<u>CSE 344: Assignment 4</u>

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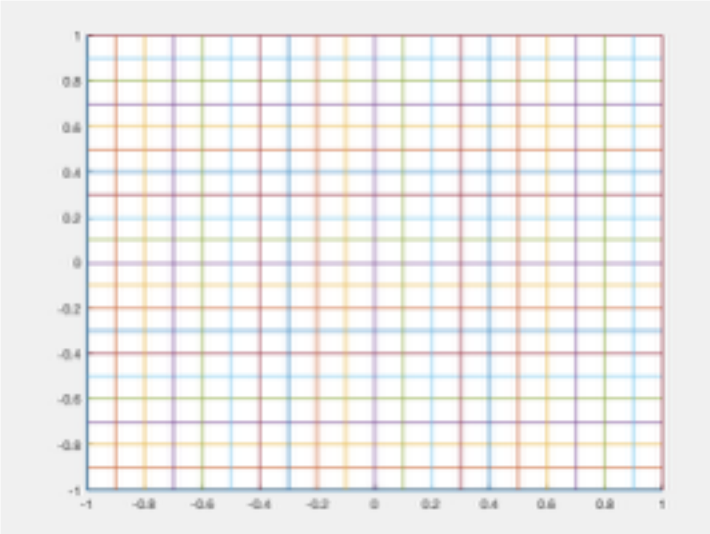
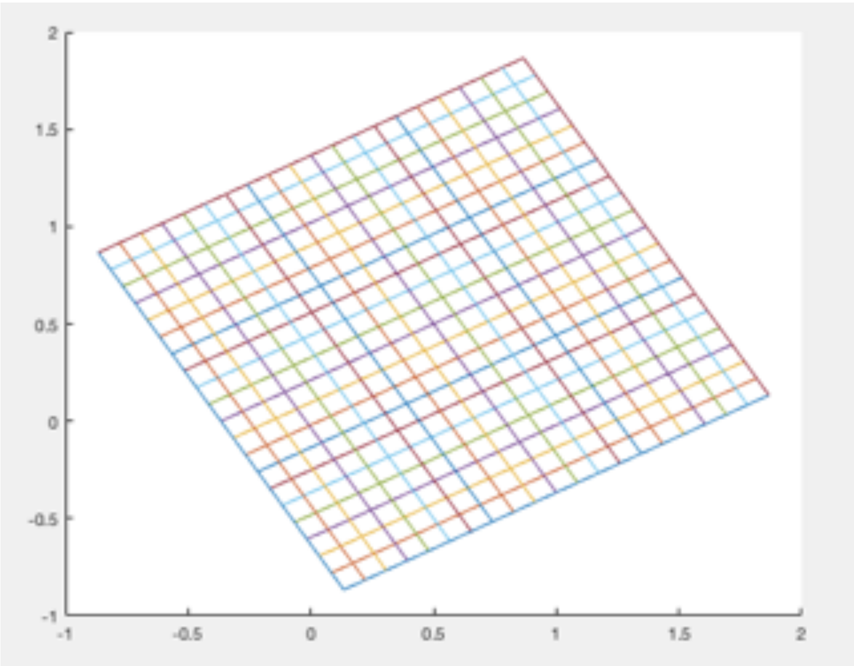
Q1. The plot for the original lines are shown below:



