CS 763/764: Computer Vision
January 28, 2022

Task 02a

Question 1. For (1), explain in a paragraph how you did the undistortion. (A trial-and-error brute force method is not expected.)

Solution.
We initially performed binarization on the distorted image, and then apply corner detection to obtain a set of possible interest points in the image. Among the set of interest points, the corner points we got were $p_1 = (598, 61)$,$p_2 = (660, 660)$,$p_3 = (61, 598)$. We mapped these corner points to $p_1^{'} = (700, 0)$,$p_2^{'} = (700, 700)$ and $p_3^{'} = (0, 700)$, and obtained the corresponding affine transformation matrix. We took the transformation matrix H as follows :

$$H = \begin{bmatrix} h_1 & h_2 & h_3 \\ h_4 & h_5 & h_6 \\ 0 & 0 & 1 \end{bmatrix}$$

We know that :

$$p_1^{'} = Hp_1$$

$$p_2^{'} = Hp_2$$

$$p_3^{'} = Hp_3$$

Combining the three into a single matrix :

$$w \cdot \begin{bmatrix} 0 & 700 & 700 \\ 700 & 700 & 0 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} h_1 & h_2 & h_3 \\ h_4 & h_5 & h_6 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 61 & 660 & 598 \\ 598 & 660 & 61 \\ 1 & 1 & 1 \end{bmatrix}$$

Using the inverse to obtain the H matrix as:

$$P^{'} = H \cdot P$$

$$H = P^{'} \cdot P^{-1}$$

On solving the above equation and keeping $w = 1$ we get the following H matrix.

$$H = \begin{bmatrix} 1.81 & -0.12 & 1.06 \\ -0.12 & 1.81 & 1.06 \\ 0 & 0 & 1 \end{bmatrix}$$

We feed h_1 to h_6 into cv2.warpAffine() and get the desired output image.

Question 2. Are there any difference in the outputs in case (1) (manual) and (2) (using the API).

Solution.

No, there is no difference between the two outputs because the H matrix that we obtained, is more or less the same as the matrix obtained from cv2.getAffineTransform() method.

Question 3. List the point correspondences you used for (2)

Solution.
As a part of experimentation, we got 3 corner points using binarization followed by Harris Corner Detection as we mentioned in (1).

The notations used in the above solution are elaborated below :

$$p_1 = (700, 0), p_1^{'} = (598, 61)$$
$$p_2 = (0, 700), p_2^{'} = (61, 598)$$
$$p_3 = (700, 700), p_3^{'} = (660, 660)$$

Question 4. Document your observations for (3), ideally with a picture

Solution.

As a part of experimentation, we got 4 corner points using the same technique we used for (1). After this, since we got 4 corner points and we only needed 3 corner points in cv2.warpAffine(), so we took 4 possible choices *(p_1, p_2, p_3),(p_2, p_3, p_4),(p_1, p_3, p_4)* and *(p_1, p_2, p_4)* and related them to *($p_1^{'}, p_2^{'}, p_3^{'}$),($p_2^{'}, p_3^{'}, p_4^{'}$), ($p_1^{'}, p_3^{'}, p_4^{'}$)* and *($p_1^{'}, p_2^{'}, p_4^{'}$)* respectively, one triplet after the other.

The notations used in the above solution are elaborated below :

$$p_1 = (0, 0), p_1^{'} = (219, 133)$$
$$p_2 = (700, 0), p_2^{'} = (576, 33)$$
$$p_3 = (0, 700), p_3^{'} = (218, 651)$$
$$p_4 = (700, 700), p_4^{'} = (576, 763)$$

Since the question was more related to affine transform, we noticed that on applying the API to (3), the perspective of the image remained the same, only there was rotation and translation of the image, depending upon the triplet of points we used.

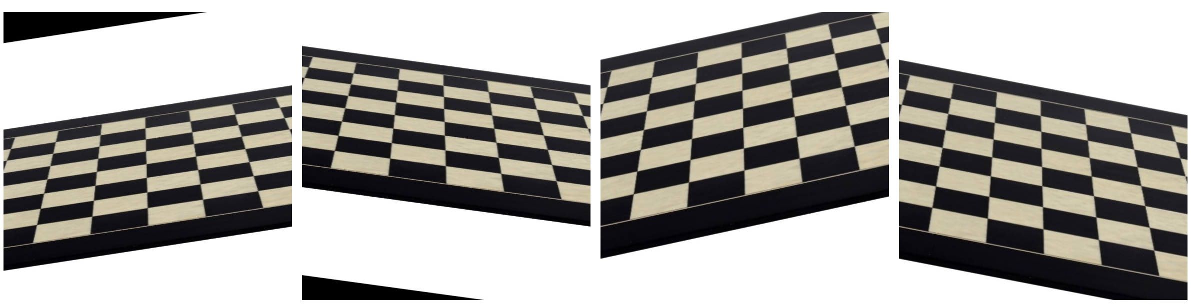

FIGURE 1. Observation Images