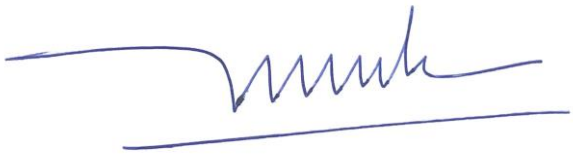
Final Examination

Date: *25 April 2024* - Room: *403*

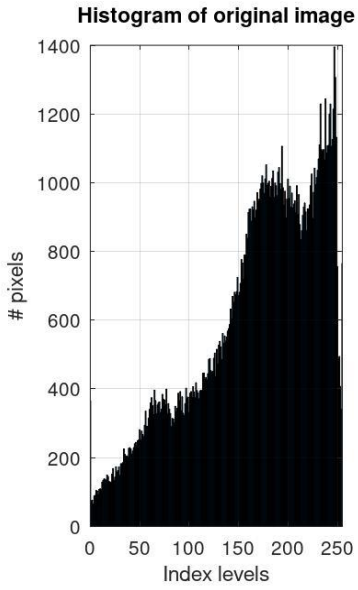
Duration: *150 minutes (18:15 – 20:45)*

Subject: Image and Video Digital Processing (Course ID: IVP501)	
	Course Instructor *Signature:*  *Dr. Nguyen Ngoc Truong Minh*

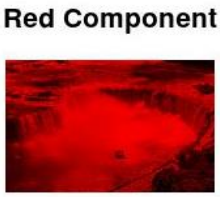
1. (15 marks) – Image Histogram and Equalization

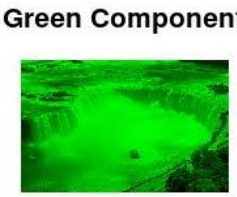
Given a color image named '*Ex1.jfif*.

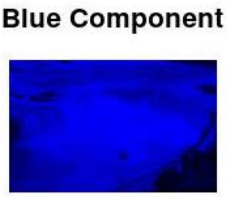
(a) Plot the original image and its histogram. Save this image as 'Color_Histogram.jpeg'



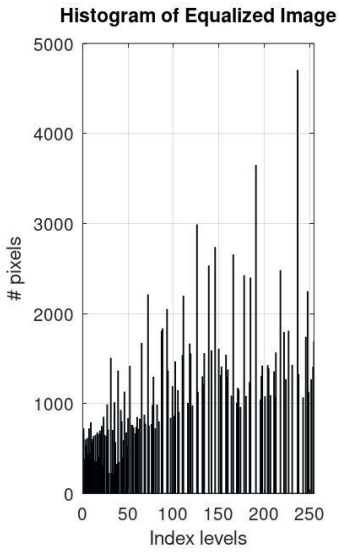
(b) Display three primary components Red, Green and Blue of the original image. Recombine them in Blue, Red, Green order. Plot these images in the same figure and save as 'Primary_Colors_and_BRG_Image.jpeg'







(c) Apply histogram equalization for the original image. Plot the image and its histogram after being equalized. Save this figure as 'Equalization_Histogram.jpeg'



2. (25 marks) – Object Counting

Given a color JPG image named '*Ex2.jpg*'.

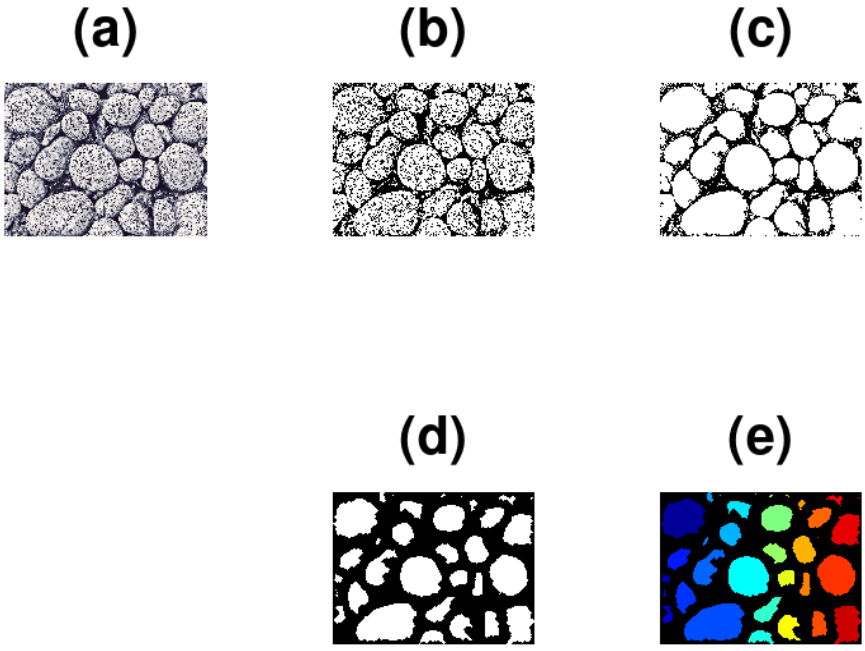
(a) Read and display the original image.

