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Enabling Technologies for Sports (5LL70)

Image Segmentation

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This chapter: Segmentation

- * Subdivide images into regions or objects
- * What a "region" or object is, is usually application-dependent
- * The problem is often the absence of a ground truth
- * Also: when to stop segmenting?

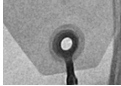
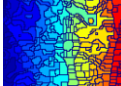

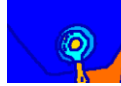







Image of ECG pad
Oversegmentation
Undersegmentation
"Good" segmentation

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Segmentation: Basic approaches

- * **"Top-down": based on discontinuity**
 - Pixels belonging to different objects will have different gray values
 - Partition an image based e.g. on edges
- * **"Bottom-up": based on similarity**
 - Pixels belonging to the same object will have similar gray values
 - Partition an image based on similarity criterion


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What we will see today

Implementations, using MATLAB, of the following techniques:

- * Point and line detection for segmentation
- * Thresholding
- * Region-based segmentation
- * Watershed transform

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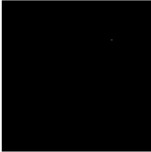
Point detection


- * Look for a point that is different from its neighborhood
- * Apply an isolating mask to calculate:

$$R = w_1 z_1 + w_2 z_2 + \dots + w_9 z_9$$
- * A point is detected at the center of the mask if

$$|R| \geq T$$
 where T is a threshold

-1	-1	-1
-1	8	-1
-1	-1	-1

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Line detection


- * Masks responding to lines of different orientations:

-1	-1	-1	-1	-1	2	-1	2	-1	-1		
2	2	2	-1	2	-1	-1	2	-1	-1		
-1	-1	-1	2	-1	-1	2	-1	-1	2		
Horizontal			+45°			Vertical			-45°		


Original image




-45° detector




-45° detector (zoomed)




absolute values of -45° detector



Thresholded absolute values of -45° detector

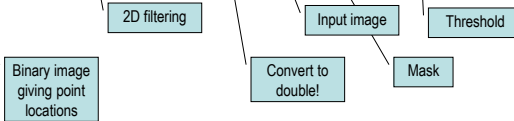


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Point and line detection in MATLAB

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```
g = abs( imfilter (double(f), w ) ) >= T;
```



- * How to set T?
- * In a first instance, by examining the values of the feature image
- * More on thresholding later

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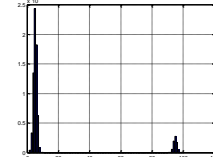
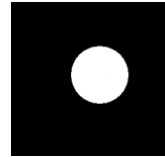
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Thresholding

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- * Simple and computationally efficient
- * Threshold selection uses intensity information
→ histogram
- * Example: bimodal histogram



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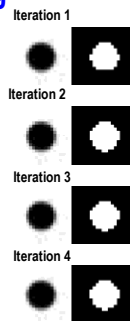
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Optimal Thresholding

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- * What value of T will give us the best segmentation?
- * Gonzalez and Woods:
 - Initialize T (e.g. halfway between min and max)
 - Iteratively set $T = 0.5 * (\mu_1 + \mu_2)$, where μ_1, μ_2 the mean values of pixels with value larger or smaller than T, respectively
 - Until T converges



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Region Growing

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- * Start from a seed point, selected manually or automatically
 - Several seed points are also possible
- * Include new neighboring points in the region based on some similarity criterion



* Image from
<http://www.mathworks.com/matlabcentral/fileexchange/19084>

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Region Growing in MATLAB

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- * Function (from textbook, *not* Image Processing Toolbox):
`[g, NR, SI, TI] = regiongrow(f, S, T);`
- * Input:
 - `f` : image
 - `S` : seed points (scalar → all points with this value, array → 1's for seed points and 0's for non-seed points)
 - `T` : threshold (scalar → global threshold, array → local threshold at each point)
- * Output:
 - `g` : segmentation result (different labels per region)
 - `NR` : # of regions
 - `SI` : final seed image
 - `TI` : image of pixels that passed threshold test

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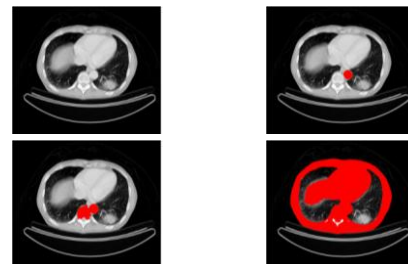
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Region Growing in MATLAB

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- * Play with seed points & thresholds



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References

- Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins,
“Digital Image Processing Using Matlab”,
Pearson Education, 2004
 - Chapter 10