3DCV Homework 1

r09944003 網媒所碩一 陳竣宇

Environment

> Python == 3.6
>
> OpenCV == 4.5.1
>
> Numpy == 1.19

Execution

- Part 1

```
python3 1.py $img1 $img2 $gt_correspondences $number_of_correspondences
```

- Part 2

```
python3 2.py images/document.jpg
```

Problem 1: Homography Estimation

1. The homography estimation result using **Normalized DLT**

```
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-1.png groundtruth_correspondences/correspon
dence_01.npy 4
The reprojection error is 2.784204432892689
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-1.png groundtruth_correspondences/correspon
dence_01.npy 8
The reprojection error is 0.744208700760365
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-1.png groundtruth_correspondences/correspon
dence_01.npy 20
The reprojection error is 0.37645043232119135
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-2.png groundtruth_correspondences/correspon
dence_02.npy 4
The reprojection error is 519.1098726544869
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-2.png groundtruth_correspondences/correspon
dence_02.npy 8
The reprojection error is 258.1976995302459
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-2.png groundtruth_correspondences/correspon
dence_02.npy 20
The reprojection error is 156.03423937171712
```

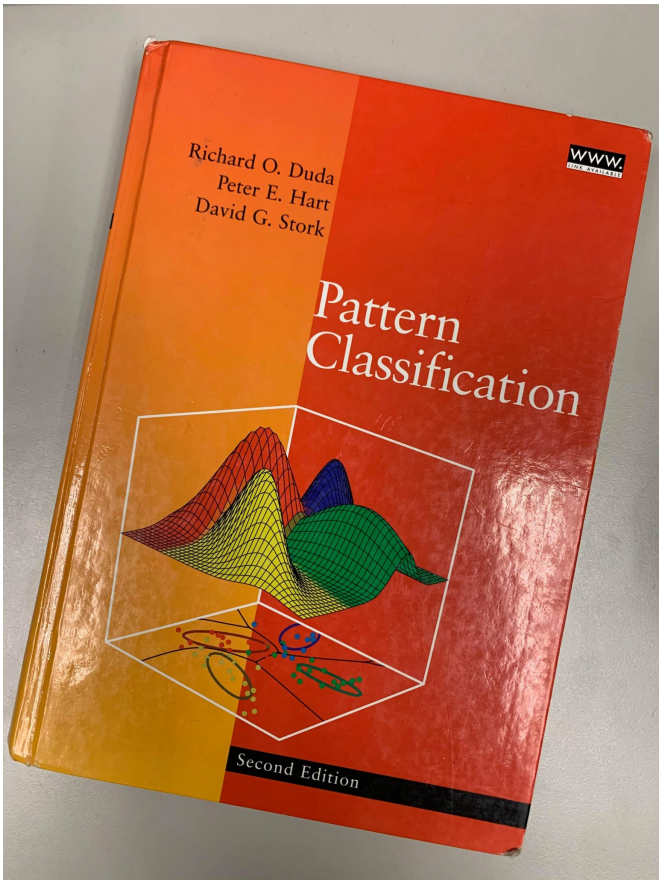
2. The homography estimation result using **DLT**

```
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-1.png groundtruth_correspondences/correspon
dence_01.npy 4
The reprojection error is 0.6636682250822565
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-1.png groundtruth_correspondences/correspon
dence_01.npy 8
The reprojection error is 0.6108098741833643
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-1.png groundtruth_correspondences/correspon
dence_01.npy 20
The reprojection error is 1176.6962090858337
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-2.png groundtruth_correspondences/correspon
dence_02.npy 4
The reprojection error is 595.0824332992332
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-2.png groundtruth_correspondences/correspon
dence_02.npy 8
The reprojection error is 737.0899434056165
Andyde-MacBook-Pro:homework1-Andychen3558 andy$ python3 1.py images/1-0.png images/1-2.png groundtruth_correspondences/correspon
dence_02.npy 20
The reprojection error is 612.523819850837
```

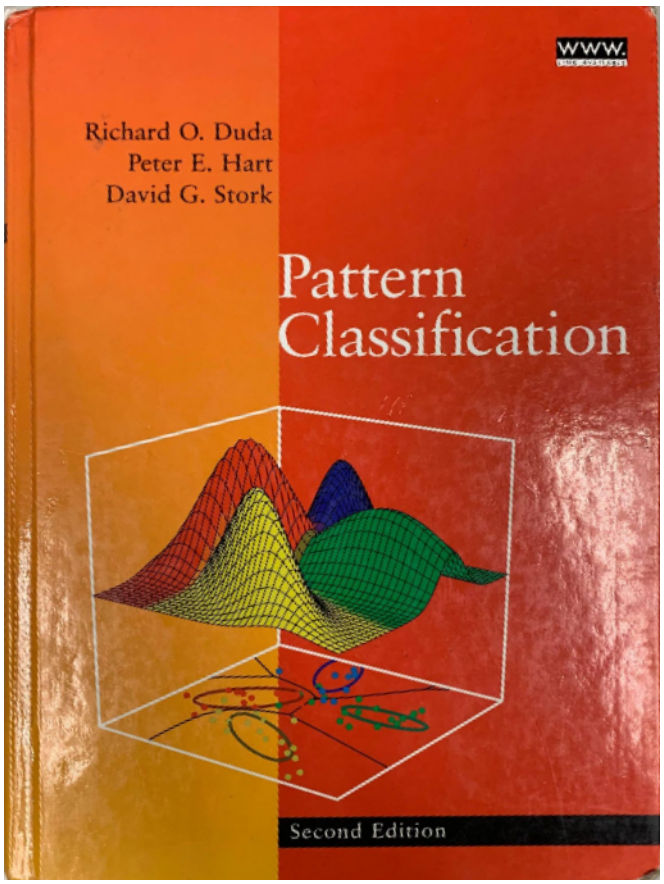
3. Discussion
    - 從reproduction error的結果可以發現Normalized DLT比單純的DLT更穩定，並且結果也更準確一些。我認為原因是因為在計算matrix A的時其中會包含圖片座標點的乘積，如果source image和target image有不同scale的話會使得variance變得很大，在正常存在noise的情況下直接做DLT就會使估測的結果更不穩定、準確。
    - 在做了多次實驗後發現sample的correspondences數目愈多結果通常會愈好，但是隨機取樣可能會導致取到outlier，導致error直接噴掉，未來可能可以去設計更好去除outlier的方法來讓結果更穩定。

Problem 2: Document Rectification

1. The input document image



2. Rectified results



3. Method
    - 我使用助教提供的 mouse_click 範例程式來取得4個corner，並且因為原圖較大所以我有做一個resize成三分之一大小的處理。依循作業投影片的步驟做完backward warping和bilinear interpolation後就能得到最終的結果。
    - 執行效率方面，我也嘗試了one-by-one地去warp每個pixel，而這樣的做法就導致warp一張圖就至少要花10秒以上的時間，後來修正為使用numpy的平行運算能力來做矩陣相乘，最終使這個task可以在0.2秒左右完成。