Transformações Geométricas

ES235 - Aula 10
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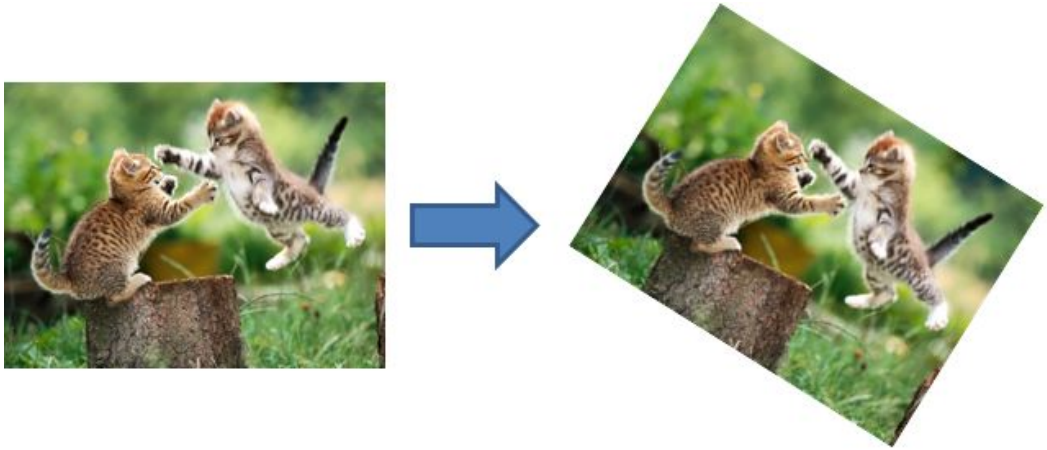
O que são Transformações Geométricas

Translação

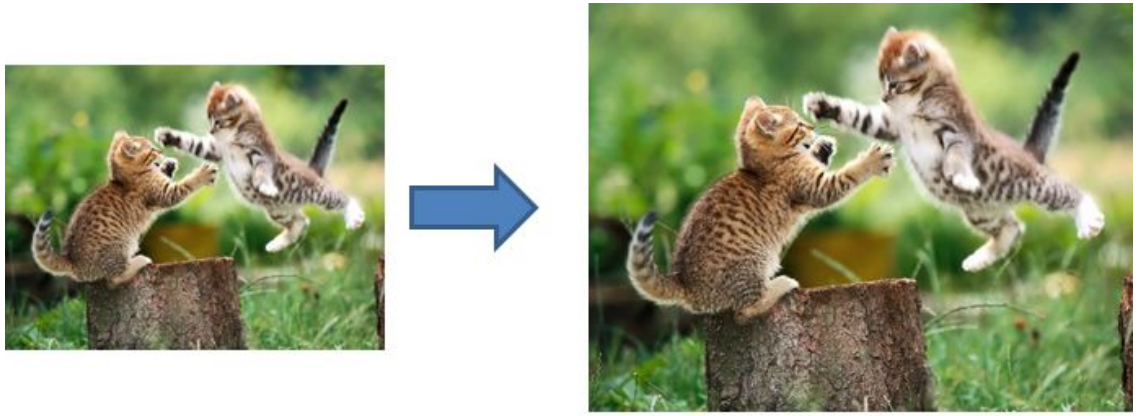
$$\begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x + t_x \\ y + t_y \\ 1 \end{bmatrix}$$

