Machine Vision

Lecture 5

Image Segmentation or Feature Extraction: Points, Lines & Edges

Based on lecture
Of course “Digital Image Processing”
Of Brian Mac Namee

Contents

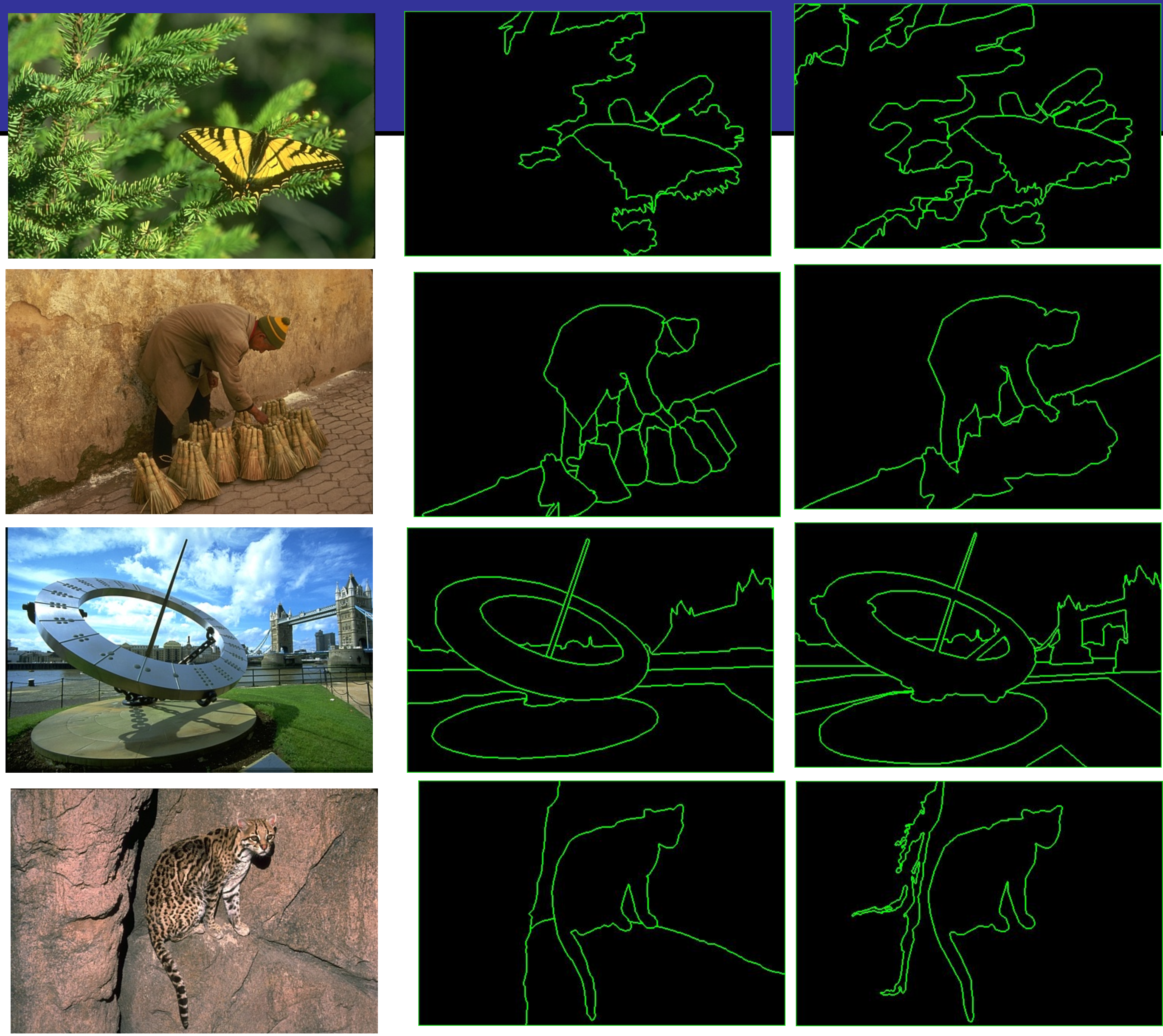
So far we have been considering image processing techniques used to transform images for human interpretation

Today we will begin looking at automated image analysis by examining the thorny issue of image segmentation:

- The segmentation problem
- Finding points, lines and edges (features)

Segmentation

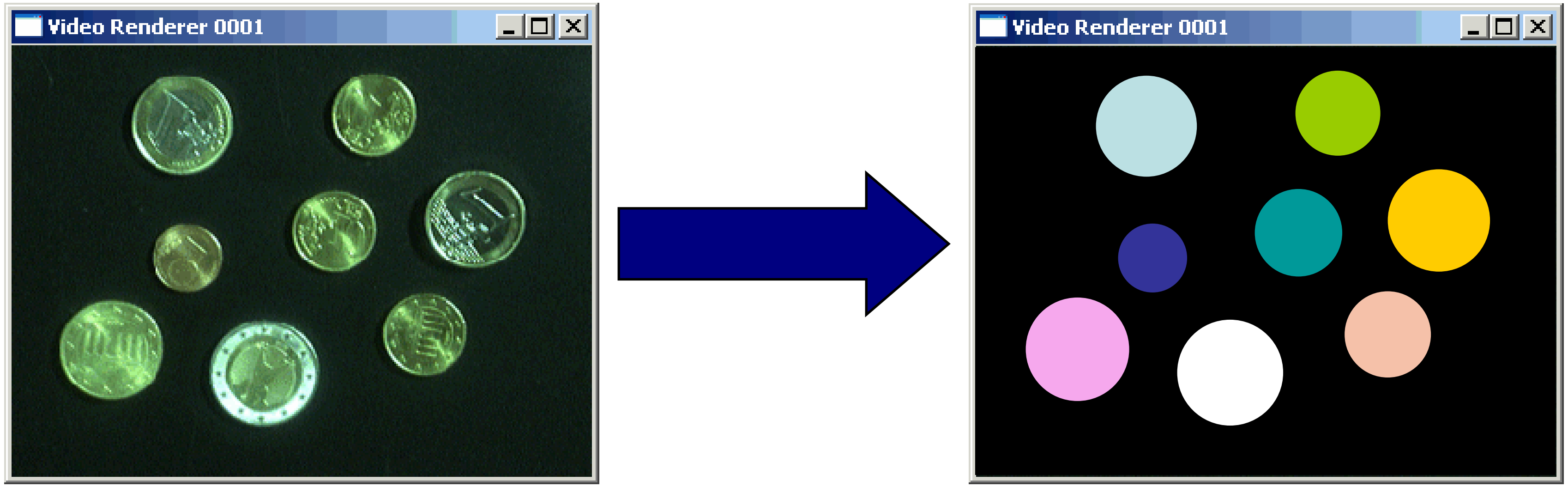
- Goal:
  - To divide an image into parts that are closely identified with objects, surfaces, features, areas, ... of the real world scene
- Problem:
  - This is (almost always) too hard to accomplish directly. We must try to infer these image-region-to-world-feature identities through an amalgam of photometric and geometric observations on the image, as well as domain knowledge



