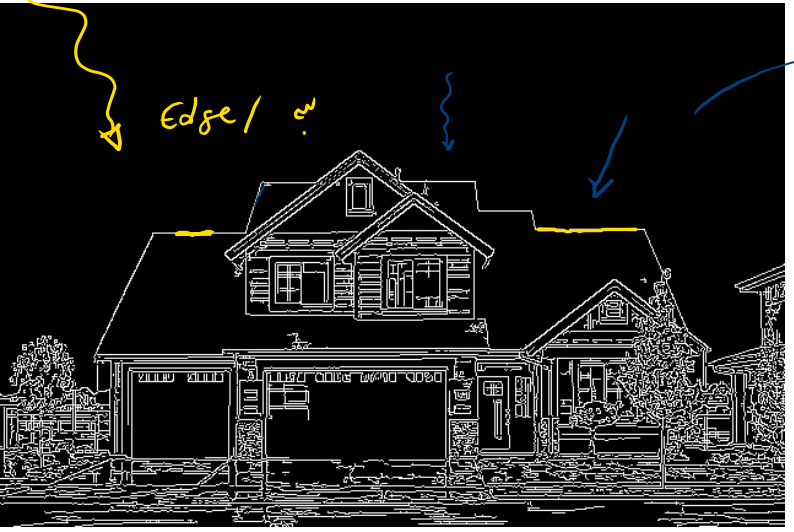
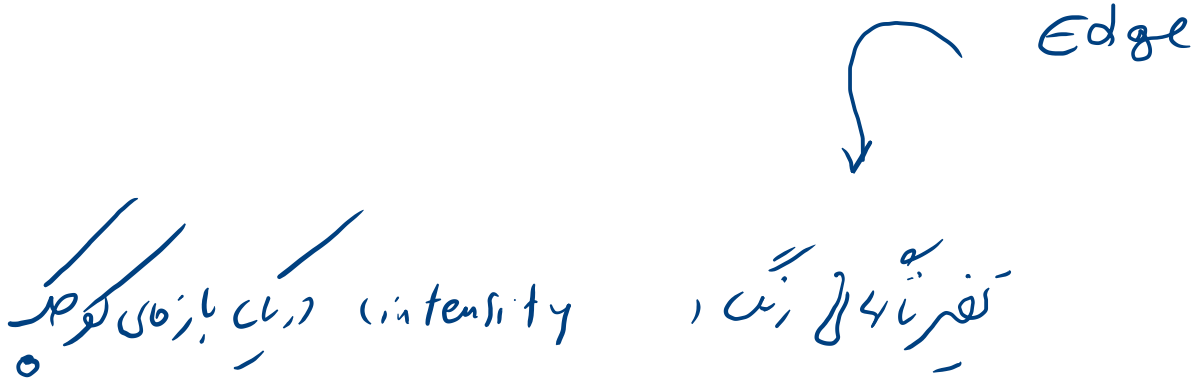
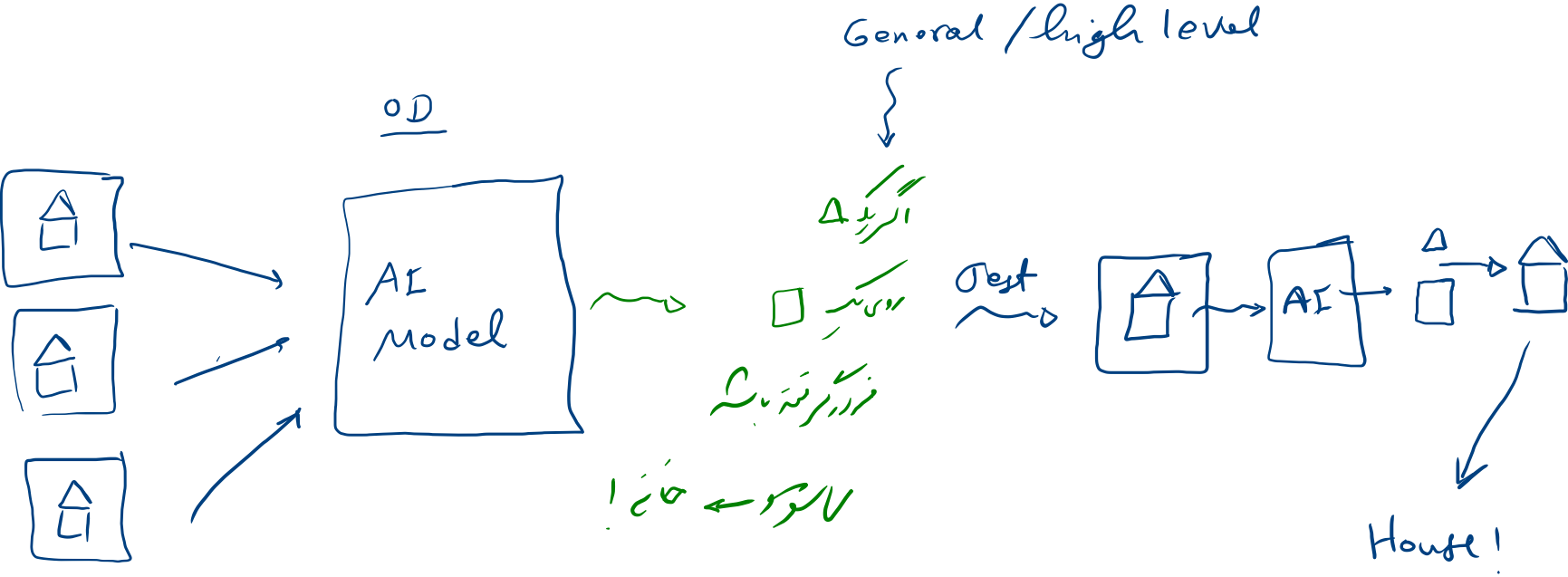
Edge Detection


