State University of New York at Buffalo

CSE 473/573 Fall 2015 Final Projects

Status Report (1-2 pages) Due: **3:00pm Monday November 23, 2015**
Final Report Due: **12:00noon Monday December 14, 2015**

Instruction:

a) Each student is allowed to either work alone or work with a partner on an assigned project – one of the three projects shown below.
b) Each team or individual is required to submit one status report (no more than two pages) and one final project report as well as all program source codes and final results by the deadlines shown above; Guideline for status report and final report will be posted separately.
c) Test images will be provided in UBLearns for students to download
d) Each team is required to write your own program codes and up to 20% of project teams shall be randomly selected to demonstrate their projects on Thursday December 17, 2015. Your program needs to be able to output partial (intermediate) results from each step, not just the final results.

Project #1 **(Wavelet-based Edge Detection)**

In this project, the students are asked to design a wavelet transform based scheme for edge detection. In particular, the wavelet transforms at two adjacent scales are multiplied in order to magnify edge structure and suppress noise. (Please see reference [1] for details) The following steps are to be performed:

(a) Select from several possible wavelet transforms and determine which two to use with convincing reasons
(b) Add Gaussian noise and impulse noise, respectively, to the test images for your implementation; You may select the level of noise with explanation in your report
(c) Perform the selected wavelet transforms to at least three different test images and their noise corrupted versions; The transform should be performed for at least four levels
(d) Perform proper scale multiplications to each of the wavelet transformed images and combine the results at different levels to form the final edge map
(e) Display the test images and their final edge detection results based on two different wavelet transforms.
(f) Compare the results of edge detection from two different wavelet transforms and from two different noise types; Explain the difference among these results
(g) **Bonus (5%)**: Implement an edge detection scheme combining wavelet transform and canny operator based on fusion rules (see reference [2])

Project #2 **(Mean Shift Segmentation)**

In this project, the students are asked to perform mean shift segmentation of given color images which may be corrupted by noise. The complete segmentation scheme consists of two

major steps: mean shift discontinuity preserving filtering and mean shift image segmentation. (See textbook 7.1 and reference [3][4])The following steps are to be performed:

(a) Perform mean shift discontinuity preserving filtering to the given images; Proper parameters h_s, h_r need to be selected
(b) Store all information about the d-dimensional convergence points $\mathbf{y}_{i,\text{con}}$
(c) Determine the clusters $\{\mathbf{C}_p\}_{p=1,\ldots,m}$ by grouping all $\mathbf{z}_i$, which are closer than h_s in the spatial domain and h_r in the range domain. That is, merge the basins of attraction of these convergence points
(d) Assign $L_i = \{p | \mathbf{z}_i \in \mathbf{C}_p\}$ for each pixel $i = 1, \ldots, n$.
(e) Select a proper parameter P so that regions smaller than P pixels will be eliminated.
(f) Visualize properly the mean shift segmentation results for the selected test images.
(g) **Bonus (5%)**: Perform the mean shift algorithm for track objects over image sequences (see reference [5] for algorithmic details)

Project #3 **(Hough Transform to detect circles)**

Hough transform is a feature extraction technique used in computer vision, and digital image processing. The main advantage of Hough transform is its capability to detect shape of the objects, even if they are occluded. In this project, you are given an image with coins of different sizes (few are overlapped). Your task is to detect and display circles around the boundary of the coins. Use text book algorithm 6.14 (3rd edition) and [6] as a reference :

(a) Denoise the image using a Gaussian blur filter of 3x3 size
(b) Apply an edge detector of your choice using external libraries
(c) Threshold the image from (b) into a binary image and report the best threshold value
(d) Pick a suitable range of radii values of circles to be detected and report why/how you picked this range
(e) Apply Hough transform to detect circle at every edge pixel from (c) and update the accumulator array.
(f) Display the circles detected over original image . How accurate is your Hough circle detector. Write your analysis on the performance of your circle detector and steps to improve its performance
(g) **Bonus (5%)** Perform circle detection without using accumulator array, randomly select four edge pixels in the image and determine whether there is a possible circle in the image [7]. Compare the performance in terms of efficiency and runtime

References

[1]. L. Zhang and P. Bao, "Edge detection by scale multiplication in wavelet domain," *Pattern Recognition Letters*, Vol. 23, No. 14, pp. 1771-1784, December 2002

[2]. L-Y. Xue and J-J. Pan, "Edge detection combining wavelet transform and canny operator based on fusion rules," Proceedings of ICWAPR 2009, IEEE International Conference on Wavelet Analysis and Pattern Recognition, pp. 324-328, Baoding, China, July 2009

[3]. Y. Cheng, “Mean shift, mode seeking, and clustering,” *IEEE Tans. Pattern Analysis and Machine Intelligence*, Vol. 17, No. 8, pp. 790-799, August 1995
[4]. D. Comaniciu and P. Meer, “Robust analysis of feature spaces: color image segmentation,” *Proc. IEEE Computer Vision and Pattern Recognition*, pp. 750-755, June 1997
[5]. D. Comaniciu, V. Ramesh and P. Meer, “Real-time tracking of non-rigid objects using mean shift,” *Proc. IEEE Computer Vision and Pattern Recognition*, pp. 142-149, June 2000
[6]. Yuen, H. K., et al. "Comparative study of Hough transform methods for circle finding." *Image and vision computing* 8.1 (1990): 71-77.
[7]. Chen, Teh-Chuan, and Kuo-Liang Chung. "An efficient randomized algorithm for detecting circles." *Computer Vision and Image Understanding* 83.2 (2001): 172-191.