Computer Vision Programming Assignment 1

Aysegul Bumin

UFID 35205078

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Question 1

The goal of this question is to remove planar distortion from the given images. In order to remove planar distortion, a linear algorithm called DLT is used. The important task is to find the homography between the points in the image plane and the world points.

In the code submitted you will need to give 4 points that are non-collinear points, and these points need to be given in clock-wise or anti-clock wise order, then the homography is calculated and the planar distortion removed form is shown. The given proportions are used to generate the figures in the report. One can change the parameters height and width and scale to try with different settings. The results presented the scale to be 4 while protecting the proportions.

In Figure 1, you can find the original picture given in the assignment. And respectively Figure 2 and Figure 3 represents the planar distortion removed parts of the selected locations.

In Figure 4, you can find the original picture given in the assignment. Figure 5 you can find the planar distortion removed version of the three frames together. Moreover in the Figure 6, Figure 7, and Figure 8 you will see the planar distortion removed version of the frames from left to right respectively.

Figure 1: Original door01.jpg

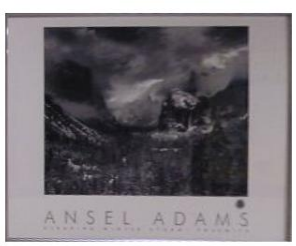

Figure 2: Distortion Removed Frame (door01.jpg)

Figure 3: Distortion Removed Door Window (door 01.jpg)

Figure 4: Original adams01.jpg

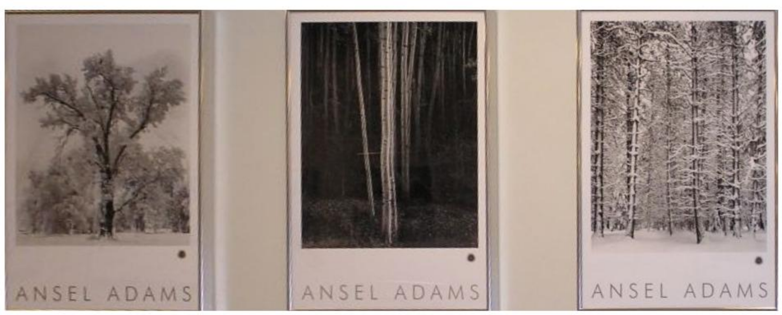

Figure 5: Three Frames (adams01.jpg)

Figure 6: Distortion Removed Frame 1 (adams01.jpg)

Figure 7: Distortion Removed Frame 2 (adams01.jpg)

Figure 8: Distortion Removed Frame 3 (adams01.jpg)

Question 2

In the second question,certain properties about a software camera is given. We are given two main tasks, one is to find the camera center in terms of world coordinate system assuming that the camera is a finite projective camera. Second task is to reproject an image of our choice through the camera defined. The focal length is later on given to be 120. Using the hint given, the camera projection matrix P is a (3,4) matrix with the given coordinates.

The steps that I followed to solve the both of the problems is as follows,

- Define the camera projection matrix P, using the coordinates given.(The columns are respectively $(5, 100, 1)^T$, $(400, 300, 1)^T$, $(500, 490, 1)^T$, $(20, 20, 5)^T$).
- Null space of matrix P will give the camera center according to the discussion we had in the class, and further reference can be found in the link.[1]. In other words C is the right singular vector corresponding to the smallest singular value. So calculating the null space of P, find the camera center, and normalize it.
- Camera center is [-4.14532243415078, -4.28065395095368, 3.42597638510445, 1] in homogeneous coordinates. (The last index 1 will be omitted for the non homogeneous coordinate representation. [-4.15, -4.28, 3.43])
- Calculate the upper left matrix (U) of size (3x3) from P.
- Calculate the QR decomposition of the upper left matrix (U) in order to find the decomposition matrices. (The aim is to get the upper triangular matrix.)

[1] https://www.uio.no/studier/emner/matnat/its/nedlagte-emner/UNIK4690/v17/forelesninger/lecture_5_2_pose_from_known_3d_points.pdf

- Use the upper triangular matrix to calculate the the reprojected image. (Make sure to use the absolute value of the upper triangular matrix, otherwise the image ends up being shifted and out of the borders.)
- Apply interpolation to the reprojected image since due to the size difference there might be holes in the reprojected image (for this particular example the artifact was horizontal lines.)

In the resultant image I plotted the origin of the sensor plane in blue and the intersection of principle axis and sensor plane in red.(Could not find color orange([0.8500, 0.3250, 0.0980]) in matlab). You can see the original picture in Figure 9 and the reprojected picture with the blue and red dot representing the sensor plane and the intersection of principle axis with the sensor plane respectively.

