基于图像的三维重建 - 作业 2

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1. 补充线性三角化代码后在终端运行程序结果如 Fig.1所示。

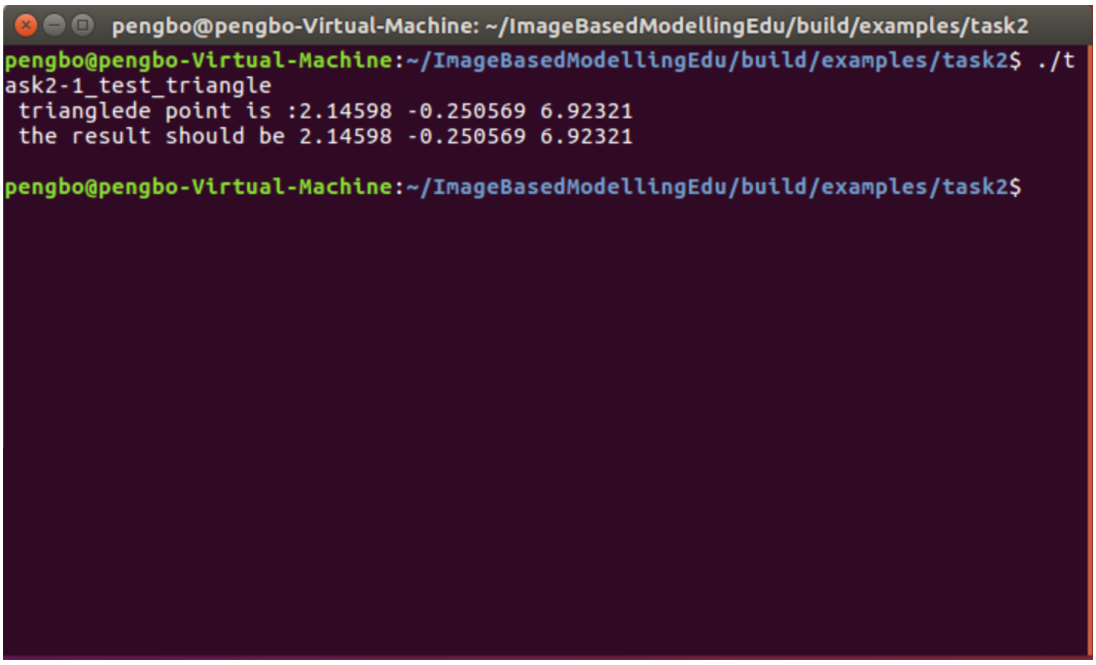

Figure 1: Task 2-1

2. 运行 Kneip 和 Ransac 进行 P3P 求解结果如 Fig.2-Fig.3。

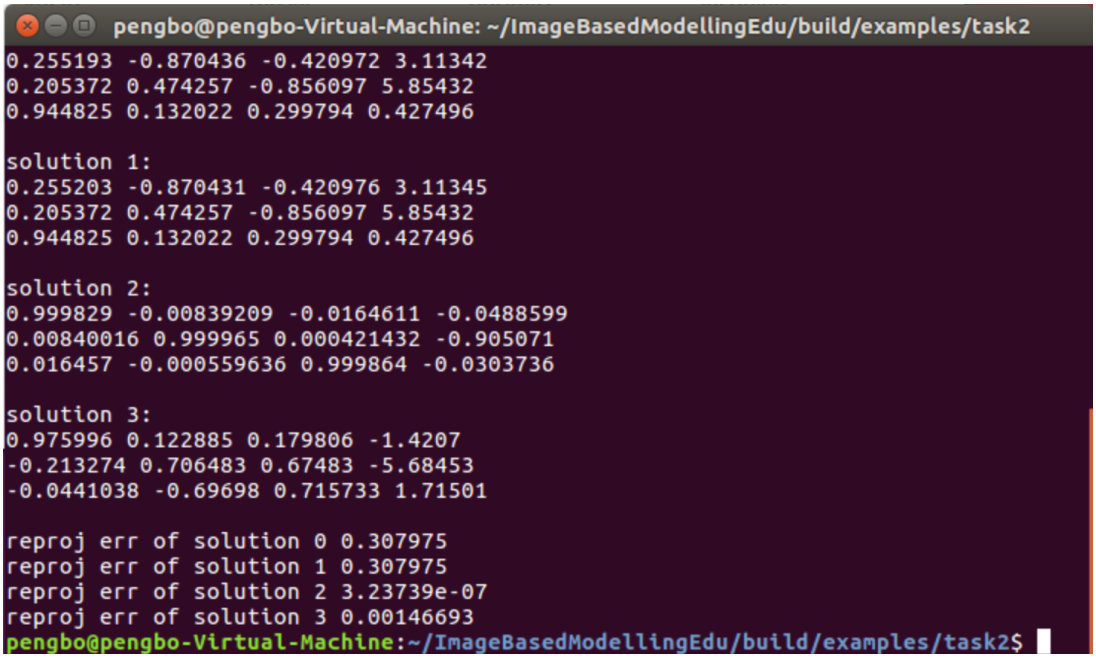

Figure 2: Task 2-2 Kneip

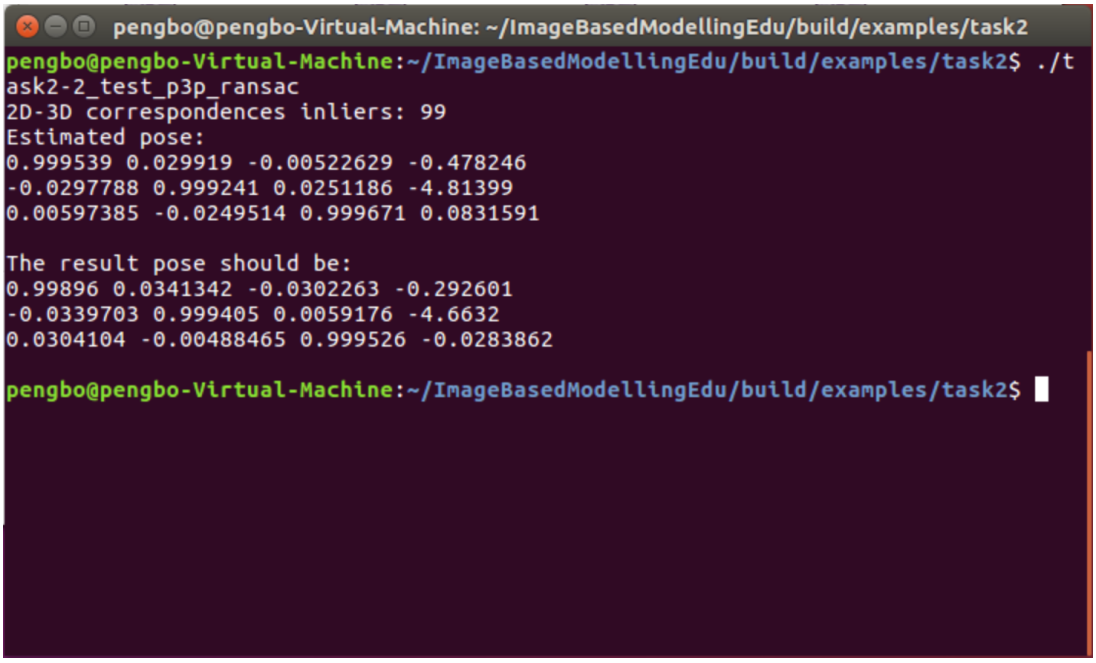

Figure 3: Task 2-2 Ransac

3. LM 算法进行 Bundle Adjustment 流程如下:

   (a) 初始化参数如重投影误差、置信域大小等;
   (b) 计算重投影误差对相机参数以及三维点位置的 Jacobian 矩阵 J_C, J_P;
   (c) 利用 Schur 补技巧求解正规方程 $(J^T J + \frac{1}{\lambda} I)\Delta x = b$, 得到迭代步长 Δx;
   (d) 尝试利用求解结果更新相机参数和三维点位置, 并计算更新后的重投影误差;
   (e) 根据重投影误差是否减小来判断是否求解成功:
      i. 如果求解成功则对相机参数和三维点位置进行更新, 同时增大置信域;
      ii. 如果求解失败则不进行更新, 同时减小置信域;
   (f) 重复以上步骤直至达到最大迭代次数或迭代步长收敛;

