Lecture 2

Quiz-1

Set-A

1. State the differences between lossless and lossy compression. [6]

1. a. Solution: O24

Lossless Compression

- Don't impact the image quality
- Only removes additional, non-essential data automatically added by the device used to take the photo
- No significant reduction in file size
- Lossless Compression algorithms: Run-length encoding, Huffman coding
- Lossless formats are .RAW, .BMP, .GIF, and .PNG

Lossy Compression

- Reduces the file size considerably by removing image data
- Quality might degrade
- This process is irreversible - can't get back to the original file
- Common algorithms - discrete wavelet transform, fractal compression, transform encryption etc.
- Lossy format; JPEG, MPEG, AVC

2. Consider 3 images img1, img2 and img3 (see the image below) overlapping each other where img1 is the foreground of img2 and img2 is the foreground of img3. Additionally, img1 has an alpha mask α1 and img2 is fully opaque. Find the value of α1 if we want to get the output image as img4. [6]

130	20	150
50	85	200
230	9	75

img1

15	20	1
200	20	50
110	99	160

img2

23	150	240
1	0	250
22	99	225

img3

38	20	150
200	59	188
176	45	92

img4

2. Solution:

$Img_4 = \alpha_1 img_1 + (1 - \alpha_1) img_2$

$\alpha_1 = (Img_4 - img_2) / (Img_1 - img_2)$ [point-wise substruction and division]

0.2	0.29	1
0	0.6	0.92
0.55	0.6	0.8

Set-B

1. Explain why triangles are commonly used as the primary primitive in computer graphics. [6]

1. a. Solution: Lecture - 2
(**simplest universal surface element, convex hull of three points**.)
Why triangles? –
It is the simplest universal surface element –
it is the convex hull of three points.

- A line or a point are even simpler, but do not create surfaces.
- it isn't possible to use only a finite number of them without having cracks.

2. . Consider 3 images img1, img2 and img3 (see the image below) overlapping each other where img3 is the foreground of img2 and img2 is the foreground of img1. Additionally, img3 has an alpha mask α1 and img2 is fully transparent. Find the value of α1 if we want to get the output image as img4. [6]

2. Solution:

$Img_4 = \alpha_1 img_3 + (1 - \alpha_1) img_1$

$\alpha_1 = (Img_4 - img_1) / (Img_3 - img_1)$ [point-wise substruction and division]

0.2	0.29	1
0	0.6	0.9
0.55	0.5	0.25

Set-D

2. Propose an alpha compositing formula for blending the colors of three objects C1, C2 and C3. Where C1 is the foreground of C2 and C2 is the foreground of C3 [6]

2. Solution: ***Added from "radia-all-mathcg.pdf"***

Ans: Let,

α = Alpha compositing parameter to blend C_1 and C_2

β = " " " " " C_2 " C_3

We know,

$$C = \alpha C_f + (1-\alpha) C_b$$

$$\therefore C = \alpha C_1 + (1-\alpha) C_2$$

$$= \alpha C_1 + (1-\alpha)\{\beta C_2 + (1-\beta) C_3\}$$

$$= \alpha C_1 + \beta C_2 - \alpha\beta C_2 + (1-\beta) C_3 - \alpha(1-\beta) C_3$$

$$= \alpha C_1 + (1-\alpha)\beta C_2 + (1-\alpha)(1-\beta) C_3$$

Here,

C_f - Foreground color

C_b - background color

C - mixed/final color

∴ This is the required alpha compositing formula.

Origin42

7. Lecture -02

(b) Consider there are two objects overlapping each other, where C_1 is the color of the foreground object and C_2 is the color of the background object. Construct an alpha compositing formula if the foreground object has 30% transparency and the background object is fully opaque. [4]

7. b. Solution: 024

Foreground color = C1 = Cf

Background color = C2 = Cb

Foreground object has 30% transparency means the foreground is 70% opaque.

Background is fully opaque.(given).

Alpha compositing formula,

C = alpha x (Cf) + (1 - alpha) x Cb

= 0.70 x Cf + 0.30 X Cb

7.

(c) Explain how to determine whether a polygon is facing towards or away from the camera. [3]

7. c. Solution: 45

Camera Position:

- Determine the position of the camera or the viewpoint in 3D space.

Camera-to-Polygon Vector:

- Calculate a vector from the camera position to any point on the polygon.

Dot Product:

- Calculate the dot product of the camera-to-polygon vector and the normal vector of the polygon.

Determine Facing Direction:

- If the dot product is positive, the polygon is facing towards the camera

Enigma41

7. Lecture -02

(b) How does a transmissive device work? Explain with appropriate diagrams. [4]

7. b. Solution: 024

Liquid crystal displays (LCDs) are an example of the transmissive type. A liquid crystal is a material whose molecular structure enables it to rotate the polarization of light that passes through it, and the degree of rotation can be adjusted by an applied voltage. An LCD pixel has a layer of polarizing film behind it, so that it is illuminated by polarized light—let's assume it is

polarized horizontally.
A second layer of polarizing film in front of the pixel is oriented to transmit only vertically polarized light. If the applied voltage is set so that the liquid crystal layer in between does not change the polarization, all light is blocked and the pixel is in the "off" (minimum intensity) state. If the voltage is set so that the liquid crystal rotates the polarization by 90 degrees, then all the light that entered through the back of the pixel will escape through the front, and the pixel is fully "on"—it has its maximum intensity. Intermediate voltages will partly rotate the polarization so that the front polarizer partly blocks the light, resulting in intensities between the minimum and maximum. Like color LED displays, color LCDs have red, green, and blue subpixels within each pixel, which are three independent pixels with red, green, and blue color filters over them.

