Homework 1

1. An image can be thought of as: (Circle all correct answers)

   ☒a) A 2-dimensional array of numbers ranging from some minimum to some max

   ☒b) A function f of x and y: f(x, y)

   ☐c) Something generated by a camera

2. Define an image as a function:

Think of an image as a collection of intensities at different locations along x and y, where xϵR and yϵR. Suppose x is 0->127, y is 0->127, and the intensity range is 0->255, fill up the blanks of the following equation:

$$I = f(x,y) \quad where \ \mathrm{f}: [\boxed{0}, \boxed{127}] \times [\boxed{0}, \boxed{127}] \rightarrow [\boxed{0}, \boxed{255}]$$

3. Define a color image as a function:

Which equations are correct? (Circle all correct answers)

a) ☒f: R×R->R^3
b) ☐f: R×R×R->R×R
c) ☒f: R×R->R×R×R
d) ☐f: R×R×R->R

4. Quantize an image:
   Here is a patch of a digital image,

   ANS:

1	2	5
3	4	5
0	5	2

   If we only have a small set of integers to represent the values of the pixels, say {0,1,2,3,4,5}, try to quantize the image following rules:
   1) Round down: 1.6->1
   2) Limits: anything<0 - >0; anything>5 -> 5

5. List at least 5 applications of computer vision.
   1. Automatic inspection, *e.g.*, in manufacturing applications
   2. Controlling processes, *e.g.*, an industrial robot
   3. Detecting events, *e.g.*, for visual surveillance or people counting
   4. Navigation, *e.g.*, by an autonomous vehicle or mobile robot
   5. Recognition process, e.g., face recognition, sign recognition
   6. 3D modeling

6. Why is computer vision difficult?
   Every data in computer vision is identified and processing by the pixels now if we consider an image that might contain range of pixels and also if it is colored image than for RGB it will be multiple of 3 then the process will be much difficult for computer to understand. And making algorithm to do this process will also be complex condition.

7. What is the difference among computer vision, computer graphics and image processing?
   Image processing: transformations are applied to an input image and an output image is returned. The transformations can e.g. "smoothing", "sharpening", "contrasting" and "stretching".
   Computer vision: an image or a video is taken as input, and the goal is to understand the image and its contents.
   Computer Graphics: is about drawing things on the screen with pixels, using mathematics and physics for example “trigonometry”,” lighting”,” shading”, ”curvature”.

Example:

Computer graphics is drawing the figure of a bicycle on your computer screen.

Computer vision is a camera looking at a bicycle, and the computer being able to figure out that it's an apple.

Image processing is taking a photo of a bicycle, and applying filters on it, just to make it more attractive.

8. What are the two major parameters of a camera which control the exposure of images? If an image was over-exposed, how can we adjust the camera?

   Two major parameters are:

   a) Aperture: controls the area over which light can enter your camera.

   b) Shutter speed: controls the duration of the exposure.

   And another important parameter is:

   c) ISO speed: controls the sensitivity of your camera**'s** sensor to a given amount of light.

   By increasing the shutter speed, we can adjust the camera.

9. How to convert analog image to digital image? How to choose sampling rate to avoid aliasing?

   To convert the analog image to digital image, sampling process is used in which the continuous-time signal reduces to a discrete-time signal. And because of this reconstruction aliasing takes place which can be reduced by making samples twice than the maximum frequency (Shannon's Sampling Theorem).

10. What is the advantage of CIE XYZ color coordinates compared with CIE RGB? What is the benefit of L*a*b* color space? Today's cameras use a color filter array (CFA) to capture colors. According to Bayer pattern, half sensors are green filters. Why?

    The advantage of XYZ over RGB is that RGB doesn't include intensity in color, this problem is called Chromaticity. And XYZ separates luminance from chrominance. Differences in luminance or chrominance are more perceptually uniform in L*a*b* color space. Because human light is most sensitive to green light.