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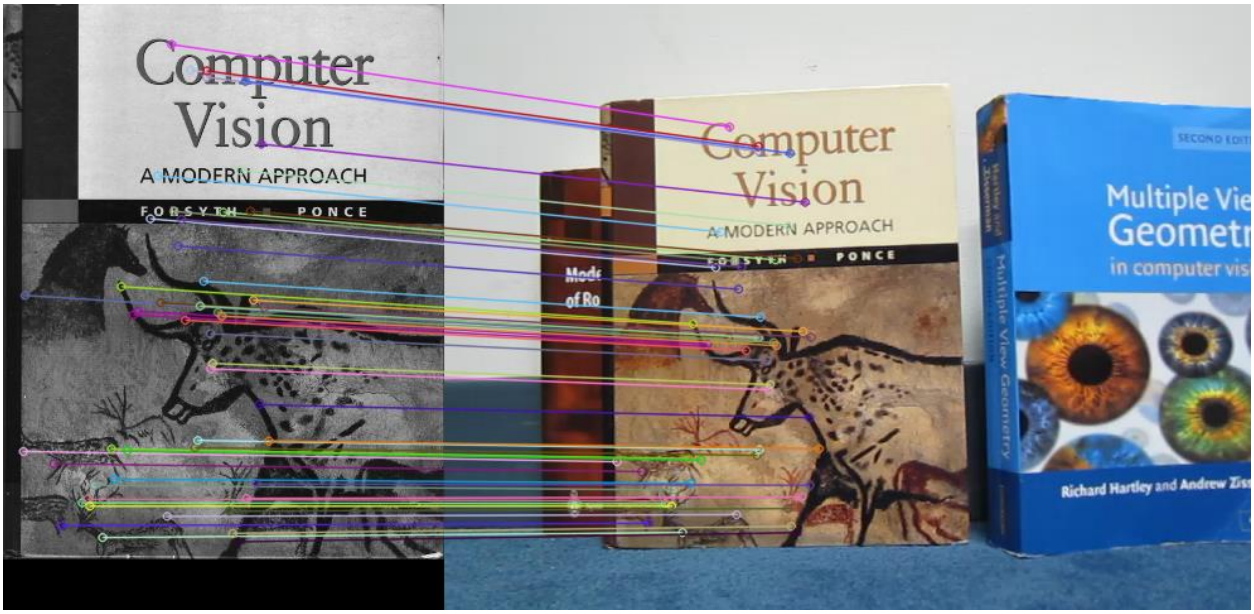
Part 1: Augmented Reality with Planar Homographies:

1.1 Getting Correspondences:

We used the SIFT descriptor to find the keypoints between the book cover photo and the first frame in video.

Then, we used the built in brute force matcher to get correspondences between the two photos and filtered these matches using knn with k = 2 taking a ratio of 0.7.



1.2 Compute the Homography Parameters:

We computed the 3*3 homography matrix that maps the 3D points (homogeneous coordinates) to 2D points in the video frame using SVD.

