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EE298 HW1

1. How to use:

run:
>> $ python arriesgado_HW1_EE298.py <your_image.jpg>

The output will be saved in a file named "output.jpg" located in the same directory as the python script

2. Brief notes on the solution

The projective distoriton is of the form $\hat{b}=Hb$, where H is the transformation matrix. This can be rewritten as,

$\begin{bmatrix}\tilde{x}\\ \tilde{y}\\ \tilde{z}\end{bmatrix}=\begin{bmatrix}p_{11}\,p_{12}\,p_{13}\\ p_{21}\,p_{22}\,p_{23}\\ p_{31}\,p_{32}\,p_{33}\end{bmatrix}\begin{bmatrix}x\\ y\\ z\end{bmatrix}$ where $\begin{bmatrix}\tilde{x}\\ \tilde{y}\\ \tilde{z}\end{bmatrix}$ and $\begin{bmatrix}x\\ y\\ z\end{bmatrix}$ are the homogenous coordinates of $\begin{bmatrix}\hat{x}\\ \hat{y}\end{bmatrix}$ and $\begin{bmatrix}x\\ y\end{bmatrix}$ respectively.

$$\tilde{x}=p_{11}x+p_{12}y+p_{13}z$$
$$\tilde{y}=p_{21}x+p_{22}y+p_{23}z$$
$$\tilde{z}=p_{31}x+p_{32}y+p_{33}z$$

But since, $\hat{x}=\frac{\tilde{x}}{\tilde{z}}$ and $\hat{y}=\frac{\tilde{y}}{\tilde{z}}$

$$\hat{x}=\frac{p_{11}x+p_{12}y+p_{13}z}{p_{31}x+p_{32}y+p_{33}z} \quad \text{and} \quad \hat{y}=\frac{p_{21}x+p_{22}y+p_{23}z}{p_{31}x+p_{32}y+p_{33}z}$$

Rearranging we have,

$$p_{11}x+p_{12}y+p_{13}z-p_{31}x\hat{x}-p_{32}y\hat{x}-p_{33}z\hat{x}=0$$
$$p_{21}x+p_{22}y+p_{23}z-p_{31}x\hat{y}-p_{32}y\hat{y}-p_{33}z\hat{y}=0$$

for each pair of point $(\hat{x^{(i)}},\hat{y^{(i)}})\wedge(x^{(i)},y^{(i)})$.

With z = 1, this can be written as a 8x9 matrix ,

$$\begin{bmatrix} x^{(1)} & y^{(1)} & 1 & 0 & 0 & 0 & -x^{(1)}\hat{x^{(1)}} & -y^{(1)}\hat{x^{(1)}} & -\hat{x^{(1)}} \\ 0 & 0 & 0 & x^{(1)} & y^{(1)} & 1 & -x^{(1)}\hat{y^{(1)}} & -y^{(1)}\hat{y^{(1)}} & -\hat{y^{(1)}} \\ & & & & & & . & & \\ & & & & & & . & & \\ & & & & & & . & & \end{bmatrix}\begin{bmatrix}p_{11}\\ p_{12}\\ p_{13}\\ .\\ .\\ .\\ p_{33}\end{bmatrix} = 0$$

This is a homogenous system of equations Ax = 0.

The elements of A are known. To determine the values of x, singular value decomposition can be used, i.e. determine the basis of the nullspace of A.

The elements of vector x will be the elements of the tranformation matrix H.

3. Sample transformations

Below are some of the sample transformations using this program.