IERG 4160 lmage and Video Processing

Homework Assignment1

Due on Oct. 28th 2019

Question 1

Please design an affine matrix for the following image operations: Shift an image along the y-axis for 4 units, followed by an anti-clockwise rotation of 30°, then translate by 2 units along the x-axis.

Question 2

lmagine that your camera has a storage space of 32 GB, and it can capture image with a maximum resolution of 2560×1920 pixels.

(a) How many uncompressed grayscale image of maximum resolution you can store in the camera storage space? The intensity of each pixel is an 8-bit quantity.

(b) How many uncompressed RGB color image of maximum resolution you can store in the camera storage space? For each color plane, the intensity of each pixel is an 8-bit quantity.

Note: we use the convention where 1MB = 1024^2 bytes and 1GB = 1024^3 bytes

Question 3

(a) The image in Fig. 3.2 is obtained by convolving the image in Fig. 3.1 with a 3×3 convolution mask. Which the following masks could have been used to give this processing result?

$$\mathrm{H}_1 = \frac{1}{9}\begin{Bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{Bmatrix};$$

$$\mathrm{H}_2 = \frac{1}{8}\begin{Bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{Bmatrix};$$

$$\mathrm{H}_3 = \frac{1}{4}\begin{Bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{Bmatrix};$$

$$\mathrm{H}_4 = \frac{1}{4}\begin{Bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{Bmatrix}.$$

(b) Which of the following operation has been applied to obtain Fig. 3.3 from Fig. 3.1? (i) power- law transformation with $\gamma = 1/5$, ii)power-law transformation with $\gamma = 5.0$, iii) bit-plane slicing, iv) image negative.

Fig. 3.1

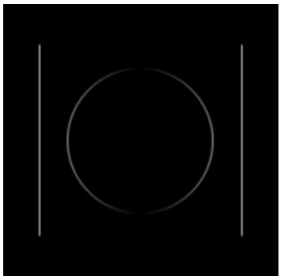

Fig. 3.2

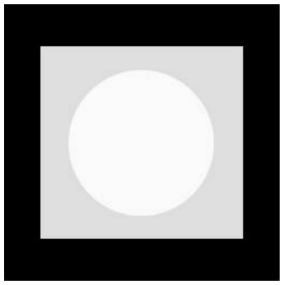

Fig. 3.3

Question 4

Suppose that the spatial positions and gray levels of four pixels are known as shown in Figure 4.1, where the gray levels

$f(1,1) = 125, f(1,5) = 30, f(6,1) = 25$, and $f(6,5) = 90$

(a) Compute the gray level at the position $(4,2)$ using the nearest neighbor method.

(b) Compute the gray level at the position $(4,2)$ using bilinear interpolation method.

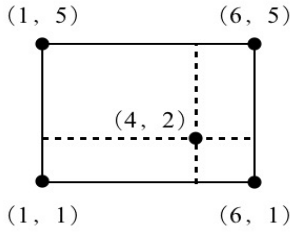

Figure 4.1

Question 5

The general equation of discrete Fourier transform (DFT) is given as below,

$$F(u,v\rangle = \frac{1}{MN}\sum_{x=0}^{M-1}\sum_{\mathrm{i}=0,\vee}^{N-1} f(x,y)e^{-j2\pi(ux/M+vy/N)}$$

Please prove that discrete Fourier transform is a linear operation.