State University of New York at Buffalo

CSE 473/573 Fall 2016 Final Projects

Status Report (1-2 pages) Due: **3:00pm Monday November 21, 2016**
Final Report Due: **6:00pm Friday December 16, 2016**

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 Saturday December 17, 2016. Your program needs to be able to output partial (intermediate) results from each step upon request, not just the final results.
e) For those who choose to submit the project report before the final exam, the deadline will be Monday December 12, 2016 and selected project teams need to demonstrate their projects on Tuesday December 13, 2016.

Project #1 **(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 [1][2])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 $\mathbf{y}_{i,\mathrm{con}}$
(c) Determine the clusters $\{\mathbf{C}_p\}_{p=1,\dots,m}$ 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 $i = 1, \dots, n$.
(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 [3] for algorithmic details)

Project #2 **(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 (3^{rd} edition) and [4] 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 [5]. Compare the performance in terms of efficiency and runtime

Project #3 (**Disparity for Stereo Vision – Block Matching and Dynamic Programming**)

Disparity estimation is the key step in perceiving depth in Stereo Vision. You are given with image dataset which has three views of the same scene and ground truth disparities of two views. In this project you will implement disparity estimation from rectified images using basic block matching and dynamic programming. Use maximum likelihood stereo algorithm [6] as your reference for dynamic programming :

(a) Try different block sizes (3x3 and 9x9) and generate disparity maps using Sum of Squared Differences (SSD) Matching.
(b) Report the estimated disparity maps and the calculated MSE (Mean Squared Error) with respect to the given ground truth disparity maps
(c) Use dynamic programming approach [6] to estimate disparity map and report the MSE (Mean Squared Error) with respect to the given ground truth disparity maps
(d) Report your inference on block size vs MSE of disparity maps in block matching. Also, report your inference on MSE of dynamic programming based disparity estimation and how it can be minimized
(e) **Bonus (5%)** Pick any paper on dynamic programming based disparity estimation and achieve comparably smaller MSE than the technique proposed in the reference paper [6].

References

[1]. Y. Cheng, “Mean shift, mode seeking, and clustering,” *IEEE Tans. Pattern Analysis and Machine Intelligence*, Vol. 17, No. 8, pp. 790-799, August 1995

[2]. 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

[3]. 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

[4]. Yuen, H. K., et al. "Comparative study of Hough transform methods for circle finding." *Image and vision computing* 8.1 (1990): 71-77.

[5]. Chen, Teh-Chuan, and Kuo-Liang Chung. "An efficient randomized algorithm for detecting circles." *Computer Vision and Image Understanding* 83.2 (2001): 172-191.

[6]. Cox, Ingemar J., et al. "A maximum likelihood stereo algorithm." *Computer vision and image understanding* 63.3 (1996): 542-567.