ECE661: Homework 4

Fall 2018
Deadline : September 25, 2018, 1:30 pm

Turn in typed solutions via Blackboard. Additional instructions can be found at [I]

1 Introduction

Given two photos of the same scene taken from two slightly different viewpoints, the goal of this homework is to first extract **interest points** from the two photos and, then, to **automatically** establish correspondences between the interest points in the two images.

When you find an interest point in one image corresponding to an interest point in the other image, you must show that result by drawing a line between those points in a display in which you show the two photos together.

As you will find out in class, in general, an **interest point** is a scale-space concept. If you think of the gray levels in an image as constituting a surface over a flat plane, an interest point would be that pixel where the surface exhibits highest curvature locally in all directions. Strictly speaking, an interest point should also have high curvature with respect to scale. When scale space is not considered, various types of corners in images constitute good interest points. And one of the most popular algorithms for extracting corners in images is the **Harris Corner Detector**.

For this homework, you will be expected to write your own code for the Harris corner detector and to apply it to a pair of images of the same scene taken from two different viewpoints. You can find the corresponding pairs of interest points by using similarity measures like the **SSD (Sum of Squared Differences)** and the **NCC (Normalized Cross Correlation)**. You must write your own code for these measures.

In addition to the Harris corner detector, this homework requires you to also experiment with the SIFT and the SURF operators for extracting the interest points and establishing correspondences between them. For SIFT and SURF, you may use either the MATLAB or the OpenCV implementations.

2 Tasks

2.1 Harris Corner Detector

You are provided with several pairs of images. Each pair contains images of the same scene taken from slightly different viewpoints.

1. Extract interest points using the Harris corner detector that you implemented. You can refer to the last section of Lecture 9 and the sample solutions available online to understand the steps involved in implementing the detection algorithm.
2. Use NCC (Normalized Cross Correlation) and SSD (Sum of Squared Differences) metrics to establish correspondences between the two sets of interest points of the image pairs.
3. Apply the Harris corner detector for at least 4 different scales. Your implementation should allow for any suitable scale as input.

2.2 SURF or SIFT

Use the OpenCV or MATLAB implementation of either SIFT or SURF algorithm to find interest points and establish correspondences between images. In this case you can directly compare the feature vectors of interest points to establish correspondences.

2.3

1. Compare the quality of the correspondences obtained from the two tasks above.
2. Show output on at least 2 set of images taken with your own camera.

2.4 Notes

1. You can find the image pairs to use for this homework on the course website [I].
2. Draw lines to indicate the selected correspondences.
3. You can use the OpenCV SURF or SIFT functions for the second task. If you are a MATLAB user you can use the VLFeat library at [II] . However, you cannot use the built-in cornerHarris function or any function that directly implements the Harris corner detection algorithm. The implementation of Harris corner detector for the first task must be your own.

3 Submission

1. Turn in a typed pdf of your report via Blackboard.
2. Your pdf must include
   - A description of your implementation of the Harris corner detector and an overview of SIFT or SURF algorithm.
   - A description of how you used the NCC and SSD metrics to establish correspondences with relevant equations.
   - The input and output images for each task. **Illustrate clearly the correspondences by drawing lines between the interest points**.
   - Your observations on the interest points detected at various scales, using the Harris Corner Detector.
   - Your observations on the relative performance of the two methods.
   - The parameters that you chose for best feature extraction and matching.
3. You are permitted to look at sample solutions from previous years to get an understanding of how to solve the problems. **Your final report must be yours**.
4. Your source code.

References

[**I**] `http://engineering.purdue.edu/RVL/ECE661_2018/`
[**II**] `http://www.vlfeat.org/`