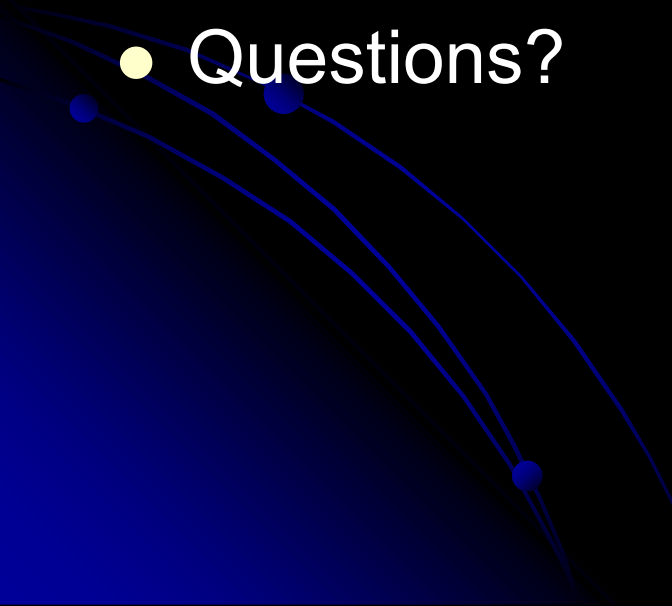# CSSE463: Image Recognition   Day 25

- Today: introduction to object recognition: template matching

- Template matching: a simple method for object detection

- Questions?

Template matching (Sonka, 6.4)
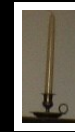
- Idea: you are looking for an exact match of an object (described by a sub-image, a *template*) in an image
- Ideal world: it matches exactly

Template matching (Sonka, 6.4)

- Algorithm:
  - Evaluate a match criterion at every image location (and size, reflection, and rotation, if those variations are expected)
  - A "match" is a local maximum of the criterion above a threshold

Template matching (Sonka, 6.4)

- One match criterion:
  - Correlation between the template and the image.
  - We are just using the template as a filter!
- Simplistic implementation
- Smarter implementation

imageT

0	0	0	0	0	0	0	7
0	4	4	4	4	4	0	10
0	0	4	6	6	4	0	9
0	0	0	4	6	4	0	10
0	0	0	0	4	4	0	8
0	0	0	0	0	4	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Correlation

- Just the dot product between the template and a neighborhood in the image.
- Idea: high correlation when the template matches.
- Demo

image$_T$

0	0	0	0	0	0	0	7
0	4	4	4	4	4	0	10
0	0	4	6	6	4	0	9
0	0	0	4	6	4	0	10
0	0	0	0	4	4	0	8
0	0	0	0	0	4	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Correlation

- Just the dot product between the template and a neighborhood in the image.

- Idea: high correlation when the template matches.

- Problem: **always** high correlation when matching with a plain bright region

image$_T$

0	0	0	0	0	0	0	7
0	4	4	4	4	4	0	10
0	0	4	6	6	4	0	9
0	0	0	4	6	4	0	10
0	0	0	0	4	4	0	8
0	0	0	0	0	4	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Correlation

- Just the dot product between the template and a neighborhood in the image.

- Idea: high correlation when the template matches.

- Problem: **always** high correlation when matching with a plain bright region

- Solution: Normalize the template and each region by subtracting each's mean from itself **before** taking dot product

image$_T$

0	0	0	0	0	0	0	7
0	4	4	4	4	4	0	10
0	0	4	6	6	4	0	9
0	0	0	4	6	4	0	10
0	0	0	0	4	4	0	8
0	0	0	0	0	4	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Other matching algorithms

- ## Chamfering (Hausdorff distance):
  - http://www.cs.cornell.edu/~dph/hausdorff/hausdorff1.html

- ## Springs and templates (Crandall and Huttenlocher)
  - http://www.cs.cornell.edu/~dph/papers/cvpr07.pdf

- ## Watershed segmentation (Sonka 6.3.4)