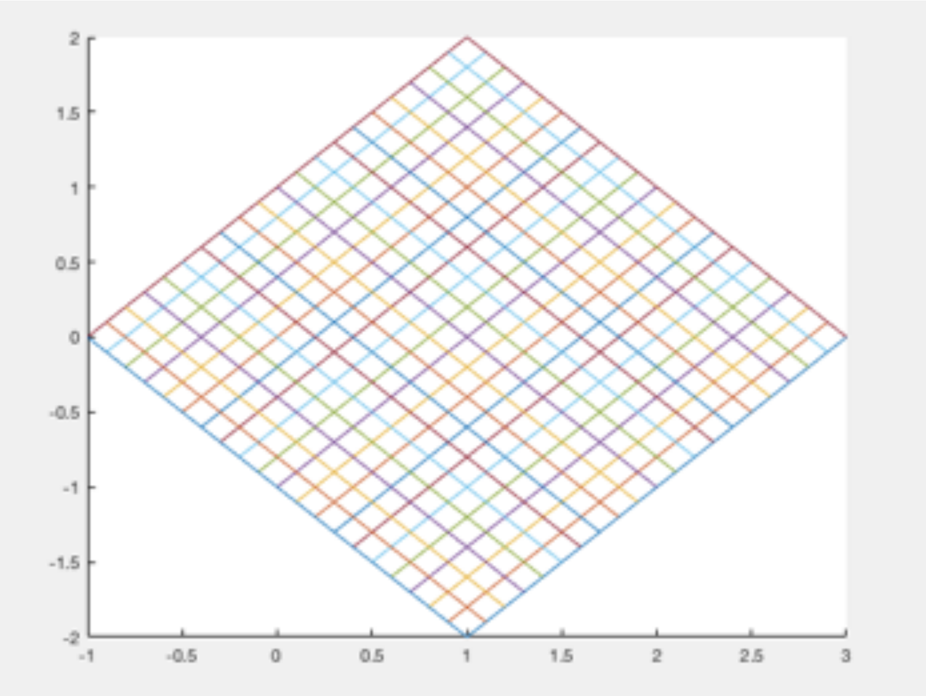
Warped lines for H1, H2, H3 and H4 respectively:

1)



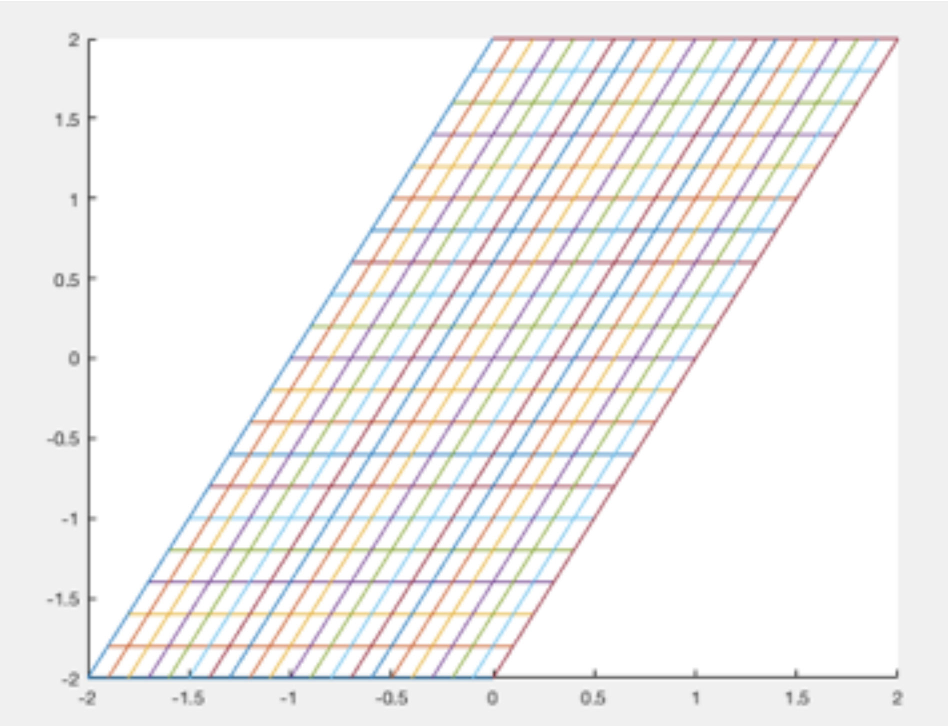
This is a euclidean transform as can be seen from the warp as well as the transform matrix. When scaled by 0.5, the matrix is of form [[R t], [0 1]]. The lines in the image is just rotated and translated. Lengths, parallelism and angles are preserved.