Figure 9: Original old picture

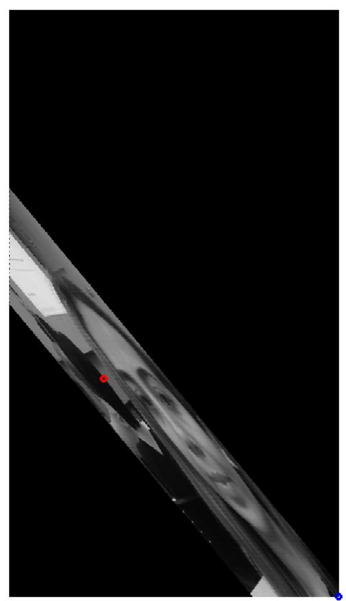

Figure 10: Reprojected old picture

Question 3

The aim of this particular question was to get familiar with Fourier Series and understand the importance of having both magnitude and the phase features at the same time. The experiments involve taking a picture of myself and reconstructing this particular image using Magnitude only and Phase only. The results related to reconstruction of my image is in Figure 11. I repeated the same with my close friend's picture and the results are as in Figure 12. In order to get these particular results I had to scale up especially for the magnitude only case it required further processing to get the image I have for both my and my friend's picture. Looking at the phase only reconstruction carefully, the silhouette type of features are visible. So it is much more successful compared to the magnitude only reconstruction. However we can as well say that the original picture itself also plays an important role. In my case, my picture have a relatively less complicated background than my friend's picture so my phase only reconstruction is much better than hers.

Looking at both my and my friend's picture's reconstruction results we can easily say that the phase component of the Fourier Transforms has decent amount of information in it, where as we cannot easily say for the magnitude case.

Magnitude reconstruction for both picture A and B look highly similar and they are not informative on their own. If we look at the magnitude component in depth we can observe that the middle section is shining more than the other parts which gives certain amount of information about the image but certainly not enough to distinguish between the pictures.

However there is a reason why we had the second part of the experiment where we reconstructed this time by using the composition of magnitude only and phase only. And the results are clearly much more better than using only one component magnitude or phase. Hence just by looking at the results we can easily conclude that the lack of either component result in problems in reconstructing the image. Magnitude only reconstruction does not contain so much specific information of the picture it belongs to on its own, however combined with the phase it gives relatively good reconstruction results. My friend's composite reconstruction is much more blurry than mine. I assume that is due to the more complicated background and not having the the phase features as distinctive as my phase features.

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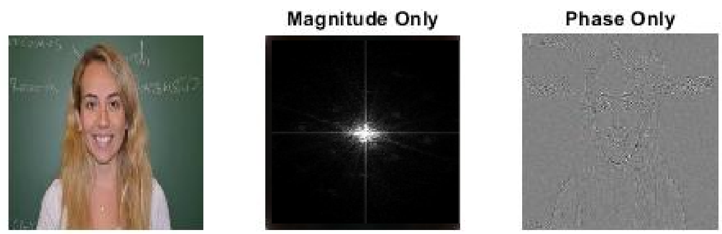

Figure 11: Picture A, Magnitude Only, Phase Only

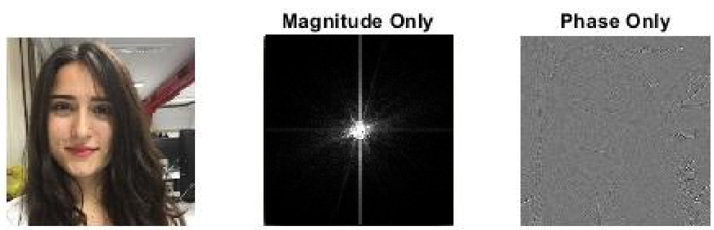

Figure 12: Picture B, Magnitude Only, Phase Only

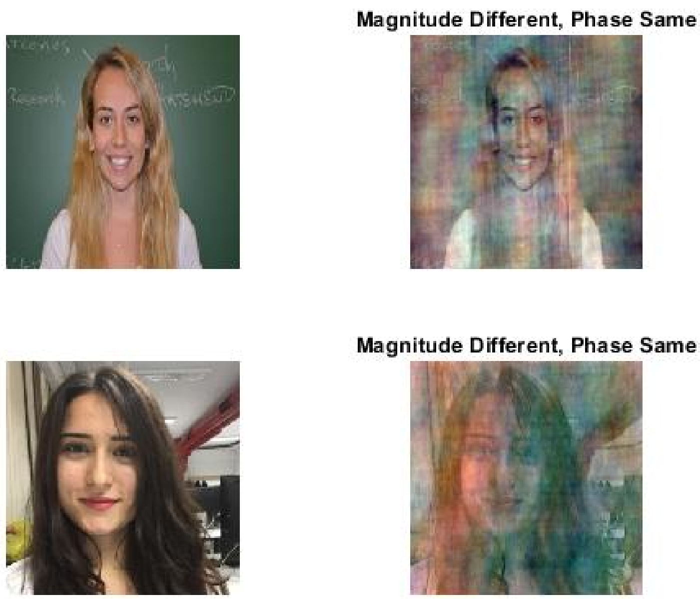

Figure 13: Picture A, Picture B, Reconstructed