Homework 4

Step 1. Compute Homography from matched corner points

Write a function: compute_Homography(corners1, corners2, matches) to compute the homography H, where $I_1 = H \cdot I_2$ from the lists of corners1 and corners2 and the matching index list matches

1) Construct a zero matrix A of dimension $2N \times 8$, and a zero vector b of dimension $2N \times 1$;
2) Fill A's $(2i)$-th and $(2i+1)$-th rows For each pair of corresponded corners in matches (**Lecture 21, Page 28**), the coordinates of a point from corners1 is $(x_i^{'}, y_i^{'})$, and the coordinates of its corresponding point from corners2 is (x_i, y_i); set $b[2i] = x'_i$, $b[2i+1] = y_i^{'}$
3) The unknown, in a 8×1 vector form, can be solved by a least square directly using
   i. h = np.linalg.lstsq(A, b)[0]
4) Finally convert this h vector to a 3×3 matrix H, where we set the last element $H(3,3) = 1$.
5) Return H

Step 2. Compute the dimension of the stitched image.

Write a function compute_StitchDimension(img1, img2, H) to compute the dimension of the stitched image

1) The dimension of the stitched image is determined by the range of image-1 and the range of the transformed image-2, $H(img2)$. The range of image-1 is $[0, img1.shape[1]) \times [0, img1.shape[0])$, (namely $[c_{min}, c_{max}] \times [r_{min}, r_{max}]$.
2) To calculate the range of $H(img2)$, do the following
   A. Write a function apply_transform(T, x, y) to calculate the transformed coordinates of (x,y) under a homogeneous transformation T.
   B. For every pixel (x, y) in $img2$, use apply_transform(H, x, y) to get its transformed coordinates $(\hat{x}, \hat{y})$. Find the min and max row and col values, denoted as $r'_{min}, r'_{max}, c'_{min}, c'_{max}$, respectively.
   C. Let $\hat{r}_{min} = \min(r_{min}, r_{min}^{'})$, $\hat{r}_{max} = \max(r_{max}, r_{max}^{'})$, same for the column values. The **dimension** of stitched image is $[0, \hat{c}_{max} - \hat{c}_{min}] \times [0, \hat{r}_{max} - \hat{r}_{min}]$ after applying a shift **translation** of $[-\hat{c}_{min}, -\hat{r}_{min}]$.

3) Return the dimension and shift translation

Step 3. Do the blending.

Write a function stitch_images(img1, img2, H, tran_x, tran_y, newDimension) to stitch and blend two images

1) Initiate an empty stitch image S with the dimension computed above.
2) Calculate the inverse of the homography H, denoted as invH.
3) For each pixel (x_0, y_0) in S, first apply the inverse of the aforementioned shift translation, we get its coordinates (x, y) in image-1.
4) Also use apply_transform(invH, x, y) to get its coordinates (x', y') in image-2.
5) Follow the four cases described in page 2 of the homework description to finish the blending and fill in the pixel value.
6) Return the final stitched image.