Edge


Edge
تغییرناگهانی رنگ ، intensity در یک بازه‌ی کوچک


General / high level
OD
AI
Model
Test
AI
House!

edge Detection $\rightsquigarrow$

- object Detection.
- Image Segmentation

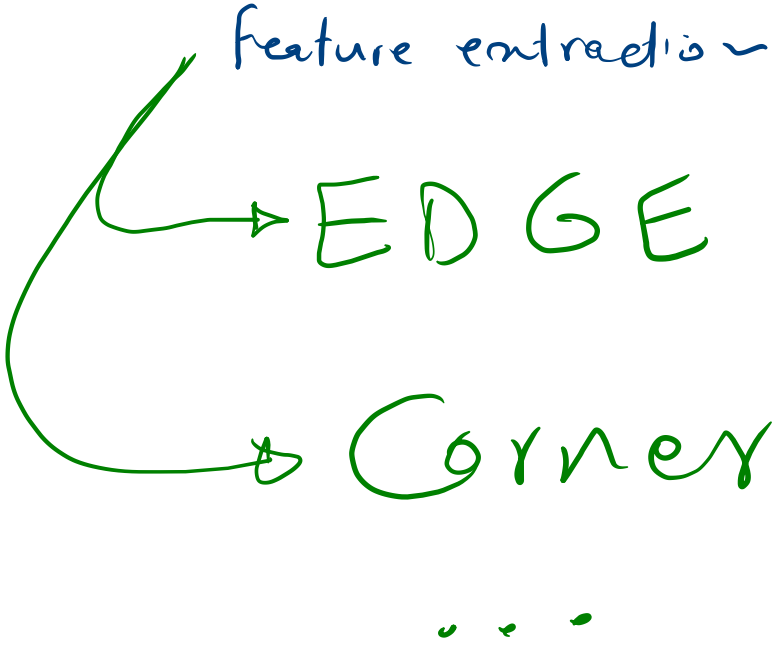
⋮

× ما برای انجام پروسه‌های computer vision ، نیازمند استخراج ویژگی از تصویر هستیم!

