EDGE DETECTION

Cause of Edges and How to Detect Them

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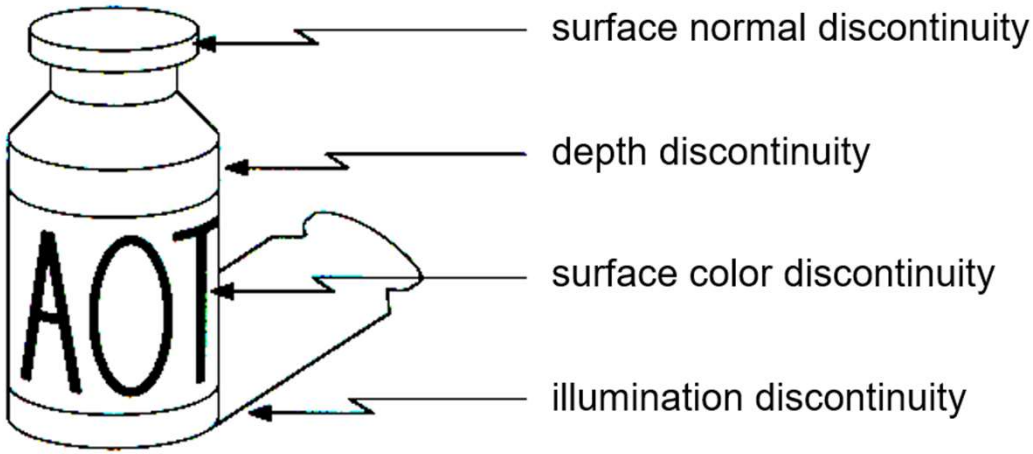
What is an Edge?

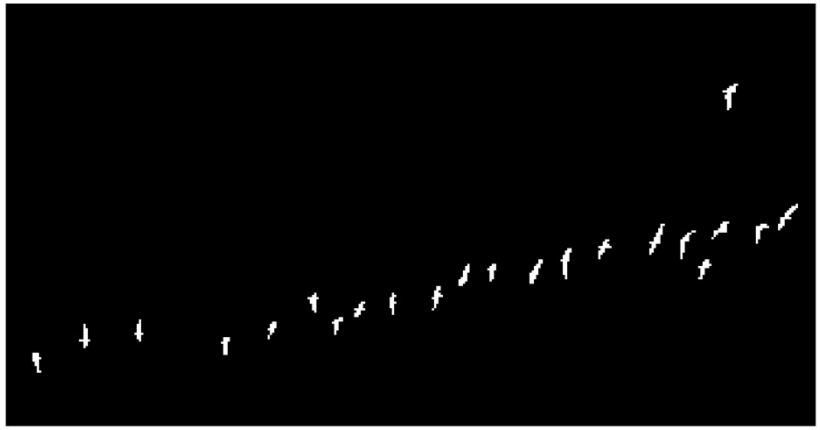
The edge is defined as *"a outside limit of an object, area, or surface."*

For image processing an *edge exists where a rapid change happens.*



What is the Goal?

Edges are used for splitting the image in to segments.



These segmented parts can be used for tasks like:

object counting, measuring, feature extraction, and classification.

How it’s Achieved?

To find most relevant edges edge detection algorithms used.

The edges that found should form meaningful lines that part the image in to segments for further usage.

Edge Forming Factors

- To find this change first and second derivate of the image is calculated.
- For derivative, a change is the main cause of an edge.