(b) Binarize the original image using Otsu method and display the binary image.

(c) Fill small holes in the binary image and display the filled image.

(d) Perform the erosion on the binary image using a diamond structuring element with size = 15.

(e) Apply region labeling on the eroded image to count number of stones in the original image. Print the result on the screen.



Number of objects: 38

3. (20 marks) – Denoise and Deblur a Noisy Blurry Grayscale Image

Given a noisy and blurry grayscale PNG image named '*Ex3.png*'.

(a) Read and display the original image.

(b) Method 1: Apply a denoise filter (default averaging kernel filter) then a sharpening filter (h = [0, -1, 0; -1, 5, -1; 0, -1, 0]) to the original image. Display the restored image.

(c) Method 2: Apply the Wiener filter to denoise and deblur the original image. Assume the Gaussian noise variance of the original image is σ=0.2. The estimated noise is calculated by the noise variance divided by the variance of the original image. The sharpening filter using the same with question b. Display the restored image.

(d) Perform the root mean square (rms) calculation in two methods between the restored image and the original image.

Method 1 = 168.71

Method 2 = 169.36

4. (25 marks) – Edge Detection and Hough Transform

Given a color JPG image named '*Ex4.jpg*'.

(a) Read and display the original image in color and grayscale format.

(b) Apply Roberts filter in two directions (horizontal and vertical). Display the logarithm of sum of edge magnitude response with a threhold value = 4000. Then, display the binary image based on this threshold.

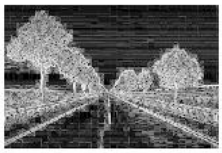
(c) Apply Canny Edge Detector using a standard deviation $\sigma = 1/\ 4\sqrt{2}$ and a threshold value = 0.2.

(d) Apply Hough Transform using a ratio = 0.8 of max peak.

Original Image

Grayscale Image

Edge Magnitude



Magnitude > 4000

Canny Edge with sigma = 0.18

Hough Transform

5. (15 marks) – Key point Detection

Given a color JPG image named '*Ex5.jpg*'.

(a) Read and display the original image in color and grayscale format.

Original Image

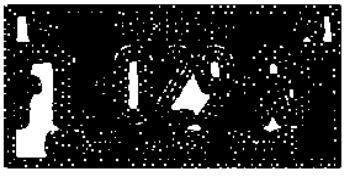
Grayscale Image

(b) Use LoG to highlight the 200 strongest key points in the original image. Choose sigma value = 4.

LoG Response

Thresholded LoG Response

Local Extrema (Dilated)

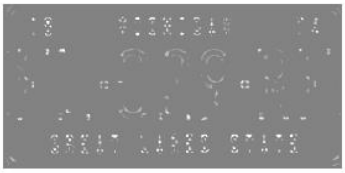


Keypoints

(c) Use DoH to highlight the 200 strongest key points in the original image. Choose sigma value = 2.

DoH Response

Thresholded DoH Response



Local Maxima (Dilated)

Keypoints

(d) Use FAST to highlight the 200 strongest key points in the original image. Choose the threshold value = 0.3.

Fast Corners

Fast Corners, Non-max Suppressed

All cases used Prewitt operator if needed. Other parameters are optional.

---------- *End of Exam* ----------