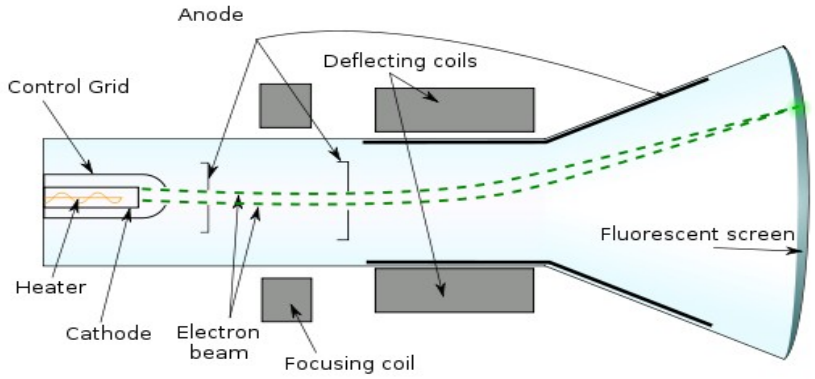
Computer Graphics CAT 1 & 2

Information technology-Computer Graphics (Mount Kenya University)

1.Using a well labelled diagram, explain how the CRT monitors works. (8 marks)



CRT stands for Cathode Ray Tube. CRT is a technology used in traditional computer monitors and televisions. The image on CRT display is created by firing electrons from the back of the tube of phosphorus located towards the front of the screen.

Once the electron heats the phosphorus, they light up, and they are projected on a screen. The color you view on the screen is produced by a blend of red, blue and green light. The main Components of CRT are:

1. Electron Gun: Electron gun consisting of a series of elements, primarily a heating filament (heater) and a cathode. The electron gun creates a source of electrons which are focused into a narrow beam directed at the face of the CRT.

2. Control Electrode: It is used to turn the electron beam on and off.

3. Focusing system: It is used to create a clear picture by focusing the electrons into a narrow beam.

4. Deflection Yoke: It is used to control the direction of the electron beam. It creates an electric or magnetic field which will bend the electron beam as it passes through the area. In a conventional CRT, the yoke is linked to a sweep or scan generator. The deflection yoke which is connected to the sweep generator creates a fluctuating electric or magnetic potential.

5. Phosphorus-coated screen: The inside front surface of every CRT is coated with phosphors. Phosphors glow when a high-energy electron beam hits them. Phosphorescence is the term used to characterize the light given off by a phosphor after it has been exposed to an electron beam.

2.Explain four line drawing algorithms and how they are achieved. (10 marks)

1. A naive line-drawing algorithm: The naïve line drawing algorithm is inefficient and thus, slows on a digital computer. Its inefficiency stems from the number of operations and the use of floating-point calculations. It is achieved by basing on floating point arithmetic for determining rounded integer pixel coordinates.

2. Digital Differential Algorithm (DDA):An incremental conversion method is a DDA Algorithm and also we called Digital Differential Algorithm (DDA). This approach is characterized by the use of the results from the previous stage in each calculation. It is achieved by using floating-point or integer arithmetic.

3. Bresenham line drawing algorithm: This algorithm is used for scan converting a line. It was developed by Bresenham. It is an efficient method because it involves only integer addition, subtractions, and multiplication operations. These operations can be performed very rapidly so lines can be generated quickly. It is achieved by transforming the equation of a line from the typical slope-intercept form into something different; and then using this new equation to draw a line based on the idea of accumulation of error.

4. Xiaolin Wu's line algorithm : This is an algorithm which is used to produce or represent line segments on any discrete graphical media, such as pixel-based displays. The algorithm consists of drawing pairs of pixels straddling the line, each coloured according to its distance from the line. It is achieved by handling the Pixels at the line ends separately.

3.Given the line coordinates (1, 2), (2, 3). Do the following operations on the given coordinates, entailing what occurs in the output.

Rotation of the line by 45 degrees about its center (5, 3)

Let imagine a circle with a center 5,3.

Let our circle have a radius, that passes through 1,2.

We need to find the length of r or distance from 5,3 to 1,2.

$$d = \sqrt{(3-2)^2 + (5-1)^2}$$

$$d = \sqrt{1^2 + 4^2}$$

$$d = \sqrt{17}$$

So the radius is sqr root of 17.

