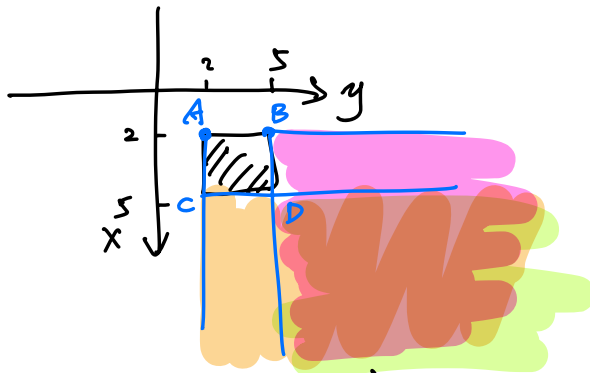21 – S1 – Q1

Q (a) $f(x,y)$ $h(x,y)$

Solution

(a) ① 2D unit step function
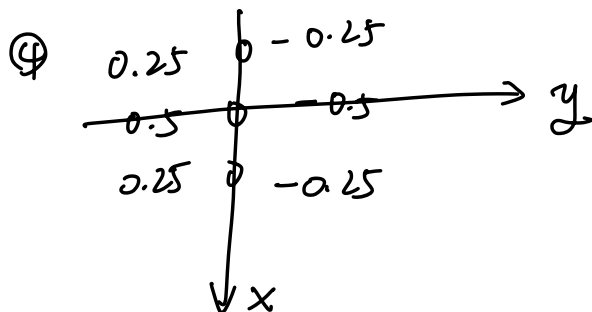
$$S(x,y)= \begin{cases} 1, & x \geqslant 0 \text{ and } y \geqslant 0 \\ 0, & \text{otherwise} \end{cases}$$

②

③ $f(x,y) = S(x-2, y-2)$

$$\quad - \ S(x-6, y-2)$$

$$\quad - \ S(x-2, y-6)$$

$$\quad + \ S(x-6, y-6)$$

④

⑤ $h(x,y) = 0.25\ \delta(x-1, y+1) + 0.5\ \delta(x, y+1)$

$+ 0.25\ \delta(x+1, y+1) - 0.25\ \delta(x+1, y-1)$

$- 0.5\ \delta(x, y-1) - 0.25\ \delta(x-1, y-1)$

(b)

$g(1,1) = 0.25 \quad g(1,2) = 0.25 \quad g(1,3) = 0 \quad g(1,4) = 0 \quad \cdots$

$g(2,2) = 0.75 \quad g(2,3) = 0 \quad g(2,4) = 0 \quad g(2,5) = -0.75$

similarly

output image

(c) $h(x,y)$ acts as horizontal gradient operator

② $h(x,y)$ computes the weighted difference between the pixels on the left and right of each position

③ $h(x,y)$ effectively detect vertical edge in the image

Verification

① Along the left edge of the rectangle in $f(x,y)$, where there is a transition from 0 to 1

② Along the right edge of the rectangle in $f(x,y)$, where there is a transition from 1 to -1

③ This behavior confirms that the filter effectively detects vertical edges