Principles and Applications of Digital Image Processing

HW 3

3.22 Answer the following:

(a)* If $\mathbf{v} = [1 \quad 2 \quad 1]^T$ and $\mathbf{w}^T = [2 \quad 1 \quad 1 \quad 3]$, is the kernel formed by $\mathbf{v}\mathbf{w}^T$ separable?

(b) The following kernel is separable. Find w_1 and w_2 such that $w = w_1 \star w_2$.

$$w = \begin{bmatrix} 1 & 3 & 1 \\ 2 & 6 & 2 \end{bmatrix}$$

3.27 An image is filtered four times using a Gaussian kernel of size 3×3 with a standard deviation of 1.0. Because of the associative property of convolution, we know that equivalent results can be obtained using a single Gaussian kernel formed by convolving the individual kernels.

(a)* What is the size of the single Gaussian kernel?

(b) What is its standard deviation?

3.38 In a given application, a smoothing kernel is applied to input images to reduce noise, then a Laplacian kernel is applied to enhance fine details. Would the result be the same if the order of these operations is reversed?

4.3 What is the convolution of two, 1-D impulses:

(a)* $\delta(t)$ and $\delta(t - t_0)$?

(b) $\delta(t - t_0)$ and $\delta(t + t_0)$?

4.32 We mentioned in Example 4.10 that embedding a 2-D array of even (odd) dimensions into a larger array of zeros of even (odd) dimensions keeps the symmetry of the original array, provided that the centers coincide. Show that this is true also for the following 1-D arrays (i.e., show that the larger arrays have the same symmetry as the smaller arrays). For arrays of even length, use arrays of 0's ten elements long. For arrays of odd lengths, use arrays of 0's nine elements long.

(a)* $\{a, b, c, c, b\}$

(b) $\{0, -b, -c, 0, c, b\}$

(c) $\{a, b, c, d, c, b\}$

(d) $\{0, -b, -c, c, b\}$