4. 补充计算 Jacobian 矩阵代码后得到程序运行结果如 Fig.4。

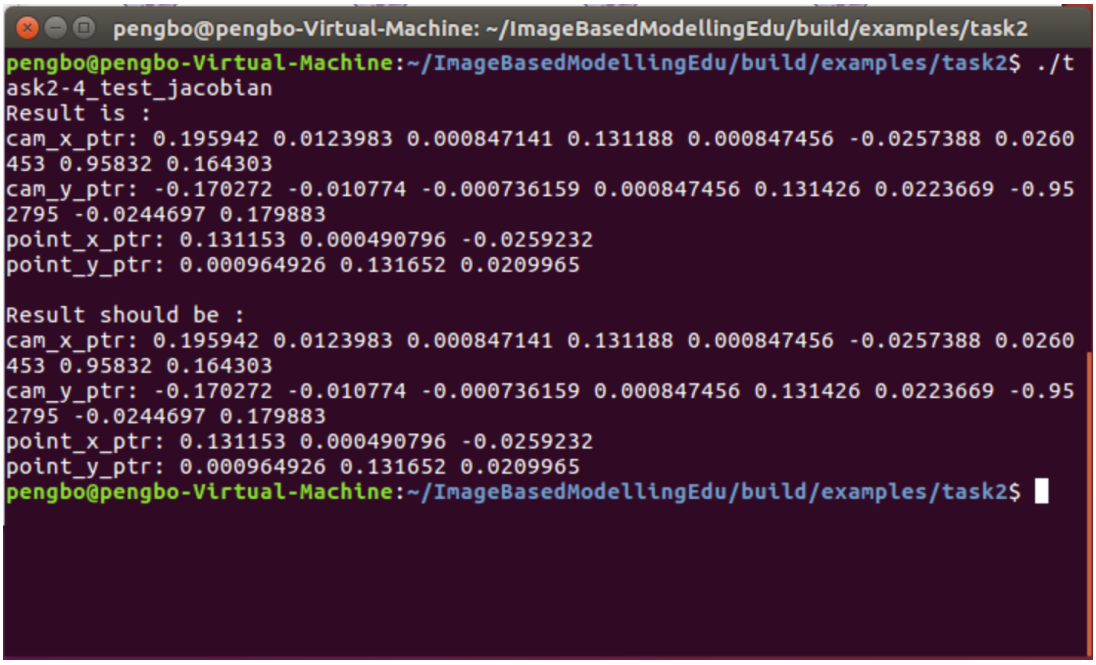

Figure 4: Task 2-4

5. 调试./task2-5_test_ba 的结果如下：

```
pengbo@pengbo-Virtual-Machine:~/ImageBasedModellingEdu/build/examples/task2$ ./task2-5_test_ba /home/pengbo/ImageBasedM
odellingEdu/examples/data/sequence/IMG_0191.JPG /home/pengbo/ImageBasedModellingEdu/examples/data/sequence/IMG_0192.JPG
Loading /home/pengbo/ImageBasedModellingEdu/examples/data/sequence/IMG_0191.JPG...
Loading /home/pengbo/ImageBasedModellingEdu/examples/data/sequence/IMG_0192.JPG...
Focal length: 0.972222 0
Focal length: 0.972222 0
focal length: f1 0.972222 f2: 0.972222
SIFT: Creating 4 octaves (0 to 4)...
SIFT: Generating keypoint descriptors...
SIFT: Generated 492 descriptors from 445 keypoints, took 209ms.
SIFT: Creating 4 octaves (0 to 4)...
SIFT: Generating keypoint descriptors...
SIFT: Generated 463 descriptors from 448 keypoints, took 205ms.
Image 1 (702x468) 492 descriptors.
Image 2 (702x468) 463 descriptors.
Consistent Sift Matches: 266
RANSAC-F: Running for 1000 iterations, threshold 0.0015...
RANSAC-F: Iteration 1, inliers 29 (10.9023%)
RANSAC-F: Iteration 4, inliers 230 (86.4662%)
RANSAC-F: Iteration 8, inliers 261 (98.1203%)
RANSAC-F: Iteration 23, inliers 262 (98.4962%)
RANSAC-F: Iteration 324, inliers 263 (98.8722%)
F: 0.0016963 -0.0705411 -0.698898
0.0543137 0.00206532 0.126149
0.685457 -0.133537 0.00329399

Number of Matching pairs is 263
E: -0.00499314 -0.0172686 0.342859
0.0237567 -0.000765821 -0.0267099
-0.342119 0.0311955 -0.00556201

P1: 0.972222 0 0 0
0 0.972222 0 0
0 0 1 0

P2: -0.95832 0.163708 -0.0061403 0.0764011
0.161803 0.951541 0.116643 0.966964
0.0263835 0.117209 -0.992757 0.0679174

A: -0.972222 0 0.180118 0
-0 -0.972222 -0.156568 -0
0.963815 -0.139297 -0.200623 -0.0622558
-0.162736 -0.955687 -0.081525 -0.969366

P1: 0.972222 0 0 0
0 0.972222 0 0
0 0 1 0
```