So now we have a circle that has a radius of sqr root of 17 and a center 5,3. Let have a line passing through 5,3 and 1,2 as well.

The slope is 1/4 so

$y = \frac{1}{4}x + \frac{7}{4}$

Look at first photo

Now,we are rotating 45 degrees So we need to find a line that is perpendicular to our original line and that pass through the center (5,3)

Negative reciprocal slope of 1/4 is -4 and our point is 5,3 so

$y - 3 = -4(x - 5)$

$y = -4x + 23$

The point that intersects the circle will be the new image after we rotate (1,2) 45 degrees.

To find the next rotated point of (2,3), the distance of the preimage (2,3) and new image (5,3) is 3 so that leaves

(5,0)

So our new rotated points are

(6,-1)

(5,0)

Translate the line by (7, 2)

Old coordinate 1,2 and 2,3

New coordinates = (1+7,2+2)= 8,10

New coordinates = (2+7,3+2)= 9,5

Scale the line by 3 in x and 2 in y (6marks)

Old coordinate 1,2 and 2,3

New coordinates = (1+3,2+2)= 4,10

New coordinates = (2+3,3+2)= 5,5

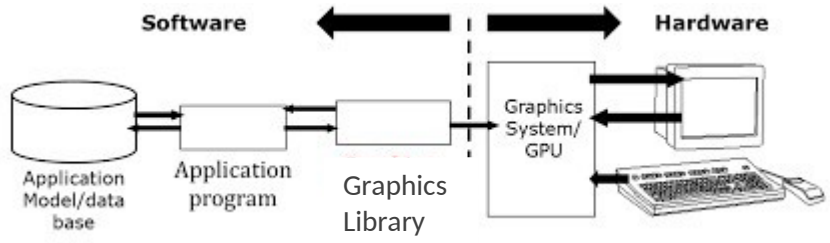
4.In memory mapping differentiate between Peeking and Poking. 2 marks

Peeking is a process where the command returned the byte value at a memory location while poking command allowed you to set the value of a memory location.

5.List any SIX desirable attributes of an ideal graphics file format. (6 marks)

1. Lossless compression
2. Animations are possible
3. Small file size
4. Short loading time
5. Supports transparency
6. Can be opened and converted with almost any application.

6.Using a simple diagram, explain the components that make up the conceptual framework for Interactive Computer Graphics system. 4 mks



Conceptual Framework has the following components:

- Graphics Library - Between application and display hardware there is graphics library / API.

- Application Program - An application program maps all application objects to images by invoking graphics.

- Graphics System – An interface that interacts between Graphics library and Hardware.

- Modifications to images are the result of user interaction.

7.Explain the meaning of the following terms.5mks

PIXEL- A pixel *is* the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device.
Memory Mapping- Memory-mapping is a mechanism that maps a portion of a file, or an entire file, on disk to a range of addresses within an application's address space
Resolution- Resolution indicates the number of pixels that are displayed per inch for an image

JPEG-Joint photographic expert group is a standardized image compression mechanism.
PNG- Portable Network Graphics is a format for storing bit-mapped (raster) images on computer

8. Describe three application areas of Computer Graphics in health sector 3 mks

1. Neuroimaging and brain mapping: Neuroimaging or brain mapping involves the use of images to analyze and study the structure or function of the brain or any other part of the nervous system.
2. Nell and molecular imaging: Molecular imaging is a field of medical imaging that provides pictures of what is happening at the molecular and cell level of a body.
3. Ultrasonic and nuclear medicine scanners (ultrasonography)
Ultrasonic scans are used to a clear image of the eye to discover eye complication. This is done by either the B-scan method or the water bath method, whereby high-frequency ultrasounds are used to give a very high axial resolution.

9.Computer Graphics can be active or passive, explain.2 mks

It is true because in active Computer Graphics user have some controls over the picture, i.e., the user can make any change in the produced image and in passive computer graphics, the picture is produced on the monitor, and the user does not have any controlled over the image, i.e., the user cannot make any change in the rendered image.

10.Explain the following types of computer monitors and for each case give two disadvantages. 9mks

Liquid Crystal Display- Liquid Crystal Displayis a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.
Disadvantages
1.Each panel has a fixed pixel resolution format determined at the time of manufacture that can not be changed.
2.LCDs using an analog input require careful adjustment of pixel tracking/phase in order to reduce or eliminate digital noise in the image.
3.Limited viewing angle. Brightness, contrast, gamma and color mixtures vary with the viewing angle. Can lead to contrast and color reversal at large angles. Need to be viewed as close to straight ahead as possible.