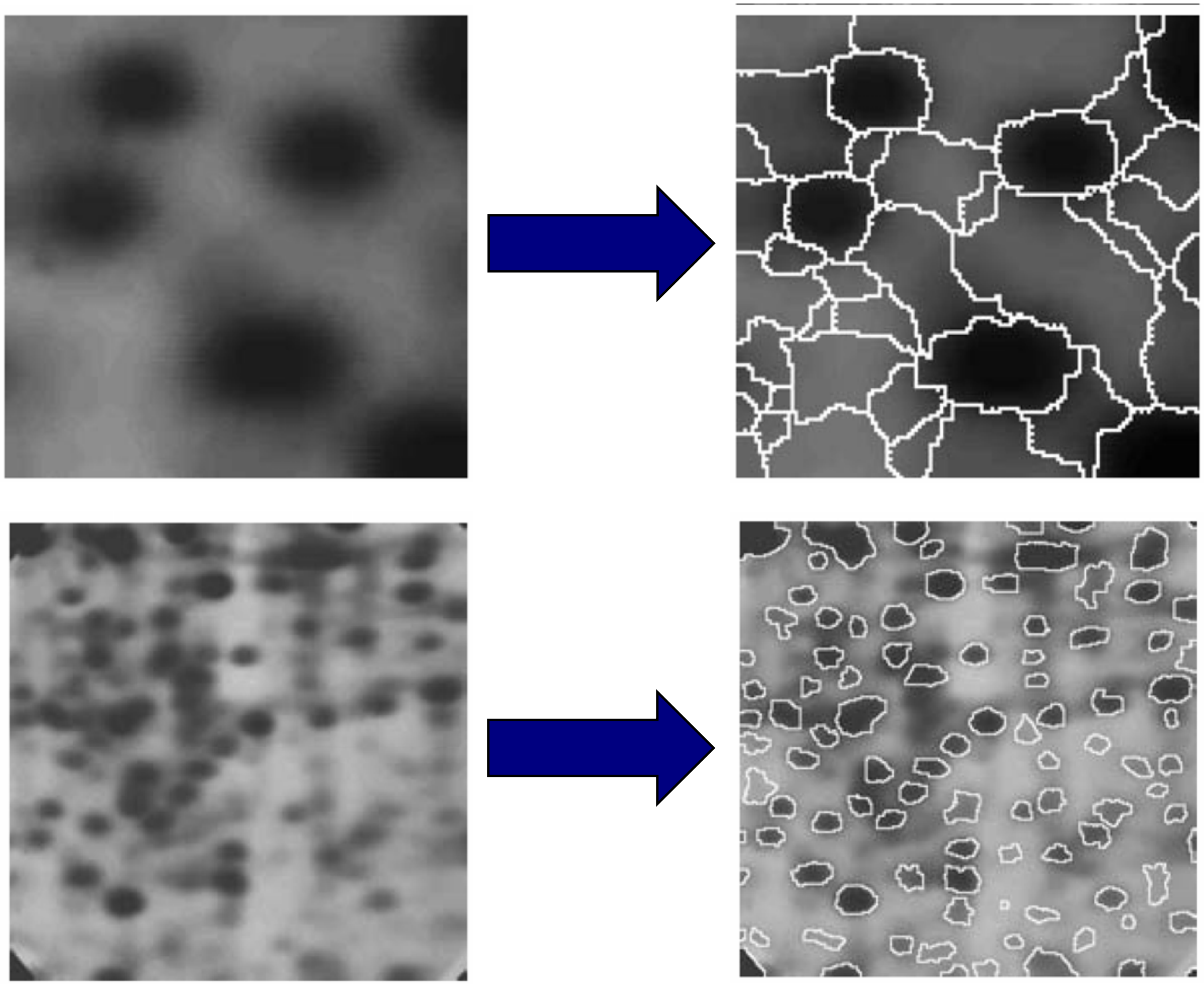
The Segmentation Problem

Segmentation attempts to partition the pixels of an image into groups that strongly correlate with the objects in an image