Figure 5: Task 2-5

```
0.0237567 -0.000765821 -0.0267099
-0.342119 0.0311955 -0.00556201

P1: 0.972222 0 0 0
0 0.972222 0 0
0 0 1 0

P2: -0.95832 0.163708 -0.0061403 0.0764011
0.161803 0.951541 0.116643 0.966964
0.0263835 0.117209 -0.992757 0.0679174

A: -0.972222 0 0.180118 0
-0 -0.972222 -0.156568 -0
0.963815 -0.139297 -0.200623 -0.0622558
-0.162736 -0.955687 -0.081525 -0.969366

P1: 0.972222 0 0 0
0 0.972222 0 0
0 0 1 0

P2: -0.95832 0.163708 -0.0061403 -0.0764011
0.161803 0.951541 0.116643 -0.966964
0.0263835 0.117209 -0.992757 -0.0679174

A: -0.972222 0 0.180118 0
-0 -0.972222 -0.156568 -0
0.963815 -0.139297 -0.200623 0.0622558
-0.162736 -0.955687 -0.081525 0.969366

P1: 0.972222 0 0 0
0 0.972222 0 0
0 0 1 0

P2: 0.972051 -0.0117274 0.013995 0.0764011
0.0119748 0.971996 -0.0172299 0.966964
-0.0141778 0.0178964 0.999739 0.0679174

A: -0.972222 0 0.180118 0
-0 -0.972222 -0.156568 -0
-0.975004 0.0154547 0.194222 -0.0622558
-0.0114732 -0.972629 -0.0181347 -0.969366

P1: 0.972222 0 0 0
0 0.972222 0 0
0 0 1 0

P2: 0.972051 -0.0117274 0.013995 0.0764011
0.0119748 0.971996 -0.0172299 0.966964
-0.0141778 0.0178964 0.999739 0.0679174
```

Figure 6: Task 2-5

```
Successful triangulation:  263 points
BA: #0  success, MSE 6.79034e-07 -> 5.44002e-08, CG  22, TRR 1000, MSE Ratio: 0.919886
BA: #1  success, MSE 5.44002e-08 -> 5.21847e-08, CG  26, TRR 3000, MSE Ratio: 0.0407265
BA: #2  success, MSE 5.21847e-08 ->  5.1636e-08, CG  32, TRR 9000, MSE Ratio: 0.0105151
BA: #3  success, MSE  5.1636e-08 -> 5.14147e-08, CG  38, TRR 27000, MSE Ratio: 0.0042852
BA: #4  success, MSE 5.14147e-08 -> 5.12402e-08, CG  42, TRR 81000, MSE Ratio: 0.00339452
BA: #5  success, MSE 5.12402e-08 ->  5.1181e-08, CG  47, TRR 243000, MSE Ratio: 0.00115461
BA: #6  success, MSE  5.1181e-08 -> 5.11757e-08, CG  38, TRR 729000, MSE Ratio: 0.00010345
BA: #7  success, MSE 5.11757e-08 -> 5.11756e-08, CG  35, TRR 2.187e+06, MSE Ratio: 1.91983e-06
BA: #8  success, MSE 5.11756e-08 -> 5.11756e-08, CG  36, TRR 6.561e+06, MSE Ratio: 2.45222e-07
BA: #9  success, MSE 5.11756e-08 -> 5.11756e-08, CG  41, TRR 1.9683e+07, MSE Ratio: 1.04848e-07
BA: #10 success, MSE 5.11756e-08 -> 5.11756e-08, CG  21, TRR 5.9049e+07, MSE Ratio: 2.32928e-08
BA: #11 success, MSE 5.11756e-08 -> 5.11756e-08, CG  10, TRR 1.77147e+08, MSE Ratio: 7.87516e-10
BA: Satisfied delta mse ratio threshold of 1e-08
BA: MSE 6.79034e-07 -> 5.11756e-08, 12 LM iters, 388 CG iters, 10ms.
# Cam 0 #
Params before BA:
  f: 0.972222
  distortion: 0, 0
  R: 1 0 0
0 1 0
0 0 1

  t: 0 0 0
Params after BA:
  f: 0.97919
  distortion: -0.0648399, 0.100804
  R: 1 -0.000287086 -0.000652844
0.000284915 0.999993 -0.00429935
0.000653779 0.00429922 0.999993

  t: 0.000631155 0.0298994 0.0223038
# Cam 1 #
Params before BA:
  f: 0.972222
  distortion: 0, 0
  R: 0.999824 -0.0120624 0.0143949
0.0123169 0.999767 -0.0177222
-0.0141778 0.0178964 0.999739

  t: 0.0785839 0.994591 0.0679174
Params after BA:
  f: 0.978153
  distortion: -0.0705936, 0.117592
  R: 0.999808 -0.0125212 0.0150941
0.0127197 0.999836 -0.0130745
-0.0149276 0.0132639 0.999803
```