Plasma Display- A plasma display panel (PDP) *is* a type of flat panel display that uses small cells containing plasma: ionized gas that responds to electric fields.
Disadvantages
1. The plasma TV screen is more reflective than the LCD.
2. The plasma display consumes more heat and energy because the phosphorus requires more light to produce good-quality images.
3. Plasma Display produces glare due to reflection.
4. They consume more electricity compared to LCDs and CRTs.

Cathode Ray Tube- A cathode-ray tube is a vacuum tube containing one or more electron guns, which emit electron beams that are manipulated to display images on a phosphorescent screen.
Disadvantages

1. Big back and take up space on a desk.
2. Not suitable for very brightly environment because less bright than LCD.
3. They are large, heavy and bulky.
4. Consume a lot of electricity and also produce a lot of heat.

11. Given that a simple graphics display has pixels coordinate (8,12) set to ON and that the computer converts coordinates to memory addresses using the formula:
location = (((Ysize - y)* Xsize) + x).Given that Xsize=20 columns and Ysize=15 rows, calculate the memory location for the above coordinate.4 mks

Given:

- Memory location is calculated by {[(YS - y) * XS] + x}
- (XS, YS) ∈ {20, 15}
- (x, y) ∈ {8, 12}

Known:

The first and second number of the pair of coordinates are columns (x) and rows (y) respectively.

Solution:

location = (15 - 12) * 20 + 8

location = 3 * 20 + 8

location = 60 + 8 = 68

Memory location=68

12.State three line drawing algorithms and explain what each algorithm is best suited to render.

1. Digital Differential Algorithm (DDA):An incremental conversion method is a DDA Algorithm and also we called Digital Differential Algorithm (DDA). This approach is characterized by the use of the results from the previous stage in each calculation. It is suitable for rasterization of lines, triangles and polygons

2. Bresenham line drawing algorithm This algorithm is used for scan converting a line. It was developed by Bresenham. It is an efficient method because it involves only integer addition,

subtractions, and multiplication operations. These operations can be performed very rapidly so lines can be generated quickly. It suitable for scanning converting a line.

3. Line Drawing Algorithm: This is an algorithm which is used to produce or represent line segments on any discrete graphical media, such as pixel-based displays.

QUESTION TWO 30 MARKS

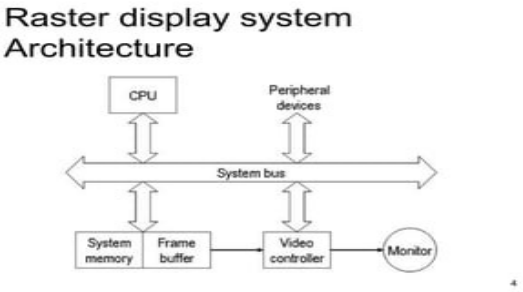
a) Define the term Polylines 2MKS

A polyline is a continuous line that is composed of one or more connected straight line segments, which, together, make up a shape.

b) Differentiate between quantilization and aliasing error in image digitization.
[3Marks]

Quantization is a process of transforming a real valued sampled image to one taking only a finite number of distinct values while aliasing occurs when a signal is sampled at a less than twice the highest frequency present in the signal.

c) With a aid of a diagram describe the raster display architecture.3MKS



Raster Scan Displays are most common type of graphics monitor which employs CRT. It is based on television technology. In raster scan system electron beam sweeps across the screen, from top to bottom covering one row at a time. A pattern of illuminated pattern of spots is created by turning beam intensity on and off as it moves across each row. A memory area called refresh buffer or frame buffer stores picture definition. This memory area holds intensity values for all screen points. Stored intensity values are restored from frame buffer and painted on screen taking one row at a time. Each screen point is referred to as pixels.

b) What is an Active Edge Table (AET), and how is it used in general polygon rasterization?
[4 Marks]

Active-edge table is a data structure that consists of all the intersection points of the edges with the current scanline. These intersection points are sorted by increasing x coordinate. This allows the intersection points to be paired off, and be used for filling the scanline appropriately.

c) Flash can create two types of tweened animation, motion tweening and shape tweening. Discuss the two types.4MKS

Motion tweening is a type of animation that uses symbols to create movement, size and rotation changes, fades, and color effects while shape tweening, you draw a vector shape at one specific frame in the timeline and change that shape or draw another shape at another specific frame. Animate then interpolates the intermediate shapes for the frames in between, creating the animation of one shape morphing into another.

g) Consider 2 raster systems with the resolutions of 640 x 480 and
1280 x 1024.
a) How many pixels could be accessed per second in each of these systems by a display controller that refreshes the screen at a rate of 60 frames per second? (3 marks).

