HW#3

Due: Wednesday, October 25, 2023

Computing homography

HW Submission: Submit your report as a PDF file. **Include your code that computes the homography from the matching points – this is common to both questions.**

1. **Correcting perspective distortion:** In this first part, you will correct the perspective distortion of an image taken at an angle with respect to the surface. Let us refer to this picture as I, shown below and you can download the same from Canvas. We are making a (reasonable) assumption that the building face (KITP on campus) is planar (it is not, but a good approximation). We would like to now *synthesize* a new image that shows an orthographic view –as if you are in front of the building with the camera axis pointing towards the building.

Figure 1: KITP View 1

How do we go about doing this? First, identify a region on the picture I that should have been a perfect rectangle in an orthographic view. Examples include rectangular door frames, windows, tiles on the building, etc. Create a blank canvas – the new image you are going to synthesize – call this image S. For the region you have identified as a potential rectangular target, *draw* a corresponding rectangular region in your image S. Note that all you need are the 4 corner point coordinates as your reference points. You may want to ensure that the lengths of the sides of the rectangle are proportional to the expected lengths as visible in image I. So, you now have 4 coordinates $\{\mathbf{x_1}, \mathbf{x_2}, \mathbf{x_3}, \mathbf{x_4}\}$ in I and the corresponding 4 coordinates from S, $\{\mathbf{x_1'}, \mathbf{x_2'}, \mathbf{x_3'}, \mathbf{x_4'}\}$.

So you need to compute the mapping from $\mathbf{x}$ to $\mathbf{x}'$ through homography transform H, $\mathbf{x}' = H\ \mathbf{x}$. You need 4 corresponding points to computer the 8 unknowns in H, as discussed in the lecture. Once you compute H, you can fill in the image S by identifying the corresponding points in I. First, note that when you map the pixels from I to S (or vice versa), you will likely get non-integer values for most of the image pixels. You can interpolate between neighboring pixel values or pick the closest pixel.

For this question, you submit the following:

   (a) The coordinates of the pixels in I that you choose and the corresponding coordinates in S.
   (b) The homography matrix H.
   (c) The synthesized new image S.
   (d) your code for computing H.
   (e) Your code for synthesizing the view S from I.

2. *For this part, you will need to take pictures on your own, in addition to using the KITP image pair below, and submit results on the 2 separate pairs of images (i.e., answer all the questions for each pair separately).*

   Take two pictures of a planar surface (e.g., face of a building or a graffiti on a wall–be creative) from two different view points, as shown in the KITP building pictures below. Then perform the following computations.

(a) manually identify a set of corresponding points.

(b) solve the homography problem (compute the parameters of the H matrix).

(c) Apply the transformation on one of the images in the pair to synthesize the other image, and vice versa.

(d) Repeat this for two image pair examples, one for the KITP pictures and the other for the pair that you took.

Your report should include the two image pairs, at least four corresponding points clearly annotated (with their image coordinates listed), the transformation matrix H for each pair, and the synthesized images. Your code from the first part should be able to compute the homography matrix. However, you will need to synthesize view 1 from view 2 and vice versa using this code.

Figure 2: A challenging image pair to register!