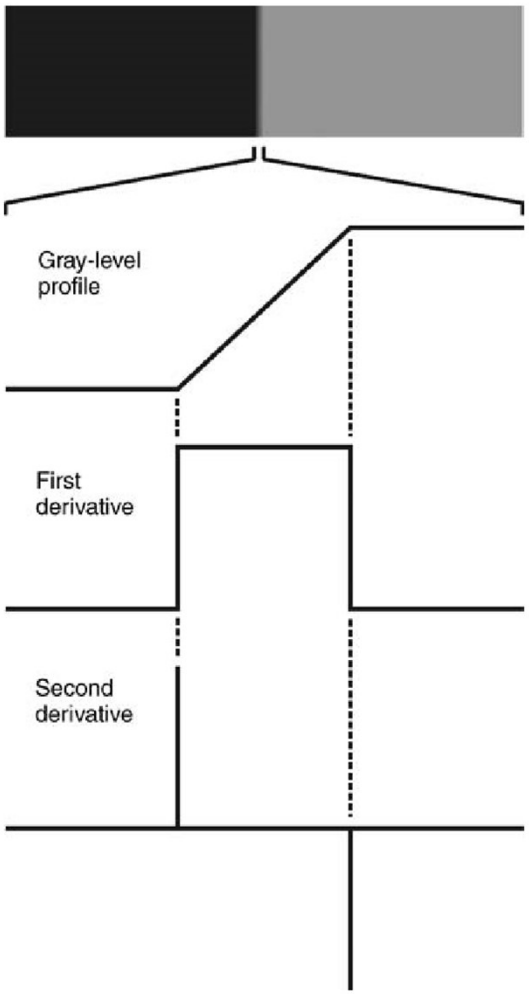
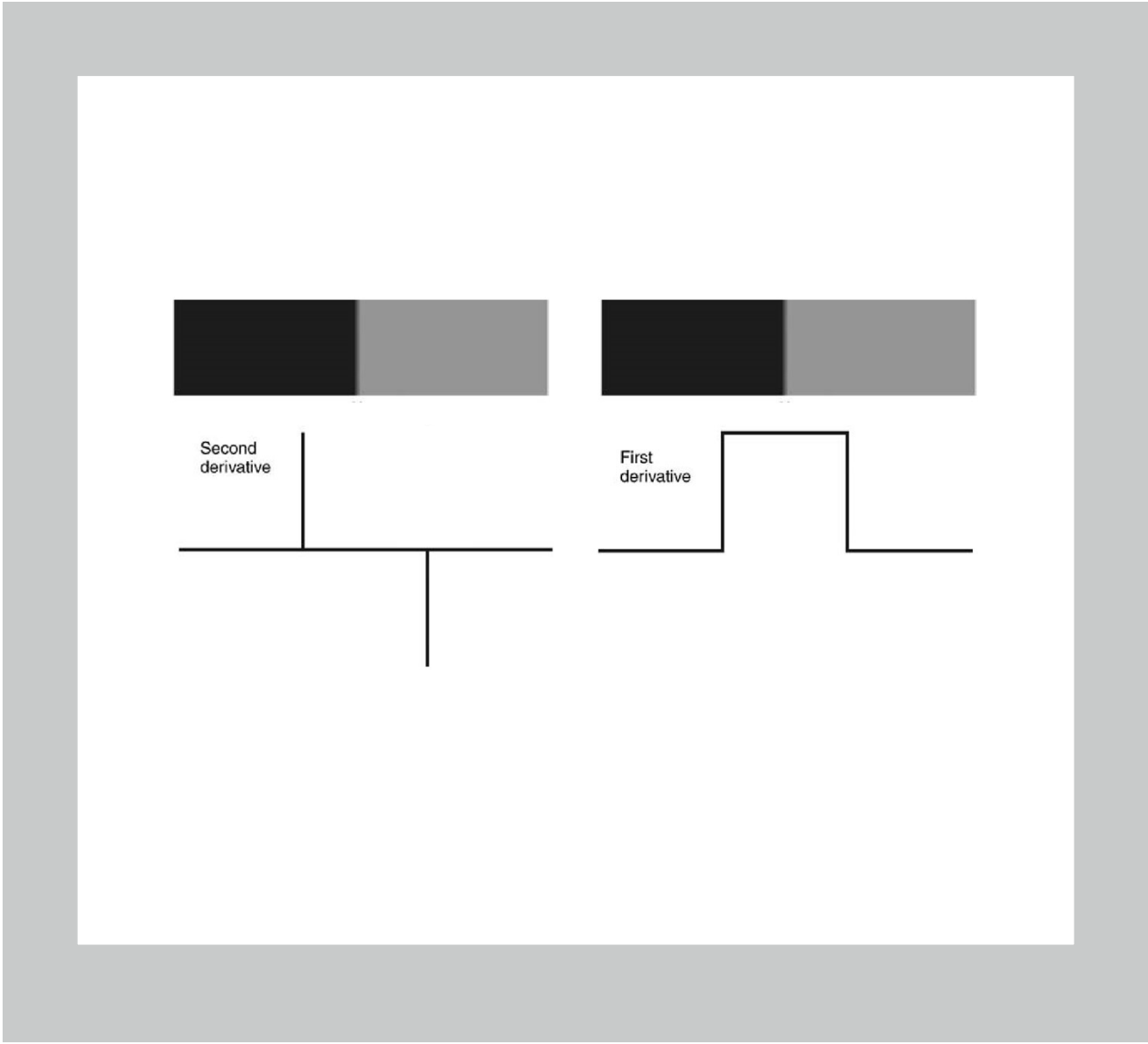
