REMOVING PROJECTIVE DISTORTION FROM IMAGES

HOMOGRAPHY

The homography (H) can be calculated using point to point correspondence. The calculated homography can be use to remove the projective distortion.

Let,

$$X_i = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

$$X_w = \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

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

The mapping between an image plane and a world plane is $X_i = HX_w$ where X_i is the coordinates in the image plane and X_w is the coordinates in the world plane. It can also be noted that $h_{33} = 1$. Thus,

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$x_i' = x_i h_{11} + y_i h_{12} + h_{13} - x_i' x_i h_{31} - x_i' y_i h_{32}$$

$$y_i' = x_i h_{21} + y_i h_{22} + h_{23} - y_i' x_i h_{31} - y_i' y_i h_{32}$$

The matrix form of the above equation is

$$\begin{bmatrix} x_1 & y_1 & 1 & 0 & 0 & 0 & -x_1'x_1 & -x_1'y_1 \\ 0 & 0 & 0 & x_1 & y_1 & 1 & -y_1'x_1 & -y_1'y_1 \\ & \vdots & & & \vdots & & \vdots & \\ x_n & y_n & 1 & 0 & 0 & 0 & -x_n'x_n & -x_n'y_n \\ 0 & 0 & 0 & x_n & y_n & 1 & -y_n'x_n & -y_n'y_n \end{bmatrix}_{2nx8} \times \begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \end{bmatrix}_{8x1} = \begin{bmatrix} x_1' \\ y_1' \\ \vdots \\ x_n' \\ y_n' \end{bmatrix}_{2nx1}$$

Note: n is the number of pairs of corresponding points

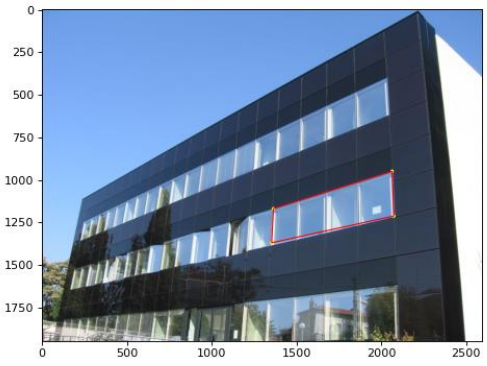
Let A be the 2nx8 matrix, B be the 2nx1 matrix and h be the 8x1 matrix. Thus, the matrix equation above can be denoted as $Ah = B$. Using the least square estimate, we can get the value of h.

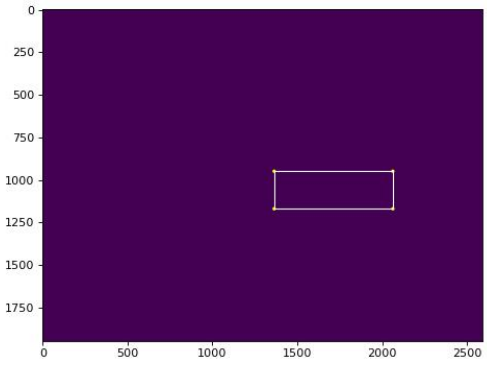
$$h = (A^T A)^{-1} A^T B$$

After calculating the homography, we can perform the mapping from the image plane to world plane.

RESULTS:

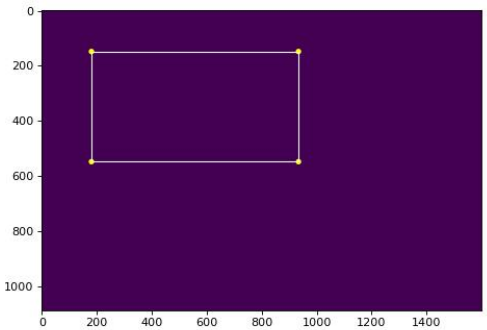
Original Image





Output Image(Projective Removed)

Original Image



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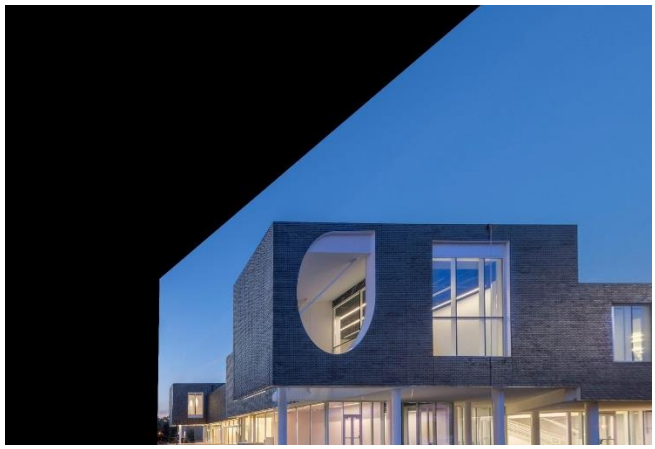
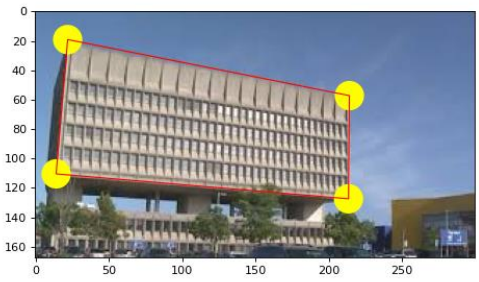
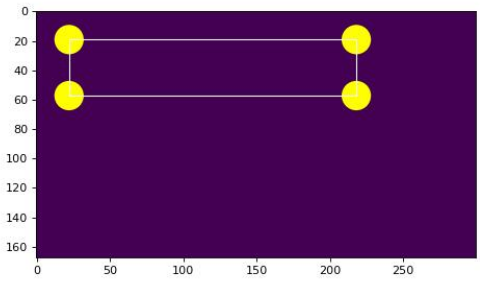


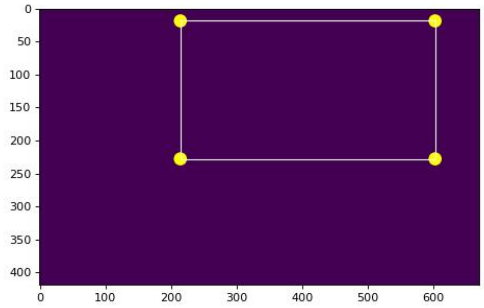
Original Image





Output Image(Projective Removed)

Original Image



Output Image (Projective Removed)

REFERENCES:

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V. Ravi, “ECE 661 Computer Vision Homework 3.” [Online] Available: https://engineering.purdue.edu/RVL/ECE661_2018/Homeworks/HW3/2BestSolutions/2.pdf