

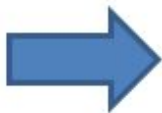
TRANSFORMAÇÕES GEOMÉTRICAS

ES235 – Aula 10
João Marcelo Teixeira
Willams Costa

O QUE SÃO TRANSFORMAÇÕES GEOMÉTRICAS

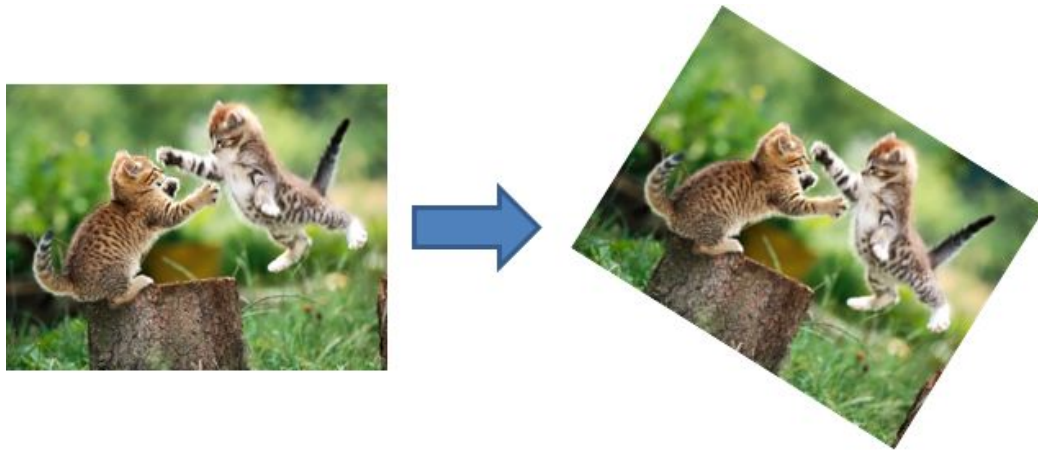


TRANSLAÇÃO



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

TRANSLAÇÃO E ROTAÇÃO



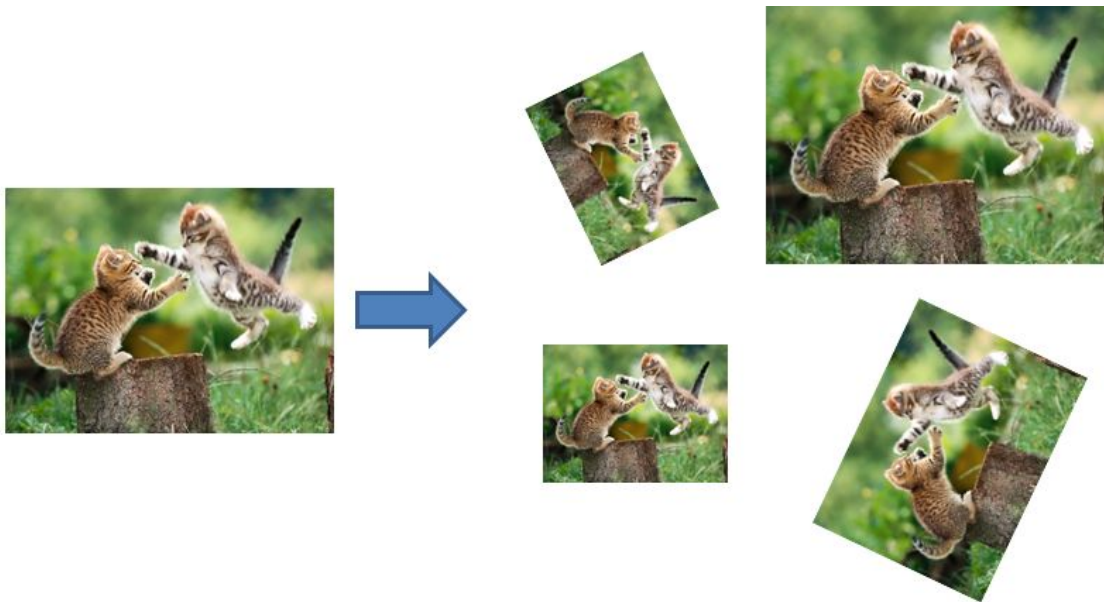
$$\begin{bmatrix} \cos(\theta) & -\sin(\theta) & t_x \\ \sin(\theta) & \cos(\theta) & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

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



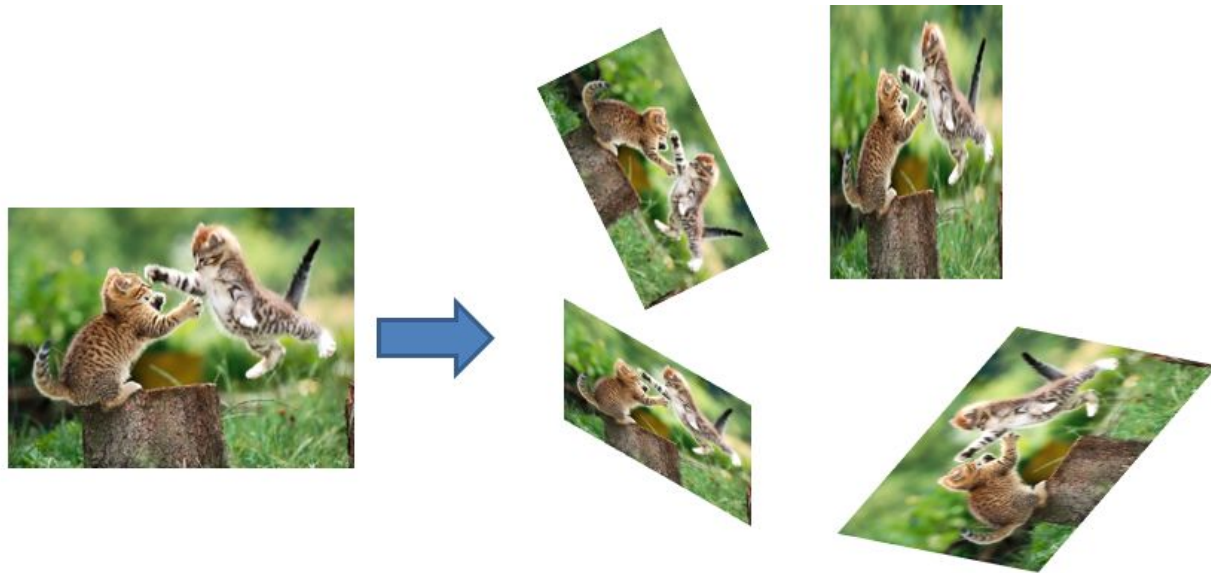
$$\begin{bmatrix} a & 0 & 0 \\ 0 & \frac{1}{a} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

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



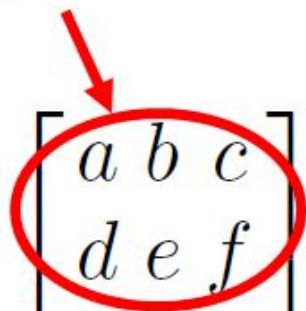
Affine transform (6 DoF) = translation + rotation + scale + aspect ratio + shear

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:

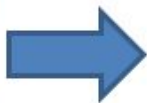
$$x' = u/w$$

$$y' = v/w$$

TRANSFORMAÇÕES DE PERSPECTIVA (HOMOGRAFIAS)

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

“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

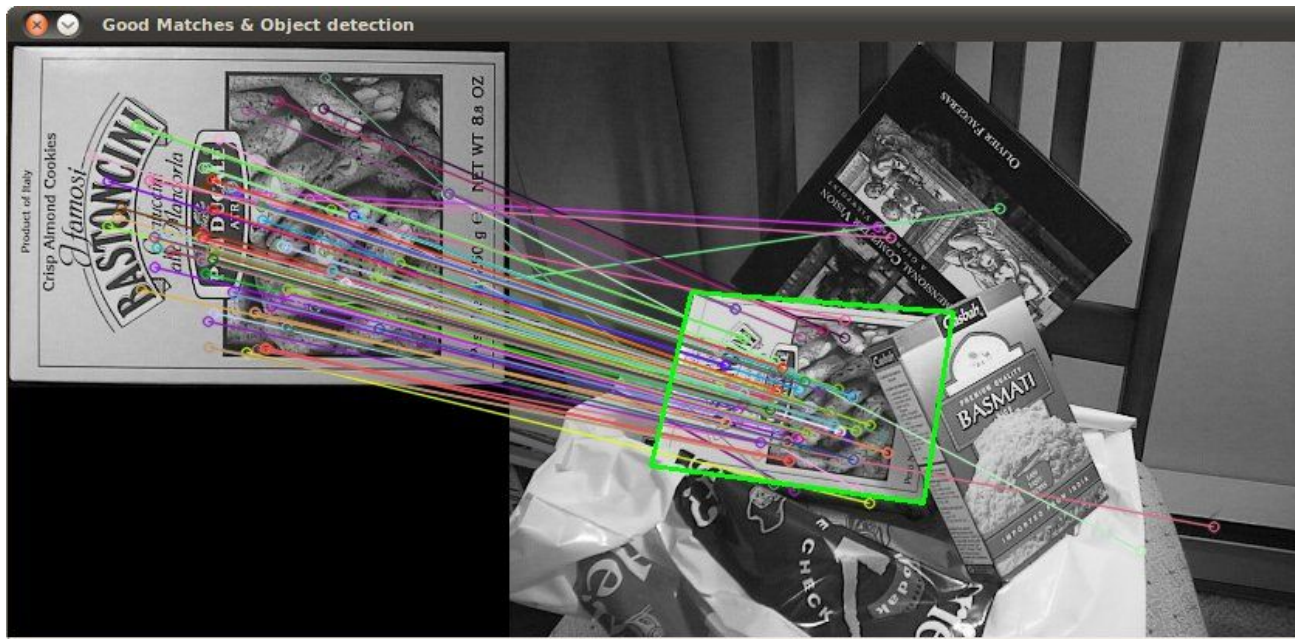
Afim = 6 graus de liberdade

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

DMV
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P.O. BOX 10050
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LEASED VEHICLES
LEASING COMPANY'S NAME

LOCATION OF TRAILER, CATCH OR VESSEL
STREET NUMBER STREET NAME
CITY, DO NOT ABBREVIATE. USE FIRST 20 CHARACTERS IN CITY NAME COUNTY, DO NOT ABBREVIATE

OLD ADDRESS
STREET NUMBER ONLY CITY STATE ZIP CODE
Your mailing address may be given to requesters providing a valid reason for requesting the information. If you receive mail at your residence, then giving DMV a separate mailing address is optional. Your residence address is restricted to authorized requesters per Vehicle Code Section 1906.21. I am the person whose name appears on the record(s) above and the mailing address shown is valid, existing and accurate. I consent to receive service of process at this mailing address pursuant to 415.2001, 415.30, and 415.90 of the Civil Procedure Code. I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

SIGNATURE X

DATE 14-JUN-2015 10:07:11 AM

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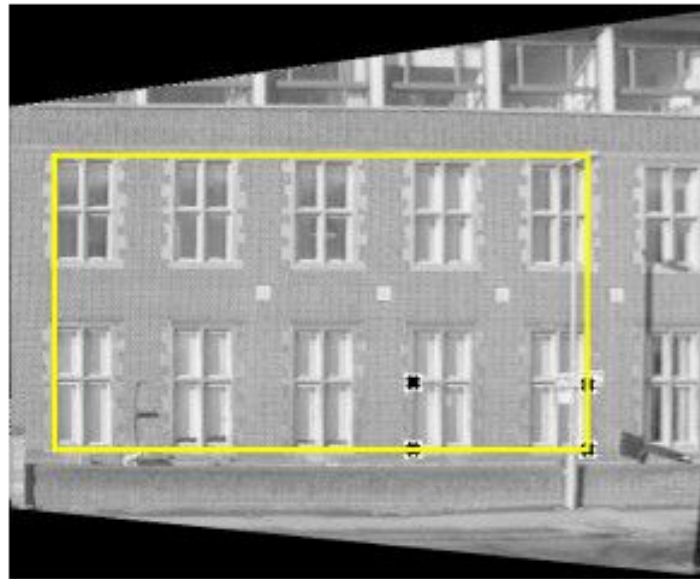
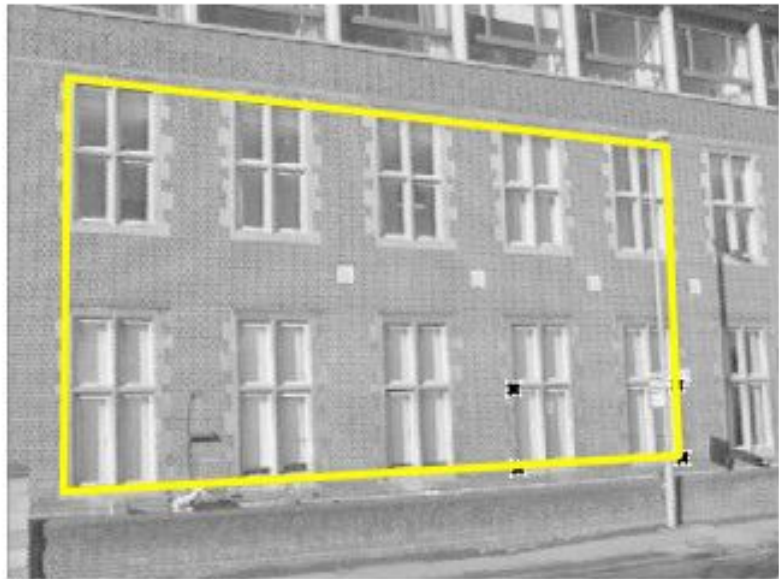
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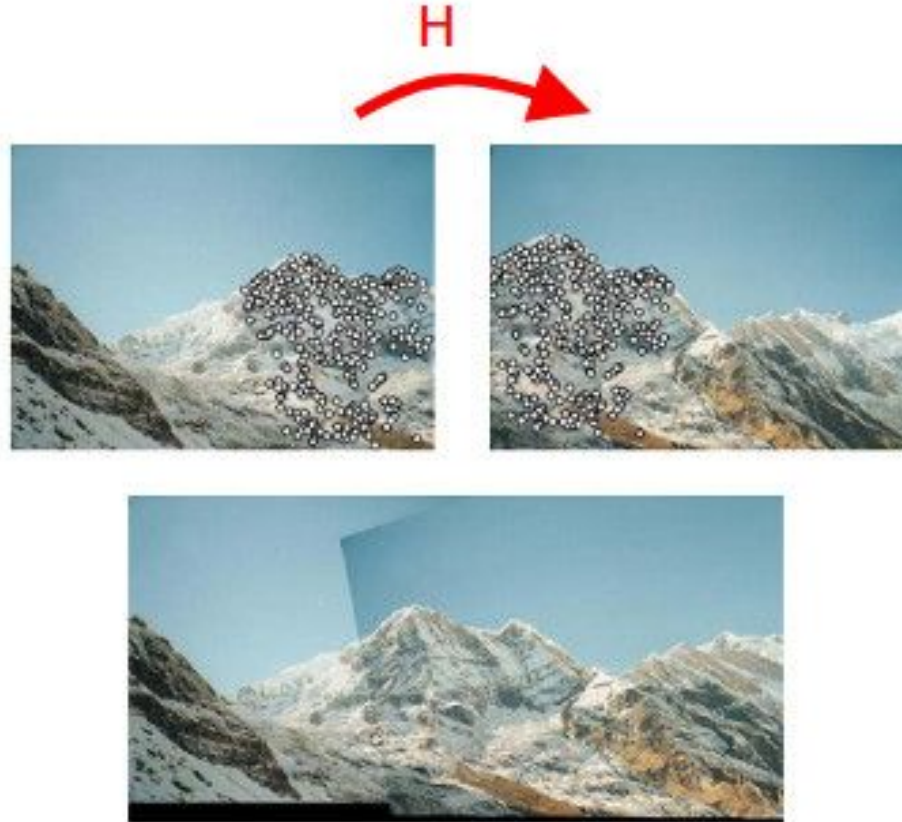
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EXEMPLOS DE APLICAÇÕES :: CORREÇÃO/REMOÇÃO DE PERSPECTIVA

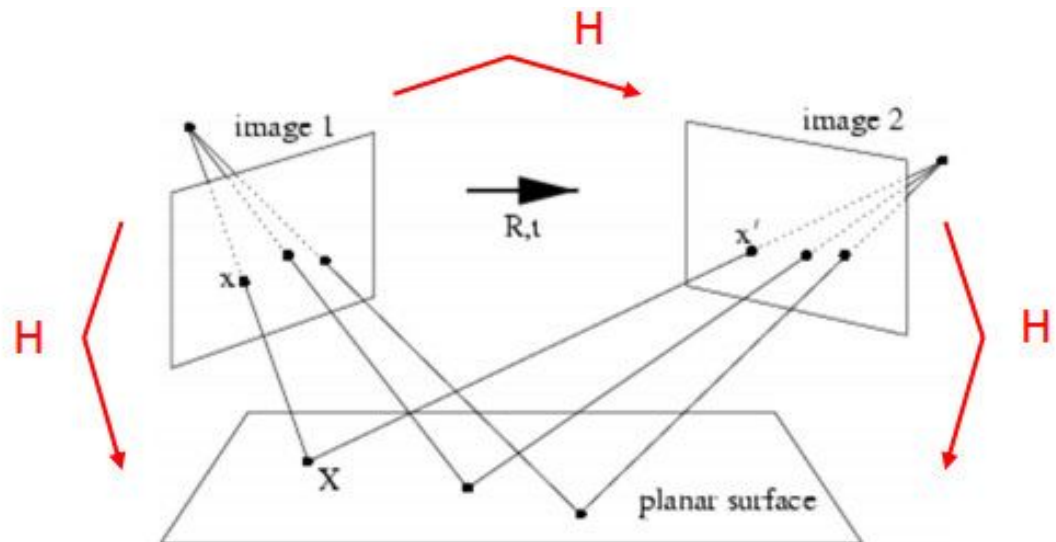
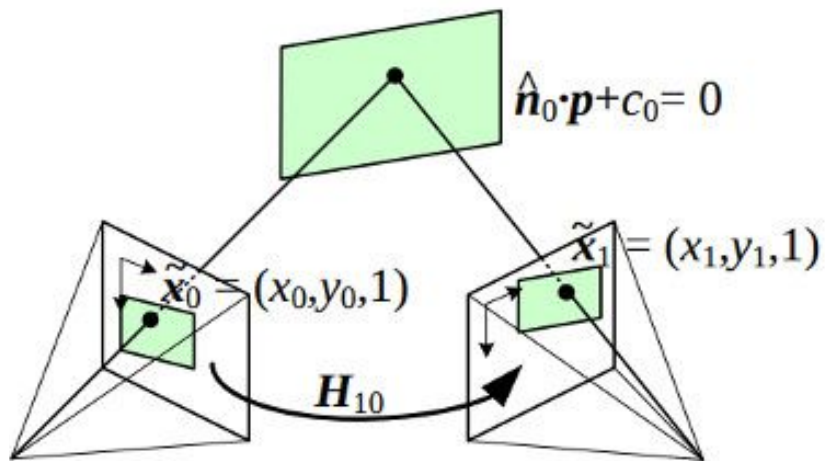


from Hartley & Zisserman

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.

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