Image Processing and Computer Vision 1

Chapter 3 – Intensity Transformation – week 4

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1 Book

1.1 Book by Gonzalez and Woods, 3.10

Assuming continuous values, show by example that it is possible to have a case in which the transformation function given in Eq. (3.11) satisfies condition (a) and (b) in Section 3.3, but its inverse may fail condition (a').

Book section 3.3 *Histogram Processing*

$$s = T(r) = (L-1)\int_0^r p_r(w)dw \tag{3.11}$$

Conditions:

(a) T(r) is monotonically increasing function in the interval $0 \leq r \leq L-1$

(b) $0 \leq T(r) \leq L-1$ for $0 \leq r \leq L-1$

Inverse conditions:

(a') $T(r)$ is a *strictly* monotonic increasing function in the interval $0 \leq r \leq L-1$

$$r = T^{-1}(s), \quad 0 \leq s \leq L-1 \tag{3.9}$$

$$r_k = T^{-1}(s_k) \tag{3.16}$$

1.2 Inversion of cumulative distributions

Specify a procedure that inverts discrete cumulative distributions as shown in Fig. P3.22(c). The inversion is ambiguous in general. Define a meaningful and unique inversion. Apply this to create a lookup table that can be used to invert the function in the Fig. P3.22(c).

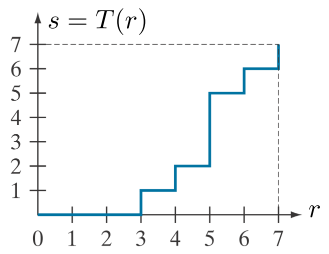

Figure P3.22(c)

1.3 Book by Gonzalez and Woods, 3.12

Two in general different images, $f(x,y)$ and $g(x,y)$ have unnormalized histograms h_f and h_g. Give the conditions (on the values of the pixels in g) under which you can determine the histograms of images formed as follows:

(a) $f(x,y) + g(x,y)$

(b) $f(x,y) - g(x,y)$

(c) $f(x,y) \times g(x,y)$

(d) $f(x,y) \div g(x,y)$

Show how the histograms would be formed in each case. The arithmetic operations are elementwise operations, as defined in Section 2.6.

1.4 Book by Gonzalez and Woods, 3.21

The local histogram processing method discussed in Section 3.3 requires that a histogram be computed at each neighborhood location. Propose a method for updating the histogram from one neighborhood to the next, rather than computing a new histogram each time.

1.5 Book by Gonzalez and Woods, 3.99

Given is the picture f and the kernel h:

$$f = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}, \qquad h = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

(a) Calculate the convolution of f with h.

(b) Describe in your own words, what the filter h does.

2 Practical Exercise

Write a program, which implements a histogram equalization of an 8 bit grayscale image. Validate that the cumulative probability density function estimate is now a straight line going through the origin.

Additional Exercise

Use the script `webcam.*` to read images from the webcam. Convert the color images to grayscale. Use the histogram equalization from above to equalize the grayscale images. Avoid for-loops and reduce the number of pixels in the images so that your implementation works in real time. Play with different objects in the field of view. What effects do you observe? Make an equalization on each layer of the color image. What is the main problem using this color-technique?