Alexandria Univeristy
Faculty of Engineering
Computer and Communication program

CCE: Computer Vision
Assigned: Oct 30, 2022
Due: Nov 11, 2022

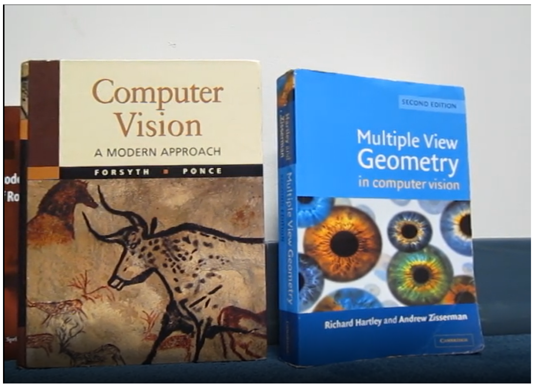
Assignment 2

1 Part 1:Augmented Reality with Planar Homographies

In this assignment, you will be implementing an AR application step by step using planar homographies. You will first learn to find point correspondences between two images and use these to estimate the homography between them. Using this homography you will then warp images and finally implement your own AR application.

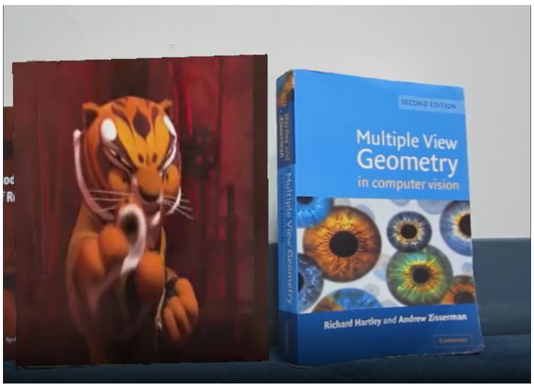
You will be provided with book.mov (Figure 1.a) and ar source.mov (Figure 1.b). Our Final goal is to overlay each frame of ar source.mov onto the book in book.mov like the result in (Figure 1.c) and create your new video from these overlay frames.

Figure 1: AR Application



(a) A screenshot from the Video of the Books

(b) A screenshot from the Video of the movie



(c) A screenshot from the generated video

Good Luck!

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1.1 Getting Correspondences

The first step is to find the correspondences between the image book (Figure 2.a) and the first frame of the video. Use SIFT descriptor from opencv library to find keypoints in each image and then use the brute force matcher from opencv to get the correspondences. Use the matching way as KNN with size 2, and apply ratio checking between the best 2 matches to filter the good correspondences.

Choose 50 correspondences and plot the book image, the first video frame and the matches as shown below.

Figure 2: Correspondences

(a) Image of the targeted book

(b) Example of getting correspondences between two images

1.2 Compute the Homography Parameters

Write a function that takes a set of corresponding image points and computes the associated 3×3 homography matrix H. This matrix transforms any point p in one view to its corresponding homogeneous coordinates in the second view, p', such that p' = Hp. Note that p and p' are both 3D points in homogeneous coordinates. The function should take a list of $n >= 4$ pairs of corresponding points from the two views, where each point is specified with its 2D image coordinates.

We can set up a solution using a system of linear equations Ax = b, where the 8 unknowns of H are stacked into an 8-vector x , the 2n-vector b contains image points from one view, and the 2n × 8 matrix A is filled appropriately so that the full system gives us $\lambda p = Hp$. There are only 8 unknowns in H because we set $H_{3,3} = 1$. Solve for the unknown homography matrix parameters.

Verify that the homography matrix your function computes is correct by mapping the clicked image points from one view to the other, and displaying them on top of each respective image. Be sure to handle homogenous and non-homogenous coordinates correctly.

1.3 Calculate Book Coordinates

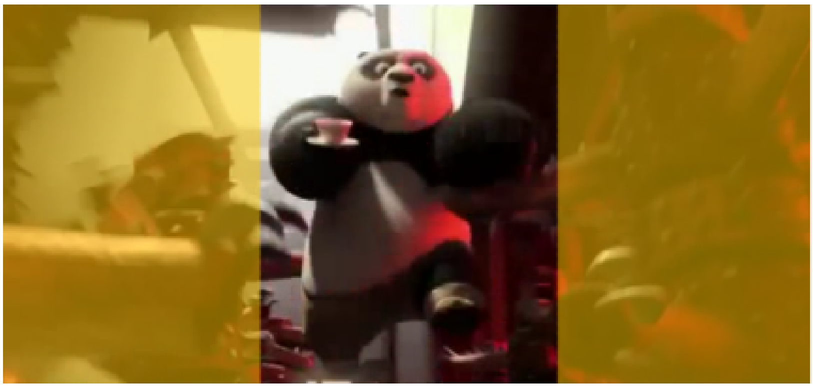
We need to detect the four corners of the book in the video. This is done by mapping the four corners of the book image (cover) to the first frame in the book video using the homography matrix calculated previously.

