UNIVERSIDAD PANAMERICANA Campus Bonaterra	Facultad de Ingeniería	Examen: Tercer Parcial
	Academia de Cómputo	Fecha: 16/11/2022
	Materia: Agentes Inteligentes	
	Profesor: JIMENA JUÁREZ	
	Carrera: IIA	
	Miembros de Equipo:	

I.	Valor: 10%	

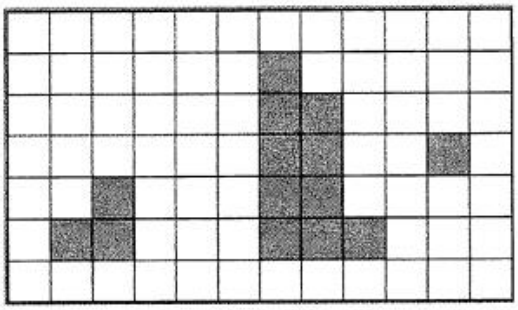

Figure I_1. Binary image of size 12x7 pixels, where gray == on, white == off.

(a) By drawing in the graphic below, show the result of dilating I_1 using a 3x3 square structuring element (SE) whose origin is at the middle pixel.

(b) (i) Show the result of eroding I_1 with this SE where the "x" marks its origin pixel:

II.	Valor: 50%	

a. Imagine you are designing an interest-point detector. Describe desirable properties for a good interest point AND list to what changes the interest point should be invariant.
b. Is non-max suppression relevant to interest-point detection? Explain why or why not.
c. Define AND describe the matrix S in the cornerness equation $\varepsilon(x,y) = \mathbf{x}^T S\mathbf{x}$.

d. What do the first and second eigenvectors reveal about a corner?
e. What does the "SIFT" interest-point detector discover about an interest point that algorithms like the SUSAN, Harris-Stephens, and FAST detectors do not find?
f. Imagine a computer vision system that can operate the mouse of a desktop computer to click at any (x,y) location, and that the system gets regularly updated undistorted images of the current computer screen. At random times, a known pop-up dialog window will appear on the computer screen at a random location, and the system must direct the mouse to click on one of the buttons in this window, to make the dialog window go away. That button's location inside the window is the same each time, and the window is opaque (not transparent). State any further assumptions you are making about the situation when answering the following questions.

i. Assume that the appearance and shape of the pop-up window is always the same, except that a random string replaces "XYZ" in the following text that appears in the window above the button (without affecting the button's location): "Hi XYZ, click to make this window go away". Write an outline of your algorithm that would call the mouse-click controller at the right times and with the right coordinates for where to click. Explain if the algorithm needs any kind of initialization. Give some consideration to computational efficiency.

ii. Now assume that the pop-up window appears each time with a random amount of transparency, so that it is always 5% or more opaque, but whatever else is on the desktop may be showing through. Describe only what you would change or add, if anything, to your previous algorithm to cope with this situation.

III.	Valor: 50%	

a. The Prewitt kernels are given by $k_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$ and $k_y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$.
For an unknown image I of size $M \times N$ you are given the edge values (computed using k_x and k_y, respectively) as matrices I_x and I_y, i.e., all the $M \times N$ values are given for both I_x and I_y. Can you uniquely recover the original image I based on I_x and I_y? If so, how? If not, what (minimal) additional information is required?

b. On what principles does the Harris corner detector work? Given a grayscale image I, describe how would you use the Harris corner detector to decide if the pixel at (i, j) is on a corner or not?

c. Given a moderately noisy image, would you use the USAN (Univalue Segment Assimilating Nucleus) or the Harris corner detector to extract corners? Why?

d. We use an analog-to-digital (A/D) convertor to digitize an analog signal, and then a digital-to-analog (D/A) to convert the signal back to an analog signal. In each of the two steps, typically a low pass filter is used. What are the purpose(s) of the two low-pass filters? Please provide appropriate explanatory figures (in the spatial domain or the frequency domain).

e. In the Canny edge detector, can we switch the order of non-maximal suppression and double thresholding without leading to performance loss? If so, why? If not, why not?

IV.	Valor: 10%	

Describe why performing edge detection on the image below to find the field boundaries may be more successful when using the original color image instead of the greyscale below (only grayscale image shown)? What basic transformations could be made to the original color image to further improve edge detection?

V.	Valor: 50%	

The Mars Rover uses a stereo system to create depth maps of the surface of Mars. The figure below shows a stereo pair of images captured by the Rover. The stereo algorithm is currently attempting to match the pixel at the centre of the yellow window in Image 1 against Image 2 using a template matching approach.

Let $I(x,y)$ be Image 2, $t(x,y)$ the template and (u,v) the location at which we position the template in Image 2 to evaluate the matching score.

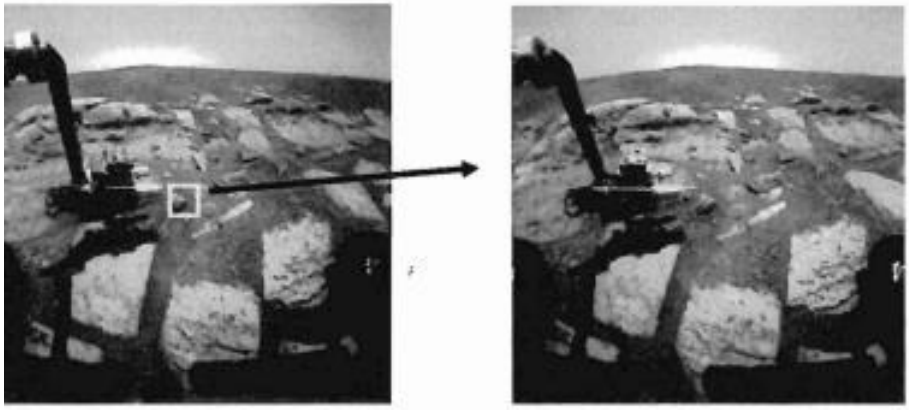

Image 1 Image 2

Give the formula for the template matching score obtained using each of the following measures:

i. Cross correlation (CC)

ii. Normalized cross correlation (NCC)

iii. Sum of squared differences (SDD)

iv. For each of the above measures, describe if it is a measure of similarity or dissimilarity. What is the relationship between cross correlation (CC) and sum of the squared differences (SSD)? What are the main advantages of using normalized cross correlation (NCC) versus unnormalized cross correlation (CC)?