Typically the first step in any automated computer vision application

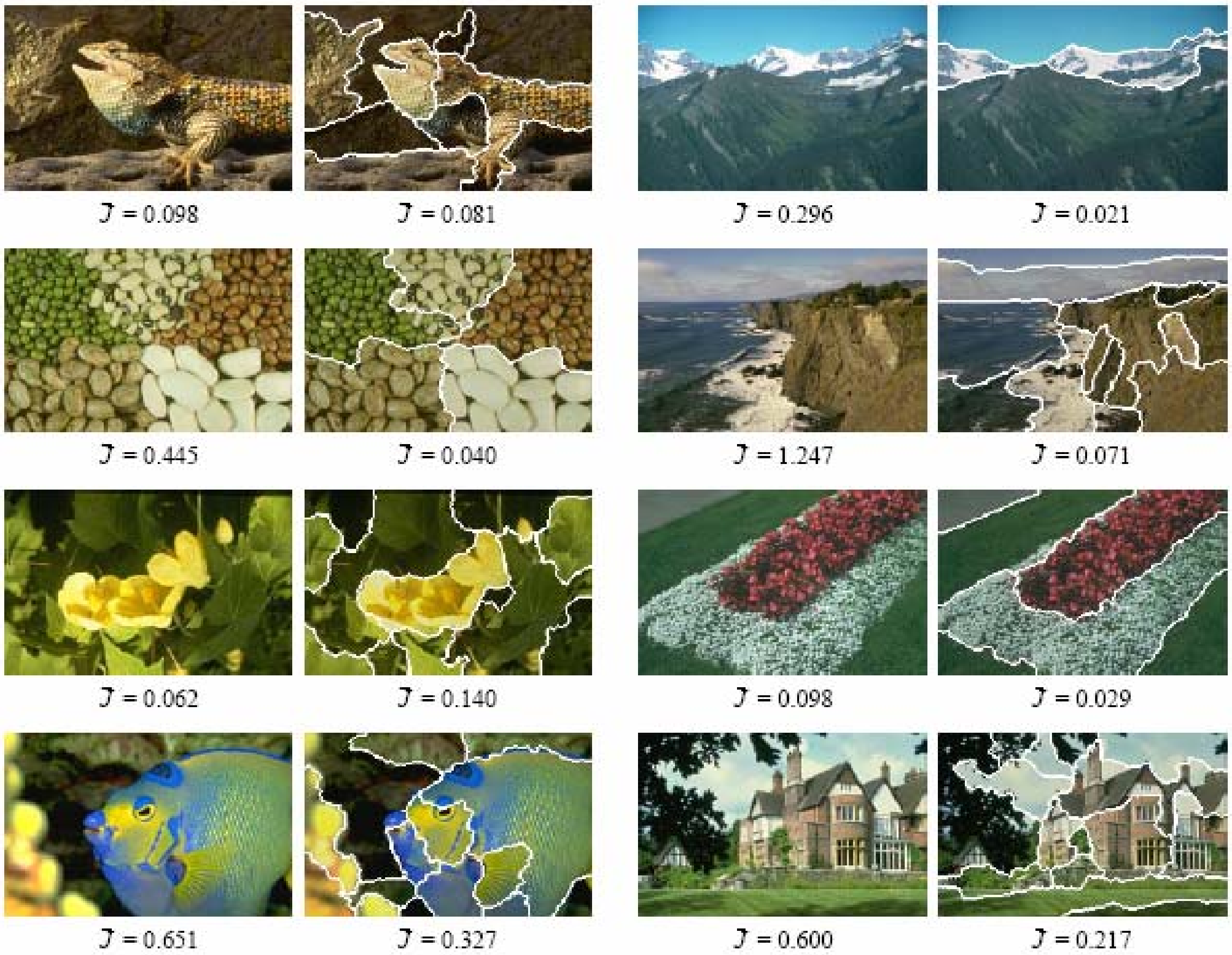


Segmentation Examples



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Segmentation Examples Cont’d



Detection Of Discontinuities

There are three basic types of grey level discontinuities that we tend to look for in digital images:

