

Solutions to Optional Homework (Lecture 12)

Problem 10.3

The kernels would have the coefficients shown in Fig. P10.3. Each kernel would yield a value of 0 when centered on a pixel of an unbroken 3-pixel segment oriented in the direction favored by that kernel. Conversely, the response would be a +2 when a kernel is centered on a one-pixel gap in a 3-pixel segment oriented in the direction favored by that kernel.

0	0	0	0	1	0	0	0	1	1	0	0
1	-2	1	0	-2	0	0	-2	0	0	-2	0
0	0	0	0	1	0	1	0	0	0	0	1
Horizontal			Vertical			+45°			-45°		

Figure P10.3

Problem 10.6

(a) The lines were thicker than the width of the line detector kernels. Thus, when, for example, a kernel was centered on the line it "saw" a constant area and gave a response of 0.

Problem 10.9

See Fig. P10.9.

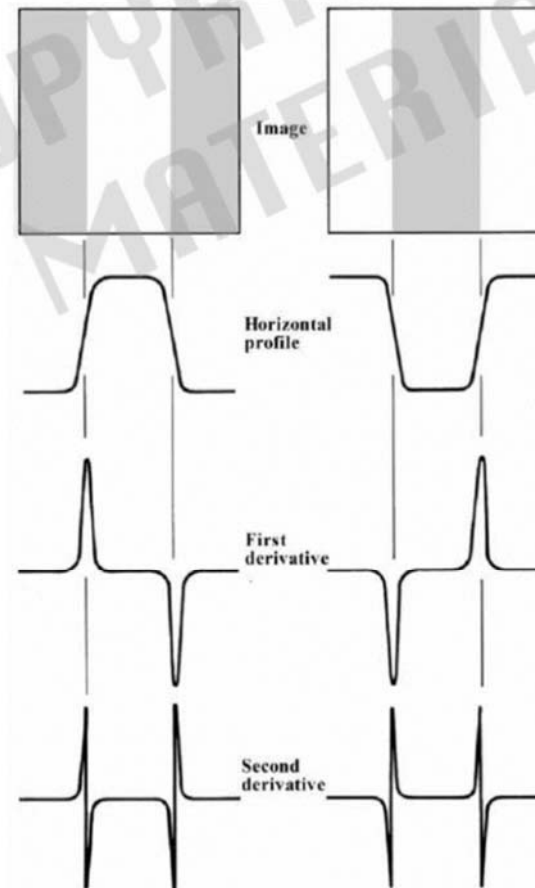


Figure P10.9

Problem 10.11

(b) Consider first the Sobel kernels in Figs. 10.14 and Fig. P10.11(a) above. A simple way to prove that these kernels give isotropic results for edge segments oriented at multiples of 45° is to obtain the kernel responses for the four general edge segments shown in Fig. P10.11(b), which are oriented at increments of 45° . The objective is to show that the responses of the Sobel kernels are indistinguishable for these four edges. That this is the case is evident from Table P10.11(b), which shows the response of each Sobel kernel to the four general edge segments. We see that in each case the response of the kernel that matches the edge direction is $(4a - 4b)$, and the response of the corresponding orthogonal kernel is 0. The response of the remaining two kernels is either $(3a - 3b)$ or $(3b - 3a)$. The sign difference is not significant because the gradient magnitude is computed by either squaring or taking the absolute value of the kernel responses. The same line of reasoning applies to the Prewitt kernels.

b	b	b	b	a	a	b	b	a	a	a	a
a	a	a	b	a	a	b	a	a	b	a	a
a	a	a	b	a	a	a	a	a	b	b	a
Horizontal			Vertical			$+45^\circ$			-45°		

Figure P10.11 (Part b)

Edge direction	Horizontal Sobel (g_x)	Vertical Sobel (g_y)	$+45^\circ$ Sobel (g_{45})	-45° Sobel (g_{-45})
Horizontal	$4a - 4b$	0	$3a - 3b$	$3b - 3a$
Vertical	0	$4a - 4b$	$3a - 3b$	$3a - 3b$
$+45^\circ$	$3a - 3b$	$3a - 3b$	$4a - 4b$	0
-45°	$3b - 3a$	$3a - 3b$	0	$4a - 4b$

Table P10.11 (Part b)

Problem 10.26

(a) Point 1 has coordinates $x = 0$ and $y = 0$. Substituting into Eq. (10-44) yields $\rho = 0$ which is a straight line in a plot of ρ vs. θ .

(b) Only the origin $(0, 0)$ would yield this result.