電腦視覺Assignment 2

Method Describtion

解題思路如下

- 1. 透過2D-to-3D的對應點組合,以及 AP = 0 的矩陣運算, 得出A矩陣,維度為 596×12
- 2. 計算min (AP)'(AP) = min P'A'AP 進而得出Projection Matrix P
- 3. 計算 A'A的eigenvalues以及eigenvectors
- 4. 將eigenvectors根據eigenvalue的大小排列
- 5. 最小的eigenvalue所對應的eigenvector就是P矩陣
- 6. 使用QR Decomposition,從P矩陣反推回calibration matrix、translation matrix、rotation matrix(P = K [R | T])
- 7. 根據P矩陣計算投影點,然後計算projection error

Experimental Results

透過讀取資料(預先將資料存成.txt),將XYZ以及xy之值填入A 矩陣

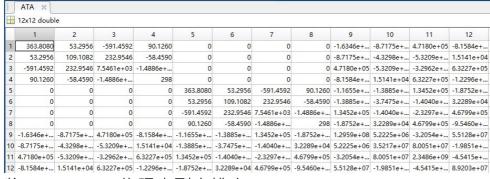
一組2D-to-3D的資料可以將參數寫成一個2 x 12的矩陣,再將P矩陣從3 x 4變成12 x 1的矩陣,兩者相乘後得到0。 A的參數欄位所代表的涵義如下:

X, Y, Z, 1, 0, 0, 0, 0, -xX, -xY, -xZ, -x

0, 0, 0, 0, X, Y, Z, 1, -yX, -yY, -yZ, -y

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.4890	1.0940	-5.8960	1	0	0	0	0	-825.4554	-606.4797	3.2686e+03	-554.3690
2	0	0	0	0	1.4890	1.0940	-5.8960	1	-244.0426	-179.3033	966.3367	-163.8970
3	1.1390	0.9360	-5.6280	1	0	0	0	0	-592.6479	-487.0223	2.9284e+03	-520.3230
4	0	0	0	0	1.1390	0.9360	-5.6280	1	-200.9993	-165.1759	993.1732	-176.4700
5	-1.0940	0.7380	-4.5310	1	0	0	0	0	244.5123	-164.9452	1.0127e+03	-223.5030
6	0	0	0	0	-1.0940	0.7380	-4.5310	1	195.4168	-131.8260	809.3544	-178.6260
7	1.2640	0.2780	-5.4720	1	0	0	0	0	-681.4300	-149.8715	2.9500e+03	-539.1060
8	0	0	0	0	1.2640	0.2780	-5.4720	1	-320.6212	-70.5164	1.3880e+03	-253.6560
9	1.5520	-0.1320	-5.8480	1	0	0	0	0	-873.7434	74.3132	3.2923e+03	-562.9790
10	0	0	0	0	1.5520	-0.1320	-5.8480	1	-470.6875	40.0327	1.7736e+03	-303.2780
11	1.5120	-0.1870	-5.8470	1	0	0	0	0	-845.0523	104.5137	3.2679e+03	-558.8970
12	0	0	0	0	1.5120	-0.1870	-5.8470	1	-467.9443	57.8741	1.8096e+03	-309.4870
13	1.8520	-0.5330	-5.6580	1	0	0	0	0	-1.1206e+	322.5007	3.4235e+03	-605.0670
14	0	0	0	0	1.8520	-0.5330	-5.6580	1	-650.6872	187.2658	1.9879e+03	-351.3430
15	1.1100	1.0160	-5.6530	1	0	0	0	0	-573.2429	-524.6980	2.9194e+03	-516.4350
16	0	0	0	0	1.1100	1.0160	-5.6530	1	-186.0626	-170.3060	947.5785	-167.6240
17	1.8210	0.4480	-5.8160	1	0	0	0	0	-1.0818e+	-266.1317	3.4550e+03	-594.0440
18	0	0	0	0	1.8210	0.4480	-5.8160	1	-431.0744	-106.0524	1.3768e+03	-236.7240

透過A'*A,得出一個12 x 12的方正矩陣



將eigenvalues依照小到大排序

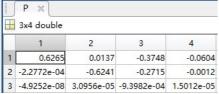
	Ds ×											
12x12 double												
	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0028	0	0	0	0	0	0	0	0	0	0	0
2	0	0.2174	0	0	0	0	0	0	0	0	0	0
3	0	0	1.3731	0	0	0	0	0	0	0	0	0
4	0	0	0	9.0207	0	0	0	0	0	0	0	0
5	0	0	0	0	47.6157	0	0	0	0	0	0	0
6	0	0	0	0	0	101.3677	0	0	0	0	0	0
7	0	0	0	0	0	0	782.1566	0	0	0	0	0
8	0	0	0	0	0	0	0	7.4922e+03	0	0	0	0
9	0	0	0	0	0	0	0	0	4.8916e+05	0	0	0
10	0	0	0	0	0	0	0	0	0	2.7977e+07	0	0
11	0	0	0	0	0	0	0	0	0	0	9.0045e+07	0
12	0	0	0	0	0	0	0	0	0	0	0	2.4841e+09