Translação e Rotação



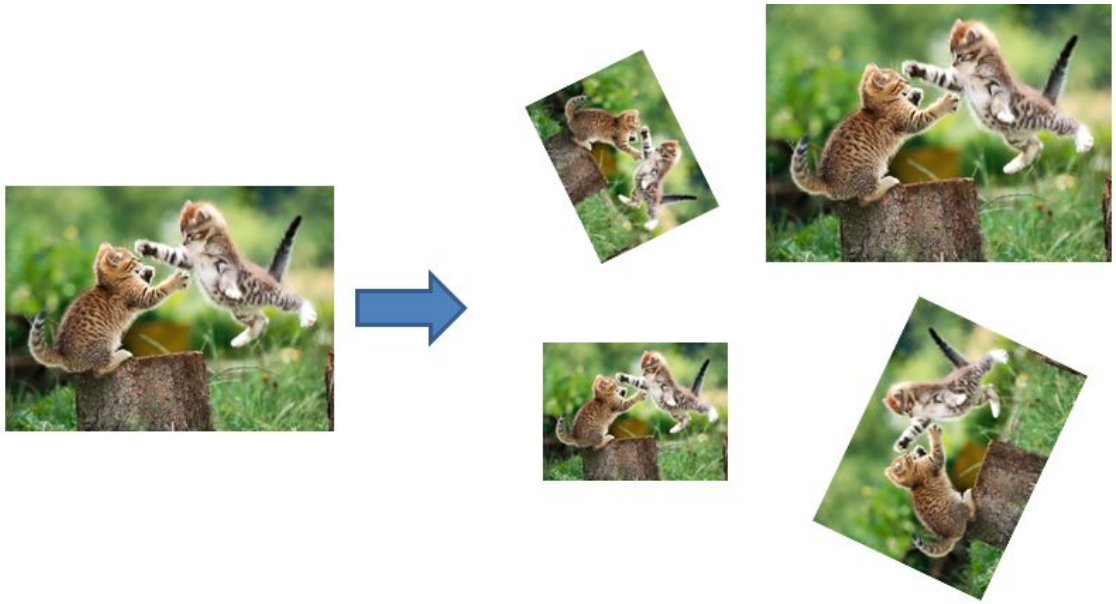
$$\begin{bmatrix} cos(\theta) & -sin(\theta) & t_x \\ sin(\theta) & cos(\theta) & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

Escala



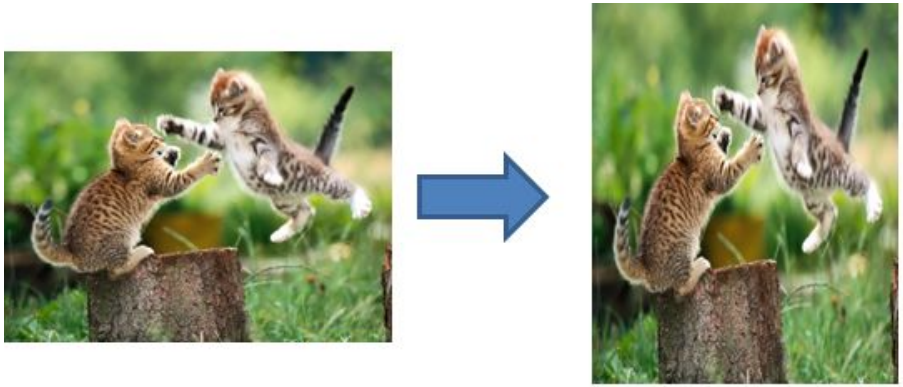
$$\begin{bmatrix} a & 0 & 0 \\ 0 & a & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

Transformações de Similaridade



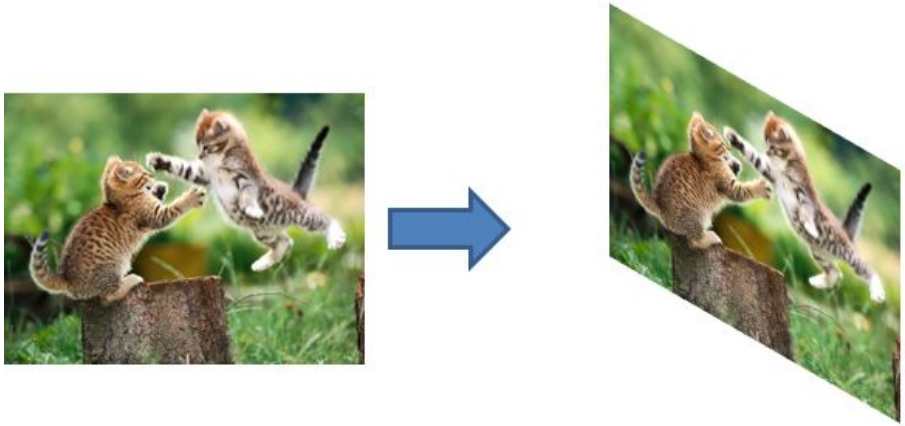
Similarity transform (4 DoF) = translation + rotation + scale

