JOB REPORT FOR PROBLEM SET2

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Abstract

My solution to resolve the **Problem set2** *use feature extract histgram of orientation gradient and match the feature to generate panorama image*

1 Implement Harris Corner Detector with non-maximal suppression

1.1 Calculate spatial derivative

$$grad_x = I_{x+1} - I_{x-1} \tag{1}$$

$$grad_y = I_{y+1} - I_{y-1} \tag{2}$$

Implemented by convolution operation, which the kernel is $[-1, 0, 1]$.

1.2 Calculate Harris response

$$M = \sum_{(x,y)\in W} \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \tag{3}$$

$$R = \det(M) - \alpha trace(M)^2 = \lambda_1\lambda_2 - \alpha(\lambda_1 + \lambda_2)^2 \tag{4}$$

Calculate the Harris Matrix with the gradients already calculated above.

1.3 Select candidate corners and non-maximal suppression

If $R > 0$ then it's the Corner, and it can be the interesting point.

2 Implement Histogram of Gradients

Because the handout didn't give the steps, so I don't make subsections.

To complete this part, I first compute the vertical and horizontal gradients, which can be computed by the function in *1.1*. Then I compute the gradients magnitude and degree.

$$\theta = \arctan(\frac{g_y}{g_x}) \tag{5}$$

$$m = \sqrt{g_y^2 + g_x^2} \tag{6}$$

With this parameters, I can calculate the histgram in a cell. The range is $[-\pi/2, \pi/2]$ the weight is magnitude. Lastly, loop each block in the image and extract the features of the corner.

3 Local feature matching

For image1 and image2, extract the feature of each corner. Then compute the distance of each features of image1 and each features in image2. For each feature in image1, the smallest distance d1 and the second smallest distance d2, if the d1/d2 < threshold, then this is a matching pair of points.

4 Image stitching and blending

4.1 Compute the alignment of image pairs

I use the SVD (singular value decomposition) to compute the homography matrix. A_{2n} is the points matrix. The goal is to minimize $||Ax||$.

$$A = U\Sigma V^T \tag{7}$$

the solution x is v[-1].

4.2 Align the image with RANSAC

The RANSAC algorithm is to get the most inliers from all points.Fistly randomly choose 4 points and compute the homography matrix through the 4 points. Then estimate the distance to the model. Reapeat the steps, get the smallest distance model.

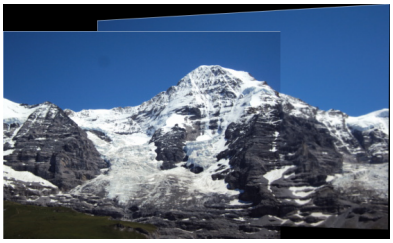
4.3 Stitch and blend the image

Firstly compute the homography matrix using the RANSAC algorithm, then wrapPespective the image1 to image2, and stitch the two images.

here is the multiple two iamges

(a) image1

(b) image2



(c) image3

4.4 Generate a panorama

Firstly I let the middle index of the sequence be the origin image, then loop from it to 0 stitch the image using the function in *4.3*

However I noticed a problem, becasue of the large rotation, the performenc e of the stitch is very poor. *I resolved this issue in BQ3*, So I put the output images in the BQ3, which has a good performence.