Figure 7: Task 2-5

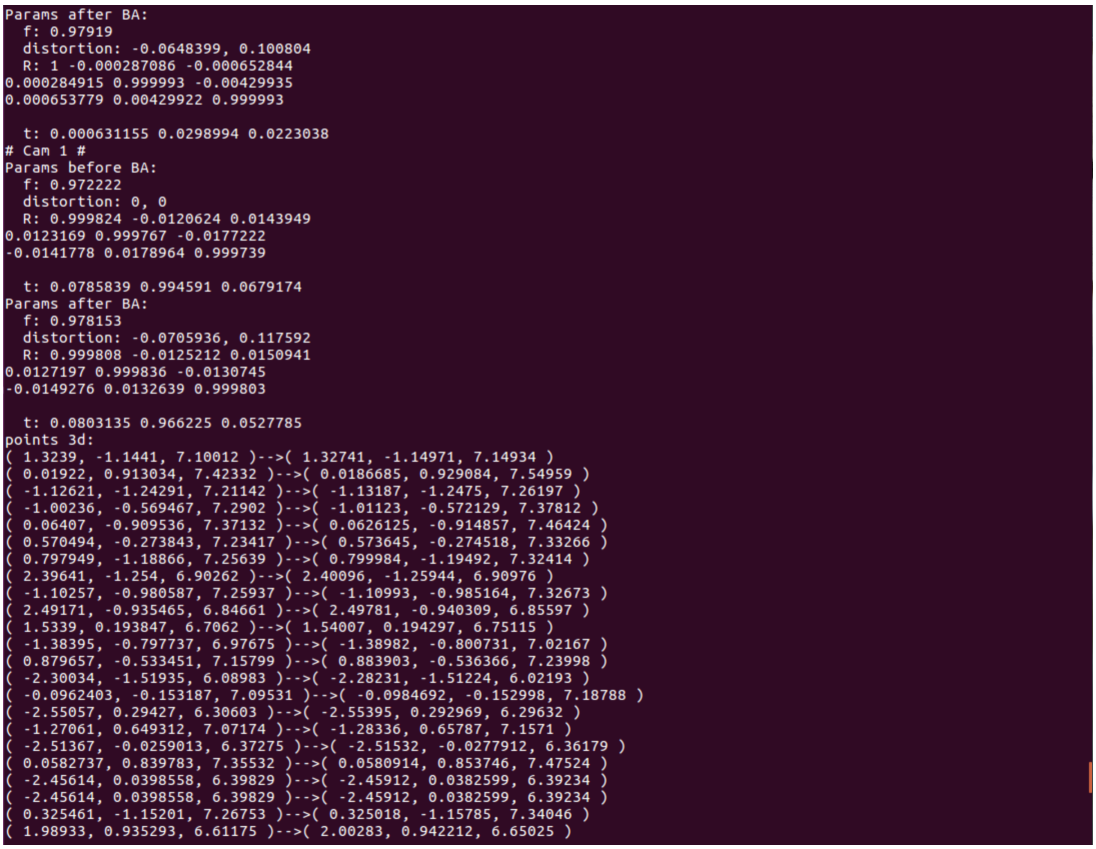

Figure 8: Task 2-5