, fcol$ and $dcol$.

Step 2 – Define the boundary values of the polygon.

Step 3 – Check if the current seed point is of default color then repeat the steps 4 and 5 till the boundary pixels reached

If `getpixel(x,y) = dcol` then repeat step 4 and 5

Step 4 – Change the default color with the fill color at the seed point.

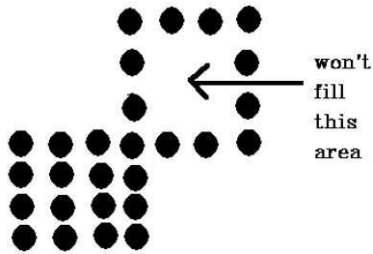
```
setPixel(seedx, seedy, fcol)
```

Step 5 – Recursively follow the procedure with four neighbourhood points

```
FloodFill (seedx - 1, seedy, fcol, dcol)
FloodFill (seedx + 1, seedy, fcol, dcol)
FloodFill (seedx, seedy - 1, fcol, dcol)
FloodFill (seedx, seedy + 1, fcol, dcol)
FloodFill (seedx - 1, seedy + 1, fcol, dcol)
FloodFill (seedx + 1, seedy + 1, fcol, dcol)
FloodFill (seedx + 1, seedy - 1, fcol, dcol)
FloodFill (seedx - 1, seedy - 1, fcol, dcol)
```

Step 6 – Exit

The 4-connected pixel technique failed to fill the area as marked in the following figure which won't happen with the 8-connected technique.



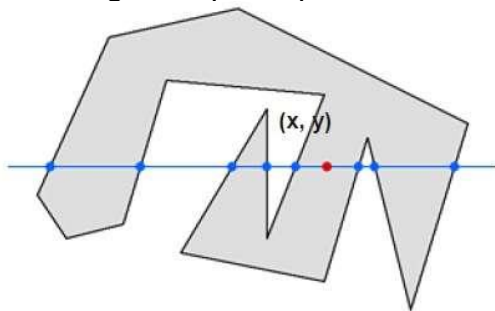
Inside-outside Test

This method is also known as **counting number method**. While filling an object, we often need to identify whether particular point is inside the object or outside it. There are two methods by which we can identify whether particular point is inside an object or outside.

- Odd-Even Rule
- Nonzero winding number rule

Odd-Even Rule

In this technique, we will count the edge crossing along the line from any point x,y to infinity. If the number of interactions is odd, then the point x,y is an interior point; and if the number of interactions is even, then the point x,y is an exterior point. The following example depicts this concept.

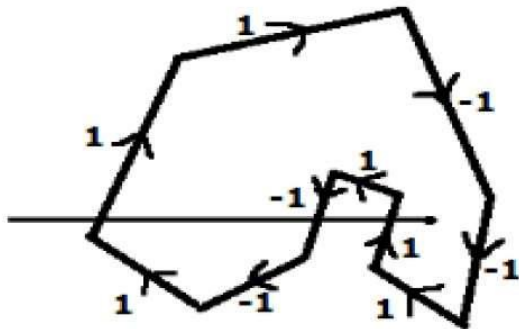


From the above figure, we can see that from the point x,y , the number of interactions point on the left side is 5 and on the right side is 3. From both ends, the number of interaction points is odd, so the point is considered within the object.

Nonzero Winding Number Rule

This method is also used with the simple polygons to test the given point is interior or not. It can be simply understood with the help of a pin and a rubber band. Fix up the pin on one of the edge of the polygon and tie-up the rubber band in it and then stretch the rubber band along the edges of the polygon.

When all the edges of the polygon are covered by the rubber band, check out the pin which has been fixed up at the point to be test. If we find at least one wind at the point consider it within the polygon, else we can say that the point is not inside the polygon.



In another alternative method, give directions to all the edges of the polygon. Draw a scan line from the point to be test towards the left most of X direction.

- Give the value 1 to all the edges which are going to upward direction and all other -1 as direction values.
- Check the edge direction values from which the scan line is passing and sum up them.
- If the total sum of this direction value is non-zero, then this point to be tested is an **interior point**, otherwise it is an **exterior point**.
- In the above figure, we sum up the direction values from which the scan line is passing then the total is $1 - 1 + 1 = 1$; which is non-zero. So the point is said to be an interior point.