ECE 470: Introduction to Robotics Homework 6

Question 1.

A region of interest (ROI) from row 181 to 200 and column 101 to 120 of an original image **I** is specified as ROI_01= **I** (181:200, 101:120) to encompass a window in the scene with an array of intensity values as shown in Fig. 1.

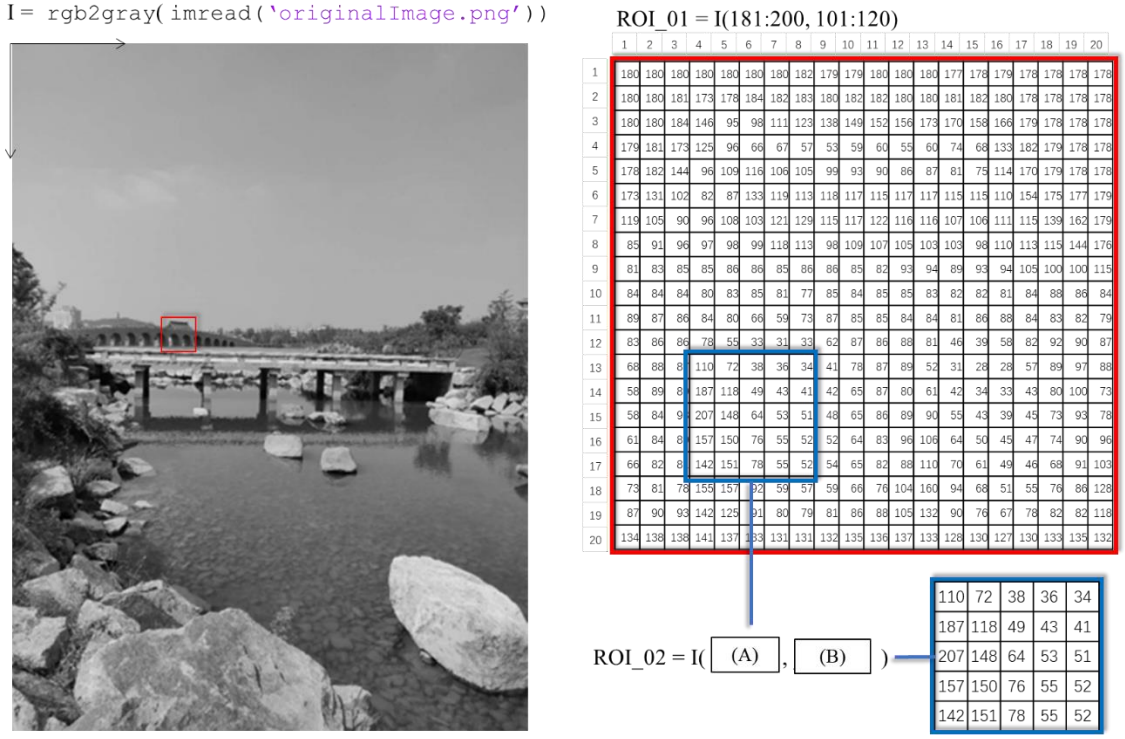


Fig. 1

a) For a 5x5 sub-region ROI_02 specified as shown in Fig 1.
   i. Write down the expressions in (A) and (B) indexing from image **I**. *(2 point)*
   ii. Tabulate the available intensity values and their respective occurrence in ROI_2. Plot the histogram *(4 points)*
   iii. Perform histogram equalization and plot the new histogram *(6 points)*
   iv. Comment on the histograms produced in (ii) and (iii) *(2 points)*

b) Determine the transformed intensity value of ROI_02 (2,2) if a 3 x 3 mean filter kernel is applied to the second ROI. *(1 points)*.