feature extraction

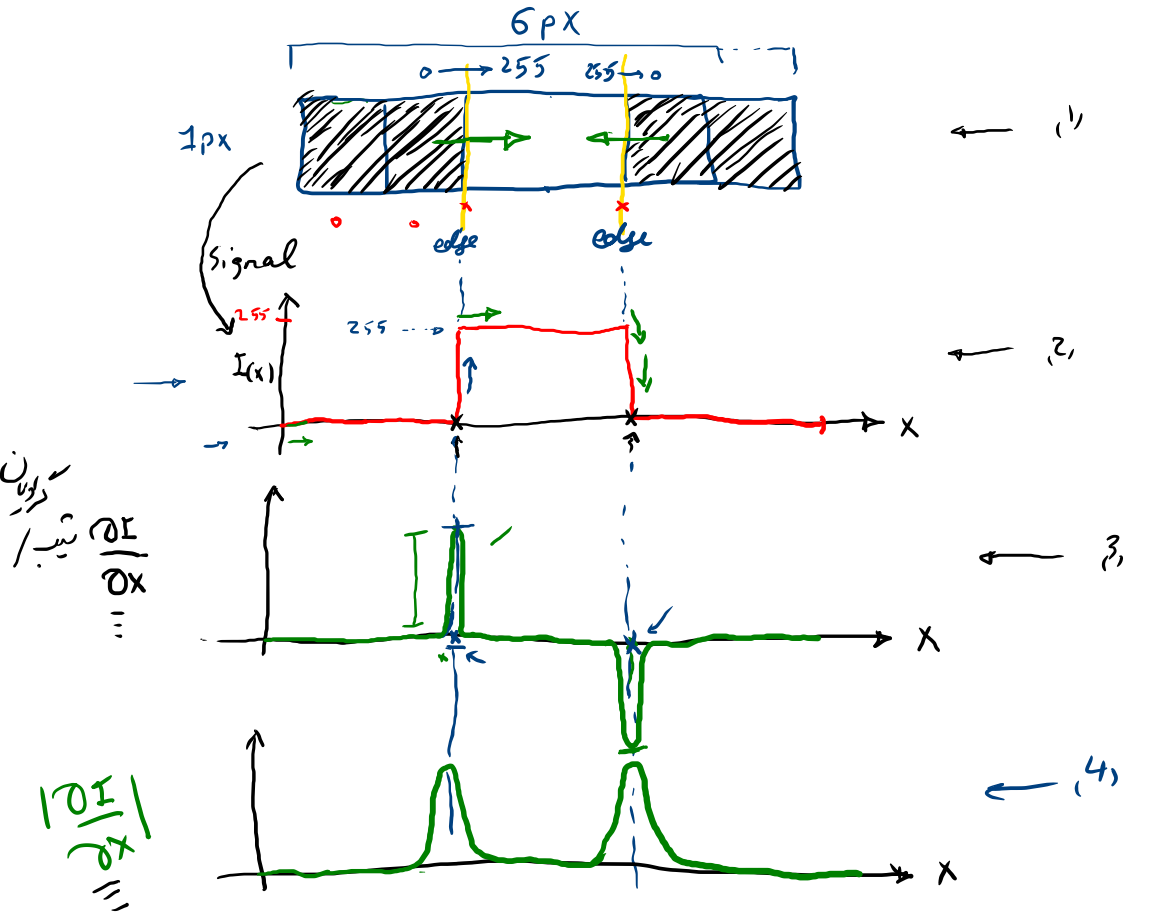
→ EDGE

→ Corner



...

Edge Detection using Gradient



1D / Binary

x برای آنالیز Edge

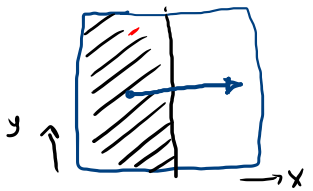
(1) strength → $\left|\frac{\partial I}{\partial x}\right|$

(2) localization.

(3) Orientation

$|\nabla I| \rightarrow \frac{\partial I}{\partial x}, \frac{\partial I}{\partial y}$

(a)

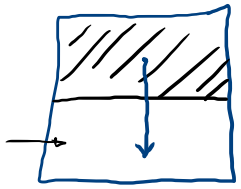


$\frac{\partial I}{\partial x}$ ✓

$\frac{\partial I}{\partial y} = 0$

$\rightsquigarrow \nabla I = \left[\frac{\partial I}{\partial x}, 0\right]$

(b)

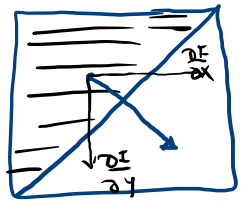


$\frac{\partial I}{\partial x} = 0$

$\frac{\partial I}{\partial y} = ✓$

$\nabla I = \left[0, \frac{\partial I}{\partial y}\right]$

(c)



$\frac{\partial I}{\partial x} = ✓$

$\frac{\partial I}{\partial y} = ✓$

$\rightsquigarrow \nabla I = \left[\frac{\partial I}{\partial x}, \frac{\partial I}{\partial y}\right]$

جهت ، orientation یک بعد (Edge) عمود بر مرز و در جهت افزایش شدت رنگ (intensity)

یا به تعبیر دیگر Gradient است !

