

Computer Vision: Problem Set 3

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1 Short answer problems

see file1.pdf

2 Programming problem: image mosaics

When stitching two images a homography matrix has to be created warping one image to the image space of the other. To calculate this matrix reference points have to be known, that is points from one image that correspond to points in the other image. For the tower pictures such reference points are shown in Figure 1 and 2.



Figure 1: First image with eight reference points (red stars *).



Figure 2: Second image with eight reference points (red stars *).

2.1 Computing the homography parameters

After the homography matrix is computed it is tested by mapping the reference points from Figure 1 to Figure 2 as shown in Figure 3.

2.2 Warping between image planes

When the homography matrix is created and verified image one (Figure 1) is warped to the image plane of image two (Figure 2). The result is shown in Figure 4.

2.3 Tower Mosaic

The final step is to stitch both images together. The result is shown in Figure 5.

2.4 Custom Panorama

Another panorama picture created by image stitching is shown in Figure 6.

2.5 Region Warp

One can also project an image into another image by specifying the corners of the to be projected image as reference points and the corners of the region to project to as corresponding reference points in the image to project to. The results are shown in Figure 7. A better effect could have been achieved by taking the open door pictures (Figure 7(b) and 7(c)) from the same angle as the hallway picture 7(a).



Figure 3: Corresponding reference points from Figure 1 warped to Figure 2. Reference points from Figure 2 are shown as circles (o) and warped reference points from Figure 1 are shown as stars ($*$).

3 [OPTIONAL] Extra credit

3.1 RANSAC

not worked on

3.2 Auto-Alignment

not worked on

3.3 Rectification

Homography warping can also be used for rectification as shown in Figure 8.

3.4 HP-Video

not worked on

4 Notes

Sometimes stitching does not work. Figure 9 shows an example. Another effect would be the warped image to be only partially visible on the image plane. The homography matrix seems to be broken even though reference points always get warped to their corresponding point in the other image. In Figure 9 the warped image seems so be "turned inside out" mapping color information to



Figure 4: Image one (Figure 1) warped to image plane of image two (Figure 2).

the outer image instead of to its center. Choosing the reference points in a small area compared to the overall size of the image causes this effect. Other effects occur (e.g. the warped image might only be partially visible in the image plane instead of "turned inside out"). The relative small area used for reference points causes small errors to have large effects on the outcome of the image, but additionally big relative errors in reference points also seem to cause problems during homography matrix calculation. Otherwise "turn inside out"-effect is hardly explainable. A similar phenomenon can be observed when stitching more than three images together as in Section 2.4 which is probably due to the same cause, as the relative width of the section used for the reference points in the already stitched image gets smaller and smaller for each added image (no example included). *Note: In Figure 9 the exact same methods to create a stitched image are used as in the rest of the problem set! The only parameters that change are the reference points.*

5 Credits

1. **Deutsches Haus** for letting me survive so far,
2. **Usama** for modeling,
3. and **National Geographic**.



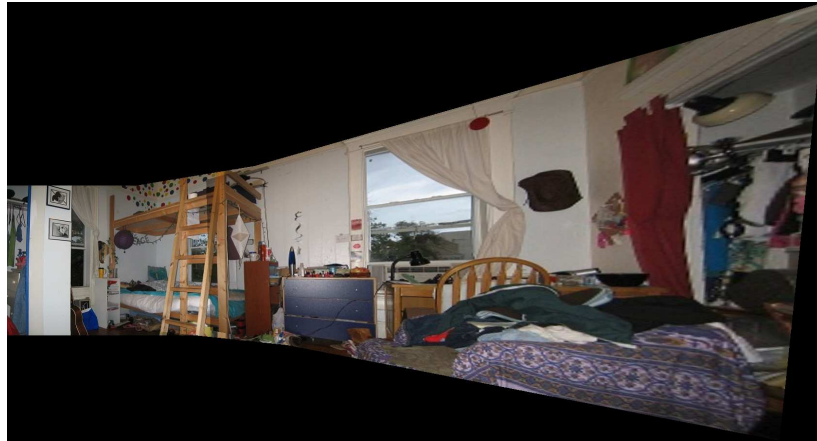
Figure 5: Warped image one (Figure 4) stitched to image two (Figure 2).



