5. Affine Transformation

5.1. Affine transformation

Affine Transformation (Affine Transformation or Affine Map) is a linear transformation from two-dimensional coordinates (x, y) to two-dimensional coordinates (u, v). Its mathematical expression is as follows:

$$\begin{cases} u = a_1 x + b_1 y + c_1 \\ v = a_2 x + b_2 y + c_2 \end{cases}$$

The corresponding homogeneous coordinate matrix representation is:

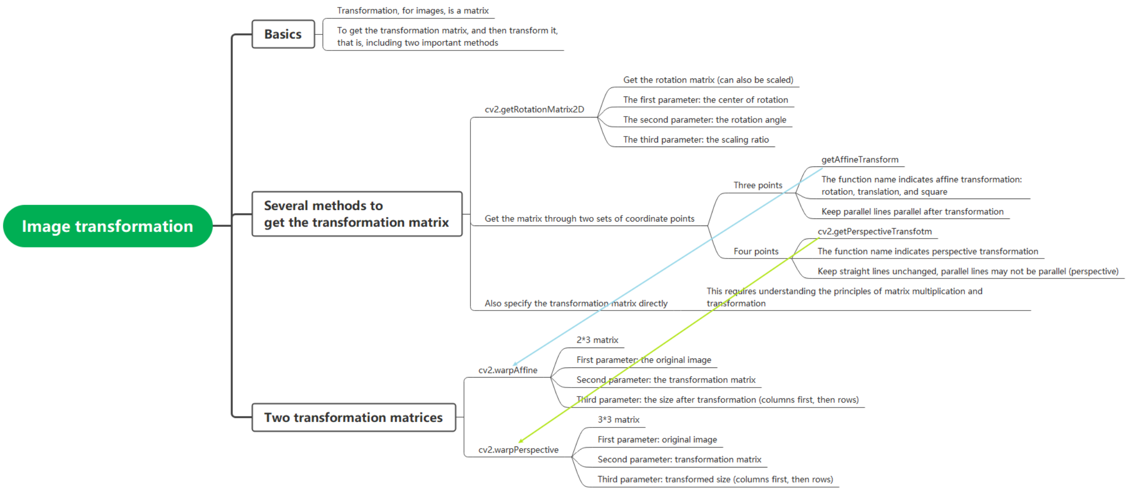
$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Affine transformation preserves the "straightness" of two-dimensional graphics (a straight line remains a straight line after an affine transformation) and "parallelism" (the relative position relationship between straight lines remains unchanged, parallel lines remain parallel lines after an affine transformation, and the position order of points on the straight line does not change). Three pairs of non-collinear corresponding points determine a unique affine transformation.

The rotation and stretching of an image is the image affine transformation. Affine transformation also requires an M matrix. However, since affine transformation is relatively complex, it is generally difficult to find this matrix directly. OpenCV provides a function to automatically solve M based on the correspondence between the three points before and after the transformation. This function is

M=cv2.getAffineTransform(pos1,pos2), where the two positions are the corresponding position relationship before and after the transformation. The output is the affine matrix M. Then use the function cv2.warpAffine().

Let's take a look at the entire affine transformation and perspective transformation usage diagram: Two methods of image transformation cv2.warpAffine and cv2.warpPerspective



5.2. Actual effect display

Let's take vertical transformation as an example to see how it is written in Python:

Code path:

/home/pi/DOGZILLA_Lite_class/4.Open Source CV/B.Geometric_Transformations/05_Affine_Transformation.ipynb

```
import cv2
import numpy as np
import matplotlib.pyplot as plt

img = cv2.imread('yahboom.jpg',1)

img_bgr2rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
plt.imshow(img_bgr2rgb)
plt.show()
# cv2.waitKey(0)
```

Code

[1]:
```python
import cv2
import numpy as np
import matplotlib.pyplot as plt

img = cv2.imread('yahboom.jpg',1)

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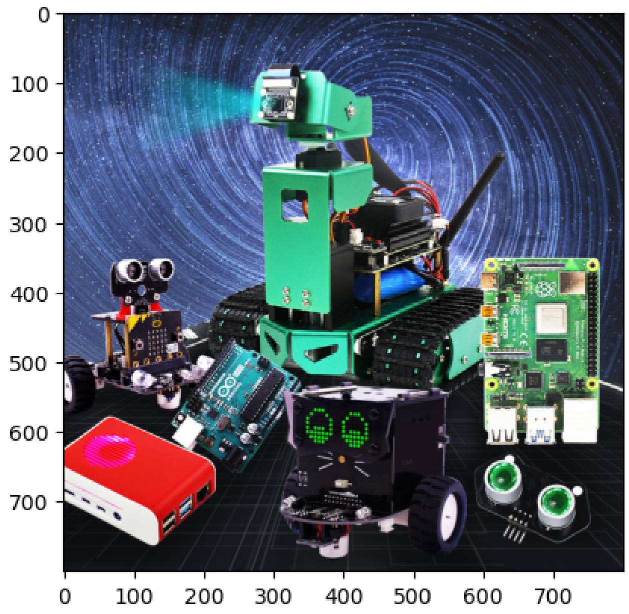


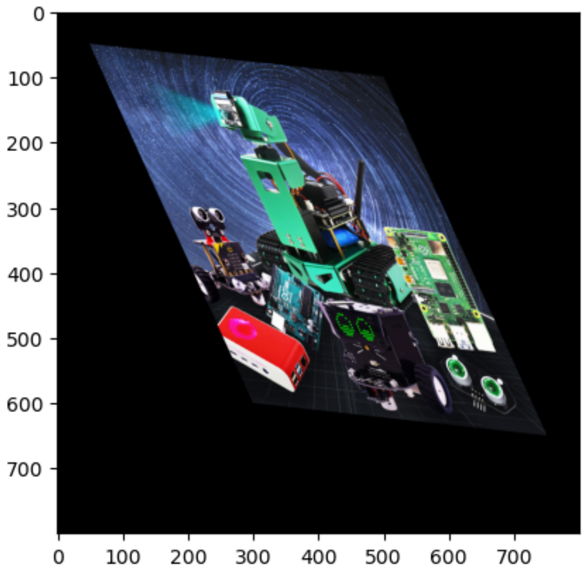

```python
imgInfo = img.shape
height = imgInfo[0]
width = imgInfo[1]
#src 3->dst 3 (左上角，左下角，右上角 Top left, bottom left, top right)
matSrc = np.float32([[0,0],[0,height-1],[width-1,0]])
matDst = np.float32([[50,50],[300,height-200],[width-300,100]])
#组合 combination
matAffine = cv2.getAffineTransform(matSrc,matDst)# mat 1 src 2 dst
dst = cv2.warpAffine(img,matAffine,(width,height))
img_bgr2rgb = cv2.cvtColor(dst, cv2.COLOR_BGR2RGB)
plt.imshow(img_bgr2rgb)
```

05_Affine_Transformation.i

Code

```python
matSrc = np.float32([[0,0],[0,height-1],[width-1,0]])
matDst = np.float32([[50,50],[300,height-200],[width-300,100]])
#组合 combination
matAffine = cv2.getAffineTransform(matSrc,matDst)# mat 1 src 2 dst
dst = cv2.warpAffine(img,matAffine,(width,height))
img_bgr2rgb = cv2.cvtColor(dst, cv2.COLOR_BGR2RGB)
plt.imshow(img_bgr2rgb)
```

[2]:
```
<matplotlib.image.AxesImage at 0x7ffe8ef5d390>
```



[ ]: