University Kasdi Merbah - Ouargla

Department of Computer Science and Information Technology

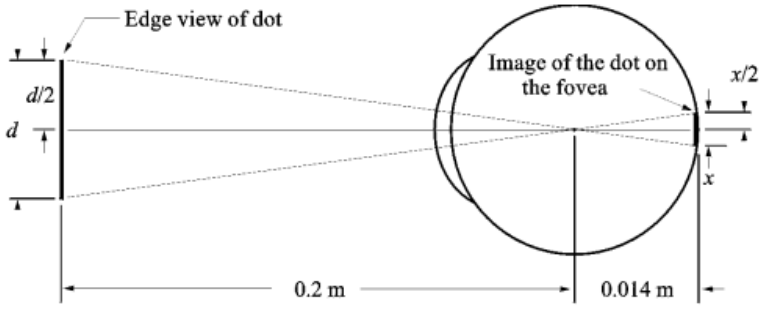
Master Artificial Intelligence and Data Science

Module: Digital Image

TD N°1

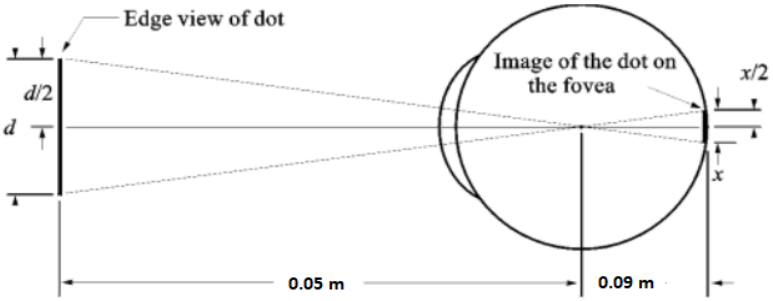
Exercise 1

Assuming that eyes cannot detect an object with a diameter less than the diameter of on light receptor in the retina (fovea). Suppose also that fovea is a square sensor array of 580×580 elements (light receptor) with equal spacing between elements, such that space and receptor widths are equal. Given that fovea dimensions are $1.5\ mm \times 1.5\ mm$, estimate the diameter of the smallest printed dot that eye can discern if the page on which the eye is printed is $0.2\ m$ away from the eyes and the focal length of the eye is $14\ mm$ (see the figure below)



Exercise 2

With $d = 0.04\ m$ and a fovea dimensions equal to $0.5 \times 0.5\ mm$, we cannot perfectly see the object at left (see the figure below), why? Adjust the parameter(s) of this configuration to become possible for the eye the see this object?



Exercise 3

A satellite wants to capture a night-time picture for the earth using an imaging system which emits waves with a wavelength $= 1.32 \times 10^{-10}$. Assuming that; in general, waves holding photons with energy of order $> 1.7 \times 10^{-2}$ cannot perfectly surpass the space to reach the object being imaged (the earth in this case). Is it possible for this imaging system to take this photo?

Exercise 4

Calculate the wavelength (λ) of a radio wave, such that its frequency (v) is equal to 10^5 Hz. (speed of light = 299 792 458 m/s).

Exercise 5

You are hired to design the front end of an imaging system for studying the boundary shapes of cells, bacteria, viruses, and protein. The front end consists, in this case, of the illumination source(s) and corresponding imaging camera(s). The diameters of circles required to enclose individual specimens in each of these categories are 50, 1, 0.1, and 0.01 m, respectively. Specify the illumination wavelength band and the type of camera needed for this process?

Exercise 6

The aim of this exercise is to simulate the human vision system using a CCD camera. A CCD camera is equipped with a lens having a focal length of $35\ mm$. This CCD of dimensions $7 \times 7\ mm$ have a sensor array of 1024×1024 elements. Suppose that the camera is focused on object located $0.5\ m$ away.

1) Calculate the size of the target object; if you know that internal size of the object in the camera is $7\ mm$?
2) Calculate the spatial resolution of the image produced by this camera in this case?

Exercise 7

Suppose that you want to upload a photo of 500×500 pixels into Google drive. Assume that you have an Internet connection with an upload speed of 30 KB/second. By considering a bit depth of 8 bits, calculate the time required to upload this photo in two cases 1) the photo is in RGB 2) the photo is in gray level ?

Exercise 8

Explain the relationship between the sampling ratio and the spatial resolution?

Exercise 9

An HD TV generates images with a resolution of 1125 horizontal TV lines. The width to height aspect ratio of the images is 16:9, and it is (aspect ratio) in proportion with vertical to horizontal resolution. This TV paints one RGB image with a bit depth of 8 bits in every 1/30 second. Calculate the amount of bits required to record 1.5 hour of an HD TV program ? Is it adequate to save these images in BMP format ? Why?