- Points
- Lines
- Edges

We typically find discontinuities using masks and correlation

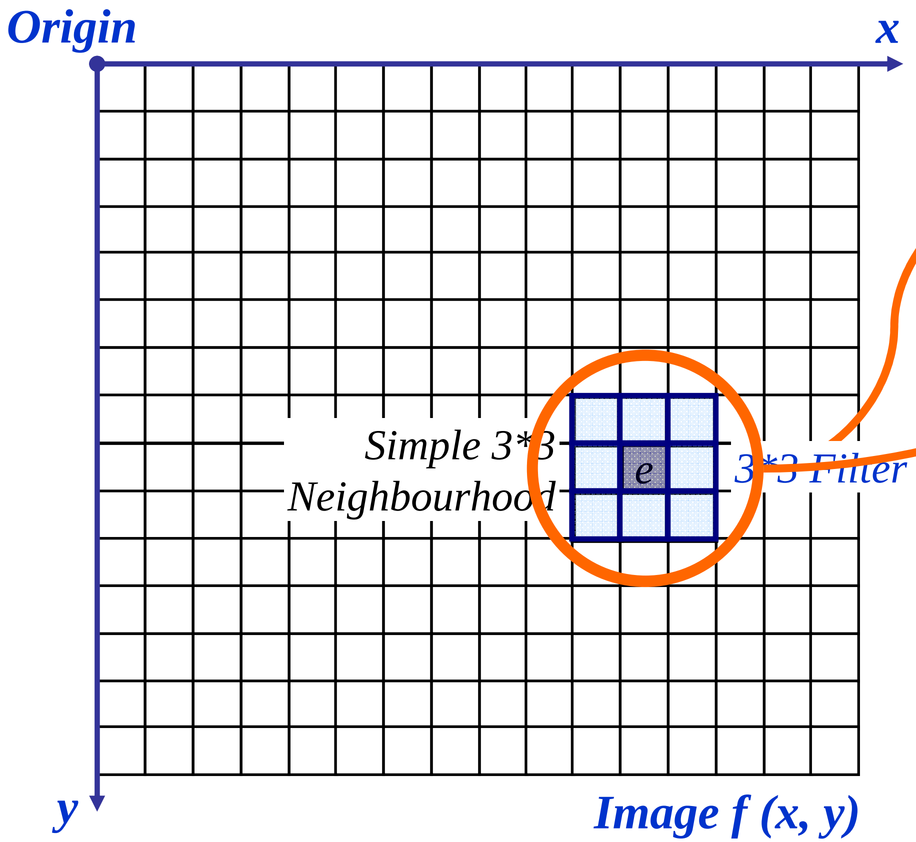
Point Detection

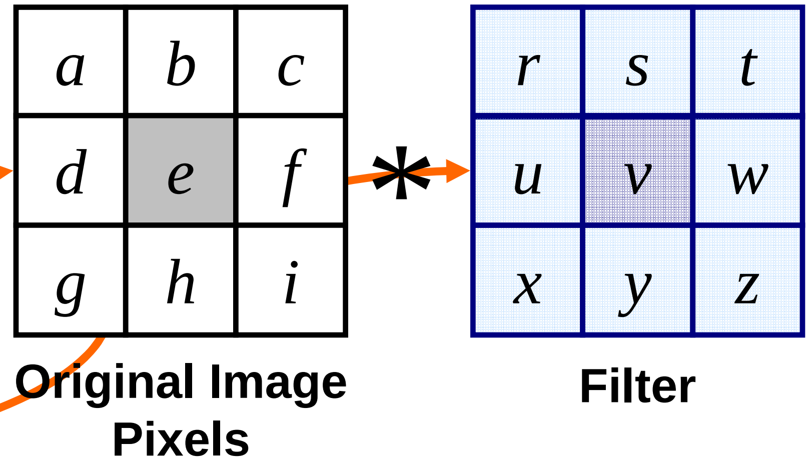
Point detection can be achieved simply using the mask below:

−1	−1	−1
−1	8	−1
−1	−1	−1

Points are detected at those pixels in the subsequent filtered image that are above a set threshold

Remind about the spatial filtering process

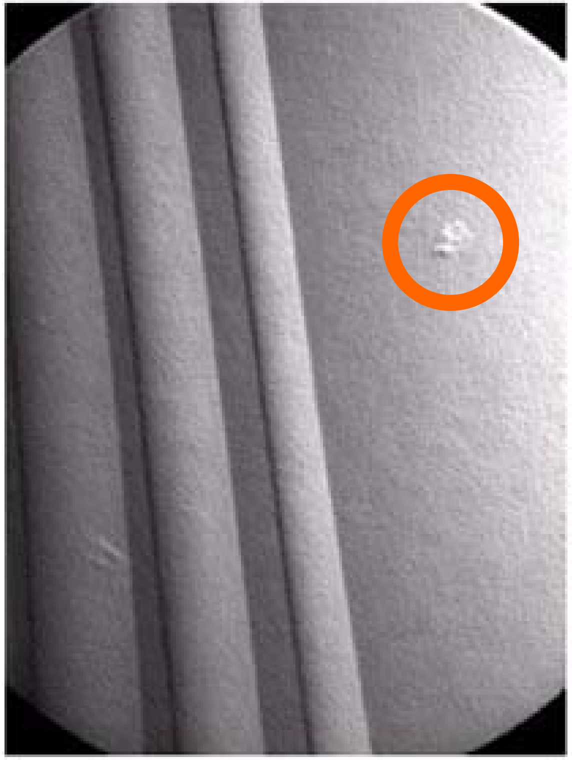




$$e_{processed} = v*e + r*a + s*b + t*c + u*d + w*f + x*g + y*h + z*i$$

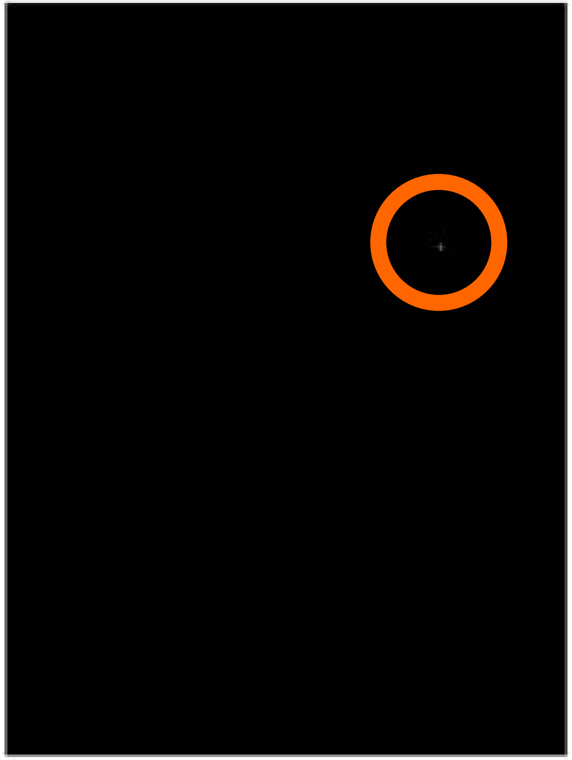
The above is repeated for every pixel in the original image to generate the filtered image

Point Detection (cont…)



X-ray image of a turbine blade

Result of point detection



Result of thresholding

Line Detection

The next level of complexity is to try to detect lines

The masks below will extract lines that are one pixel thick and running in a particular direction

