EE264 Edge Detection Technique
Part I, HL, 2009.1.15

1) Given a digital image $f(x,y)$, design 4 edge detectors to pick up vertical edge components.

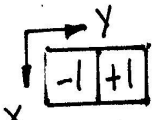
Sol

First, use forward difference technique,

$f(x,y)$ (Y →, X ↓)

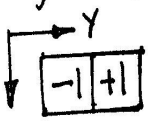
0	100	100
0	100	100
0	100	100

$$\frac{\partial f(x,y)}{\partial y} \simeq f(x,y+1) - f(x,y) \quad \cdots (1)$$



Second, use backward difference

$$\frac{\partial}{\partial y} f(x,y) \simeq f(x,y) - f(x,y-1) \quad \cdots (2)$$



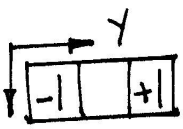
Now, based on the central difference technique.

$$\frac{\partial}{\partial y} f(x,y) = \frac{1}{2}\left[\frac{\partial f(x,y)}{\partial y}\bigg|_{\text{Forward}} + \frac{\partial f(x,y)}{\partial y}\bigg|_{\text{Back}}\right]$$

$$= \frac{1}{2}[f(x,y+1) - f(x,y) + f(x,y) - f(x,y-1)]$$

$$= \frac{1}{2}[f(x,y+1) - f(x,y-1)] \quad \cdots (3)$$

$\frac{1}{2}$ ×

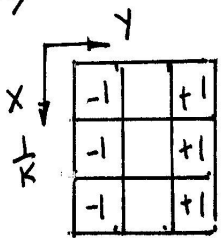


Finally, Expand the edge detector in eqn(3) to 3x3 kernel, we have,

$$\frac{\partial}{\partial y} f(x,y)\bigg|_{x=x} + \frac{\partial}{\partial y} f(x,y)\bigg|_{x=x+1} + \frac{\partial}{\partial y} f(x,y)\bigg|_{x=x-1}$$

$$= \frac{1}{2}[f(x,y+1) - f(x,y-1) + f(x+1,y+1) - f(x+1,y-1) + f(x-1,y+1) - f(x-1,y-1)] \quad \cdots (4)$$

So,



Note: K=2 Based on (4), however as a common practice K is set to be the sum of the absolute values of each element in the 3x3 kernel.

2) For the same digital image, derive 4 edge detectors to pick up horizontal edge components.

Sol

First, $\frac{\partial f(x,y)}{\partial x} \simeq f(x+1,y) - f(x,y) \quad \cdots (5)$

Second, $\frac{\partial f(x,y)}{\partial x} \simeq f(x,y) - f(x-1,y) \quad \cdots (6)$

And,

$$\frac{\partial f(x,y)}{\partial x} = \frac{1}{2}[f(x+1,y) - f(x-1,y)] \quad \cdots (7)$$

Finally, we can use same Technique to expand it to 3x3 kernel.

(END)