Question 2

The image, **I** is being applied with filters as described below:

F1: Mean filter with kernel size of 15 x 15

F2: Gaussian filter with kernel size 15 x 15 and standard deviation, σ=1

F3: Gaussian filter with kernel size 15 x 15 and standard deviation, σ=3

a) Match the filter with their respective output images in Fig. 2. *(3 points)*

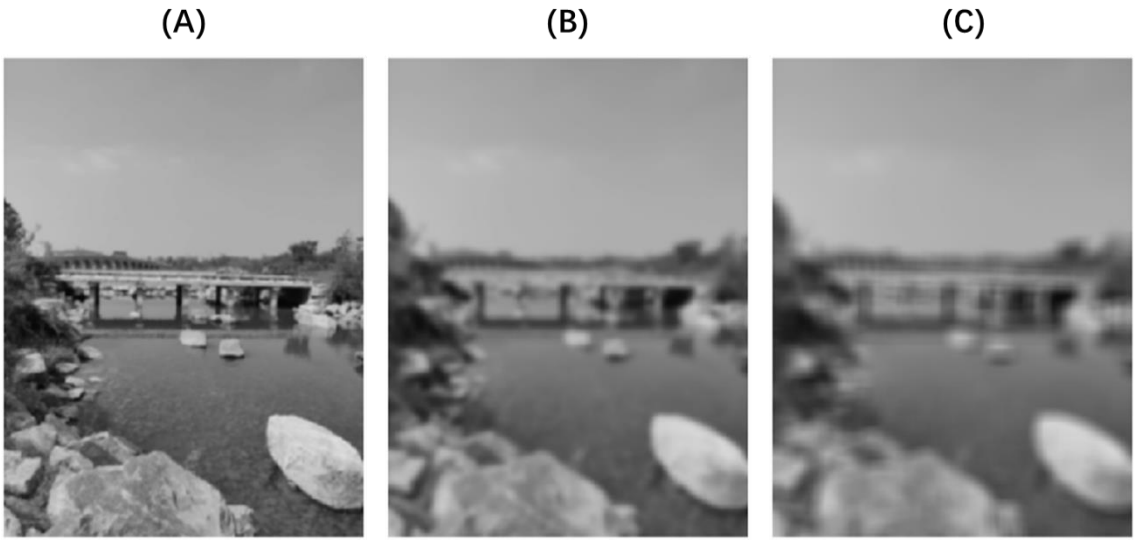


Fig. 2

b) Match the output images (A) and (B) to the associated edge detection methods performed, namely, (I) Canny edge detection and (II) Sobel edge detector, assuming the original image is a noisy image as depicted in Fig. 3. *(2 points)*