−1	−1	−1
2	2	2
−1	−1	−1

Horizontal

−1	−1	2
−1	2	−1
2	−1	−1

+45°

−1	2	−1
−1	2	−1
−1	2	−1

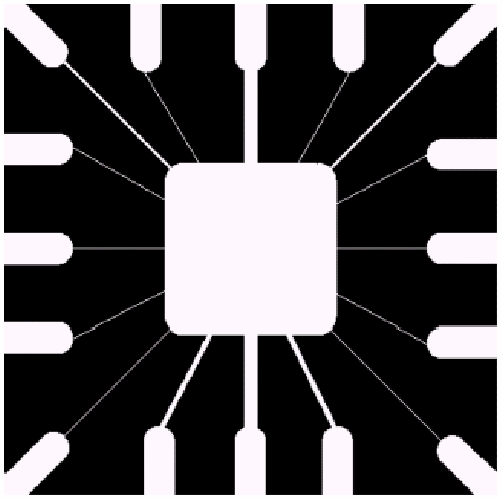
Vertical

2	−1	−1
−1	2	−1
−1	−1	2

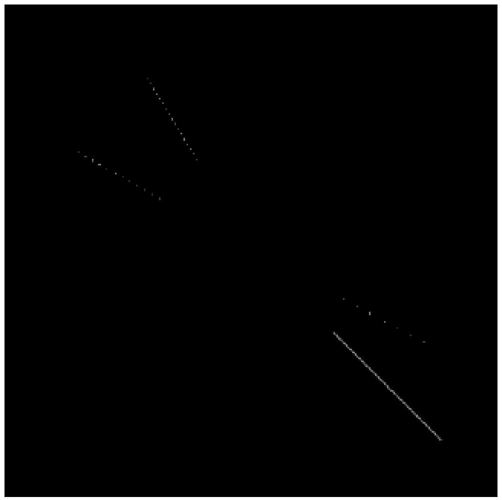
−45°

Line Detection (cont…)

Binary image of a wire bond mask



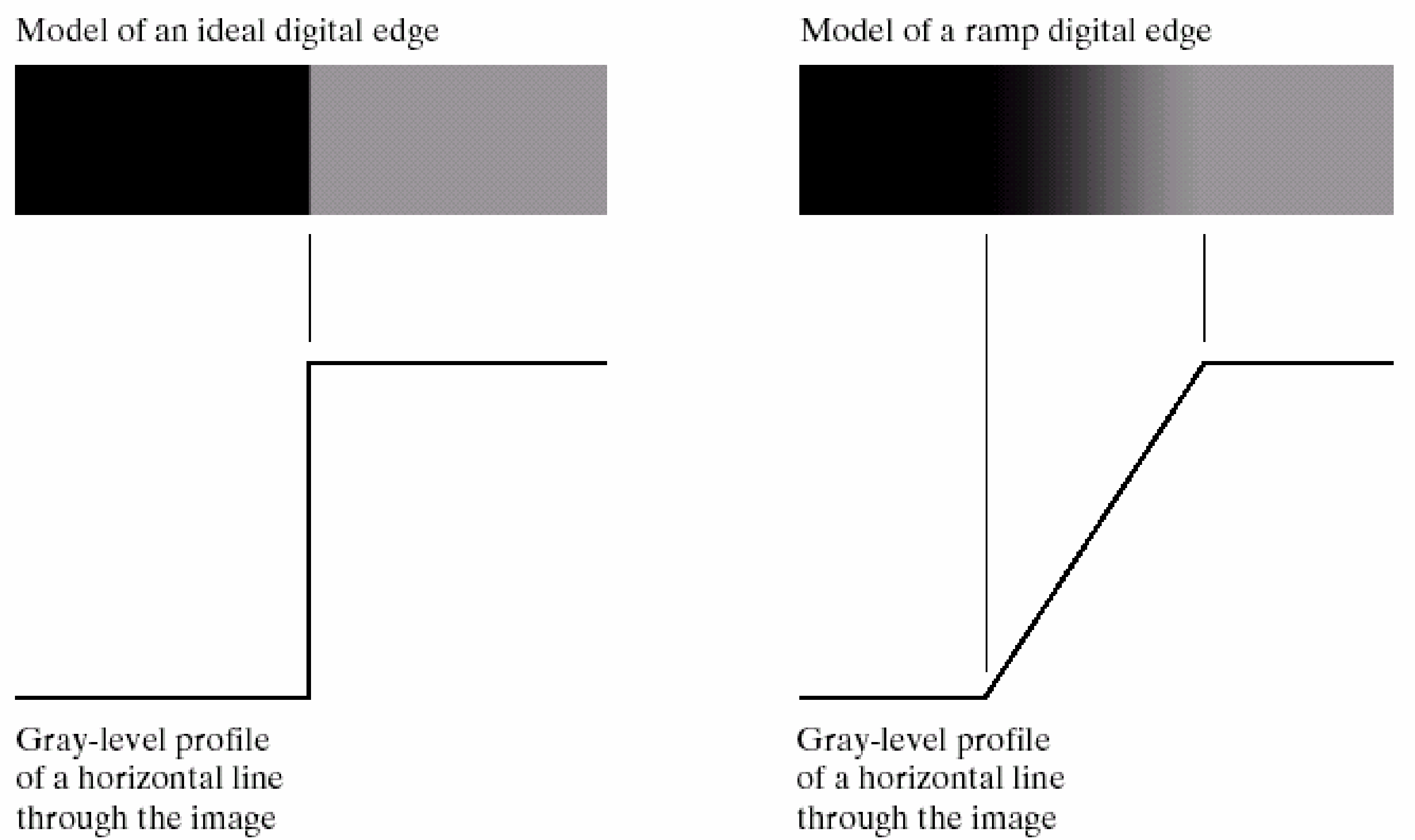
After processing with -45° line detector