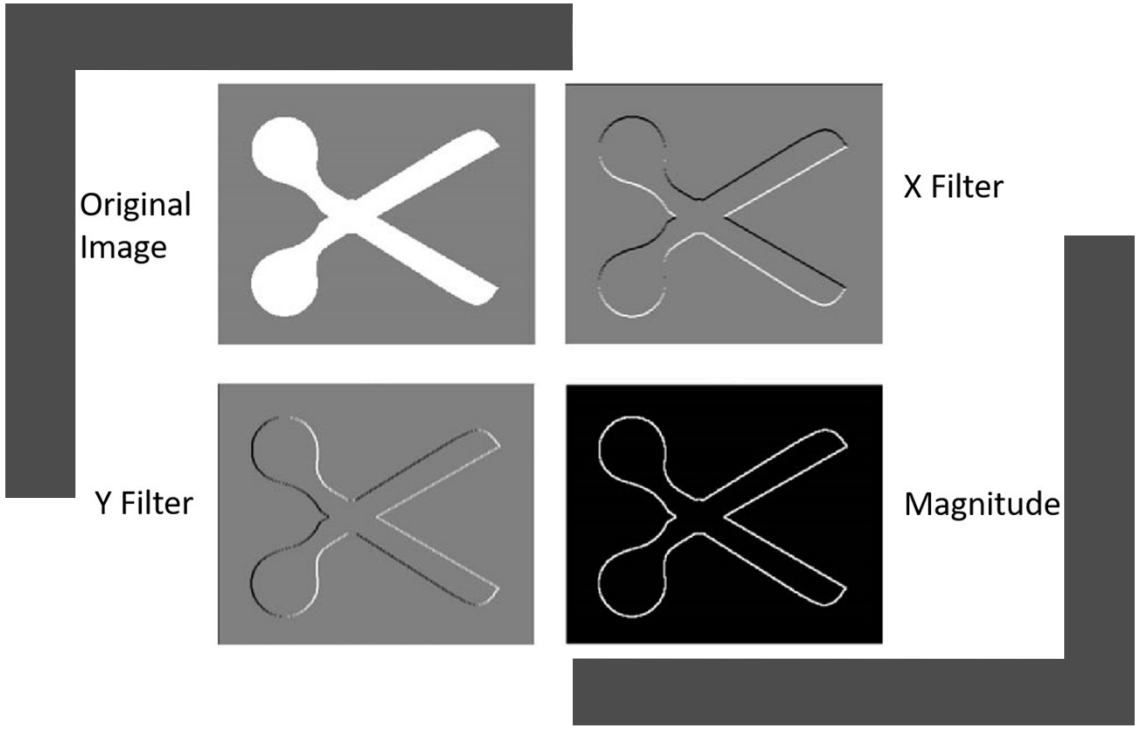