Since 60 frames are refreshed per second and each frame consists of 640 x 480 pixels, the access
rate of such a system is (640 x 480) * 60 = 1.8432 x 107 pixels/second.
Likewise, for the 1280 x 1024 system, the access rate is (1280 x 1024) * 60 = 7.86432 x107 pixels/second.

b) What is the access time per pixel in each system?(2 marks)

According to the definition of access rate, we know that the access time per pixel should be
1/(access rate). Therefore, the access time is around 54 nanoseconds/pixel for the 640 x 480 system,
and the access time is around 12.7 nanoseconds/pixel for the 1280×1024 system.

a) Using homogeneous coordinates,
i) Describe the matrix formula for 2D translation, scaling and rotation. 2mks)

Transformation means changing some graphics into something else by applying rules. We can have various types of transformations such as translation, scaling up or down, rotation, shearing, etc. When a transformation takes place on a 2D plane, it is called 2D transformation. Transformations play an important role in computer graphics to reposition the graphics on the screen and change their size or orientation.

ii) For the Triangle A(1,0),B(0,1),C(1,1), find its transformation by rotating 450 about the origin then translating one unit in X and Y direction. 3mks)

We rotate a polygon by rotating each vertex of it with the same rotation angle.

Given-
Old corner coordinates of the triangle = A (1, 0), B(0, 1), C(1, 1)
Rotation angle = θ = 450°

For Coordinates A(1, 0)

Let the new coordinates of corner A after rotation = (X_{new}, Y_{new}).

Applying the rotation equations, we have-

X_{new}
$= X_{old} \times \cos\theta - Y_{old} \times \sin\theta$
$= 1 \times \cos450° - 0 \times \sin450°$
$= 0$

Y_{new}
$= X_{old} \times \sin\theta + Y_{old} \times \cos\theta$
$= 1 \times \sin450° + 0 \times \cos450°$
$= 1$

Thus, New coordinates of corner A after rotation = (0, 1).

For Coordinates B(0, 1)

Let the new coordinates of corner B after rotation = (X_{new}, Y_{new}).

X_{new}
$= X_{old} \times \cos\theta - Y_{old} \times \sin\theta$
$= 0 \times \cos450° - 1 \times \sin450°$
$= -1$

Y_{new}
$= X_{old} \times \sin\theta + Y_{old} \times \cos\theta$
$= 0 \times \sin450° + 1 \times \cos450°$
$= 0 + 0$
$= 0$

Thus, New coordinates of corner B after rotation = (-1, 0).

For Coordinates C(1, 1)

Let the new coordinates of corner C after rotation = (X_{new}, Y_{new}).

X_{new}

$= X_{old} \times \cos\theta - Y_{old} \times \sin\theta$

$= 1 \times \cos450° - 1 \times \sin450°$

$= 0 - 1$

$= -1$

Y_{new}

$= X_{old} \times \sin\theta + Y_{old} \times \cos\theta$

$= 1 \times \sin450° + 1 \times \cos450°$

$= 1 + 0$

$= 1$

Thus, New coordinates of corner C after rotation of 450 = (-1, 1).

d) OpelGL is a state machine. Discuss. 2MKS

This is because each bit of state represents some registers in the GPU. Those registers are state. Shaders need to be loaded in order to render. You need to set the viewport registers. You need to set up which texture addressing registers you're using. And so forth. Thus, the APIs are state machines because the GPU is a state machine.

d. Discuss OpenGL rendering pipeline. 2MKS

The OpenGL rendering pipeline is initiated when you perform a rendering operation. Rendering operations require the presence of a properly-defined vertex array object and a linked Program Object or Program Pipeline Object which provides the shaders for the programmable pipeline stages.