COMP9517

Lab 1, T2 2019 (18/06/2019)

This lab presents a revision of important concepts from weeks 1 and 2 lectures.

The last question (Question 3) is assessable AFTER THE LAB. Please submit both gradient images computed in Question 3 in a zip file via webCMS3 by 23:59:59 on June 18th, 2019. Submission instruction will be posted prior to the lab session.

The sample image "SanFrancisco.jpg" is to be used for all three questions.

Contrast Stretching

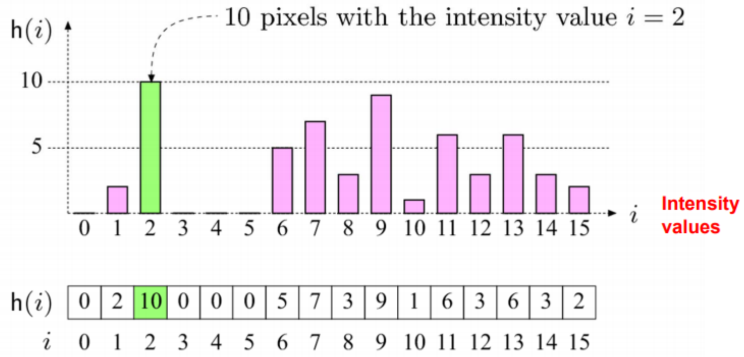
Contrast in an image is a measure of the range of intensity values within an image, and is the difference between the maximum and minimum pixel values. The full contrast of an 8-bit image is 255(max)-0(min)=255, and anything less than that results in a lower contrast image. Contrast stretching attempts to improve the contrast of an image by stretching (linear scaling) the range of intensity values**.** Assume that ***Or*** is the original image and ***Tr*** is the transformed image. Let a and b be the min and max pixel values allowed in an image (8-bit image, a=0 and b=255), and let c and d be the min and max pixel values in a given image, then the contrast stretched image is given by the function:

$$\boldsymbol{Tr = (Or - c)\left(\frac{b - a}{d - c}\right) + a}$$

QUESTION 1: Read the given grey scale image and perform contrast stretching to improve the quality of the image.

Histogram

The histogram of an image shows the frequency of pixel intensity values. It gives statistical information and removes the location information of the pixels. For a digital image with grey levels from 0 to L-1, the histogram is a discrete function $\boldsymbol{h(Or_k) = n_k}$, where ***Or$_k$*** is the k^{th} grey level and ***n$_k$*** is the number of pixels with a grey level ***r$_k$***.



h(i)	0	2	10	0	0	0	5	7	3	9	1	6	3	6	3	2
i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Figure 1: Histogram (Picture from [3]).

QUESTION 2: Write a function that computes the histogram of the given grey scale image and displays a plot.

Image Edges

Edges are an important source of semantic information in images, and they occur in human visual perception at divisions between different areas of brightness, colour and texture. A grey scale image can be thought of as a 2D representation of heights and areas of different brightness live at different heights. A transition between different areas of brightness in an image I , means there must be a steep slope which we formalise as the gradient of

$$\nabla \mathrm{I} = (\frac{\partial \mathrm{I}}{\partial \mathrm{x}}, \frac{\partial I}{\partial y})$$

of the Image. Now our image I is discrete so we approximate the continuous quantities $\frac{\partial \mathrm{I}}{\partial \mathrm{x}}$ and $\frac{\partial I}{\partial y}$ by finite difference kernels. A simple example of a finite difference kernel is the Sobel filter (F_x and F_y), which is the subject of the following question.

QUESTION 3 (1 mark): With the given image, use the Sobel operator to compute the image gradients at x and y directions. To do this, first define the 2D filters (F_x and F_y). Then perform convolution between the image and F_x to obtain the gradients at x direction, and similarly perform convolution between the image and F_y to obtain the gradients at y direction. Submit the two gradient outputs as images for marking.

F_x = $\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$

F_y = $\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

Note: The OpenCV built-in sobel functions can be applied to achieve the result. This can be a way of verifying the gradient outputs. (Hint: use cv2.CV_8U as the data type)

REFERENCES

[1]. Krig S. (2014) Image Pre-Processing. In: Computer Vision Metrics. Apress, Berkeley, CA, https://link.springer.com/chapter/10.1007/978-1-4302-5930-5_2#citeas

[2]. http://cursa.ihmc.us/rid=1GJRS5FYJ-HBJGJG-1FF0/Cindy%20and%20Melonie's%20CMAP%20Digital%20Imaging%20Processing.cmap.cmap

[3]. http://machinelearninguru.com/computer_vision/basics/convolution/image_convolution_1.html