Result of thresholding filtering result

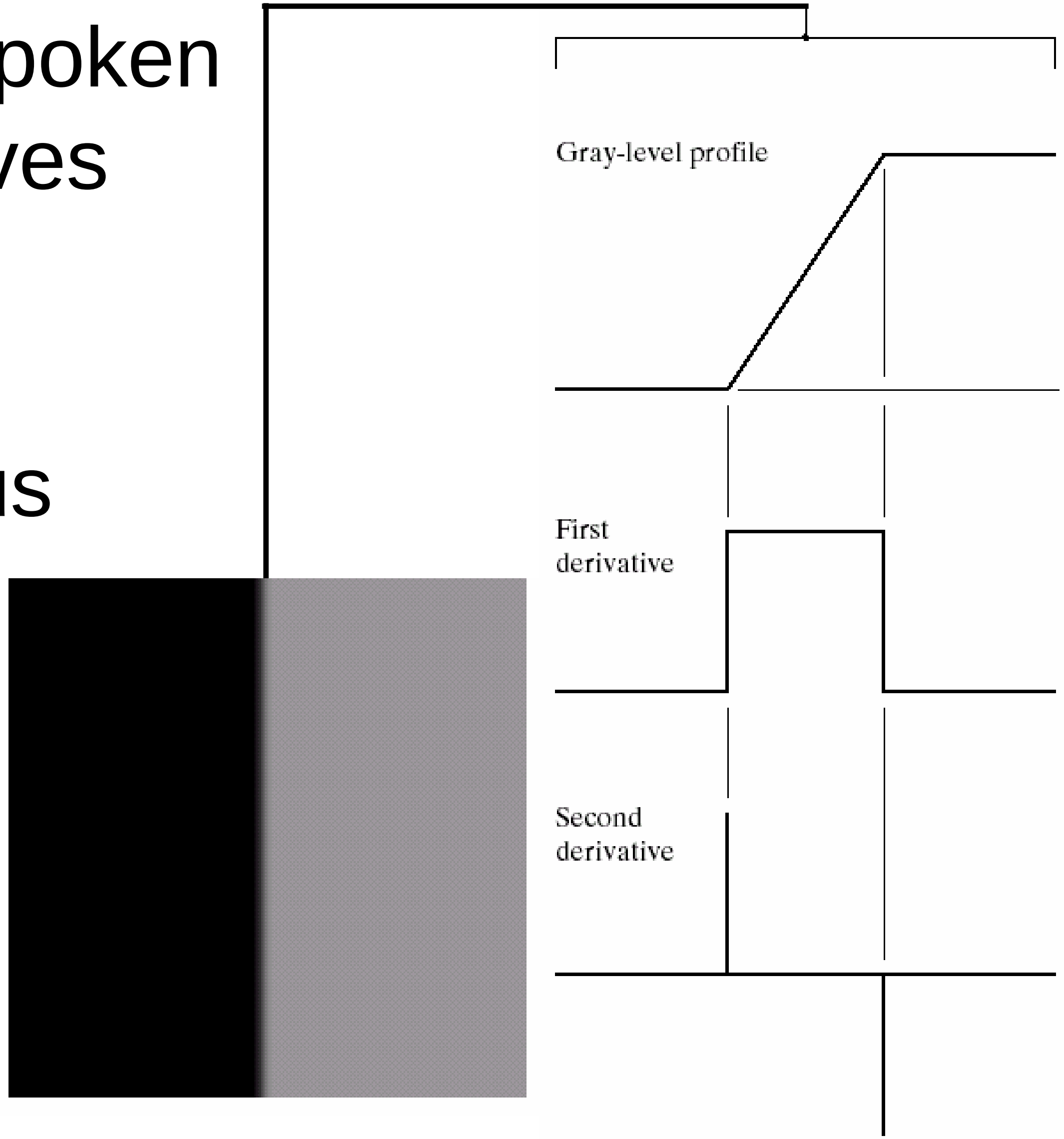
Edge Detection

An edge is a set of connected pixels that lie on the boundary between two regions



Edges & Derivatives

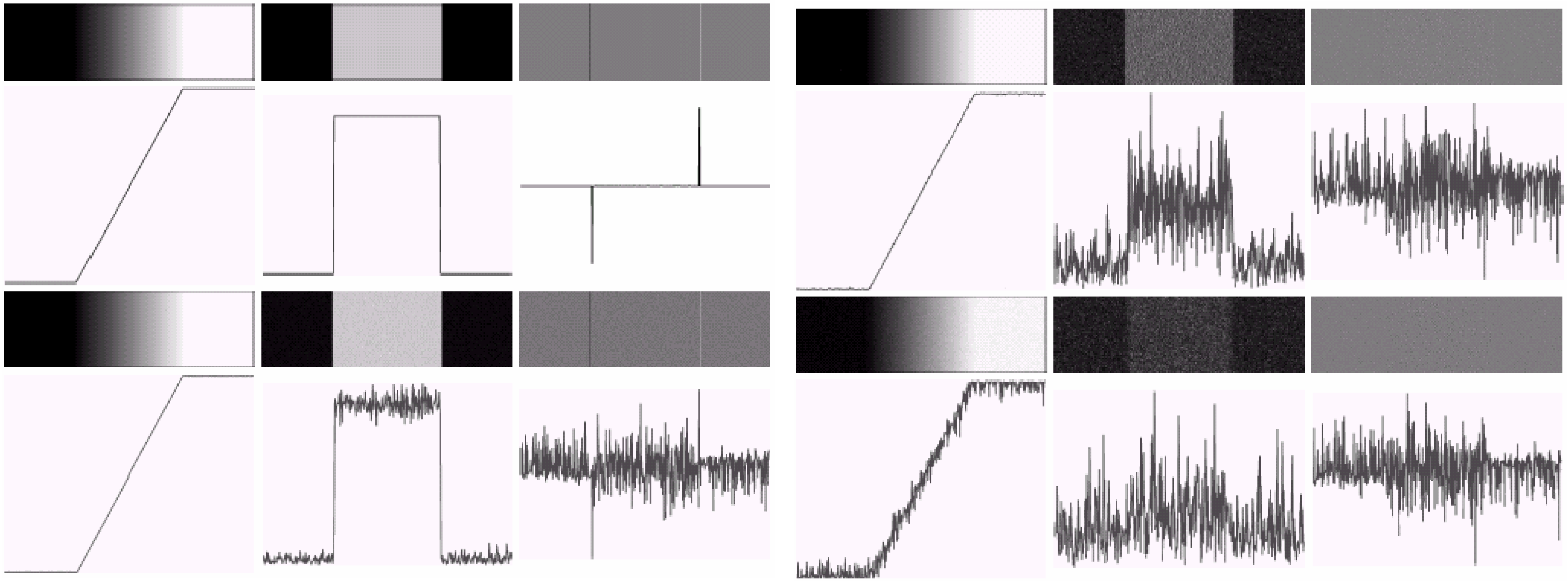
- We have already spoken about how derivatives are used to find discontinuities
- 1st derivative tells us where an edge is
- 2nd derivative can be used to show edge direction



