National University of Computer and Emerging Sciences, Lahore Campus

Course:	Computer Vision	Course Code:	CS-495
Program:	BS(Computer Science)	Semester:	Fall 2016
Duration:	60 Minutes	Total Marks:	35
Paper Date:	10-Sep-16	Weight	15%
Section:	ALL	Page(s):	3
Exam:	Midterm-II	Roll No:	

Instruction/Notes: Attempt all questions in the space provided to you.

Question 1: Who Did This? [15 Marks]

Imagine that you are an artist who creates tiny digital images:

5	6	9	1	3
2	4	4	2	7
0	1	0	3	3
4	8	1	8	5
7	3	6	6	1

5	6	9	1	3
2	-5	-3	-6	7
0	-1	4	1	3
4	6	5	1	5
7	3	6	6	1

The image on the left is your masterpiece, worth millions of dollars, where numbers indicate the intensity of a pixel: One day you enter your atelier, look at your masterpiece as you do every morning, and suddenly realize that someone destroyed it! It now looks like the image on the right. Instead of the beautiful pixels that you composed, it shows some random looking pixels, some with negative intensity (let us not even think about what that may look like). After you recover from your shock, there is just one question on your mind: Who did this?

(a) After some Sherlock Holmes inspired thinking, you are quite certain about what happened: A convolution filter from the computer vision lab downstairs must have broken into your atelier and performed a complete convolution of your image! But who exactly is the culprit? There are thousands of filters in the lab, so you need an exact description. Please determine the identity of the criminal convolution filter based on the images above and draw it. Remember that we defined convolution on images in such a way that the entire filter is always inside the image, and those pixels that its center cannot reach are filled with original values.

1	0	0
0	0	0
0	0	-1

(b) If you had forgotten the numbers in your original image but only knew the image on the right and the convolution filter, could you perfectly reconstruct the original image? Give an argument (not a mathematical proof) why this is or is not generally possible

No, as center value is destroyed

Question 2: ***Hough Transform [6+ 4 = 10 marks]***

(a) Explain (briefly & to the point) how the Hough Transform detects straight lines in an image such as shown in the image below using $\theta\rho$ line parameterization

1. Initialize H[d, θ]=0

2. For each edge point in $E(x,y)$ in the image
θ = gradient orientation at (x,y)
d = x cos θ + y sin θ
H(θ, d) = H(θ, d) + 1
end
3. Find the value(s) of (d, θ) where H[d, θ] is maximum. There will be 4 such points corresponding to 4 edges.

4. The detected line in the image is given by
$d=x\cos\theta+y\sin\theta$ (points satisfying the equation for maximum d and θ will be marked)

(b)What is the effect on the process if the image is degraded as shown below?

We will still be able to detect lines. Uniform noise can lead to spurious peaks in the array but number of max votes will increase also increase. Very tolerant to noise and missing data

Question 3: ***Canny Algorithm [marks 10]***

Apply Non-Maximum suppression on the supposed data given below.

Magnitude

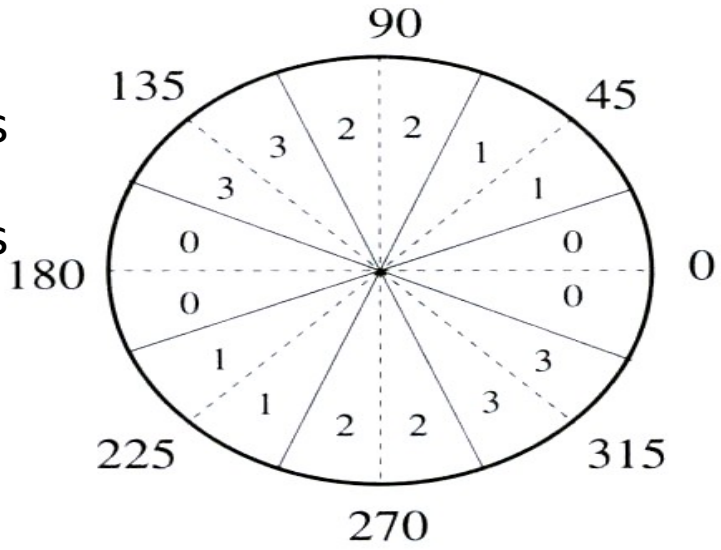
40	30	20	10
45	90	100	5
6	45	60	65
10	30	25	110

Direction

180	315	0	180
180	95	45	135
180	95	40	95
255	115	225	95

Answer:

0 degrees --> 0,
45 degrees --> 1,
90 degrees --> 2,
135 degrees --> 3.



40	***0***	***0***	***0***
0	***90***	***100***	***0***
0	***0***	***60***	***0***
10	***30***	***0***	***110***