7 Further Edge Detection 153-172

i). Canny operator op' designed for

i). optimal response - no response to noise

ii) single edges - thin edges / no blurring

iii). good localisation - edges in right place

common approximation

a). Gaussian smoothing

b). Sobel

c). non maximum suppression "peak detection"

d). hysteresis thresholding (has memory)

ii). can differentiate twice
a find zero crossing

$$f'(x) = f(x) - f(x+1)$$

$$f''(x) = f'(x) - f'(x-1)$$

$$\big(f(x) - f(x+1)\big) -$$

$$\big(f(x-1) - f(x-2)\big)$$

$\boxed{1 \; -1}$

$- \boxed{1 \; -1}$

$1 \quad -2 \quad +1$

gives template $\boxed{1 \mid -2 \mid 1}$

Laplacian, needs smoothing.

iii). Laplacian of Gaussian

$$g = e^{-(x^2+y^2)/2\sigma^2}$$

unit vectors

$$\nabla g = \frac{\partial g}{\partial x} U_x + \frac{\partial g}{\partial y} U_y$$

$$\nabla^2 g = \frac{\partial \nabla g}{\partial x} U_x + \frac{\partial \nabla g}{\partial y} U_y$$

$$\frac{\partial g}{\partial x} = -\frac{\cancel{2}x}{\cancel{2}\sigma^2} e^{(\sim)} = \frac{-x}{\sigma^2} e^{(\sim)}$$

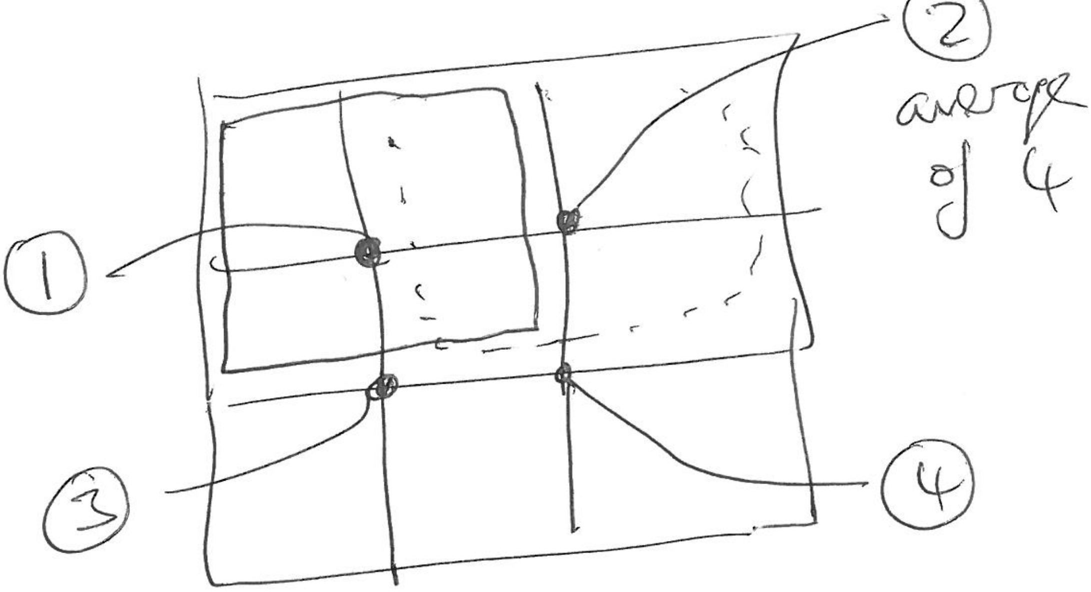
$$\frac{\partial^2 g}{\partial x^2} = \left(\frac{\cancel{2}x^2}{\cancel{2}\sigma^2 \times \sigma^2} - \frac{1}{\sigma^2} \right) e^{(\sim)}.$$

2 !!

$\frac{\partial^2 g}{\partial y^2}$ is similar

$$\nabla^2 g = \left(\frac{x^2+y^2}{\sigma^4} - \frac{\cancel{1}}{\sigma^2} \right) e^{(\sim)}$$

iv. zero Xing detection



IF $(1 \vee 2 \vee 3 \vee 4) > 0 \wedge$

$(1 \vee 2 \vee 3 \vee 4) < 0$

THEN EDGE

ELSE NO EDGE

IF ~~[illegible]~~ $\max(1,2,3,4) > 0 \wedge$

$\min(1,2,3,4) < 0$

THEN EDGE

ELSE NOT EDGE