Joshua Genova
CIVE 6374 – Optical Imaging Metrology
Spring 2023

Lab #2

Tasks 1-4:

Image 27	
Fiducial Coordinates	
X	Y
-9.4492	96.2439
85.0325	103.7430
-2.3240	-6.0007
105.9490	-0.4074
18.9146	-81.8141
90.2871	-91.0456
18.1697	109.5464
44.6791	7.4901
-7.5846	-49.0707
52.7325	-93.1360

Image 28	
Fiducial Coordinates	
X	Y
-105.3835	98.7624
-10.1310	109.6993
-95.0282	-4.8416
10.3289	4.0189
-72.5433	-79.7803
-1.4113	-86.9362
-77.8452	113.3822
-48.7951	10.1706
-98.8174	-48.0328
-38.9301	-90.0300

Principal Point Offset		
X	**Y**	**Radius**
-9.4431576	96.23791684	96.7001027
85.03847611	103.7369713	134.137622
-2.31797657	-6.00665112	6.43839056
105.9550442	-0.41335267	105.955851
18.92058979	-81.82010003	83.9792682
90.29311622	-91.05162049	128.231215
18.17574591	109.5404195	111.038107
44.68509712	7.48408807	45.3074991
-7.57860784	-49.07673555	49.6584461
52.73847417	-93.14201246	107.036354

Principal Point Offset		
X	**Y**	**Radius**
-105.3775	98.7564	144.4204
-10.1250	109.6933	110.1595
-95.0222	-4.8476	95.1458
10.3349	4.0129	11.0867
-72.5373	-79.7863	107.8309
-1.4053	-86.9422	86.9535
-77.8392	113.3762	137.5249
-48.7891	10.1646	49.8367
-98.8114	-48.0388	109.8700
-38.9241	-90.0360	98.0896

Radial Lens Distortion Correction	
Δxrad	**Δyrad**
-7.6902E-05	7.8373E-04
1.3599E-03	1.6589E-03
2.0432E-04	5.2947E-04
1.7501E-03	-6.8277E-06
-1.3547E-04	5.8582E-04
1.8384E-03	-1.8539E-03
3.5833E-04	2.1596E-03
-2.6645E-03	-4.4626E-04
4.1149E-04	2.6647E-03
9.1187E-04	-1.6105E-03

Radial Lens Distortion Correction	
Δxrad	**Δyrad**
-1.3380E-04	1.2539E-04
-1.9485E-04	2.1110E-03
-6.1496E-04	-3.1372E-05
-8.9821E-04	-3.4876E-04
-1.2932E-03	-1.4224E-03
4.6325E-06	2.8660E-04
-9.4982E-04	1.3834E-03
2.6381E-03	-5.4962E-04
-1.8855E-03	-9.1664E-04
-3.7291E-04	-8.6258E-04

Radial Lens Distortion Correction w/ Principal Point	
x_corrected	**y_corrected**
-9.4432	96.2387
85.0398	103.7386
-2.3178	-6.0061
105.9568	-0.4134
18.9205	-81.8195
90.2950	-91.0535
18.1761	109.5426
44.6824	7.4836
-7.5782	-49.0741
52.7394	-93.1436

Radial Lens Distortion Correction w/ Principal Point	
x_corrected	**y_corrected**
-105.3776	98.7566
-10.1252	109.6954
-95.0228	-4.8476
10.3340	4.0125
-72.5386	-79.7877
-1.4053	-86.9419
-77.8401	113.3775
-48.7865	10.1641
-98.8133	-48.0397
-38.9245	-90.0369

Decentering Lens Distortion Correction	
Δxdec	**Δydec**
-1.2604E-03	-9.6536E-05
-4.5845E-03	-2.8585E-03
-7.3668E-06	-5.1388E-06
-4.5322E-03	-1.2563E-04
-1.0077E-03	1.6654E-04
-4.2067E-03	1.8090E-03
-1.7972E-03	-9.8062E-04
-8.2202E-04	-1.1652E-04
-3.5648E-04	-1.8927E-04
-2.1706E-03	9.6975E-04

Decentering Lens Distortion Correction	
Δxdec	**Δydec**
-5.5419E-03	2.3074E-03
-1.6338E-03	-1.4411E-04
-3.6604E-03	-2.3538E-04
-4.6313E-05	-1.3063E-05
-3.1232E-03	-1.8561E-03
-1.0212E-03	-3.1048E-04
-3.9607E-03	1.8296E-03
-9.6296E-04	1.0057E-04
-4.3694E-03	-1.4821E-03
-1.7887E-03	-1.2596E-03

