İTÜ

BLG634E 3D Vision

Guideline for submitting your homework: In submitting your homework:

i. Comment your codes clearly.
ii. All your code should be written in Python language.
iii. Do not send your HWs via e-mail. No exception!

In this assignment, you will work with Projective Transformations / Homographies that map image planes to planes. By this assignment: you can insert planar objects into other images (this would be called the most basic augmented reality); you can stitch several images together to create a panoramic image.

Task 1:

The first time I've listened Myslovitz's self-titled album, every song in it stuck in my head for at least a week. I was just like the cat in this video. In the first task of the homework, you will create a video for your favourite album. A frame of the target video is given in Figure 1.

Figure 1: The cat is wishing to get rid of the album, but it is impossible.

- Create an 572x322 pixels sized empty image.
- For every frame of the video I extracted the corner points of each plane. Use your favourite album cover to change the video. For each plane's correspondences, create transform matrices (**Do not use OpenCV's built-in functions. Find coefficients using $q = M^{-1}A$.**)
- Warp the album covers using matrix multiplication and place onto empty image.
- Complete the video by adding the cat. Decide which planes are behind or front of the cat considering areas of the planes.

- While my augmented image looks pretty good, there may be a pixelation effect on the edges of the album cover, making the image look somewhat synthetically generated. How might this be improved? Explain in few sentences.

Task 2:

In this task, you will implement and experiment with estimation of a Homography matrix between images of a given scene (planar scene) from different views. You will use the Normalized Direct Linear Transform with SVD we studied in the class to estimate the 3x3 Homography matrix H. You will then use the estimated transformation to form a panoramic image, i.e. a combination of the three images by simple stitching.

In this task, you will select the corresponding points from the images manually, i.e. by clicking on the point with a mouse.

First, work on this assignment by using two images. Then add the third image.

2.1. Load the pier images given in Figure 2. Try to choose rich interest points such as corners that are visible in both images. What is the minimum number of corresponding feature points to be selected from the images? Due to noise in measurements, you should try to choose more than 4, e.g. I chose 6 or 7 points.

Figure 2: Three different scenes from the pier.

2.2. Using the set of feature point coordinates from the images, write a functiton **homography2D** to estimate the Homography matrix H using the normalized direct linear transform that employs SVD for solution of the homogeneous linear system we learned in class. You should normalize each set of points separately, which makes the origin at the centroid of all the points, and mean distance from the origin is set to sqrt(2). You should write another **normalise2Ddpts** function. Then write a routine to transfer coordinate points in one image to another using the estimated homography matrix.

Note: You can find the bounding box of the panoramic image onto which you can overlay both of the images. Use the corners of the input image to transform the

image bounding box to the output domain and find the coordinates of the big bounding box (panoramic coordinates) that includes both image domains. Transfer these coordinates to the input image domain to resample your input image. Then place your output image over the panoramic image domain.
Print/display your result.

Image Blending: Rather than copying the second image over the first one as you did before, try simple image blending ideas, such as taking convex combinations of images etc.

How does the result differ from that of simple copying?
Print/display your result. An expected result is given in Figure 3.

Figure 3: An expected output.

Task 3:

In order to create a panoramic image, typically more than 2 images are used. In this task, you will stitch 3 images to create a panorama. To do that, estimate the homography matrices by taking the center image as your reference and estimate the homographies from the other two images towards the center image. Then repeat what you did in Task 2. Show your final panorama image constructed using 3 images.

Task 4:

In this task, you will use a feature extraction and matching technique based on a technique such as SIFT to automatically extract a set of corresponding point coordinates from the given images. You can use a built-in function or already available routine from another library to do this task. Using the extracted feature point sets, estimate the Homography matrix as in Task 2.2.

If you're not satisfied with both of the results, what are possible reasons?

Next, use RANSAC method we learned in class to eliminate outlier point correspondences. Play and experiment with different parameters of RANSAC, particularly the support distance t. Then obtain the Homography matrix with a good inlier point correspondence set. Now, stitch the images together automatically. Show your results.

Compare your panaroma result to the one in Task 2 and 3. Did your result improve? Comment why or why not.

In addition to the given Pier images, use selected Hagia Sofia images from CVPR Image Matching Challenge[1] given in Figure 4. How are the results compared to the previous ones? Could you improve the results using some preprocessing?

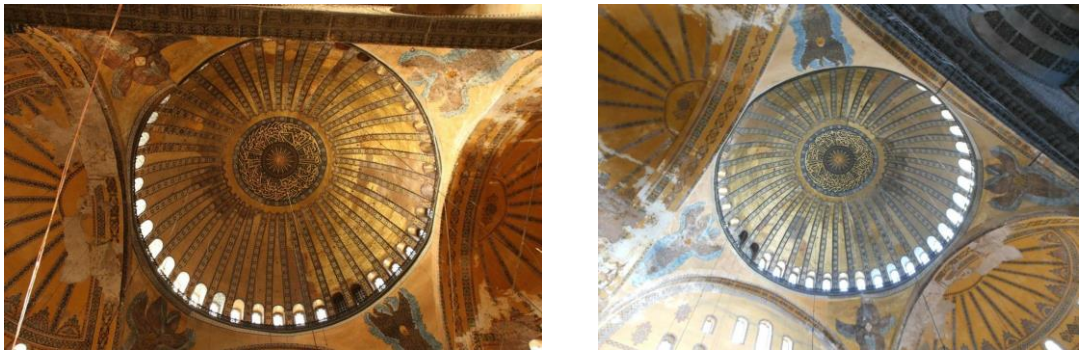

Figure 4: Dome images from Hagia Sofia

[1] https://image-matching-workshop.github.io/