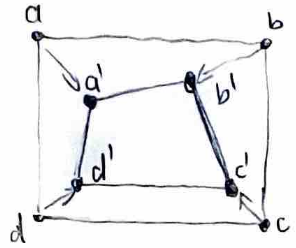

$$\underline{\underline{A}} \cdot \underline{p} = \underline{p}'$$

$$\begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} \tilde{x}' \\ \tilde{y}' \\ \tilde{z}' \end{bmatrix} \rightarrow \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \tilde{x}'/\tilde{z}' \\ \tilde{y}'/\tilde{z}' \\ 1 \end{bmatrix}$$

$$\left.\begin{aligned} x \cdot h_{11} + y \cdot h_{12} + h_{13} &= \tilde{x}' \\ x \cdot h_{21} + y \cdot h_{22} + h_{23} &= \tilde{y}' \\ x \cdot h_{31} + y \cdot h_{32} + 1 &= \tilde{z}' \end{aligned}\right\} \rightarrow \begin{aligned} \frac{x \cdot h_{11} + y \cdot h_{12} + h_{13}}{x \cdot h_{31} + y \cdot h_{32} + 1} &= x' \\ \frac{x \cdot h_{21} + y \cdot h_{22} + h_{23}}{x \cdot h_{31} + y \cdot h_{32} + 1} &= y' \end{aligned}$$

$$\Rightarrow \begin{aligned} x \cdot h_{11} + y \cdot h_{12} + h_{13} &= x' \cdot (x \cdot h_{31} + y \cdot h_{32} + 1) \\ x \cdot h_{21} + y \cdot h_{22} + h_{23} &= y' \cdot (x \cdot h_{31} + y \cdot h_{32} + 1) \end{aligned}$$

$$\begin{aligned} x \cdot h_{11} + y \cdot h_{12} + h_{13} &= x' \cdot x \cdot h_{31} + x' \cdot y \cdot h_{32} + x' \\ x \cdot h_{21} + y \cdot h_{22} + h_{23} &= y' \cdot x \cdot h_{31} + y' \cdot y \cdot h_{32} + y' \end{aligned}$$

$$\begin{aligned} x \cdot h_{11} + y \cdot h_{12} + h_{13} + 0 \cdot h_{21} + 0 \cdot h_{22} + 0 \cdot h_{23} - x' \cdot x \cdot h_{31} - x' \cdot y \cdot h_{32} &= x' \\ 0 \cdot h_{11} + 0 \cdot h_{12} + 0 \cdot h_{13} + x \cdot h_{21} + y \cdot h_{22} + 1 \cdot h_{23} - y' \cdot x \cdot h_{31} - y' \cdot y \cdot h_{32} &= y' \end{aligned}$$

$$\boxed{\begin{bmatrix} x & y & 1 & 0 & 0 & 0 & -x' \cdot x & -x' \cdot y \\ 0 & 0 & 0 & x & y & 1 & -y' \cdot x & -y' \cdot y \end{bmatrix} \cdot \underline{h} = \underline{p}' = \begin{bmatrix} x' \\ y' \end{bmatrix} \qquad \hookrightarrow \underline{h} = \begin{array}{cccccccc} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ {[}h_{11} & h_{12} & h_{13} & h_{21} & h_{22} & h_{23} & h_{31} & h_{32}{]}^T \end{array}}$$

for 4-4 point (they are corresponding to each others)

$$\underbrace{\begin{bmatrix} \; & \; \\ \vdots & \\ \vdots & \end{bmatrix}}_{8 \times 8} \begin{bmatrix} \\ \underline{h} \\ \\ \end{bmatrix}_{8 \times 1} = \begin{bmatrix} p_1' \\ \vdots \\ \\ \end{bmatrix} \Rightarrow \boxed{\underline{\underline{A}} \cdot \underline{h} = \underline{p}'}$$

forward transformation

$$\cancel{\underline{\underline{A}}^{-1} \cdot \underline{\underline{A}}} \cdot \underline{h} = \underline{\underline{A}}^{-1} \cdot \underline{p}'$$

$$\boxed{\underline{h} = \underline{\underline{A}}^{-1} \cdot \underline{p}'}$$

$$\underline{h} = [h_{11} \; h_{12} \; h_{13} \; h_{21} \; h_{22} \; h_{23} \; h_{31} \; h_{32}]^T$$

$$\underline{p}' = \left[[a_x' \; a_y']^T \; [b_x' \; b_y']^T \; [c_x' \; c_y']^T \; [d_x' \; d_y']^T \right]^T$$

$$\underline{\underline{A_i}} = \begin{array}{c} \begin{array}{cccccccc} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{array} \\ \begin{bmatrix} p_{ix} & p_{iy} & 1 & 0 & 0 & 0 & -p_{ix}' \cdot p_{ix} & -p_{ix}' \cdot p_{iy} \\ 0 & 0 & 0 & p_{ix} & p_{iy} & 1 & -p_{iy}' \cdot p_{ix} & -p_{iy}' \cdot p_{iy} \end{bmatrix} \end{array}$$

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