Image and Derivatives

- With the fist derivative the edges and their intensities can be observed.
- With the sign of the second derivative it can be decided that whether the edge is bright or dark side of an edge.



The Gradient



- Gradient is the result image of the derivate of the picture.
- With gradient, intensity increase can be observed.
- Different directions of gradient filters results in different edge directions.
- The magnitude of the image allow to observe edges in every direction

$$\theta = tan^{-1}(g_x/g_y)$$

Direction Formula

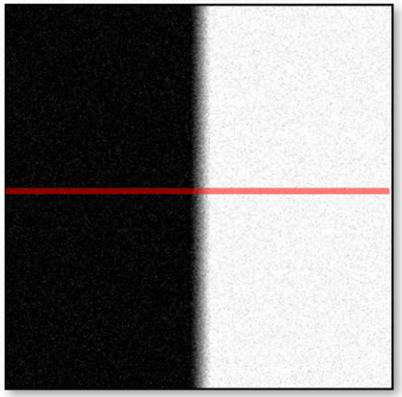
$$g = \sqrt{g_x^2 + g_y^2}$$

Magnitude Formula

$$G_x = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix} \quad G_y = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

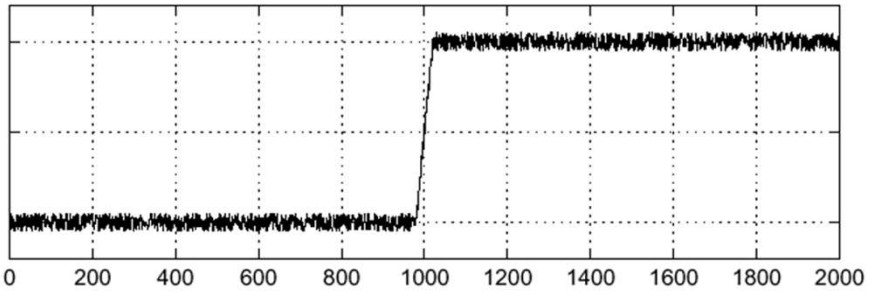
Filter for X and Y gradient.

