EE 569: Homework #4

Issued: 10/31/2014 Due: 11:59PM, 12/7/2014

General Instructions:

1. You are allowed to use any on-line source codes in solving all problems in Homework #4. However, you need to give a clear reference to the course of these codes (e.g. matlab, OpenCV, etc.)
2. You need to understand the USC policy on academic integrity and penalties for cheating and plagiarism. These rules will be strictly enforced.

Problem 1: Contour-based Image Segmentation (32 %)

Convert the four test images in Figure 1 to gray level images and, then, apply two contour-based image segmentation algorithms (*i.e.,* the snake algorithm and the level-set algorithm) to segment each image into two parts: foreground and background. Discuss the performance of your segmentation results and the strengths and weaknesses of each of the two contour-based image segmentation algorithms.

(a) Monkey

(c) Babies

(b) Basket

(d) bananas

Figure 1: Four Test Images

Problem 2: Region/Color-based Image Segmentation Algorithms (40 %)

One challenging question is the suitable number, K, of segments for a given image. What are the suitable number of segments for the four images in Figure 2? Please list a couple of reasonable numbers for each image.

(a) Convert color images in Figure 2 into gray-level images and apply the watershed algorithm to each image for image segmentation. How do you select the marker map? Show a couple of segmented images that are reasonable for each test image. Discuss the strengths and weaknesses of the watershed algorithm based on your observation on segmentation results on these examples.

(b) Apply the color-based K-means clustering algorithm to the four test images in Figure 2. Discuss your way in choosing the segmentation number, K. Discuss the strengths and weaknesses of the color-based K-means algorithm based on segmentation results on these examples. (Hint: Use the L*a*b color space.)

(a) Coast

(c) kitten

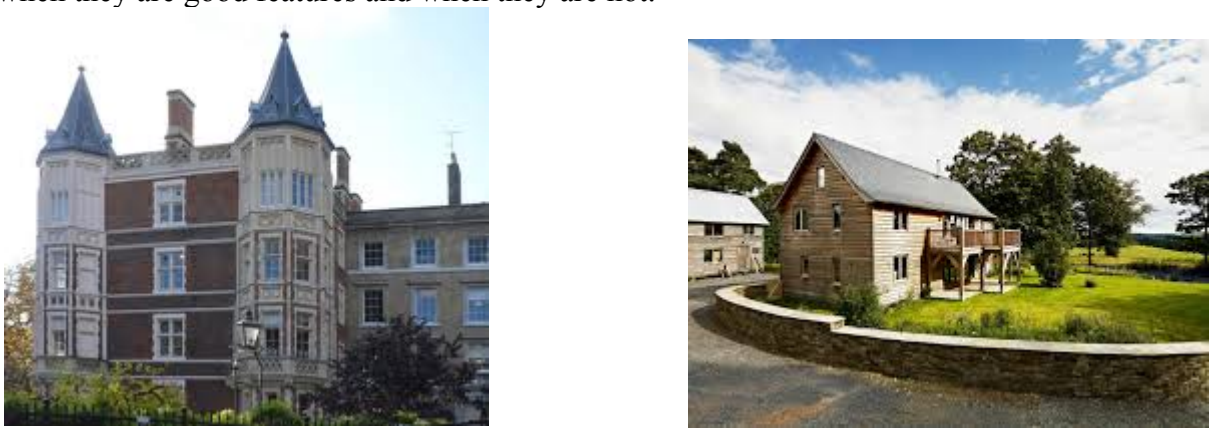
(b) Horse

(d) painting

Figure 2: Four More Test Images

Problem 3: SIFT, Bag of Words and Image Matching (38 pts.)

(a) SIFT Points Extraction (10 pts.)
Extract SIFT features from the two images in Figure 3. Are these results meaningful? Discuss when they are good features and when they are not.



(a) Building_1 (b) Building_2

Figure 3: Two Building Images

(b) Bag of Words (10 pts)
Use the k-mean clustering algorithm to partition the selected SIFT feature vector from the two images in Figure 3 into K=8 bins, where each bin is characterized by the SIFT feature vector of the centroid. It is called a codeword. All K codewords form a codebook. Then, we can use the histogram of these K bins as an image feature, which is called the Bag of Words (BoW). For this toy example, what is the codebook and what are the BoWs of Building_1 and Building_2?

(c) Image Matching Using SIFT Features (18 pts.)
First, extract the SIFT points from the two USC bookstore images in Figure 4 and show the results. Next, show the corresponding SIFT pair between the two images.

(a) USC_Bookstore_1 (b) USC_Bookstore_2

Figure 4: Two USC Bookstore Images

Appendix:

Problem 1: Contour-based Image Segmentation

Monkey.raw	444x277	24-bit	color(RGB)
Babies.raw	475x233	24-bit	color(RGB)
Basket.raw	424x291	24-bit	color(RGB)
bananas.raw	304x405	24-bit	color(RGB)

Problem 2: Spectral-based Image Segmentation Algorithms

Coast.raw	469x263	24-bit	color(RGB)
kitten.raw	405x304	24-bit	color(RGB)
Horse.raw	469x263	24-bit	color(RGB)
painting.raw	405x304	24-bit	color(RGB)

Problem 3: SIFT, Bag of Words and Image Matching

Building_1.raw	379x327	24-bit	color(RGB)
Building_2.raw	407x304	24-bit	color(RGB)
USC_Bookstore_1.raw	435x343	24-bit	color(RGB)
USC_Bookstore_2.raw	435x343	24-bit	color(RGB)

Sample Codes Provided

kmeans.c	C code provided for k-means algorithm

References

[1] Michael Kass, Andrew Witkin, Demetri Terzopoulos, "Snakes: Active contour models," *International Journal of Computer Vision* 1(4), 321-331, 1988.

[2] Tony F. Chan and Luminita A. Vese, "Active contours without edges," *IEEE Trans. on Image Processing,* Vol. 10, No. 2, February 2001.

[5] David G. Lowe, "Distinctive image features from scale-invariant keypoints," *International Journal of Computer Vision*, 60(2), 91-110, 2004.

Reference Images

All images in this homework are from Google images or the USC-SIPI image database.