CS 532: Homework Assignment 3
Due: October 21, 6:00pm

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Collaboration Policy. Homeworks will be done individually: each student must hand in their own answers. It is acceptable for students to collaborate in understanding the material but not in solving the problems. Use of the Internet is allowed, but should not include searching for previous solutions or answers to the specific questions of the assignment. I will assume that, as participants in a graduate course, you will be taking the responsibility of making sure that you personally understand the solution to any work arising from collaboration.

Late Policy. No late submissions will be allowed without consent from the instructor. If urgent or unusual circumstances prohibit you from submitting a homework assignment in time, please e-mail me explaining the situation.

Submission Format. Electronic submission on Canvas is mandatory. Submit in a zip file, **a single pdf file containing**:

- a description of what you did,
- the source code,
- the accuracy specified in the last step below.

Also include the source code separately. Images are not necessary, but they can be valuable debugging tools.

Harris Corner Detection and Matching Download the Teddy stereo pair and ground truth disparity map from the same link as for the second assignment. *This is the only time in this course that we will IGNORE the epipolar constraint.* The only reasons for doing this is that the ground truth disparity map can be used to evaluate the matched corners without any manual labeling.

Implement the following steps:

1. Compute the image derivatives I_x and I_y for each pixel of image separately. Use $\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$ to compute I_x and its transpose to compute I_y. Use these first order derivaties to compute I_x^2, I_y^2 and I_{xy} at each pixel.

2. Apply Gaussian smoothing to the derivatives using the 5× 5 filter shown at `http://homepages.inf.ed.ac.uk/rbf/HIPR2/gsmooth.htm`. If for some reason, you are unable to do this, average the derivative values in 5× 5 windows centered at each pixel. Averaging will be penalized, but a filtering step is absolutely necessary to proceed.

3. Apply the Harris operator as in slide 61 of the 4^{th} set of notes. Pick as corners all pixels above a threshold so that you select about 300-500 corners per image after the next step. 2000 is a good starting value for the threshold.

4. Apply *non-maximum suppression* on the responses of the Harris operator in 3×3 windows. This means that if a pixel does not have the maximum response in its 3×3 neighborhood, then it should not be included in the output. Make sure that the order you process pixels does not affect the output of this step.

5. Compute the distance between every corner of the left image to every corner of the right image. IGNORE the epipolar constraint and use SAD in 3×3 windows for computing distances. If there are N corners in the left image and M corners in the right image there should be NM potential correspondences for which you should compute distance values.

6. Sort the distance values and select the top 5% most likely correspondences. Report the number of correct and incorrect correspondences included in this set. Use the ground truth disparity map and count small errors up to 1 pixel as correct. Repeat for the top 10% all the way to 100% in 5% increments.

Ignore all pixels for which any window falls out of the boundaries of the image.