Computer Vision Programming Assignment

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1 Geometric Transformation

Rotation Matrix R for angle θ is given by

$$R = \begin{vmatrix} cos(\theta) & sin(\theta) \\ -sin(\theta) & cos(\theta) \end{vmatrix}$$

This Matrix can rewritten as a combination of three matrices

$$R = \begin{vmatrix} 1 & -tan(\theta/2) \\ 0 & 1 \end{vmatrix} \begin{vmatrix} 1 & 0 \\ sin(\theta) & 1 \end{vmatrix} \begin{vmatrix} 1 & -tan(\theta/2) \\ 0 & 1 \end{vmatrix}$$

Therefore, Rotation can be obtained by applying an X-shear with parameter as $\lambda = -tan(\theta/2)$ followed by a Y-shear with parameter as $\lambda = sin(\theta)$ and again an X-shear with parameter as $\lambda = -tan(\theta/2)$. Doing a rotation with combination of shears gives computational advantage over rotating with original matrix R. In the sense that computation for rotating using original matrix R takes 4MN multiplications where as combination of shear takes MN multiplications each and 3MN in total, where (M,N) is size of the Image.

2 Vanishing Lines and length Ratios

For finding the ratio of heights I took an image of a chess board with chess pieces placed on it as shown in figure 5. For finding the correctness i have chosen the vertical objects as the King pieces, which should result in Ratio 1.Using the Get2DPoints function and following the algorithm given, the resulting ratio is also shown in the figure 5

3 Planar Projective Distortion

For Finding image with no distortion from the image with distortion, the Matrix H in DLT was used

$$A = \begin{vmatrix} X^T & 1 & 0 & 0 & 0 & -Y(1)X^T \\ 0 & 0 & 0 & X^T & 1 & -Y(2)X^T) \end{vmatrix}$$

$$AH = Y$$

where X is inhomogeneous coordinate of point in the world and Y is inhomogeneous coordinate of the corresponding point on the distorted image. We can get H matrix with 4 point correspondences. Once we get H matrix we can apply H^{-1} on the distorted image to obtain the image with no distortion. The results are show in figure 6. Since this is an inverse problem, a complete recovery is not obtained.

4 Phase Reconstruction

Let I be an image and F be the Fourier transform of the image. I is an array consisting of real numbers and F is a array consisting of complex numbers. F = $Re^{i\theta}$, where R is the magnitude and θ is the phase. Reconstruction only using magnitude R gives Magnitude only image. Similarly, reconstruction only using $e^{i\theta}$ give the phase only image. Let E some Noise and define functions F_1, F_2 such that F_1 = $(R + E)e^{i\theta}$ and F_2 = $Re^{i(\theta+E)}$. Now reconstruction from F_1 gives an image with error in magnitude and reconstruction from F_2 gives an image with error in phase. All the results are shown in figure 7. Image formed by reconstruction with F_1 is has more perceptual clarity than the image formed by reconstruction with F_2. The reason for this could be that most of the image information is stored in phase rather than magnitude. This is more evident when we observe the images for phase of phase only and magnitude only, from phase of phase only image the original image can be imagined but not possible with the magnitude only image.

5 Matlab Results

Figure 1: Input used for Rotation

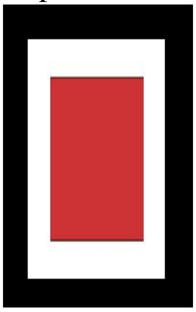

Figure 2: Output using Rotation Matrix R, Left-$\pi/6$ Right-$\pi/3$

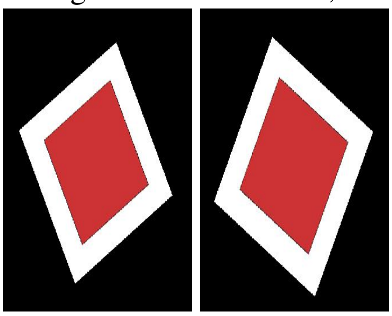

Figure 3: Output showing Rotation using shears, figure shows the result after each step for angle $\pi/6$

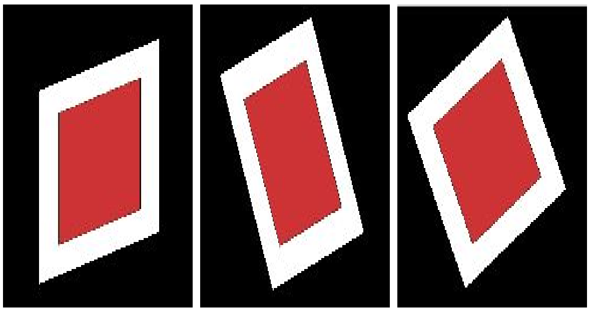

Figure 4: Output showing Rotation using shears, figure shows the result after each step for angle $\pi/3$

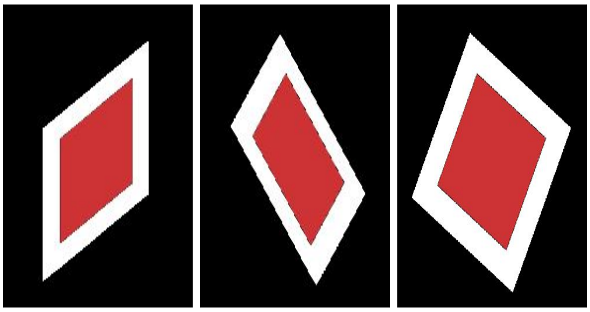

Figure 5: Input used for finding the ratio of lengths on the left and the output ratio on the right, the ratio of heights of two king pieces is considered.


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Ratio =

    0.9944
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Figure 6: Input of distorted Image on the left and output of image with no distortion on right

Figure 7: Below images shown for Magnitude only, Phase of Phase only, Error in Magnitude and Error in Phase in the same order