با توجه به مطالب فوق ← مجبوریم در روش گرادیان در ۲ جهت x و y گرادیان را محاسبه کنیم !

$$\nabla I = \left[\frac{\partial I}{\partial x}, \frac{\partial I}{\partial y} \right] \rightsquigarrow$$

strength

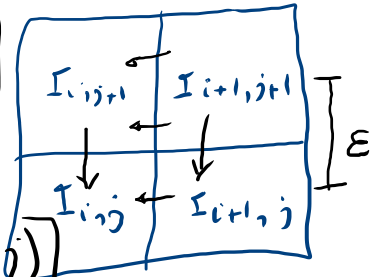
اندازه‌ی بسته $\longrightarrow \|\nabla I\| = \sqrt{\left(\frac{\partial I}{\partial x}\right)^2 + \left(\frac{\partial I}{\partial y}\right)^2}$

orientation

جهت بسته $\longrightarrow \theta = \tan^{-1}\left(\frac{\partial I}{\partial y} \Big/ \frac{\partial I}{\partial x} \right)$

* چون تصاویر دارای شدت های گسسته می باشند

$$\begin{cases} \dfrac{\partial I}{\partial x} \approx \dfrac{1}{2\varepsilon}\left[\left(I_{i+1,j+1} - I_{i,j+1} \right) + \left(I_{i+1,j} - I_{i,j} \right) \right] \\[2ex] \dfrac{\partial I}{\partial y} \approx \dfrac{1}{2\varepsilon}\left[\left(I_{i,j+1} - I_{i,j} \right) + \left(I_{i+1,j+1} - I_{i+1,j} \right) \right] \end{cases}$$



$$\frac{\partial I}{\partial x} = \frac{1}{2\varepsilon}\left[\left(I_{i+1,j+1} - I_{i,j+1} + I_{i+1,j} - I_{i,j} \right) \right] \rightsquigarrow \frac{\partial I}{\partial x} = \frac{1}{2\varepsilon} \begin{array}{c} \text{Kernel} \\ \begin{bmatrix} -1 & 1 \\ -1 & 1 \end{bmatrix} \end{array} \circledast \begin{array}{c} \text{Image} \\ \begin{bmatrix} I_{i,j} & I \\ I & I \end{bmatrix} \end{array}$$

$$\frac{\partial}{\partial x} \approx \frac{1}{2\varepsilon}\begin{bmatrix} -1 & 1 \\ -1 & 1 \end{bmatrix} \quad (A)$$

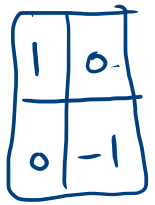
$$\frac{\partial}{\partial y} \approx \frac{1}{2\varepsilon}\begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix} \quad (B)$$

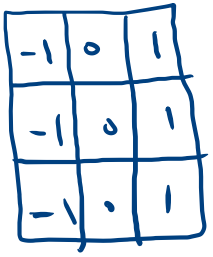
α کانوالوکردن کرنل A روی تصویر، معادل مشتق جزئی شدت آن تصویر در جهت x است!

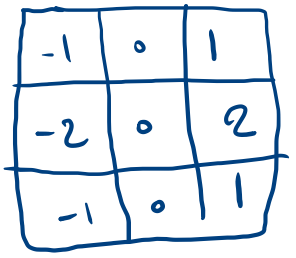
α " " B " "

" " " (y) " "

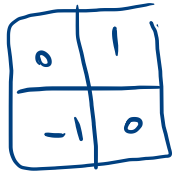
× Gradient-based Kernels.

