Intro to Image Understanding (CSC420)

Assignment 3

Posted: March 7, 2021 **Submission Deadline : March 16, 11.59pm, 2021**

Instructions for submission: Please write a document (either pdf, doc, etc) with your solutions (include pictures where needed). Include your code inside the document.

Max points: 15

1. For this exercise you will use the Scale-Invariant Feature Transform (SIFT) for matching. You will extract SIFT features from two images and use them to find feature correspondences and solve for the affine transformation between them. Please include code under each question. You are allowed to use existing code for SIFT keypoint and descriptor extraction (**but not for matching**).

   (a) [**1.5 points**] **Feature extraction:** Compute SIFT features for reference.png, test.png, and test2.png. You can use e.g. function SIFT() from existing packages to output, for each image, a list of feature descriptors and a list of their corresponding frames. Please visualize the detected keypoints on the image. By visualize we mean: plot the image, mark the center of each keypoint, and draw either a circle or rectangle to indicate the scale of each keypoint. For clarity, please plot only 100 keypoints. Please write the visualization function yourself – a function that loops over the extracted keypoints, and displays each keypoint on the image.

   (b) [**3 points**] **Matching:** Given the extracted features on reference.png and test.png, describe a simple matching algorithm to find the best feature matches (correspondences) for the features in reference.png and features in image test.png. How did you define "best" matches? Implement the algorithm in your favorite programming language. Visualize the top (best) 3 correspondences. Please describe what you chose as a criteria to evaluate best matches. Please do the same using the test image test2.png. Show each image and visualize each correspondence by indicating the feature's position and scale in the appropriate image. Use a separate color for each correspondence.

   (c) [**2 points**] **Affine transformation:** Use the top 3 correspondences from part (b) to solve for the affine transformation between the features in the two images.

   (d) [**1 point**] Visualize the affine transformation. Do this visualization by taking the four corners of the reference image, transforming them via the computed affine transformation to the points in the second image, and plotting those

transformed points. Please also plot the edges between the points to indicate the parallelogram. If you are unsure what the instruction is, please look at Figure 12 of [Lowe, 2004].

2. [**2.5 points**] In this exercise, you are asked to take a photo. In particular, please take a planar item/object for which you know the real-world width and height (in cm), for example a piece of paper or a dollar bill. Tape the item on the door. Take a picture of the door such that all four corners of the door are visible on the photo. Take this picture in an oblique view, ie, the door is not a perfect rectangle but rather a quadrilateral in the photo. Estimate the width and height of the door (in cm) from the picture.

3. [**5 points**] You are given a few photos of landscape. The goal is to take two photos, LANDSCAPE_1 and LANDSCAPE_2 and stitch them into one photograph. You can do this by extracting SIFT features from both photos, match them, and estimate a homography of one photo with respect to the other. Use RANSAC to find the best homography. Once you compute the homography, "stitch" the two photos together, forming a small panorama. We will give half points if you compute affine transformation instead of a homography.