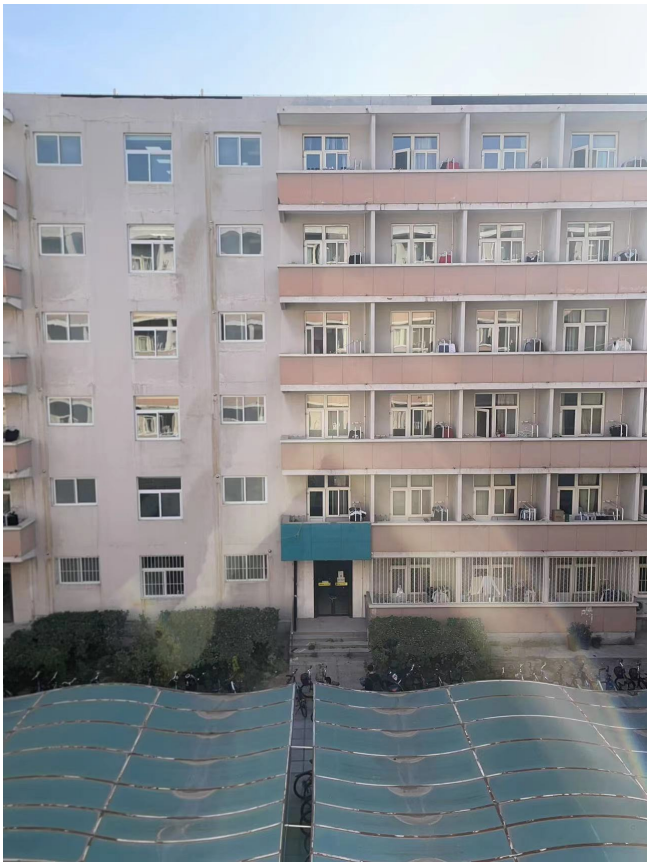
5 Analyze

5.1 Try various settings for shooting the image sequences

The image taken when I rotate the camera only, the angle is too large , so the splicing edge is not completely aligned. The problem is the outliers is to much because of the similar trees and the moving people.
the image I took for rotation

(a) rotation

The image taken when I translate the camera only has a good performence. So we can see just tranlation perform better than just rotation
the image I took for translation



(a) translation

5.2 Try small and large translational/rotational distances

we can see the large rotate image, the edge is not stitch perfect. In the small rotate image, the per formence is well.

(a) large rotate

(b) small rotate

Same as the rotate, the large translation behave not as good as small translation.

(a) large translation

(b) small translation

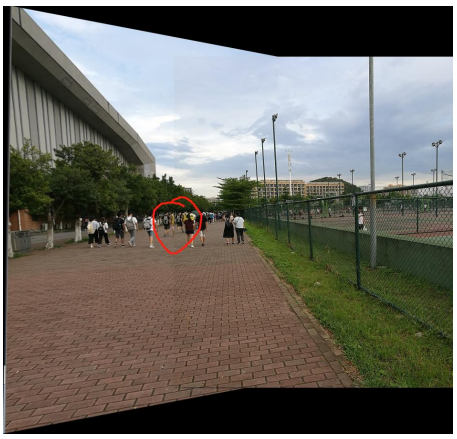
5.3 remove 'ghosted' versions of the objects

For this issue, I refered the method of a dissertation.
In the stitching model calculation stage, I develop a layered warping algorithm to align the background scenes, which is location-dependent and turned out to be more robust to parallax than the traditional global projective warping methods. On the selective seam updating stage, I propose a change-detection based optimal seam selection approach to avert ghosting and artifacts caused by moving foregrounds.

the ghost image

5.4 same person appears multiple times

the image my program generate



(a) multiplePerson

To resolve this issue, should be center on the moving objects.
The specific steps of extracting the object region that produces displacement are:
(1) Establish the best seam line for the accurately registered image:
(2) Draw the circumscribed rectangle of the best suture line. Differentiate the firs t input image and the second image after coordinate transformation in the corresponding rectangular area
(3) Perform the binarization operation of adaptive threshold on the differential image, an d then dilate and corrode the binary image to eliminate small noise points and fill in the holes
(4) Extract the moving target area that produces displacement.

the Improved image

(a) improved image

6 BQ 2

The HOG descriptor is not good enough, because it's not scale invariant. So I use the cv2 package module SIFT, which is scale, translation, rotation invariant.

The steps: (1) Construct a scale space, detect extreme points, and obtain scale invariance.
(2) Feature point filtering and precise positioning.
(3) Assign orientation values to feature points.
(4) Generate feature descriptors.

Here is the comparision of the result

(a) Using SIFT Image

7 BQ 3

To do this question, I should first know the focal length, besides I didn't use homography matrix which is not necessary when I use the translation.

(a) The panorama image

Besides I remove the black blocks.

(a) Remove the panorama image black block

Here are other examples

(a) panorama

(b) Remove the panorama image black block

(c) Remove the panorama image black block