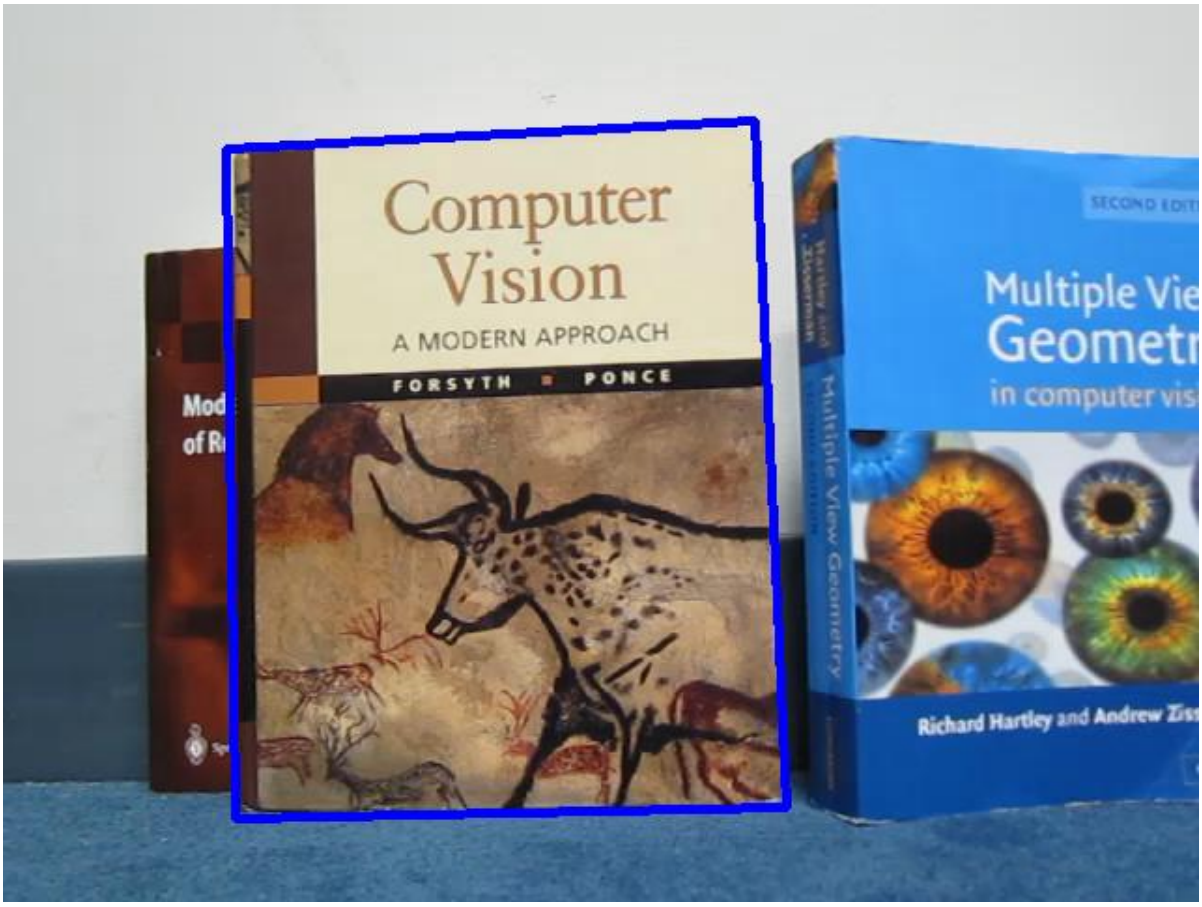
$$\mathbf{A}\boldsymbol{h} = \mathbf{0}$$

$$\begin{bmatrix} -x & -y & -1 & 0 & 0 & 0 & xx' & yx' & x' \\ 0 & 0 & 0 & -x & -y & -1 & xy' & yy' & y' \end{bmatrix}$$
$$\begin{bmatrix} -x & -y & -1 & 0 & 0 & 0 & xx' & yx' & x' \\ 0 & 0 & 0 & -x & -y & -1 & xy' & yy' & y' \end{bmatrix}$$
$$\vdots$$
$$\begin{bmatrix} -x & -y & -1 & 0 & 0 & 0 & xx' & yx' & x' \\ 0 & 0 & 0 & -x & -y & -1 & xy' & yy' & y' \end{bmatrix}$$

$$\begin{bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \\ h_5 \\ h_6 \\ h_7 \\ h_8 \\ h_9 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

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:

We cropped each frame such that only its central region is used in the final output. After Getting the four corners of the book, We calculated the dimensions needed to crop the frame.

Original Frame

After Crop

1.5 Overlay the First Frame of the Two Videos:

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

1.6 Creating AR Application:

We repeated the past step and overlayed each cropped video frame to its corresponding frame of the book video.
With the homography matrix, the book corners in each frames can be calculated and the movie frames can be overlayed.

https://drive.google.com/file/d/1YX_vVtbLuNer3sBFTt9lnnpAnbdeU5ql/view?usp=sharing