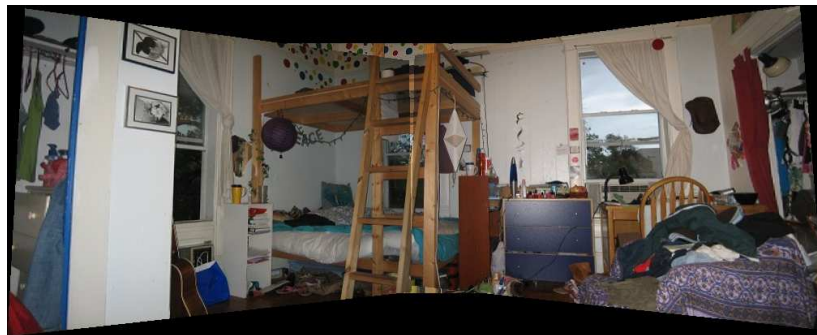
(a) Left

(b) Right

(c) Midle



(d) Left, middle and right stitched together.



(e) Left, middle and right stitched together.

Figure 6: Image 6(d) and 6(e) show 6(a), 6(b) and 6(c) stitched together.



(a) Doors.



(b) Open door one.



(c) Open door two.



(d) Open doors warped to doors.

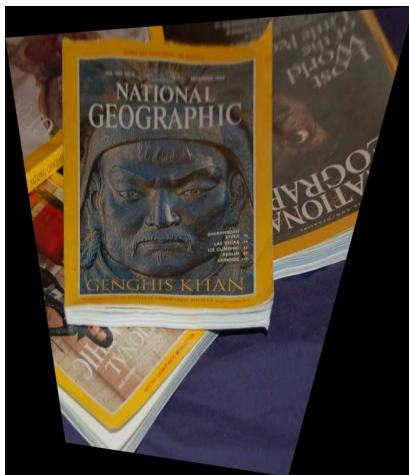


(e) Another example of the open doors warped to the doors.

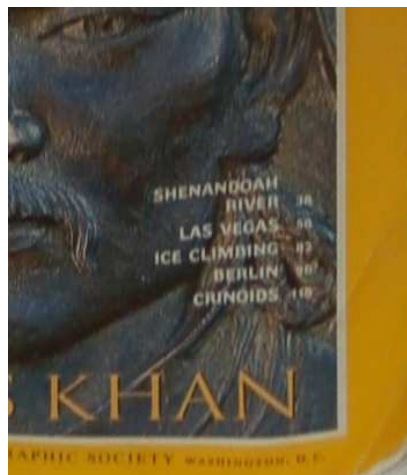
Figure 7: Image 7(d) and 7(e) show 7(b) and 7(c) warped into 7(a).



(a) Original.



(b) Rectified image.



(c) Magnification of the rectified image.

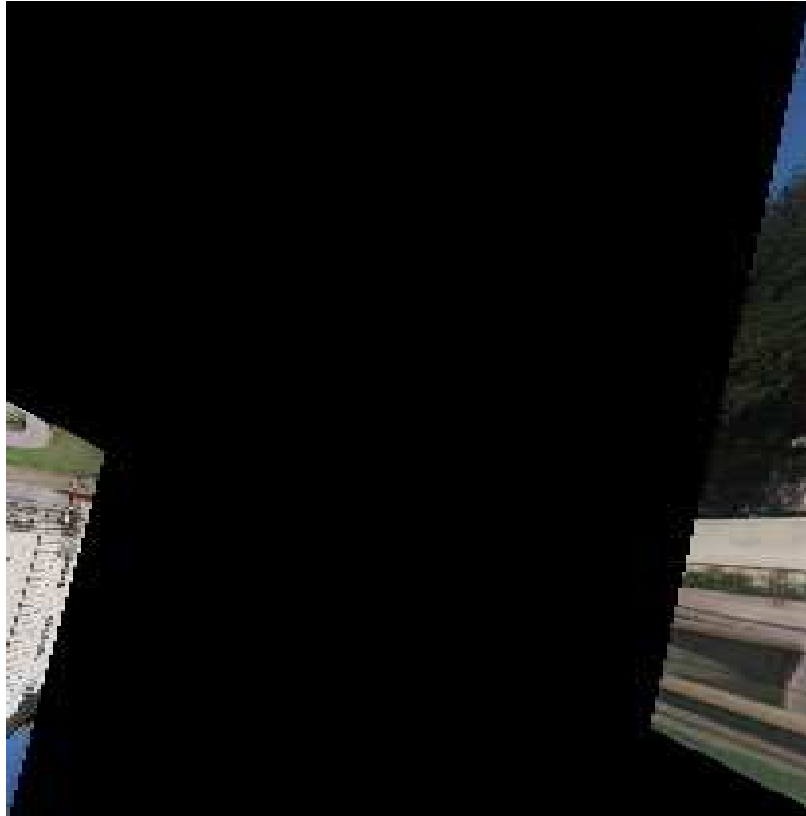
Figure 8: The images in this figure show the rectification process done by homography warping.



(a) Left.



(b) Right.



(c) Broken warp of Figure 9(b) to Figure 9(a).

Figure 9: The images in this figure show reference points and a corresponding warp so that the warp is broken.