CV HW01 - Theoretical Questions

A1) Image Formation

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a) $f_1 = 50mm$

$u_1 = v_1 = 36mm$

$f_2 = 4mm$

No. of pixels $= 16 \times 10^6$

$$\frac{f_1}{z} = \frac{u_1}{x} = \frac{v_1}{y}$$

$$\frac{f_2}{z} = \frac{u_2}{x} = \frac{v_2}{y}$$

$$\Rightarrow \frac{50}{4} = \frac{u_1}{u_2} = \frac{v_1}{v_2}$$

$$\Rightarrow \frac{50}{4} = \frac{36}{u_2}$$

$$u_2 = 2.88\,mm$$

Since it's a square sensor too, so $u_2 = v_2 = 2.88mm$

Ratio to smartphone size to professional sensor size:

$$\frac{2.88\,mm}{36mm} = \boxed{\frac{4}{50}}$$

b) Size of sensor pixel element:

We know that the sensor size $= 2.88mm$

$$(2.88)^2 = (16 \times 10^6) \times m$$

where m is size of pixel in smartphone

$$\boxed{m = 0.518 \times 10^{-12}\,m^2}$$

Professional Camera :-

$(36)^2 \times 10^{-6} = 16 \times 10^6 \times m$

where m is size of pixel in professional camera.

$$m = \frac{(36)^2 \times 10^{-6}}{16 \times 10^6}$$

$$m = 81 \times 10^{-12}\ m^2$$

Reasons:

The reasons why professionals or amateurs prefer expensive large cameras is because:

1. larger camera:- larger sensor size. So larger sensor can capture more light
2. Its also better quality
3. More clarity
4. Good for low light images

Advantages of more pixels → You can capture more information, more resolution.

Longer focal length means larger aperture diameter. Its the aperture that gives you more light to pixels

Disadvantages of large expensive cameras:

- More expensive
- Big
- Bulky

c) Storage requirement

It can be calculated by multiplying the number of pixels by the number of channels

In our case, we have RGB → 3 channels

So the storage requirement for both the professional camera images & smartphone images

$16 \times 10^6 \times 3$ bytes

$= 48$ MB

A2)

Here (a) ⇒ Image (a)
(b) ⇒ Image (b)

There are four cases :-

Case 1 :- 8-neighborhood foreground & 4-neighborhood background

Image (a) 1 component for 8-neighborhood foreground
1 component for 4-neighborhood background

Image (b) 1 component for 8-neighborhood foreground
2 component for 4-neighborhood background

Case 2 :- 8-neighborhood background, 4-neigh. foreground

Image (a) = 25 components → 4neigh. foreground
1 component → 8 neigh. background

Image (b) = 11 components → 4 neigh. foreground
1 component → 8 neigh background

Case 3 :- 8 neigh foreground, 8 neigh background

Image (a) → 1 Component → 8 neigh. foreground
1 Component → 8 neigh. background

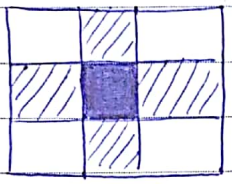
Image (b) → 1 Component → 8 neigh foreground
1 Component → 8 neigh background

Case 4 :- 4-neigh. foreground, 4-neigh background

Image (a) → 25 Components → 4 foreground
1 Component → 4 background

Image (b) → 11 Components → 4 foreground
2 Components → 4 background

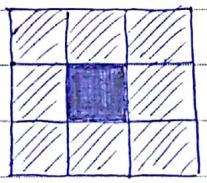
4-connected means:



Pixels neighbors → above, below, left & right are connected to the pixel.

4-connected pixels are neighbors to every pixel that touches one of their edges.

8-connected :- 8 connected pixels are neighbors to every pixel that touches one of theire edges or curves



→ all those are counted as 8-connected.

A3) Histogram Equalization:

Why is the histogram of a discount discrete image not flat histogram equalization.

⇒ Equalization is used to enhance contrast

While doing histogram equalization of a discrete image, we use a discrete sum to approximate a continous integral of the CDF (which is cumulative sum of PDF)

In other words, the resulting number of pixels is also a discrete integer which affects final outcome

Discrete histogram is an approximation of continous PDF & no new intensity levels are created in equalization process

Hence a non-flat histogram is an effect of discretization.