Aspect Ratio



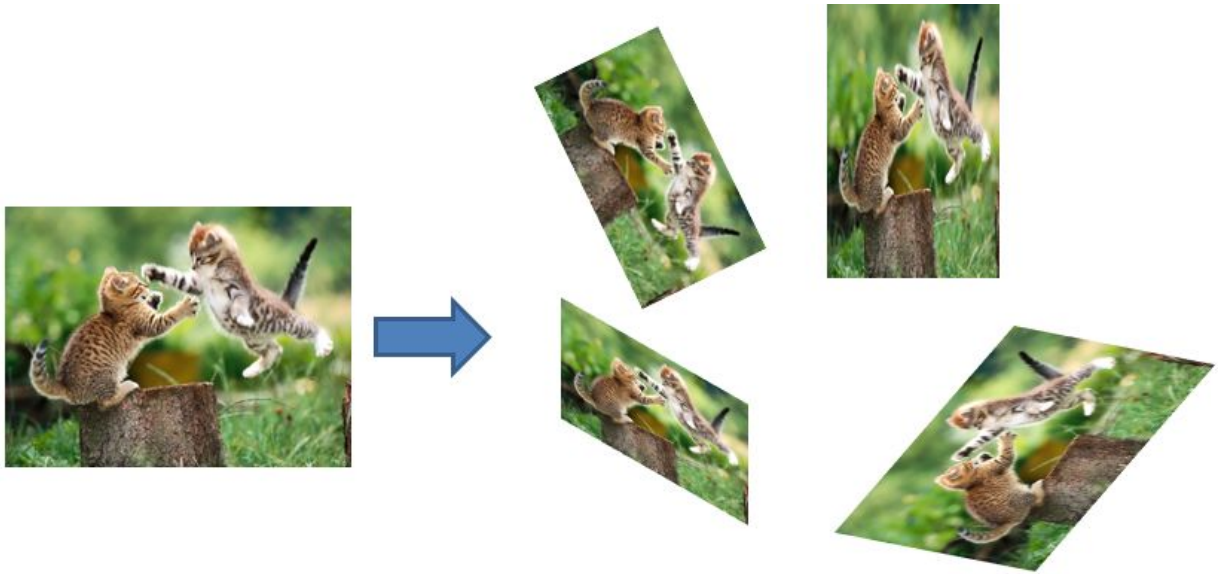
$$\begin{bmatrix} a & 0 & 0 \\ 0 & \frac{1}{a} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

Cisalhamento (Shear)



$$\begin{bmatrix} 1 & a & 0 \\ b & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

Transformações Afins

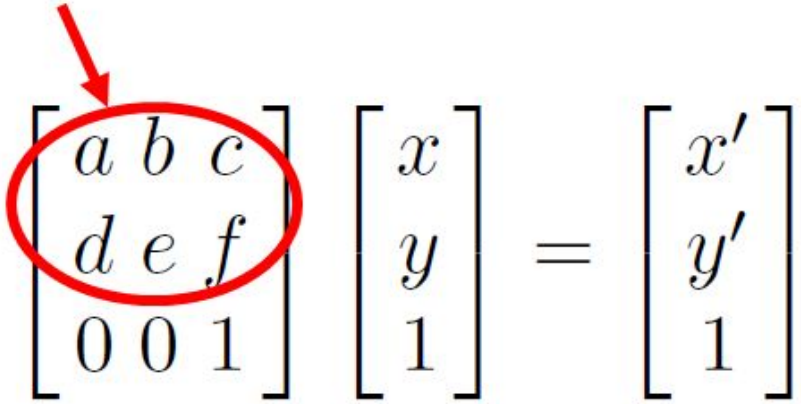


Affine transform (6 DoF) = translation + rotation + scale + aspect ratio + shear

O que falta?

Transformação Afim

We already used these



$$\begin{bmatrix} a & b & c \\ d & e & f \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

How do we compute projective transformations?

