State University of New York at Buffalo

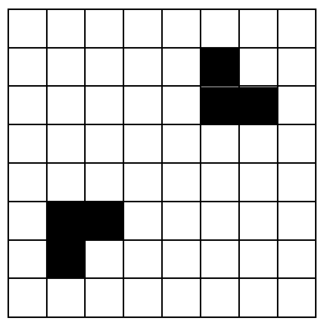
CSE 473/573 Fall 2016 Homework Set #1

Assignment Date: Monday September 21, 2016; Due: ***Monday October 3, 2016 at 3:00PM***

Name: ______________________________ Student Number: ________________________

Problem (1) **(Distance Transform)** 20%

Consider the following image for performing Distance Transform computation



(a) Compute and label the distance map for this image using 4-neighbour distance
(b) Compute and label the distance map for this image using 8-neighbour distance

Problem (2) **(Histogram Construction and Entropy Calculation)** 20%

1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2

Image 1

10	15	15	06	01	01	01	15
06	10	10	10	10	10	10	10
06	15	04	01	01	01	01	10
06	04	15	01	01	10	01	10
15	04	04	15	01	10	01	10
15	10	10	10	15	10	01	10
15	10	10	10	10	15	01	10
15	10	10	10	10	10	15	10

Image 2

(a) Compute the histograms for these two images (4-bit)
(b) Compute the entropy of these two images
(c) Comment on the relationship between the entropy of an image and its complexity in terms of composition and explain why?

Problem (3) **(Convolution – infinite series)** 20%

The discrete-time unit-step function can be defined as:

$$u[n] = \begin{cases} 1, & n \geq 0 \\ 0 & n < 0 \end{cases}$$

Consider a linear time-invariant system whose impulse response function $h[n]$ is defined as:

$$h[n] = \left(\frac{1}{3}\right)^n u[n]$$

Compute and hand plot each of the following convolutions when $x[n] = u[n]$:

(a) $y_1[n] = x[n] * h[n]$
(b) $y_2[n] = x[n-9] * h[n]$
(c) $y_1[n] = x[-n] * h[n]$

Problem (4) **(1D Fourier Transform)** 20%

Consider the rectangular pulse that is frequently encountered in computer circuit applications. It can be defined by the following:

$$x(t) = \begin{cases} 1 & |t| \leq T_0 \\ 0 & |t| > T_0 \end{cases}$$

(a) Compute the Fourier transform of $x(t)$ when $T_0 = 2$
(b) Compute the Fourier transform of $x(t)$ when $T_0 = 4$
(c) Compute the Fourier transform of $x(t)$ when $T_0 = 8$
(d) Comment on the behavior of Fourier transform of $x(t)$ when T_0 is further increased.
(e) Compute the convolution $y(t) = x(t) * x(t)$ and its Fourier transform when $T_0 = 2$ (convolution property may be applied when computing the Fourier transform of $y(t)$)

Problem (5) **(2D Fourier Transform)** 20%

Many imaging systems can be considered as a linear shift invariant systems whose characteristics can be represented by their impulse response of the camera. It is well known that the impulse response of a camera can be modeled by:

$$h(x,y) = \begin{cases} \dfrac{1}{T_1 T_2} & |x| < \dfrac{T_1}{2}, |y| < \dfrac{T_2}{2} \\ 0 & \text{otherwise} \end{cases}$$

where T_1, T_2 are the horizontal and vertical size of the camera aperture, respectively.

(a) Compute the continuous-time Fourier transform of $h(x,y)$, $H(u,v)$
(b) Sketch the magnitude of the $H(u,v)$ (note the symmetry of $H(u,v)$ with respect to (u,v))
(c) Comment on the effect of the parameters T_1, T_2 on the frequency response of such camera.