Image Signal Processing: LAB 2

Occlusion Detection

1 Introduction

Two Images are given namely IMG1.png and IMG2.png Here we are supposed to compute first the Homography matrix H then apply the inverse of H to IMG2.png to carry out the Target to Source mapping and finally apply bilinear interpolation for mapping.

2 Theory:

The homogeneous matrix H is:

$$\begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \tag{1}$$

However its mentioned that only in-plane rotation and translation is applied, so the matrix looks like the one shown below,

$$\begin{bmatrix} k\cos\theta & k\sin\theta & t_x \\ -k\sin\theta & k\cos\theta & t_y \\ 0 & 0 & e \end{bmatrix} \tag{2}$$

Thus the matrix has a similar structure to the one below,

$$\begin{bmatrix} a & b & c \\ -b & a & d \\ 0 & 0 & e \end{bmatrix} \tag{3}$$

Now we are given 2 corresponding points ,(29,124) and (93,248), (157,372) and (328,399) and using these I build 4 equation.

$$\frac{29a + 124b + c}{e} = 93 \tag{4}$$

$$\frac{-29b + 124a + d}{e} = 248 \tag{5}$$

$$\frac{157a + 372b + c}{e} = 328 \tag{6}$$

$$\frac{-157b + 372a + d}{e} = 399 \tag{7}$$

These equations when re-arranged will give a matrix named A such that

Ah=0.Now it might be the situation that the nullspace of A is empty, i.e there is no solution to Ah=0. Thus, we try to minimize $||Ah||^2$ such that $||h||^2 = 1$.This is called **constrained least square**,

$$\min ||Ah||^2 = \min((Ah)^T(Ah)) = \min(h^T A^T Ah) \tag{8}$$

such that $h^T h = 1$.
A loss function can be defined such that

$$L(h, \lambda) = h^T A^T Ah - \lambda(h^T h - 1) \tag{9}$$

Taking the derivative,

$$2A^T Ah - 2\lambda h = 0 \tag{10}$$

$$A^T Ah = \lambda h \tag{11}$$

Equation 11 shows that h is the eigenvector of $A^T A$ and the we take the eigenvector corresponding to the smallest eigenvalue, rearrange the h(in this case 3×3) that finally gives the H matrix.

After that the H is applied onto IMG2.png and bilinear interpolation is applied to do the target to source mapping.And in order to see the changes I took the difference of the images and normalized it, but changes were not that properly visible. So I took a binary mask and mapped it onto the image that shows the two planes that were not there before, in IMG1.png.