The Gradient Formulas

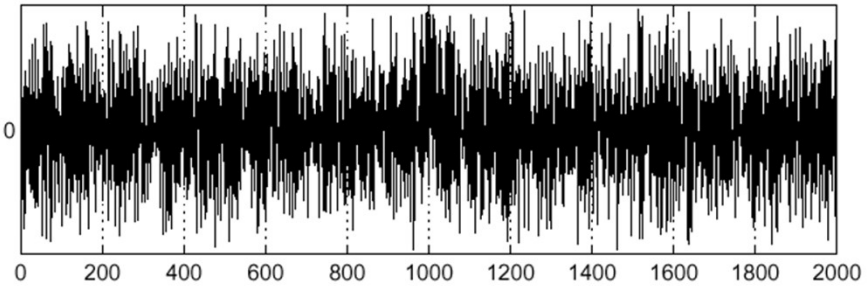


Noisy input image

$f(x)$



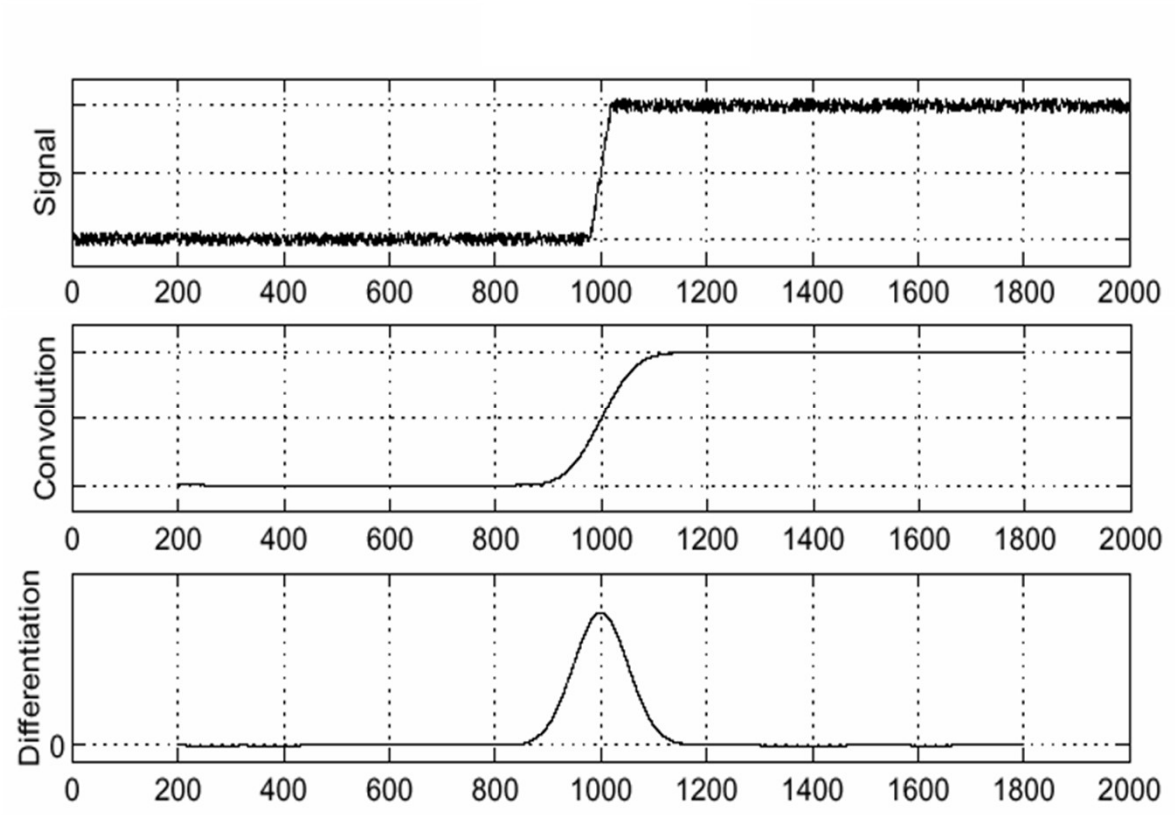
$\frac{d}{dx}f(x)$



The Noise

In a noisy image it is hard to pin point the edge mathematically.

Smoothing the Noise



Before taking the derivative of the image blurring can be done.

This process will smooth the noisy edges and provide a better edge detection.

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

x filter

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

y filter

Sobel

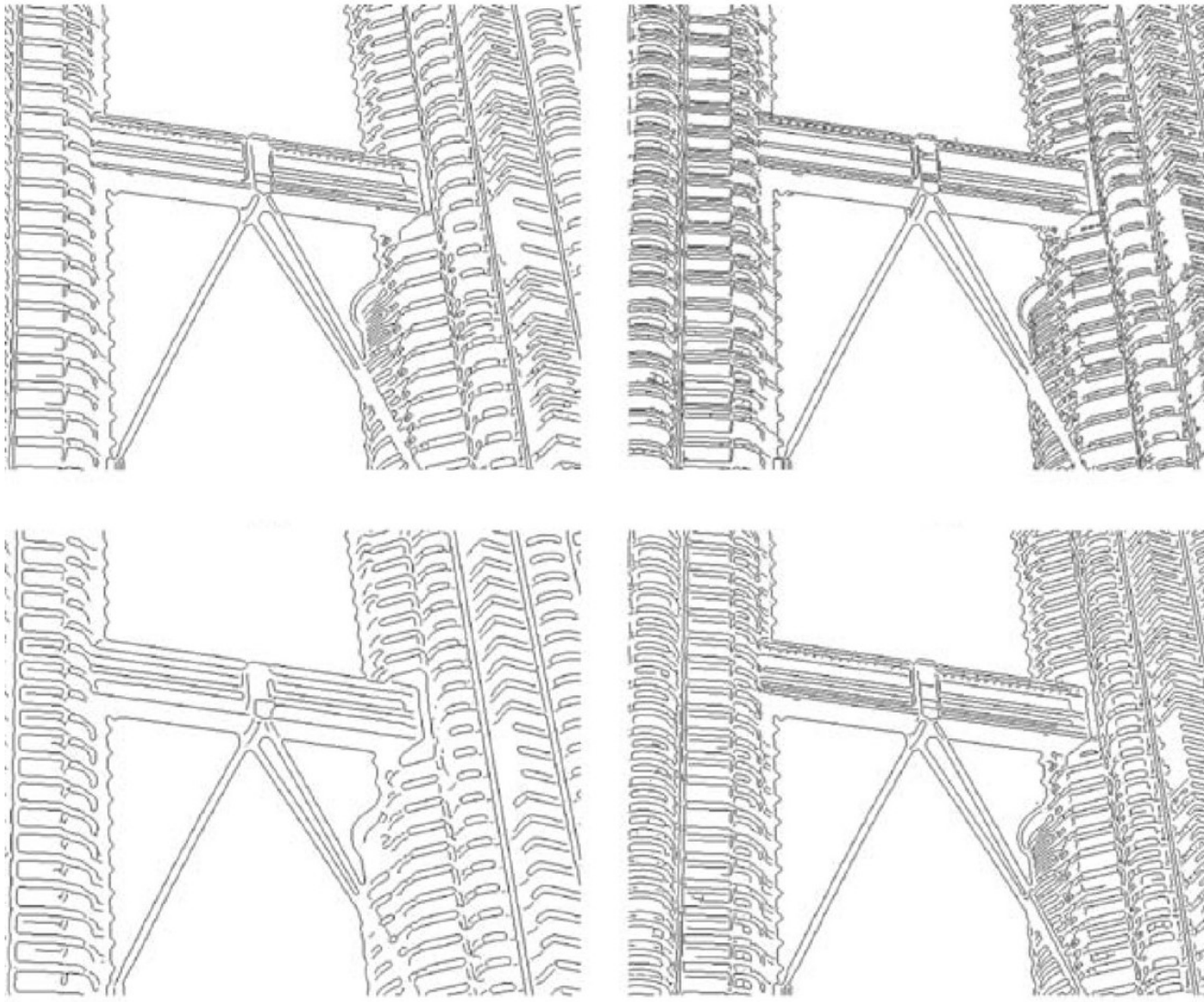
- Sobel works better than regular derivative filter if a noise is present.
- Instead of doing Gaussian before the derivative Sobel is an approximation of Gaussian derivative.