Coordenadas Homogêneas

$$\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} u \\ v \\ w \end{bmatrix}$$

One extra step:

$$x' = u/w$$

$$y' = v/w$$

Transformações de Perspectiva (Homografias)

$$\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} u \\ v \\ w \end{bmatrix}$$

$$x' = u/w$$

$$y' = v/w$$

"keystone" distortions

Transformações Geométricas no OpenCV

- Scaling
- Translation
- Rotation
- Affine
- Perspective

Encontrando a transformação

How can we find the transformation between these images?

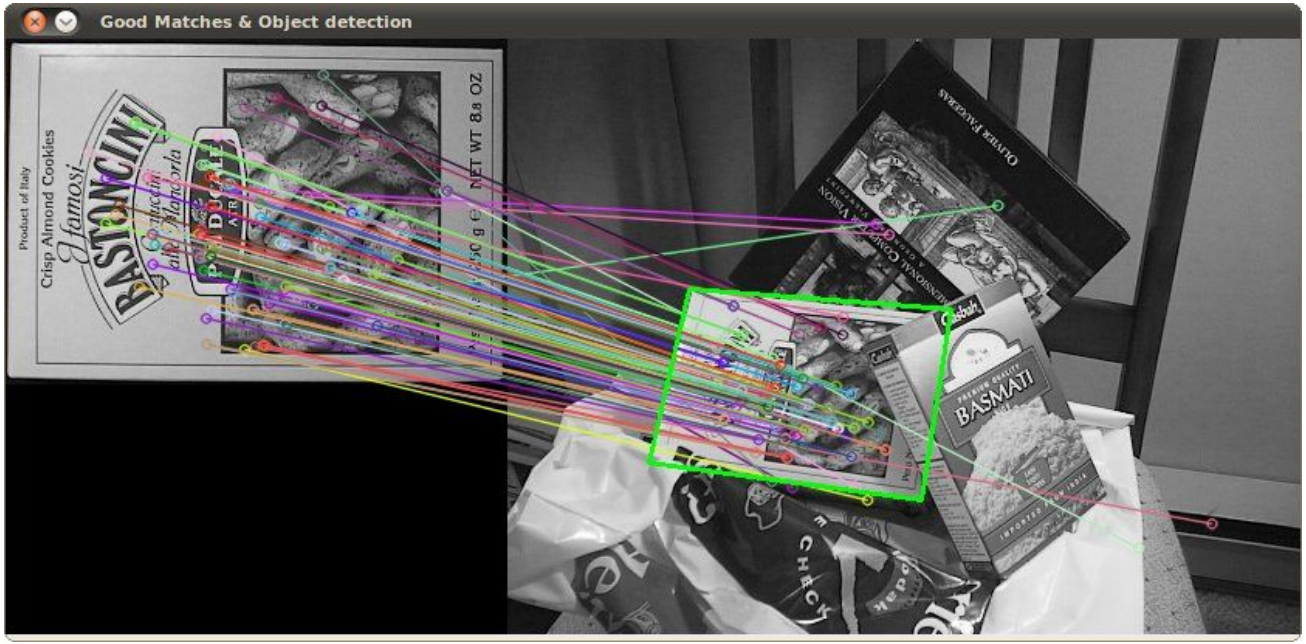
Encontrando a transformação

```
Translação    =   2 graus de liberdade

Similaridade  =   4 graus de liberdade

Afim          =   6 graus de liberdade

Homografia    =   8 graus de liberdade
```