2)



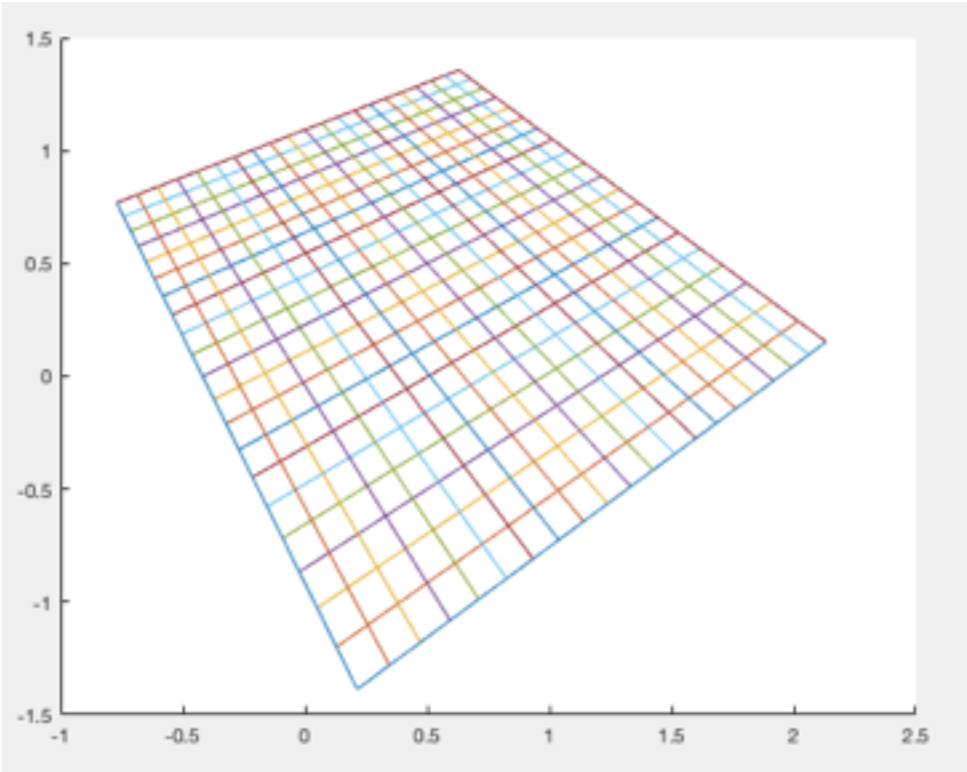
This is a similarity transform: the matrix is of form [[sR t], [0 1]]. The lines are rotated, translated and scaled. Ratio of lengths, parallelism and angles are preserved.

3)



This is an affine transform: the matrix is of form [[sR t], [0 1]]. Parallelism of lines is preserved through the warp. Lengths and angles are not preserved.

4)



This is a projective transform, with 8 d.o.f. Neither of parallelism, lengths and angles are preserved.

Transformed end points for each case are attached as a Matlab mat file.

Q2.

a) To remove projective distortion, we map the vanishing line to its canonical position [0 0 1]. We can recover the affine properties from images by a transformation matrix H that performs this mapping.
If the vanishing line is at [l1 l2 l3], H will be:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ l1 & l2 & l3 \end{bmatrix}$$

The vanishing line can be found by joining 2 vanishing points. These 2 vanishing points are found by 2 pairs of parallel lines.
So, we select 2 such pairs of parallel lines and solve for the vanishing line and H. This warp is applied to the image to get an affine rectified image.

b) Affine rectified images for the given data is shown below:

The horizontal and vertical lines on the floor are parallel to each other in the rectified image.

The yellow stripes on the wall and the opening walls of the lift are parallel to each other in rectified image.

c) For metric rectification, we want the length ratios and angles to be preserved. For this, we map the 'dual conic' to its canonical position.
Suppose we have a pair of physically orthogonal lines, l and m. Let l′, m′ be the transformed lines under an affine transformation H. So,
(l1/l3, l2/l3) . (m1/m3, m2/m3 = 0
then,
l1m1 + l2m2 = l . Cm = 0 ,
where C = [[1 0 0], [0 1 0], [0 0 0]] is the dual degenerate conic.