1.4 Crop AR Video Frames

The book and the videos we have provided have very different aspect ratios (the ratio of the image width to the image height). You must crop each frame to fit onto the book cover. You should crop each frame such that only its central region is used in the final output.

After Getting the four corners of the book, you can calculate the dimensions of the needed cropped frame.

Figure 3: Cropping Frames of the AR Video



(a) Crop out the yellow regions of each frame to match the aspect ratio of the book

(b) Result After Cropping

1.5 Overlay the First Frame of the Two Videos

In this step, you should replace the computer vision book in the first video frame with the first cropped frame of the movie video to make the AR Effect.

1.6 Creating AR Application

To create the final video, you need to repeat step 1.4 and overlay each cropped video frame to its corresponding frame of the book video. To do this you need to get the new location of the book in the following frame. This will be done by computing the homography matrix between each 2 consecutive frames or between the vision book cover and all the frames.

With this done, the book corners in each frames can be calculated and the movie frames can be overlayed as mentioned in step 1.4

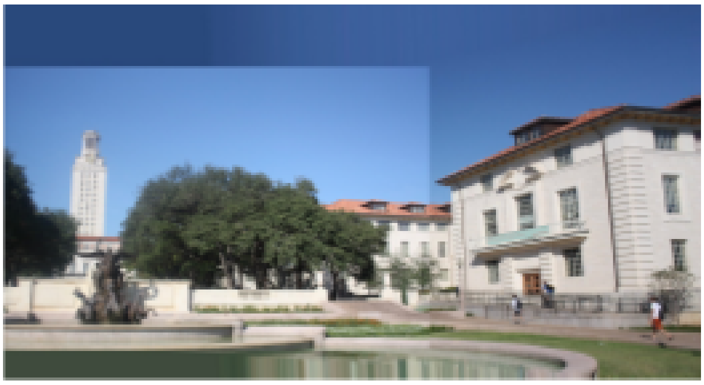
2 Part 2: Image Mosaics

In this part of the assignment, you will implement an image stitcher that uses image warping and homographies to automatically create an image mosaic. We will focus on the case where we have two input images that should form the mosaic, where we warp one image into the plane of the second image and display the combined views. original input.

Figure 4: Image Mosaics

(a) First View

(b) Second View



(c) Final View

2.1 Getting Correspondences and Compute the Homography Parameters

The first steps of this part is the same as 1.1 and 1.2. We will follow the same steps to get the correspondences and the homography matrix.

2.2 Warping Between Image Planes

Write a function that can take the recovered homography matrix and an image, and return a new image that is the warp of the input image using H . Since the transformed coordinates will typically be sub-pixel values, we can solve this by rounding the resulting coordinates or by distributing the pixel value to the nearby destination pixels. For the later case the destination pixel value is the average of any pixel values that maps to it. For color images, warp each RGB channel separately and then stack together to form the output.

To avoid holes in the output, use an inverse warp. Warp the points from the source image into the reference frame of the destination, and compute the bounding box in that new reference frame. Then sample all points in that destination bounding box from the proper coordinates in the source image (linear interpolation). Note that transforming all the points will generate an image of a different shape/dimensions than the original input.

2.3 Create the output mosaic

Once we have the source image warped into the destination images frame of reference, we can create a merged image showing the mosaic. Create a new image large enough to hold both (registered) views; overlay one view onto the other, simply leaving it black wherever no data is available. Do not worry about artifacts that result at the boundaries.

3 Bonus

Instead of stitching 2 images, stitch 3 images that overlap with each other.

- Stitch 2 images together following the previous steps.
- Get correspondences between the output of stitching the 2 first images and the third image Note: The order of stitc.
- Stitch the output with the third image creating the final output .

Note: The order of stitching yields different results.

4 Notes

You are required to deliver the following:

- Your code.
- Output video.
- The panorama result of the provided 2 images, and the panorama of another example of your choice.
- Report including explanation of your code and representative results on sample test images.

You can work in groups of 3.

Part one of the assignment is inspired from Carnegie Mellon University(CMU).