Decentering Lens Distortion Correction w/ Principal Point	
x_corrected	**y_corrected**
-9.4444	96.2378
85.0339	103.7341
-2.3180	-6.0067
105.9505	-0.4135
18.9196	-81.8199
90.2889	-91.0498
18.1739	109.5394
44.6843	7.4840
-7.5790	-49.0769
52.7363	-93.1410

Decentering Lens Distortion Correction w/ Principal Point	
x_corrected	**y_corrected**
-105.3830	98.7588
-10.1266	109.6931
-95.0259	-4.8478
10.3349	4.0128
-72.5404	-79.7882
-1.4063	-86.9425
-77.8431	113.3780
-48.7901	10.1647
-98.8158	-48.0403
-38.9259	-90.0372

Atmospheric Refraction Correction	
Δxatm	Δyatm
1.5957E-04	-1.6262E-03
-1.8148E-03	-2.2138E-03
2.8076E-05	7.2754E-05
-1.8926E-03	7.3835E-06
-2.9737E-04	1.2859E-03
-1.8550E-03	1.8706E-03
-3.3497E-04	-2.0188E-03
-5.8744E-04	-9.8387E-05
1.0124E-04	6.5560E-04
-9.4828E-04	1.6748E-03

Atmospheric Refraction Correction	
Δxatm	Δyatm
2.4040E-03	-2.2530E-03
1.8559E-04	-2.0106E-03
1.5911E-03	8.1171E-05
-1.2561E-04	-4.8773E-05
1.3106E-03	1.4416E-03
2.2454E-05	1.3892E-03
1.6980E-03	-2.4732E-03
6.5220E-04	-1.3588E-04
1.8079E-03	8.7895E-04
6.6316E-04	1.5340E-03

Atmospheric Refraction Correction w/ Principal Point	
x_corrected	y_corrected
-9.4430	96.2363
85.0367	103.7348
-2.3179	-6.0066
105.9532	-0.4133
18.9203	-81.8188
90.2913	-91.0497
18.1754	109.5384
44.6845	7.4840
-7.5785	-49.0761
52.7375	-93.1403

Atmospheric Refraction Correction w/ Principal Point	
x_corrected	y_corrected
-105.3751	98.7542
-10.1248	109.6912
-95.0206	-4.8475
10.3348	4.0128
-72.5360	-79.7849
-1.4053	-86.9408
-77.8375	113.3737
-48.7884	10.1645
-98.8096	-48.0379
-38.9235	-90.0345

Total Correction	
x'	y'
-9.4443	96.2370
85.0334	103.7336
-2.3178	-6.0061
105.9504	-0.4135
18.9191	-81.8181
90.2889	-91.0498
18.1740	109.5396
44.6810	7.4834
-7.5785	-49.0736
52.7363	-93.1410

Total Correction	
x'	y'
-105.3808	98.7566
-10.1267	109.6932
-95.0249	-4.8477
10.3339	4.0124
-72.5404	-79.7881
-1.4063	-86.9408
-77.8424	113.3769
-48.7868	10.1640
-98.8159	-48.0403
-38.9256	-90.0366

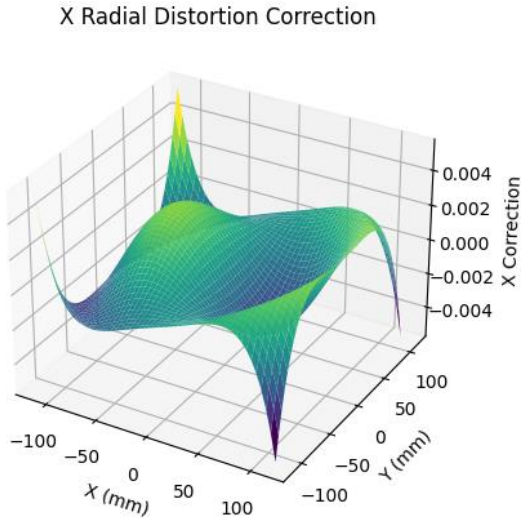
Task 5:

