

Edge Detection

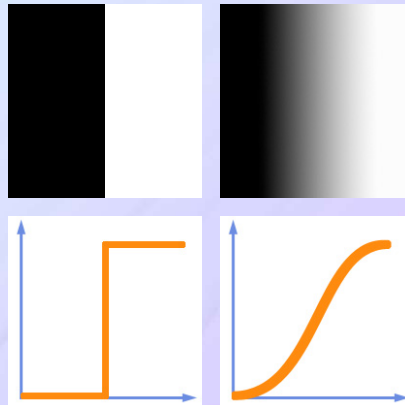
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Mikko "photari" Tapionlinna
Kalle "häh?" Rannikko

Edge detection

- What are edges in an image?
- Where is edge detection used?
- Edge detection methods
- Edge operators
- Performance
- Edge detection in Adobe Photoshop
- Edge detection in Matlab

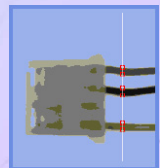
What are edges in an image?

- Edges correspond to object boundaries
- Pixels where image brightness changes significantly
- Calculated from image function behavior in the neighborhood of the pixel
- Vector variable



Where is edge detection used?

- There are numerous applications for edge detection
- Segmentation and identification of objects
- A common example of image segmentation is the "magic wand" tool
- Quality inspection and verification



Edge detection methods

- Most of the methods can be grouped into two categories: 1st and 2nd derivative
- Based on discrete approximations to differential operators.
- This is done with convolution masks
- Some operators return orientation information. Other only return information about the existence of an edge at each point

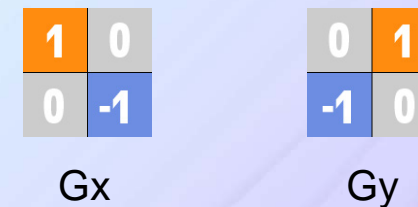
Edge Operators



Roberts Mask

- Marks edge points only
- No information about edge orientation
- Work best with binary images
- Primary disadvantage:
 - High sensitivity to noise
 - Only few pixels are used to approximate the gradient

Roberts Mask



Sobel Masks

- The Sobel operator performs a 2-D spatial gradient measurement on an image
- Horizontal and vertical directions.

-1	0	1
-2	0	2
-1	0	1

Gx

1	2	1
0	0	0
-1	-2	-1

Gy

Prewitt Masks

- Similar to the Sobel, with different masks:

-1	0	1
-1	0	1
-1	0	1

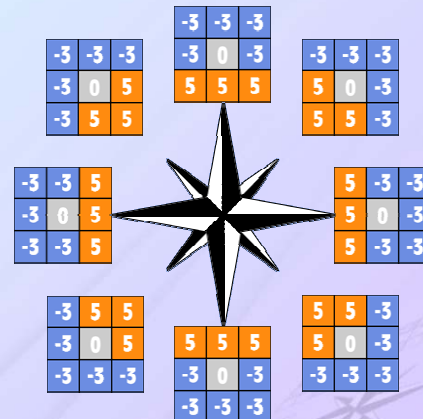
Gx

1	1	1
0	0	0
-1	-1	-1

Gy

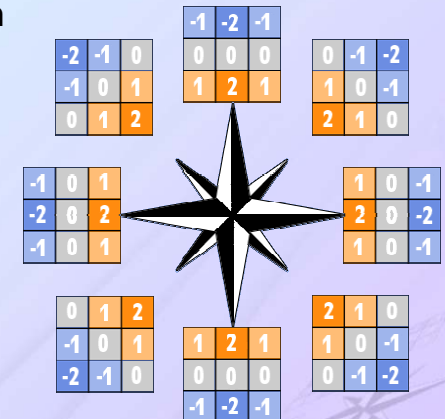
Kirsch Compass Masks

- Rotates a mask in 8 directions
- Detects edge magnitude and direction



Robinson Compass Masks

- Similar to the Kirsch masks
- Mask coefficients similar to Sobel method



2nd Derivative Operators

- Laplacian methods
- Masks for 4 and 8 neighborhoods
- Mask with stressed significance of the central pixel or its neighborhood

0	-1	0	-1	-1	-1
-1	4	-1	-1	8	-1
0	-1	0	-1	-1	-1

1	-2	1	-2	1	-2
-2	4	-2	1	4	1
1	-2	1	-2	1	-2

Laplacian Operatives

- Laplacian of Gaussian (LoG) smoothes the image first
- Difference of Gaussian (DoG) approximates LoG
- "Mexican Hat" filter
- The bigger the mask, the wider the edges found

0	0	-1	-1	-1	0	0
0	-2	-3	-3	-3	-2	0
-1	-3	5	5	5	-3	-1
-1	-3	5	16	5	-3	-1
-1	-3	5	5	5	-3	-1
0	-2	-3	-3	-3	-2	0
0	0	-1	-1	-1	0	0

Our simple operators for 1st and 2nd derivatives

- Laplacian and especially Kirsch- and Robinson –methods are very heavy methods without significantly better results
- We experimented with our own, extremely simple masks
- Results with 1st derivative were comparable to Sobel method
- Results with 2nd derivative were not that excellent with our test picture

-2
0
2

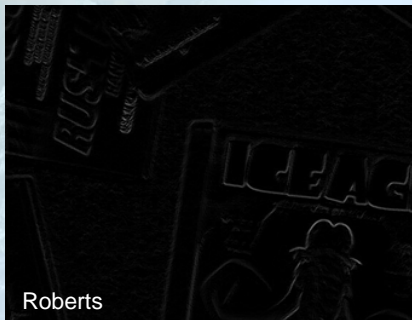
Gy

-2	0	2
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Gx

-1	-1	4	-1	-1
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Roberts



Prewitt



Sobel



Simple



Kirsch Compass



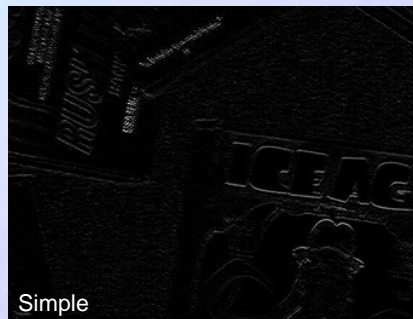
Robinson Compass



Laplacian of Gaussian



Difference of Gaussian



Simple

Performance

- Sobel and Prewitt methods are good for edge mapping
- Kirsch and Robinson methods require more time and their results are not better
- Different methods suit for different needs

Edge detection in Adobe Photoshop

- The edge detection algorithm used by Photoshop is not mentioned in Photoshop documentation
- According to our research, Photoshop uses Robinson Compass method

Edge detection in Matlab

- Matlab's image processing toolbox provides edge function to find edges in an image
- Edge function supports six different edge-finding methods: Sobel, Prewitt, Roberts, Laplacian of Gaussian, Zero-cross, and Canny