1. Basic Concepts

(1) Three membranes enclose the eye: the cornea and sclera, choroid, and retina.
(2) Iris is actually a part of choroid and it can contract or expand to control the amount of light that enters the eye.
(3) Images are formed on retina, which contains two kinds of light receptors, cones and rods.
(4) Cones are primarily located in the central portion of the retina, called fovea and are sensitive to color; cone vision is called bright-light vision. Rods are distributed over the retinal surface; they are not involved in color vision and are sensitive to low levels of illumination; rod vision is called dim-light vision. There is a blind spot on the retina.
(5) Perceived brightness is not a simple function of intensity. Consider the “Mach bands” and the “Simultaneous contrast” phenomenon.
(6) The colors that we perceive are determined by the nature of the light reflected from an object.
(7) Besides frequency, other three properties are used to describe a light, radiance, luminance, and brightness.
(8) The purpose of sampling and quantization is to convert a continuous image signal to a discrete digital form.
(9) DPI is used to measure the spatial resolution.
(10) The number of bits used to quantize intensity is often referred as the intensity resolution.
(11) Traditional image interpolation methods include nearest neighbor, bilinear, and bicubic.
(12) There are three kinds of adjacencies usually used, 4-adjacency, 8-adjacency, and $m$-adjacency.
(13) Three kinds of distance metrics are widely used, Euclidean distance, city-block distance, and chess-board distance.

2. Exercises

(1) Compared with a commercial digital camera, then lens of the human eye can be considered as____, the iris can be considered as______, and the retina can be considered as_____.
(2) Are there any defects of the human eye?
(3) Cones are sensitive to____; rods do not respond to____ and is sensitive to______.
(4) When you enter a dark theater on a bright day, it takes an appreciable interval of time before you can see well enough to find an empty seat. Which of the visual process mentioned in our lecture is at play in this situation?
(5) For our humans, perceived brightness is not a simple function of the intensity. Can you give some examples?
(6) We see the grass is green, that is because grass____ green light.
(7) There are two images $A$ and $B$, whose sizes are $1024*1024$ and $256*256$, respectively. Is it correct to say that the resolution of $A$ is greater than $B$?
(8) We have a raw image with 320 rows and 480 cols, having 16 different gray levels. How many
bytes are needed to store this image?

(9) Based on considerations of hardware design, usually intensity level of an image is the power of ___.

(10) \( p(0, 0) \) and \( q(3, 4) \) are two positions on an image. Calculate the distances between them, in terms of Euclidean distance, \( D_4 \) distance, and \( D_8 \) distance, respectively.

(11) Consider two image subsets \( S_1 \) and \( S_2 \), shown in the following figure. For \( V = \{1\} \), determine whether these two subsets are (a) 4-adjacent, (b) 8-adjacent, or (c) \( m \)-adjacent.

\[
\begin{array}{cccccccc}
0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\
1 & 0 & 1 & 0 & 1 & 0 & 0 & 1 \\
1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\
0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \\
\end{array}
\]

(12) Consider the image segment shown below. Let \( V = \{0, 1\} \) and compute the lengths of the shortest 4-, 8-, and \( m \)-path between \( p \) and \( q \).

\[
\begin{array}{c}
3 & 1 & 2 & 1(q) \\
2 & 2 & 0 & 2 \\
1 & 2 & 1 & 1 \\
(p) & 1 & 0 & 1 & 2 \\
\end{array}
\]

3. Matlab Programming

- **Load, save, and display an image** \( \text{imread, imwrite, imshow, imfinfo, figure} \)
- **Conversion of images** \( \text{rgb2gray, im2bw, im2uint8, im2uint16, mat2gray} \)
- **Algebraic operations of images** \( \text{imadd, imsubtract, immultiply, imdivide, imabsdiff, imlincomb} \)
- **Spatial operations of an image** \( \text{imresize, imrotate, imcrop} \)
- **Matrix and vector operations** \( \text{size, rot90, flipud, fliplr, round, floor, ceil} \)
- **Matrix construction** \( \text{zeros, ones, true, false, magic, rand, randn} \)

(1) Test the functions of the routine imresize, imcrop, and mat2gray.

(2) Given a gray-scale image with 256 intensity levels. Convert it to images with 128 levels, 64 levels, 16 levels, and 2 levels, respectively and display them.

(3) Load a colorful image, flip it (up-down, or left-right), and display the results.