依照eigenvalues的index下去對eigen vector排序。這裡剛好eigenvalues就是從小到大,所以順序在排序過後並無更動。

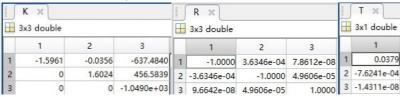
	Vs ×												
	12x12 double												
	1	2	3	4	5	6	7	8	9	10	11	12	
1	0.6265	0.1120	0.0081	0.0454	0.5437	-0.3801	-0.3902	0.0208	-0.0021	-1.0496e-04	0.0011	-1.9967e-04	
2	0.0137	0.0895	0.0770	0.9115	-0.0010	0.3461	-0.1850	-0.0323	0.0010	0.0013	3.0532e-04	2.2062e-05	
3	-0.3748	0.0843	0.1191	-0.2294	0.1150	0.1741	-0.6417	-0.5746	-0.0047	-0.0019	-2.7612e-04	0.0014	
4	-0.0604	0.7354	0.6388	-0.0748	0.0048	-0.0340	0.1646	0.1163	0.0021	2.8686e-04	-5.8274e-05	-2.6141e-04	
5	-2.2772e-04	0.0157	-0.0933	-0.1326	0.6953	0.5704	0.3950	-0.0931	0.0012	-3.2992e-04	0.0011	-6.0285e-05	
6	-0.6241	-0.0443	-0.0540	0.2695	0.4232	-0.5721	0.1630	0.0111	6.5460e-04	7.9145e-04	4.6195e-04	5.7116e-05	
7	-0.2715	0.0821	-0.1565	-0.1355	0.1220	0.2222	-0.4357	0.7891	3.2133e-04	2.0346e-04	0.0022	9.5631e-04	
8	-0.0012	0.6500	-0.7318	0.0197	-0.1172	-0.0471	0.0462	-0.1528	9.6742e-04	-1.0096e-04	-5.5251e-04	-1.9181e-04	
9	-4.9252e-08	1.3852e-05	-1.2964e-04	-2.8882e-04	0.0018	5.9397e-04	-6.1500e-04	0.0016	-0.0588	0.2798	-0.9485	0.1367	
10	3.0956e-05	1.9971e-04	3.9800e-05	0.0019	3.3518e-04	-2.1179e-04	0.0011	0.0021	-0.1032	-0.9539	-0.2798	-0.0330	
11	-9.3982e-04	1.6459e-04	-3.8369e-05	-1.9145e-04	2.5153e-04	6.8347e-04	-5.4961e-04	6.1236e-04	-0.1929	0.0847	-0.1031	-0.9721	
12	1.5012e-05	0.0017	-3.8148e-05	0.0016	-8.1076e-04	4.8842e-04	0.0046	0.0025	-0.9740	0.0674	0.1074	0.1878	

最小的eigenvalue為Ds(1,1),其對應的eigenvector為

Vs(:,1),將其assign給P,並且重新reshape成3 x 4的矩陣



使用QR Decomposition求出K、R、T



XYZ座標投影後對應的xy座標,先將前兩個row除以第三個row,讓第三個dimention變成1

	P × thre	e_z × th	ree_y × t	hree_x ×	two_x ×	two_y ×	test_xyz1	× px ×	xnorm ×				
= 3	3x298 double												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	554.0720	520.3899	224.0299	539.3078	563.2816	558.7940	604.4479	516.4304	594.4597	546.4261	500.1045	498.3951	560.4573
2	163.9475	176.7000	178.9059	253.6909	302.9848	309.3182	351.2290	167.7957	236.1894	253.8336	255.5485	271.7871	298.1089
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Projection Error(使用second norm的平均下去計算)

x	у
0.0304	0.0213

Discussion of results

以projection error來說,在x座標的投影,平均有0.0304的誤差; y座標的投影,平均有0.0213的誤差。這樣的誤差值,Projection Matrix P應該算有一定程度的準確,具有參考價值。

Problem and difficulties

- 1. 透過AP = 0去推導的P矩陣·再將其推導成P = K[R | T]· 從第三個row來觀察·數值基本上都很小·但就衍生出一 個問題·sin(phi)以及cos(phi)會趨近於0·在數學上是不 合理的。但是可以透過QR decomposition下去求出K、 R、T,這個問題還尚未想出來。
- 2. 以K來說,對角線上的Fx以及Fy代表為焦距,但焦距出現 負數。