ECE661: Homework 2

Fall 2018
Deadline : September 6, 2018

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

1 Introduction

In this homework you will estimate homographies between images and use the estimated homographies to transform images.

This homework depends on you knowing how to use a tool that displays the coordinates of a pixel that is selected by clicking your mouse on it. For that purpose, you could use a tool like GIMP in Linux and IrfanView in Windows. So, even before you start this homework, download such a tool into your personal computer and become familiar with it. Tools like GIMP and IrfanView will also allow you to draw what are known as bounding boxes for delineating specific regions in an image. Learn how to do that.

In addition to a tool like GIMP, you will also find the ImageMagick library very useful for all kinds of things related to working with images. Regarding its immediate usefulness to you, you can use its "identify" command to get details regarding the contents of an image. You will also find the command "display" very useful — this command can display an image for practically very image format that is out there.

You will be calculating a homography between two images by manually recording the pixel coordinates of a set of corresponding points in the two images and using these coordinates to calculate the unknown elements of the homography.

(a) (b) (c) (d)

Figure 1

2 Tasks

1. You are given four images which are shown in Figs. 1a, 1b, 1c, and 1d. The first three images consist of a painting hanging on a wall, while the fourth image contains the face of a famous celebrity. Complete the following tasks using these images.

   (a) Project the face shown in Fig. 1d on the frame PQRS shown in Figs. 1a, 1b, and 1c. For this task you need to find homographies between the following pairs of images: (1) images shown in Figs. 1d and 1a, (2) images shown in Figs. 1d and 1b, and (3) images shown in Figs. 1d and 1c.

   (b) Find homographies between images shown in Figs. 1a and 1b, and between images shown in Figs. 1b and 1c. Then apply the product of the two homographies to the image shown in Fig. 1a. The resulting image should look similar to the image shown in Fig. 1c.

2. Repeat tasks 1(a) and 1(b) using your own images. You can capture three images of a planar surface from three different viewpoints such as the ones shown in Figs. 1a, 1b, and 1c. For the fourth image you can obtain a picture of a celebrity from the Internet or use a picture of your own face.

2.1 Notes

1. To project the face shown in Fig. 1d into the frame PQRS you can draw a bounding box P'Q'R'S' around the face and estimate the homography using the corresponding pairs of points. In this case PP', QQ', RR', and SS' are the corresponding pairs of points. However, using just four correspondences for computing a homography is likely to give you very poor results. When using a system of linear equations for calculating the unknowns, a general rule of thumb is that you need five times as many equations as the number of unknowns. For this homework, we just want you to experiment with increasing the number of equations though additional correspondences between the two images of an image pair. For example, you can double the number of equations by using the perpendicular bisectors of the bounding boxes as shown below. Use such ploys to whatever extent you wish and see how that affects the quality of your homographies.

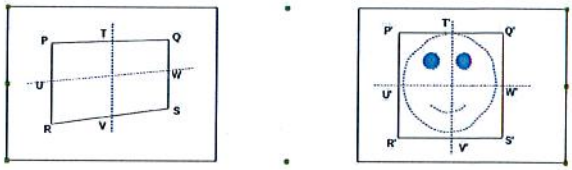

Figure 2

2. You can use an image editor such as GIMP or IrfanView to determine the pixel coordinates of a point in an image.
3. You can use OpenCV C++/Python libraries to handle low-level image and matrix operations. However, you cannot use the built-in OpenCV functions such as findHomography or warpPerspective.
4. You can find the images at [I].

2.2 Submission

1. Turn in a typed pdf of your report via Blackboard.
2. Your pdf must include a description of
   - The logic that you used to solve the given tasks.
   - The steps that you used to compute the homographies including equations.
   - The required final images for the tasks.
   - Your source code.
3. Indicate the points that you used on each image to obtain the homographies.
4. 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 your own.**

References

[I] `http://engineering.purdue.edu/RVL/ECE661_2018`