Derivatives & Noise

Derivative based edge detectors are extremely sensitive to noise

We need to keep this in mind



Common Edge Detectors

Given a 3*3 region of an image the following edge detection filters can be used by convolution

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

−1	−1	−1
0	0	0
1	1	1

−1	0	1
−1	0	1
−1	0	1

Prewitt

−1	0
0	1

0	−1
1	0

Roberts

−1	−2	−1
0	0	0
1	2	1

−1	0	1
−2	0	2
−1	0	1

Sobel

Edge Detection Example

Original Image

Horizontal Gradient Component

Vertical Gradient Component

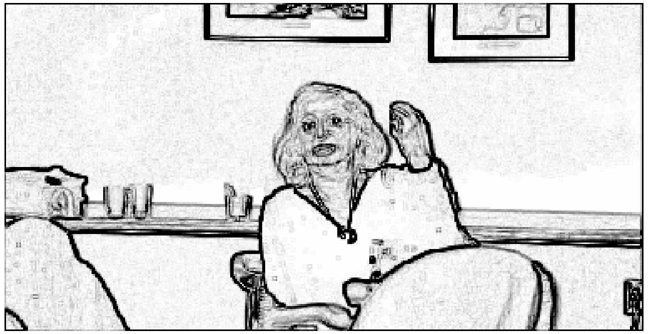
Combined Edge Image

Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Difference between filters

Examples:

