# Harris corner detection

| | | | |
|---|---|---|---|
| 255 | 255 | 0 | 0 |
| 255 | 255 | 0 | 0 |
| 0 | 0 | 255 | 255 |
| 0 | 0 | 255 | 255 |

| |
|---|
| -1 |
| 1 |

d/dy

| -1 | 1 |
|---|---|

d/dx

Solve w.r.t x

1) (255x-1)+(255x1) =0
2) (255x-1) +(0x1) =-255
3) (0x-1) +(0x1) =0
4) (0x-1) =0
5) (255x-1) +(255x1) =0
6) (255x-1) +(0x1) =-255
7) (0x-1) +(0x1) =0
8) (0x-1) =0
9) (0x-1) +(0x1) =0
10) (0x-1) +(255x1) =255
11) (255x-1) +(255x1) =0
12) (255x-1) =-255
13) (0x-1) +(0x1) =0
14) (0x-1) +(255x1) =255
15) (255x-1) +(255x1) =0
16) (255x-1) =-255

$I_x$ =

| | | | |
|---|---|---|---|
| 0 | -255 | 0 | 0 |
| 0 | -255 | 0 | 0 |
| 0 | 255 | 0 | -255 |
| 0 | 255 | 0 | -255 |

Solve wrt y

1) $(255 \times -1) + (255 \times 1) = 0$
2) $(255 \times -1) + (0 \times 1) = -255$
3) $(0 \times -1) + (0 \times 1) = 0$
4) $(0 \times -1) = 0$
5) $(255 \times -1) + (255 \times 1) = 0$
6) $(255 \times -1) + (0 \times 1) = -255$
7) $(0 \times -1) + (0 \times 1) = 0$
8) $(0 \times -1) = 0$
9) $(0 \times -1) + (0 \times 1) = 0$
10) $(0 \times -1) + (255 \times 1) = 255$
11) $(255 \times -1) + (255 \times +1) = 0$
12) $255 \times -1 = -255$
13) $(0 \times -1) + (0 \times 1) = 0$
14) $(0 \times -1) + (255 \times 1) = 255$
15) $(255 \times -1) + (255 \times 1) = 0$
16) $255 \times -1 = 255$

$I_y =$

| | | | |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| -255 | -255 | 255 | 255 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | -255 | -255 |

$$M = \sum_{(x,y)\in w} \begin{bmatrix} I_x(x,y)^2 & I_x(x,y)I_y(x,y) \\ I_x(x,y)I_y(x,y) & I_y(x,y)^2 \end{bmatrix}$$

$$\sum_{(x,y)\in w} I_x(x,y)^2 = (0)^2 + (-255)^2 + (0)^2 + (0)^2 + (0)^2 + (-255)^2 + (0)^2 + (0)^2 + (0)^2 + (255)^2 + (0)^2 + (-255)^2 + (0)^2 + (255)^2 + (0)^2 + (-255)^2$$

$$\sum_{(x,y)\in w} I_y(x,y)^2 = (0)^2 + (0)^2 + (0)^2 + (0)^2 + (-255)^2 + (-255)^2 + (-255)^2 + (-255)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (-255)^2 + (-255)^2$$

$$\sum_{(x,y)\in w} I_x(x,y)I_y(x,y) = \cancel{(0\times0)} +$$

$$= (0\times0) + (0\times-255) + (0\times0) + (0\times0) + (-255\times0) + (-255\times-255) + (255\times0) + (255\times0) + (0\times0) + (0\times255) + (0\times0) + (0\times0) + (0\times0) + (0\times255) + (0\times-255) + (-255\times-255)$$

$$H = \begin{bmatrix} Ix^2 & IxIy \\ IxIy & Iy^2 \end{bmatrix}$$

$$C = \det(H) - k\,\text{trace}(H)^2$$

$$\det(H) = (Ix^2)(Iy^2) - (IxIy)(IxIy)$$

$$\text{trace}(H)^2 = \text{trace}(Ix^2 + Iy^2)^2$$

$$C = \det(H) - k\,\text{trace}(H)^2$$

Edge $\leftarrow C < 0$
corner $\leftarrow C > 0$
Flat $\leftarrow C \approx 0$

— x — x —

$$C = \lambda_1\lambda_2 - K(\lambda_1 + \lambda_2)^2$$

$$|A - \lambda I| = 0$$

$C < 0 \Rightarrow$ Edge
$C > 0 \Rightarrow$ corner
$C \approx 0 \Rightarrow$ Flat

→ When $\frac{d}{dx}$ & $\frac{d}{dy}$ is not given. We use shaded region to find $\lambda_1$ & $\lambda_2$ value. Then we calculate C.