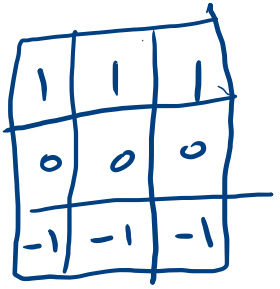


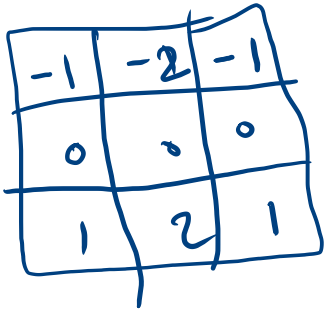




	Robert	prewitt	Sobel
$\frac{\partial I}{\partial x}$	$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$	$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$	$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$
$\frac{\partial I}{\partial y}$	$\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$	$\begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$	$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$







localization ←

noise sensivity →

* قبل از edgeDetect ← حتماً که Denoising انجام شود

* حتماً Edge های ضعیف را حذف کنید!

$$\|\nabla I\| = \sqrt{\left(\frac{\partial I}{\partial x}\right)^2 + \left(\frac{\partial I}{\partial y}\right)^2} \geq \text{Threshold}$$

50,

* در روش Gradient ، در بخش localization همچنان ضعف داریم!

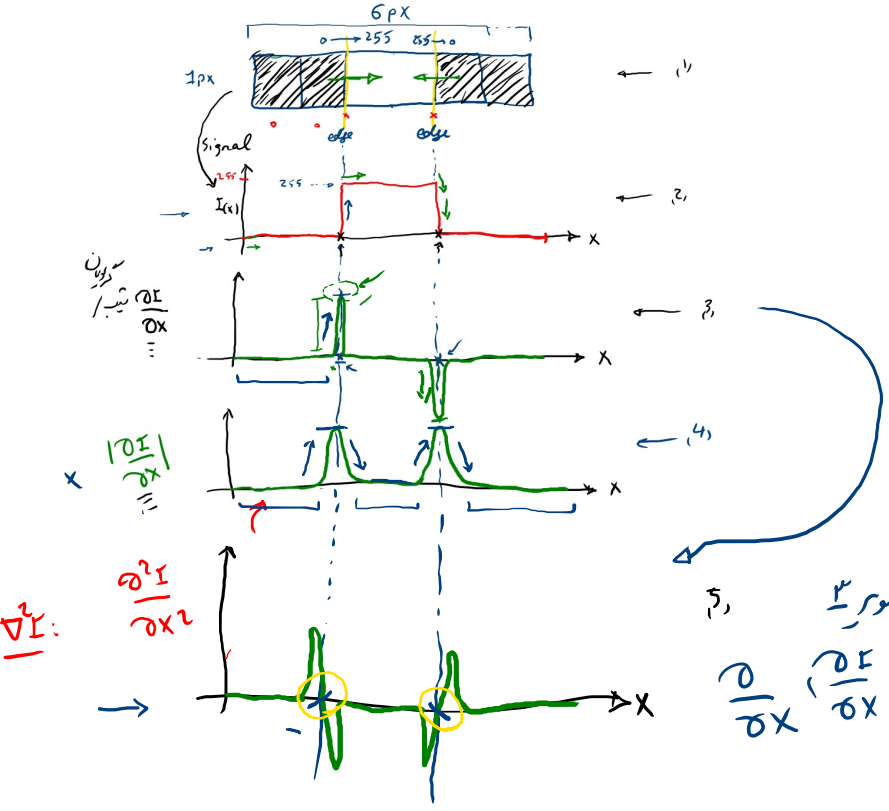
محاسبه دقیق محل سم (edge)

راه حل

Laplacian!

لاپلاسین

روش مشتق دوم!


6px
1px
0 → 255
255 → 0
edge
edge
Signal
255
I(x)
x
1
2
3
4
5
$\frac{\partial I}{\partial x}$
$\left|\frac{\partial I}{\partial x}\right|$
$\frac{\partial^2 I}{\partial x^2}$
$\nabla^2 I$
$\frac{\partial}{\partial x}\left(\frac{\partial I}{\partial x}\right)$
Laplacian
Zero crossing!
more accurate localization

* در روش laplacian ← localization

در laplacian جهت بعد (orientation)

را نداریم!

$$\nabla^2 I \approx \frac{1}{\varepsilon^2}\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix} \times$$

× در لاپلاسین، برخلاف زیرگرادیانت ← فقط یک کرنل و فقط یک بار روی تصویر اعمال می‌شود!

The End