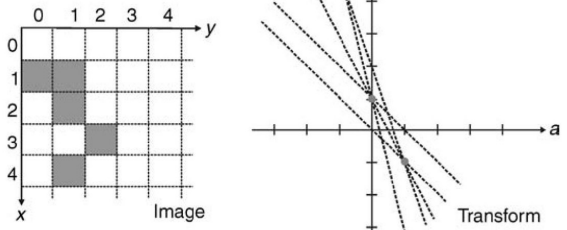
Canny Edge Detector

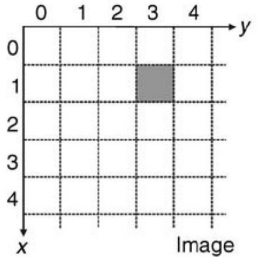
- Input of canny edge detector is the output of the Sobel.
- Canny edge detector thins the sharp edge lines to detect the edge better.
- After Sobel canny runs a threshold to the edge that Sobel produced and check the neighboring pixel and try to define a clearer edge.
- If the threshold is low then more edges will appear at the outcome. If the threshold is high than some edges might be lost.

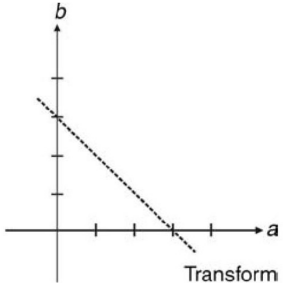
Edge Linking And Boundary Detection

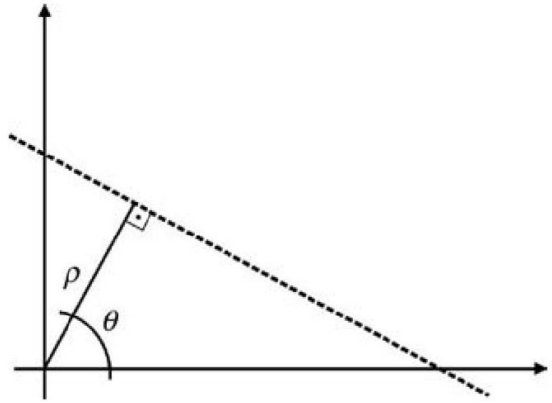
Some edges lost during Sobel or canny edge detection to fix these there are some edge linking and boundary detection algorithms.











The Hough Transform

The Hough Transform uses mathematical methods to find edges and attach them in a proper manner.

Questions?

Reference:
lec02_edge.ppt
PRACTICAL IMAGE AND VIDEO PROCESSING USING MATLAB