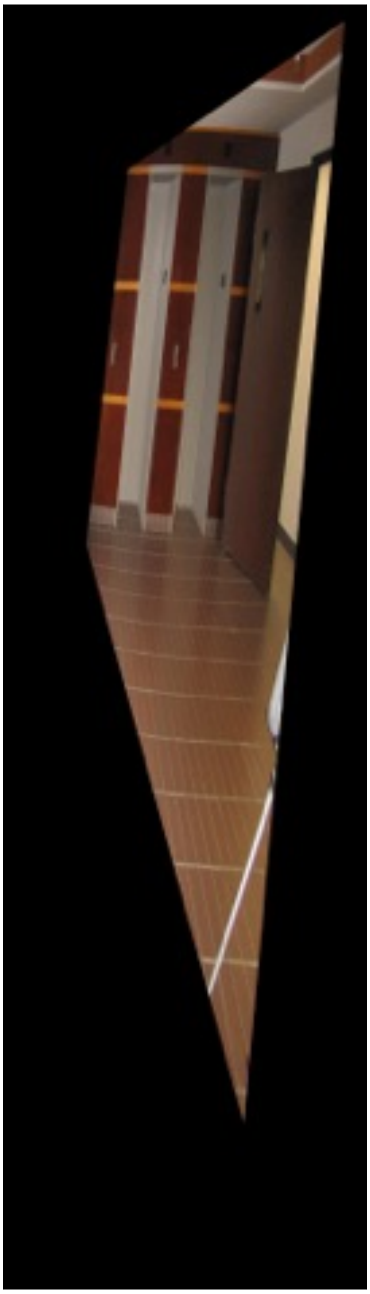
C′ = HCH' is the conic in the warped image.

The above two equations when expanded, gives us an equation in two variables s1 and s2, which helps us recover the relevant part,A, of the affine transform H = [[A t], [0 1]].

The inverse of this transform can be applied to the image to get the rectified image.

Thus, we need to select two pairs of orthogonal lines in the image to solve for A and hence H, and finally apply H inverse to image.

d) Metric rectification applied to affine rectified images from previous part:



Q3. The estimated tomography was:

H =	1.2768	-0.0790	-562.522
	0.1657	1.1899	-161.141
	0.000266	-3.247e-06	1

The top 500 matches as found by VLfeat SIFT are plotted below:

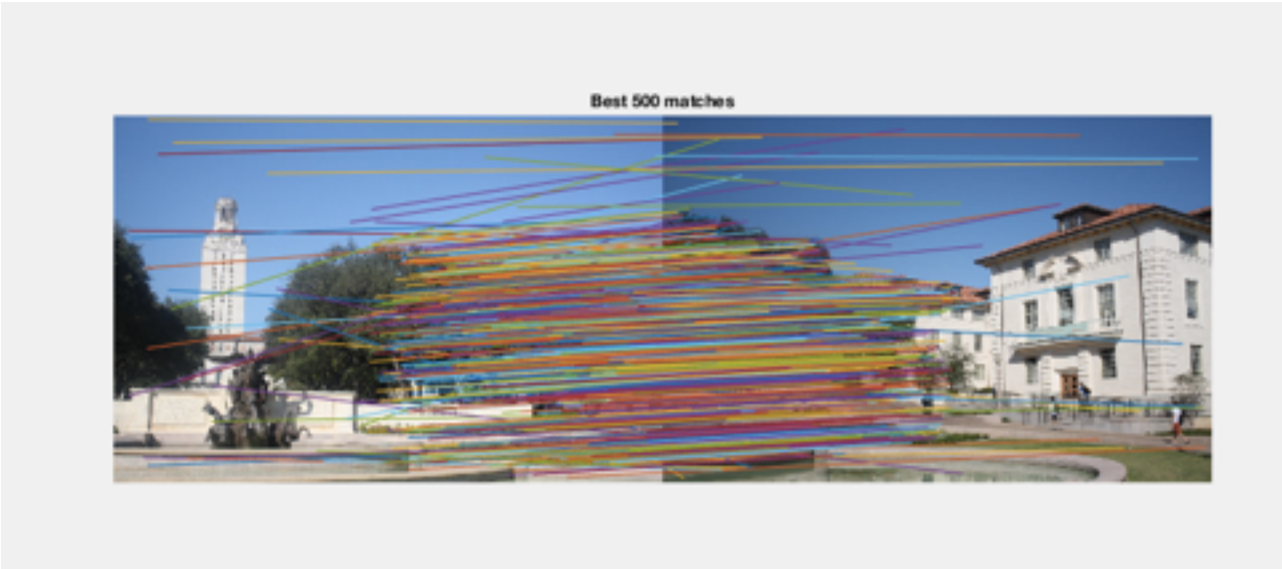


Image 1 warped, and image 2 inverse warped are shown below:

Overlapped on each other, we get a continuous view as follows:

Original images are: