

```

1 import cv2
2 import numpy as np
3
4
5 def transform(img, angle): # forward transformation
6     height, width = img.shape
7     result = np.zeros((height, width), np.uint8) # result image
8
9     affine = np.array([
10         [np.cos(np.radians(angle)), np.sin(np.radians(angle)), 0],
11         [-np.sin(np.radians(angle)), np.cos(np.radians(angle)), 0],
12         [0, 0, 1]
13     ]) # Affine transformation matrix
14
15     for x in range(width):
16         for y in range(height):
17             p = affine.dot(np.array([x, y, 1]))
18
19             xp = int(p[0])
20             yp = int(p[1])
21
22             if 0 <= yp < height and 0 <= xp < width:
23                 result[y, x] = img[yp, xp]
24     return result
25
26
27 in_image = cv2.imread('dgu_gray.png', 0) # img2numpy
28
29 out_image = transform(in_image, 20)
30
31 cv2.imshow('Input Image', in_image)
32 cv2.imshow('Result Image', out_image)
33
34 cv2.imwrite('dgu_gray_rotate.png', out_image) # save result img
35 cv2.waitKey()
36

```