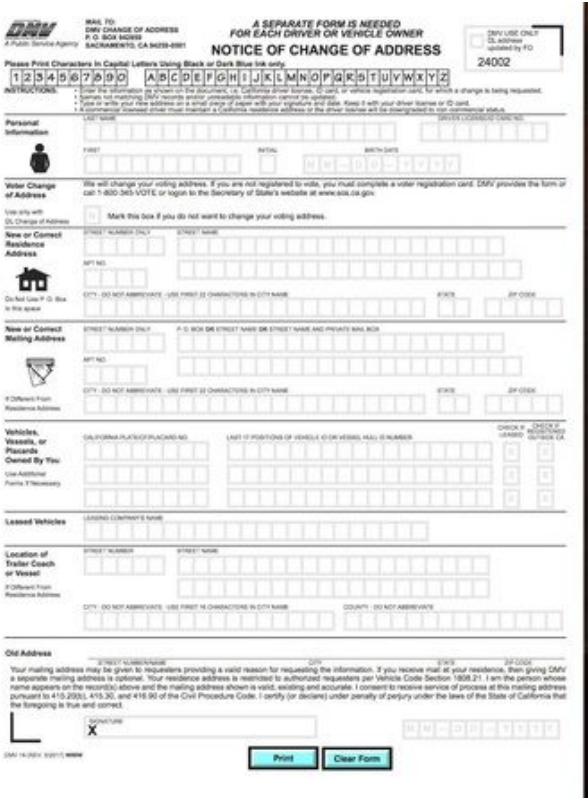
How many corresponding points do we need to solve?

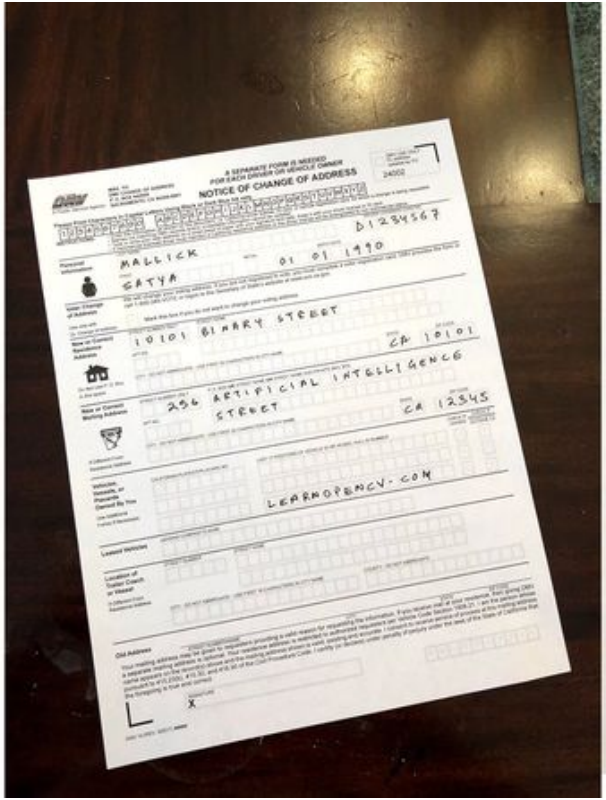
Encontrando a transformação no OpenCV

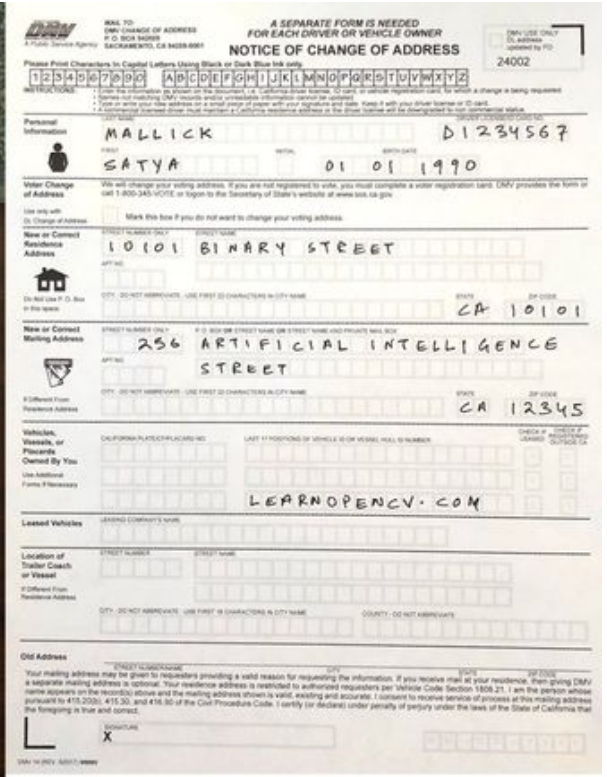
```
cv2.findHomography(srcPoints, dstPoints)
```



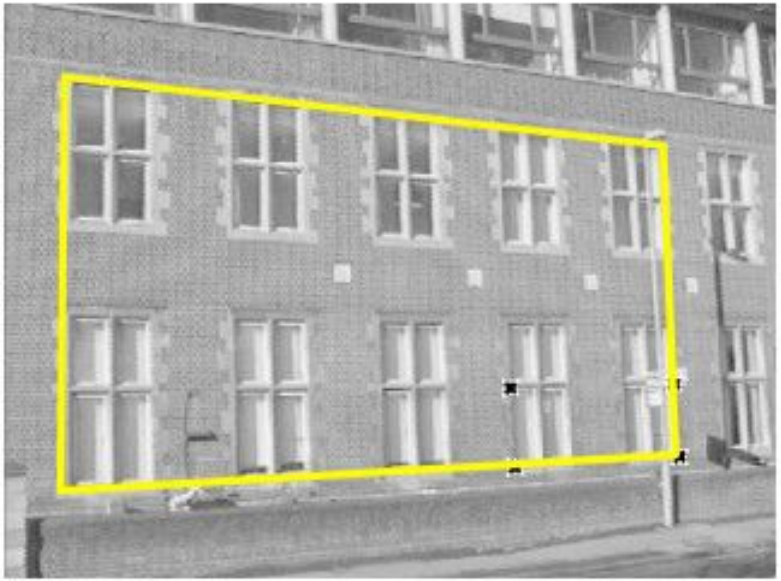
Exemplos de APlicações :: Alinhamento de Imagens

