COMP 558 Assignment 3

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Posted: Wednesday November 13th, 2019
Due: Sunday December 1st, 2019 (midnight)

Introduction

This assignment covers the material from lectures 14 – 20, with a particular focus on homographies.

In order to do the assignment, you need to know how to use Matlab and to be familiar with indexing conventions for matrices, with plots and with the various image processing commands. Use Matlab's documentation for guidance. In particular, typing "doc functioname" will give you detailed information about "functioname" and its variants. If you click on http://mathworks.com, you will also find webinars and tutorials for various computer vision and image processing tasks.

Please use mycourses->Discussions for questions related to this assignment. We expect questions to arise and answers will be posted here. You are also free to discuss the questions with one another. *However, the solutions that you submit must represent your own work.* You are not permitted to copy code from each other, or from the internet. In order to receive full points, your solution code must be properly commented, and you must provide a clear and concise description of your computed results in the PDF file. The TAs will spend at most 20 minutes grading each assignment.

Instructions

Submit a single zipped file **A3.zip** to the mycourses-> Assignment 2 folder. The zip file must contain:

- A PDF with figures and explanatory text and discussion for each question. Whereas you don't have to spend time on elaborate typesetting, please do make sure that your explanations and discussions are clear and that the figures are easy to read and interpret. Also, make sure that all your figures are embedded in your PDF document so that the TAs can provide feedback.
- The Matlab code that you wrote for each part.
- Any images that you used.

Late assignment policy: Late assignments will be accepted up to 2 days late, but this time without penalty so that *the absolute deadline is Wednesday December 3rd, before midnight.*

(SIFT FEATURE VECTORS, MATCHING, RANSAC, HOMOGRAPHIES) 100 points

For this assignment you will use the sets of images we provide which contains a few snapshots in a sequence of images. *Each set of images we provide has its own challenges, and you are free to use either sequence (or both) in this assignment.* For both sequences there is a rotation of the camera about its optical centre to generate the sequence (the amount of translation of the camera between frames is intentionally very small). In addition, the datasets contains a sample ``stitched'' result, which illustrates what your final output could look like once your stitching algorithm is working. Note, your final output will not look as nice since we have included a rectification step, which is not part of the assignment. Finally we also provide some sample code ``SIFT.m'', which can be used for generating SIFT features for matching. You are also free of course to use your SIFT features from assignment 2, if you had good results there.
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1. [**10 marks**] For a sample image from a sequence compare the results of computing SIFT features using your solution for assignment 2, with those obtained by the implementation we have provided. We don't expect the results to be the same, and we want you to discuss how and why they might differ. For this question you might want to show and compare keypoint locations and feature vectors (histograms) for a region of interest. Some of the differences could in fact be due to the more elaborate method for constructing SIFT feature vectors than the one which we used in assignment 2.

2. [**10 marks**] We shall now build on the ideas above, using the set of images we have provided, where you have a sequence of images created by an approximate rotation of a camera about its optical centre. First, using the code we have provided, create a selected number of SIFT features in two consecutive images. Then, for a successive image pair in the sequence, illustrate the process of matching features. Here you can use a naive notion of a match, such as that implemented in Matlab's built in matchFeatures function. Provide a few illustrations of matched features in your report between successive image pairs, and discuss any particular implementation details behind your approach, along with the feature matching strategy you have used. If you like, you can also show sample results from the SIFT feature vector generation and matching process you implemented in assignment 2. Remember that in the "horizontal" image sequence, images 1 to 5 are easier to handle, while image 0 includes some distortion and intensity changes, so use the easier images first.

3. [**30 marks**] The matches you have so far will be noisy, since they are estimated in isolation, without consideration of an underlying model. Building on your results so far, implement the ideas in the RANSAC example discussed in the lecture notes and slides, but for estimating the best approximate homography between a successive image pair. Look at the end of the Lecture 20 detailed notes. For this you can assume the case of pure rotation (and not translation) of the camera, which is one of the cases we have discussed in class. First, detail the steps of your RANSAC solution in your report, and describe a specific algorithm. Then, come up with an implementation of it in Matlab. Once you have this working, you also have a way to detect the inliers and the outliers, when it comes to pairs of matched features. The inliers correspond to those pairs which are consistent with the homography you estimate, i.e., are in its consensus set. But you still need to come up with a sensible criterion for selecting the inliers and to explain your ideas. Illustrate your results by comparing the matched features following the application of the RANSAC algorithm, with your original naive matches.

4. [**30 marks**] Once you have the homography between two successive images, you can apply the mapping technique from the first image to the second, to create an overlay. Now apply

the same stitching strategy iteratively (using your pair-wise estimated homographies) to ultimately create a panorama for the dataset. To give you an idea of what these panoramas might look like we have provided a sample solution for each image sequence. In order of difficulty, the easiest set is images 1 to 5 of the horizontal sequence, then images 1 to 6 of the vertical sequence, and last images 0 to 5 of the horizontal sequence.

5. [**10 marks**] Apply the same pipeline, but now to a sequence of images taken by you, to demonstrate the generality of your solution. For this part you simply have to show the individual images, and then the overlay.

6. [**10 marks**] The above strategy for creating overlays should generally give you decent results, but with the caveat that there might be ghost edges at the locations where one image has been overlayed above another. Discuss a potential solution to this problem, by doing a bit of a literature search. You just have to describe the method you would use to alleviate this problem; you don't have to actually implement it!

Good luck, and please get started early!!