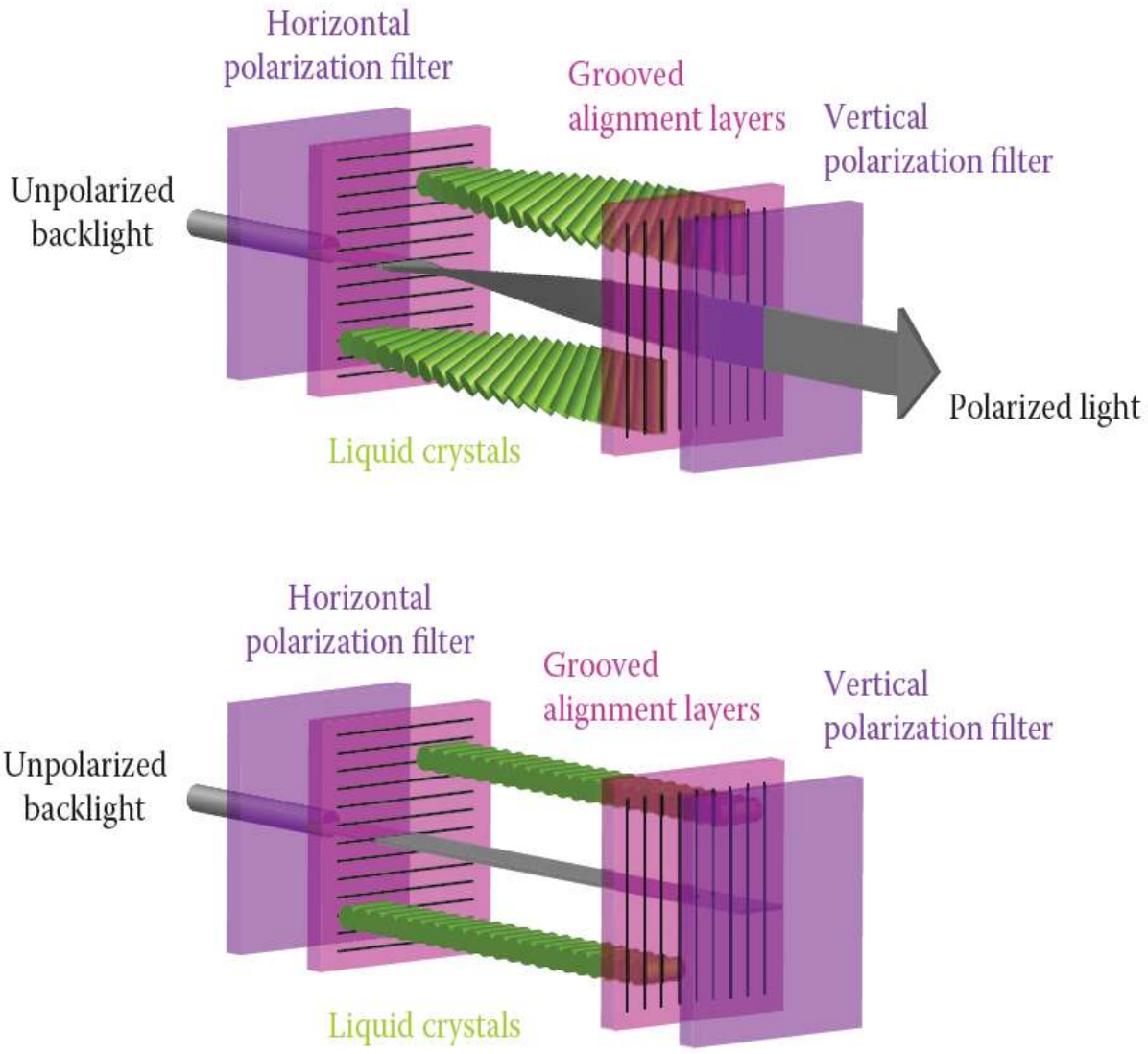
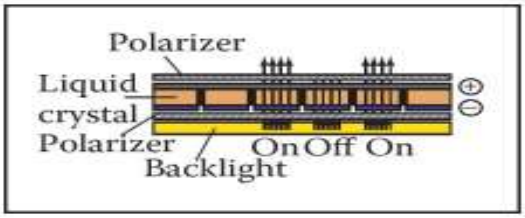


Figure: One pixel of a LCD display in ON and OFF state

Transmissive Displays (1/3)

- Transmissive Displays:
  - Example: light crystal display (LCD)
  - Molecular structure of liquid crystal rotates the polarization of light that passes through it
  - LCDs also have sub-pixels.



Credit: Fundamentals of Computer Graphics 3rd Edition by Peter Shirley, Steve Marschner | http://www.cs.cornell.edu/courses/cs4620/2019fa/

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Transmissive Displays (2/3)

- Degree of rotation ↔ applied voltage

Recursive40

1. lecture-2

b) Given that, $C_f = 1.0$, $C_b = 0.2$ and $C = 0.8$, where C_f, C_b and C are the foreground, background and composite intensities respectively. What is the alpha value to perform this composition? [3]

1. b. Solution: ***Solved by Younus-131***

$$C = \alpha C_f + (1-\alpha) C_b$$

$$\Rightarrow \alpha = \frac{C - C_b}{C_f - C_b} = \frac{0.8 - 0.2}{1 - 0.2}$$

$$= 0.75$$