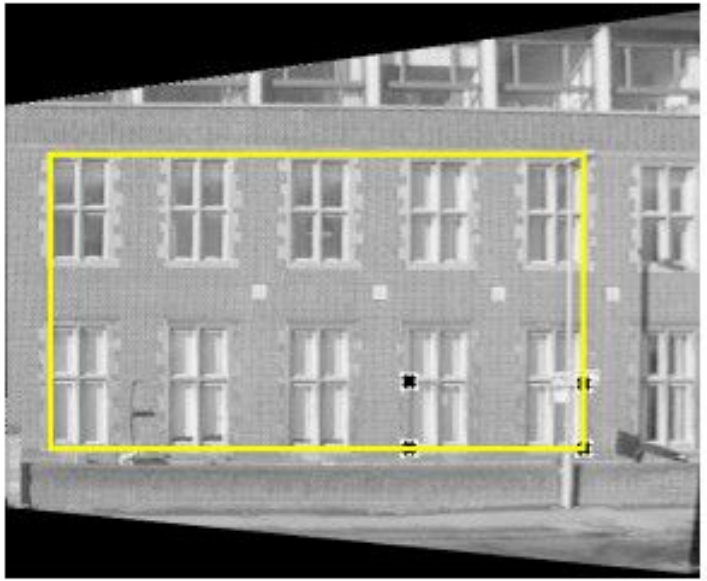






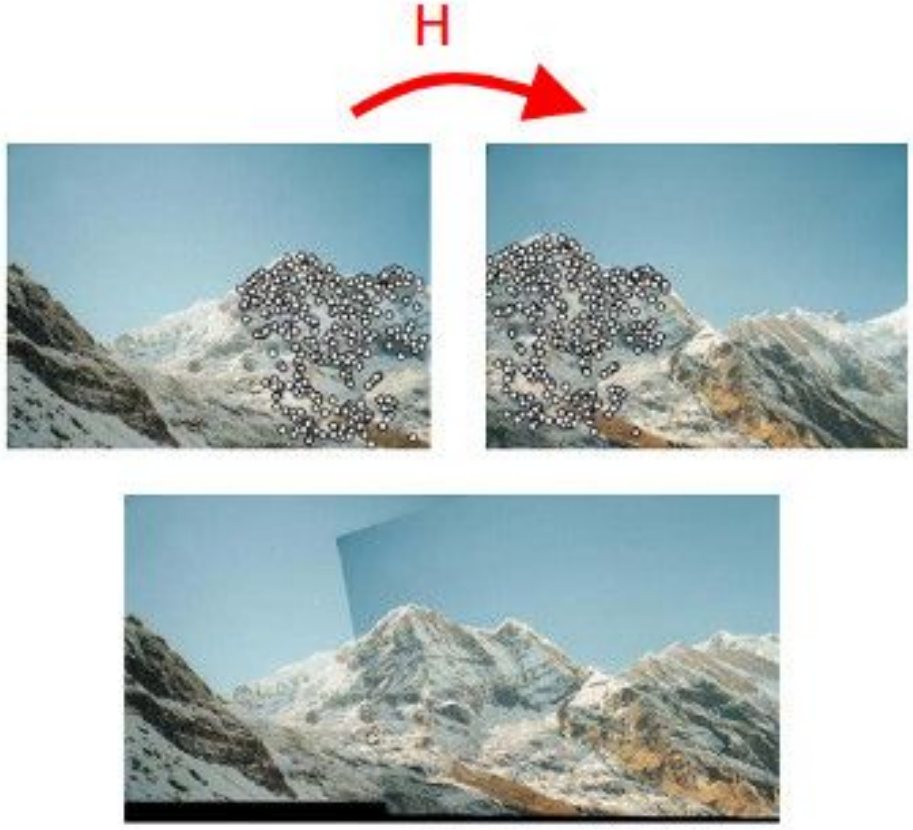
Exemplos de Aplicações :: Correção/Remoção de Perspectiva