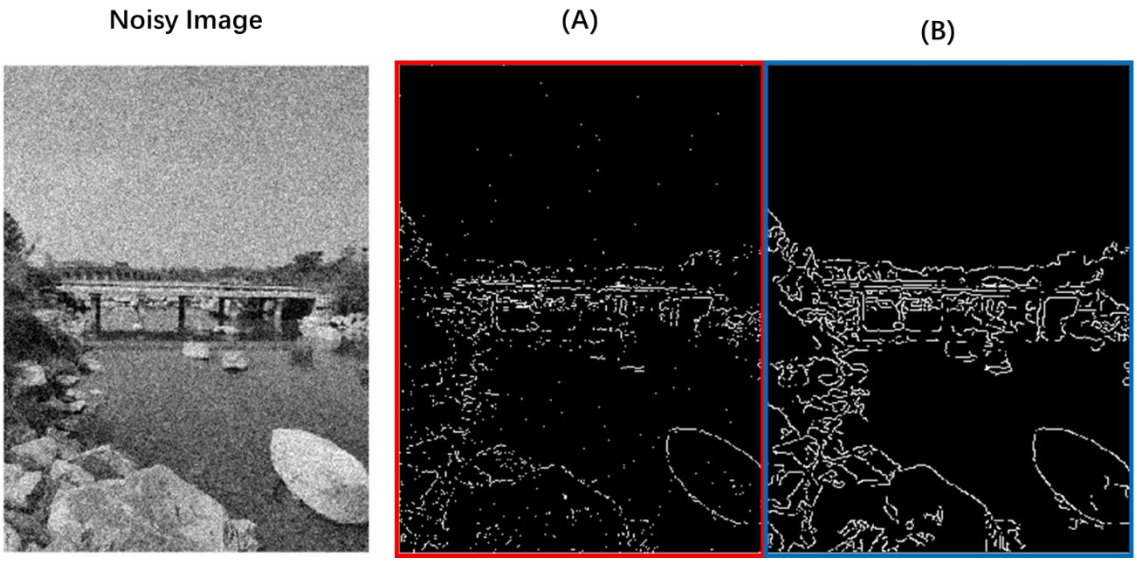


Fig. 3

Solution:

Question 1

a) i)

(A) 193:197; (B) 104:108

ii) Intensity value *i* and the respective occurrence in ROI_2 n_k, $N_k = n_1 + n_2 + \cdots n_k$

i	34	36	38	41	43	49	51	52	53	55	64	72	76	78	110	118	142	148	150	151	157	187	207
n_k	1	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
N_k	1	2	3	4	5	6	7	9	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25

The histogram plot is represented by the non-solid bar (step).

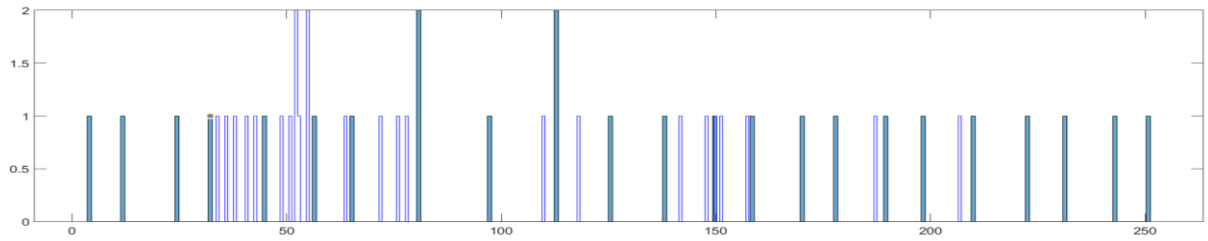
iii) Transformation for histogram equalization:

$$S_k = \left(\frac{n_1 + n_2 + \cdots n_k}{N}\right)(L-1)$$

Substitute L-1=255, N=5x5, $S_k = \left(\frac{N_k}{25}\right)(255)$

Rounding off to nearest integer for digital representation of transformed intensity, J.

i	34	36	38	41	43	49	51	52	53	55	64	72	76	78	110	118	142	148	150	151	157	187	207
n_k	1	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
N_k	1	2	3	4	5	6	7	9	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25
j	10	20	31	41	51	61	71	92	102	122	133	143	153	163	173	184	194	204	214	224	235	245	255



The new plot is represented by the solid bar.

iv) The histogram becomes more spread out suggesting a richer contract as the image is represented by a wider range of pixel values.

b) It becomes the mean of the regional values defined in the 3x3 window as shown.

$\frac{1}{9}$ $\begin{matrix}1&1&1\\1&1&1\\1&1&1\end{matrix}$ $*$ $\begin{matrix}110&72&38\\187&118&49\\207&148&64\end{matrix}$ = 110

Question 2

The image, $\mathbf{I}$ is being applied with filters as described below:

(A)→ F2: Gaussian filter with kernel size 15 x 15 and standard deviation, σ=1→(A)

(B)→ F3: Gaussian filter with kernel size 15 x 15 and standard deviation, σ=3→(B)

(C)→ F1: Mean filter with kernel size of 15 x 15→ (C)

b)

(A)→(II) Sobel edge detector as noise can be picked up by the purely gradient-based operator.

(B)→(I) Canny edge detection as noise is being reduced in the first step of the algorithm so as not to pick noise up undesirably while using obtaining the gradient of intensity.