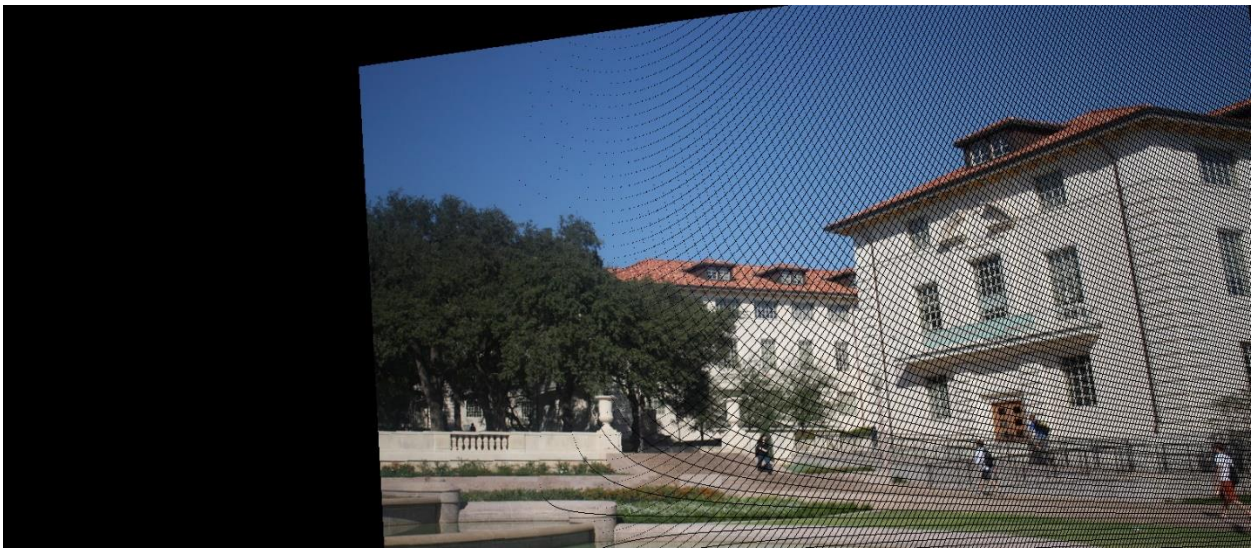
Part 2: Image Mosaics:

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:

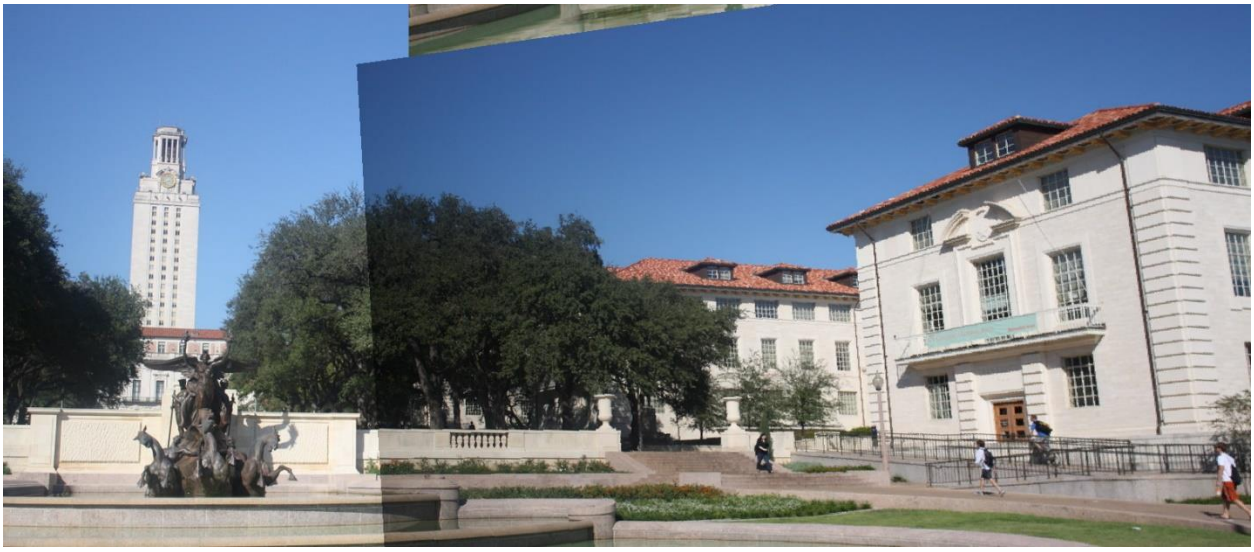
The new image is the warp of the input image using H . Since the transformed coordinates will typically be sub-pixel values, we solved this by rounding the resulting coordinates for each channel.



To avoid holes in the output, we used an inverse warp. This means waping 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).

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.



Alternative Way

3.Bonus: Stitching 3 images