Roberts



Prewitt

Sobel

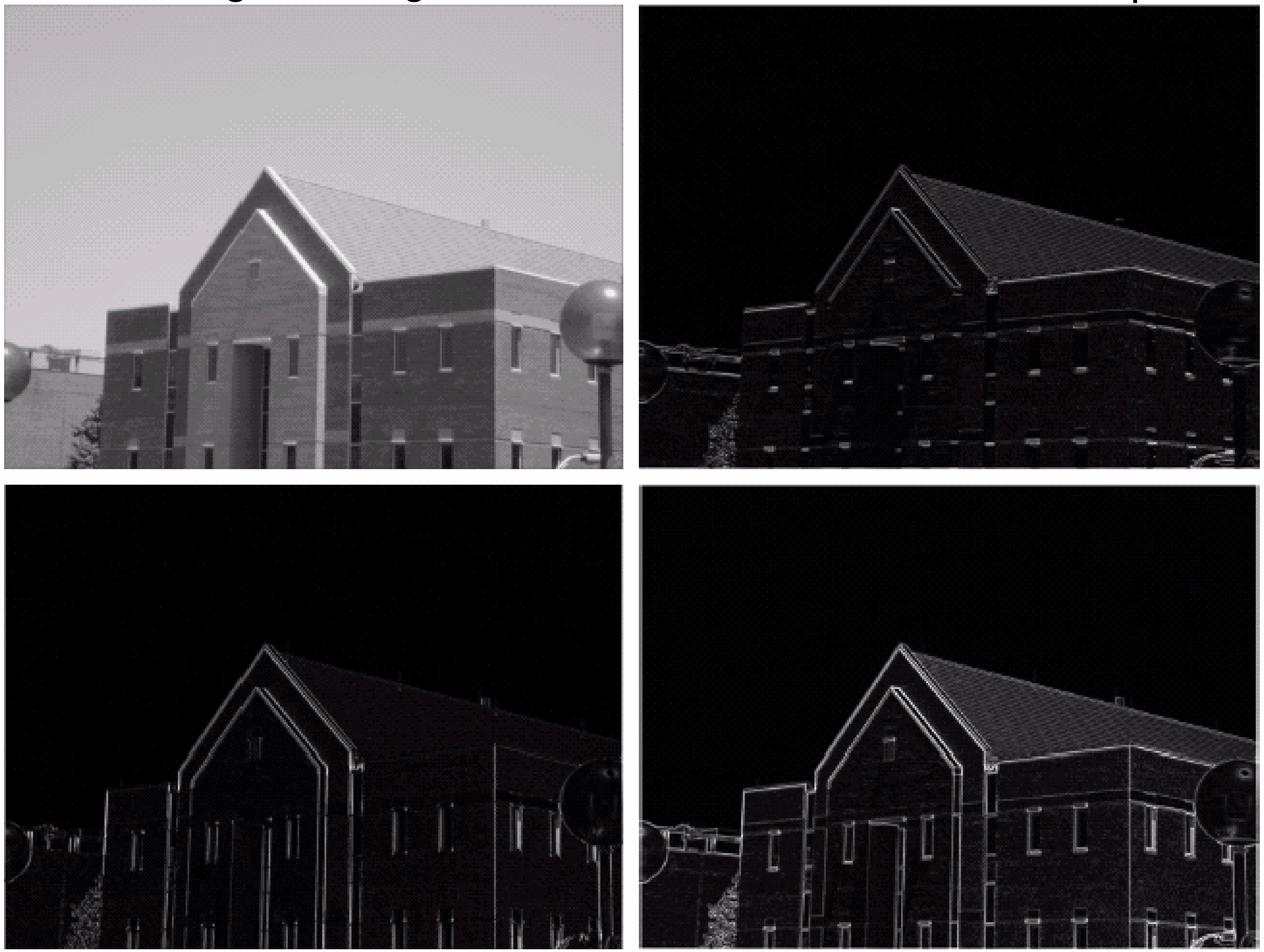
Edge Detection Problems

Often, problems arise in edge detection in that there are is too much detail

For example, the brickwork in the previous example

One way to overcome this is to smooth images prior to edge detection

Edge Detection Example With Smoothing



Original Image — Horizontal Gradient Component

Vertical Gradient Component — Combined Edge Image

Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Laplacian Edge Detection

The 2^{nd}-order derivative based Laplacian filter

0	−1	0
−1	4	−1
0	−1	0

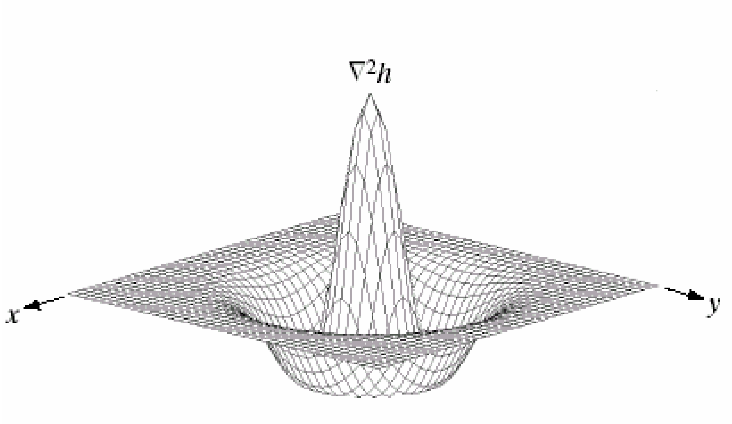
−1	−1	−1
−1	8	−1
−1	−1	−1

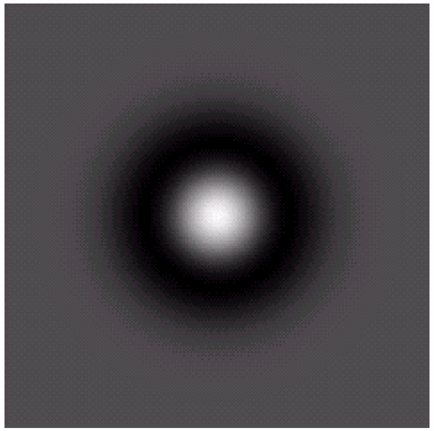
The Laplacian is typically not used by itself as it is too sensitive to noise

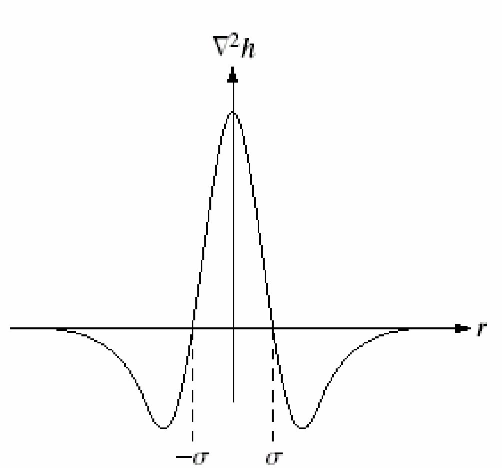
Usually hen used for edge detection the Laplacian is combined with a smoothing Gaussian filter

Laplacian Of Gaussian

The Laplacian of Gaussian (or Mexican hat) filter uses the Gaussian for noise removal and the Laplacian for edge detection

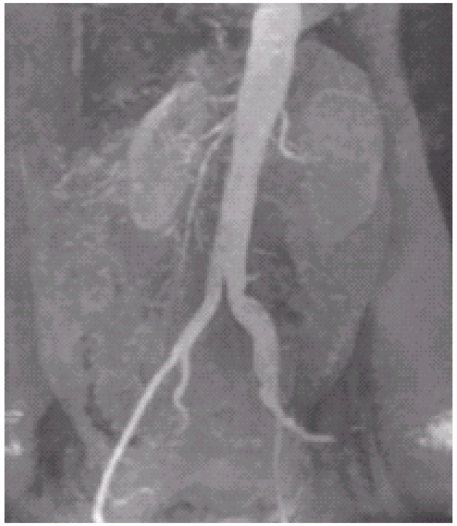


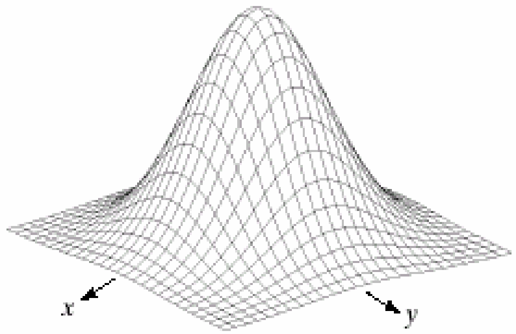




0	0	−1	0	0
0	−1	−2	−1	0
−1	−2	16	−2	−1
0	−1	−2	−1	0
0	0	−1	0	0

Laplacian Of Gaussian Example





−1	−1	−1
−1	8	−1
−1	−1	−1