**CVI620/ DPS920 Worksheet 2- Digital Images**

1. We have a lens with a focal length of 100mm. How far away from the lens should the sensor be for a sharp (not blurry) image of an object which is 5 meters away from the lens?



f = 100mm

zo= 5m = 5000 mm

zi = 102.04 ≈ 102 mm

1. If the above lens is used in a camera with a maximum aperture of f/4, and the sensor is at 101 mm away from the lens, how wide would the circle of confusion be?

Assuming a simple case shown in the figure,

Due to similarity of the two triangles, we have

C= 0.25 mm

1. Would the object be more blurry or less blurry if the aperture was set to f/1.9?

(Wider aperture)

C= 0.52 mm (more blurry)

Wide apertures are used to obtain pictures with a nice blurry background.

1. For a camera with the maximum aperture of f / 1.9, in which the sensing plane is 106mm away from the lens, how should we adjust the focal length for an object that is 40m away from the camera?



zi = 106mm

zo= 40m = 40000 mm

f = 105.72 mm

Note: For objects that are far away, 1/zo ≈ 0 and therefore f ≈ zi.

1. How much memory is needed for an image with 1080p HD resolution (i.e. 1920x1080), if
2. Black and white (binary)

File size= number of pixels \* memory needed per pixel

Number of pixels = 1920 \* 1080 = 2,073,600

Memory needed per pixel = 1 bit

🡪 File size = 2,073,600 \* 1 bit= 2,073,600 bits

= = 259,200 bytes

= = 253.125 KB

= 0.25 MB

1. Grayscale with 256 gray levels

Since 256 = 28, each pixel will need 8 bits or 1 byte

Memory needed per pixel = 1 byte

🡪 File size = 2,073,600 \* 1 byte= 2,073,600 bytes

= 1.98 MB

1. RGB color channels, each with 256 colors

Each pixel will need 1 byte per 3 color channels, i.e. 3 bytes per pixel

Memory needed per pixel = 3 bytes

🡪 File size = 2,073,600 \* 3 byte= 6,220,800 bytes

= 5.93 MB

1. If the above color image is compressed to 2MB, does it have a lower quality than the original image?

The image will have a lower quality after compression, only if the compression is lossy. It is possible to compress an image using lossless compression, which results in preserving all information and maintain the original quality. Therefore, with the information given in the question, we cannot say whether the quality is lower or not.