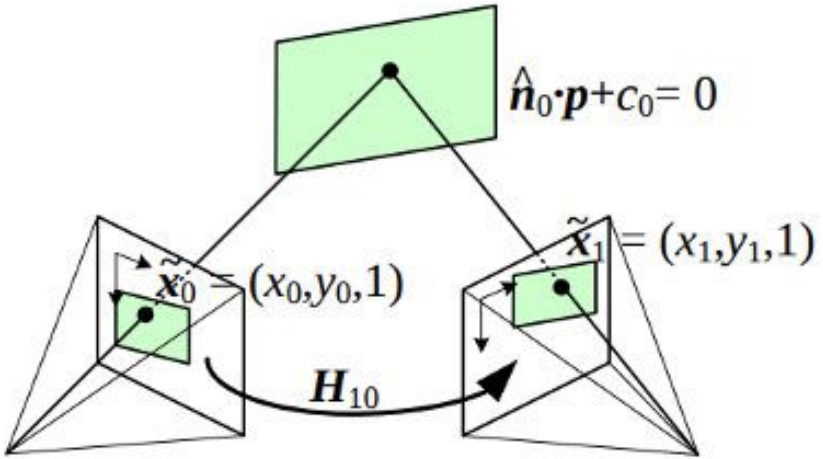


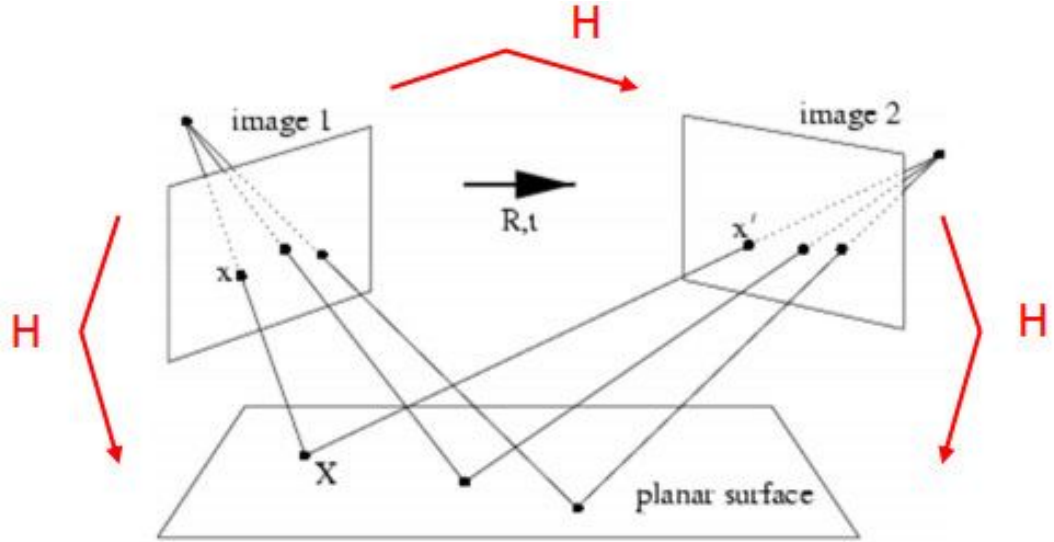
from Hartley & Zisserman

Exemplos de Aplicações :: Costura de Panorama

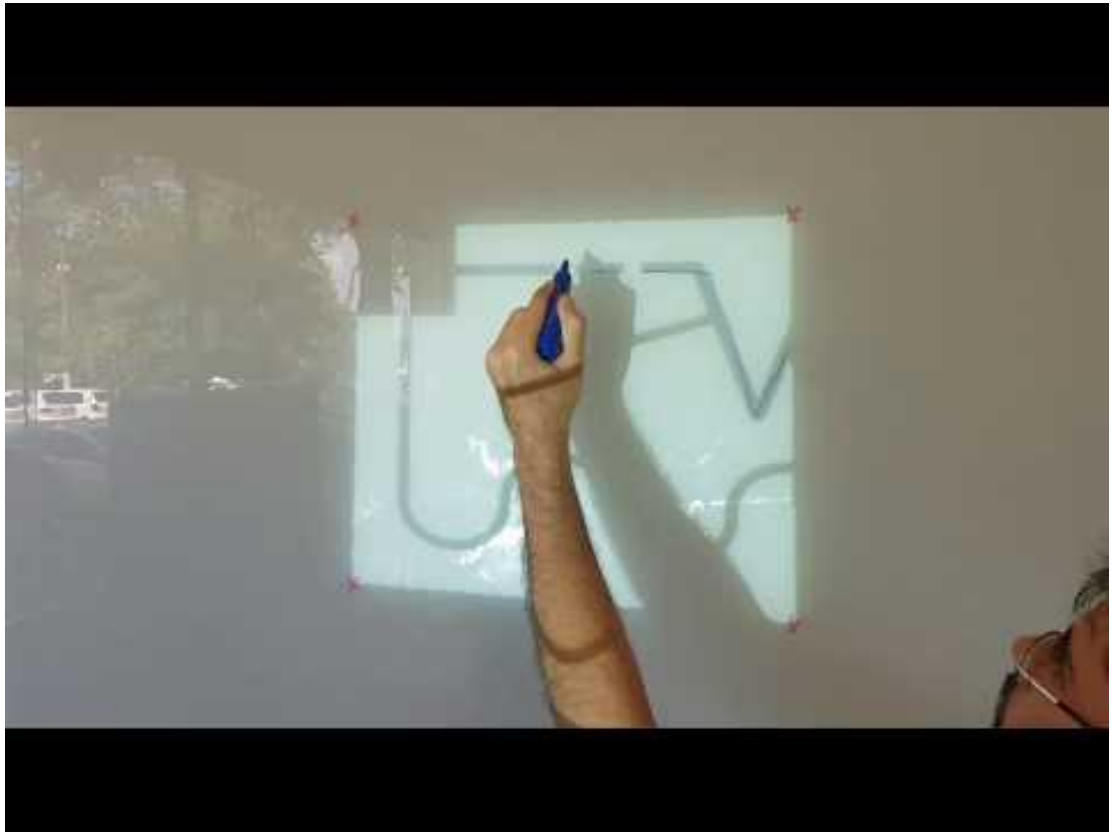


Combinando Transformações





Combinando Transformações :: ARena



REFERÊNCIAS

Rafael C. Gonzalez and Richard E. Woods. 2006. Digital Image Processing (3rd Edition). Prentice-Hall, Inc., Upper Saddle River, NJ, USA.

https://docs.opencv.org/3.0-beta/doc/py_tutorials/py_imgproc/py_geometric_transformations/py_geometric_transformations.html

https://courses.cs.washington.edu/courses/csep576/11sp/ppt/Transformations.pptx

https://docs.opencv.org/3.4.1/d9/dab/tutorial_homography.html