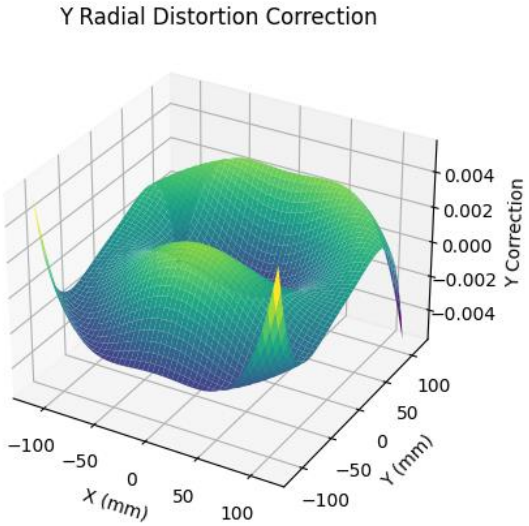
The maximum magnitude occurs at the corners of the image from the center (0,0) at the principal point. In mm, point (114.3, 114.3) was used to find distortion values.

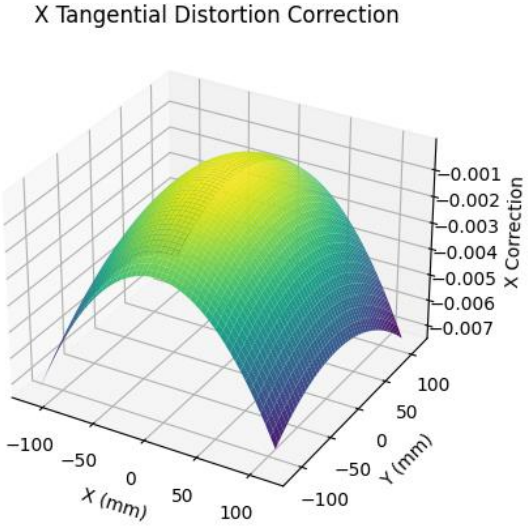
Max Magnitude	
max radial distortion x	0.00552854327567554
max radial distortion y	0.00552854327567554
max tangential distortion x	0.00735374013120000
max tangential distortion y	0.00415659813840000
max atmospheric refraction x	0.00291735710134084
max atmospheric refraction y	0.00291735710134084

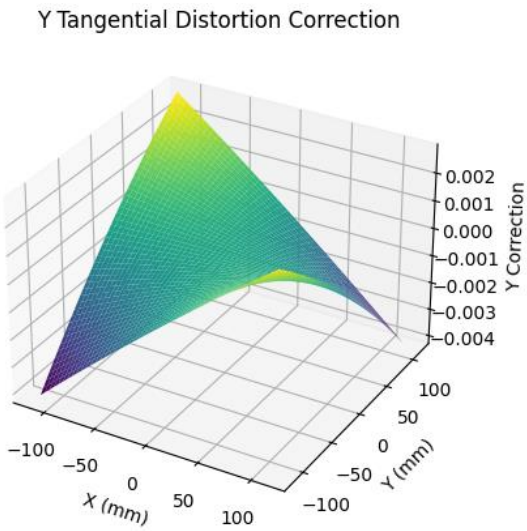
Max Magnitude (Ground)	
max radial distortion x	27.6427163783777
max radial distortion y	27.6427163783777
max tangential distortion x	36.7687006560000
max tangential distortion y	20.7829906920000
max atmospheric refraction x	14.5867855067042
max atmospheric refraction y	14.5867855067042

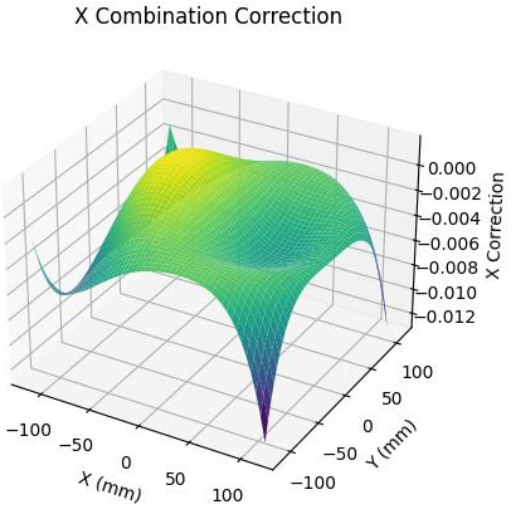
Task 6:

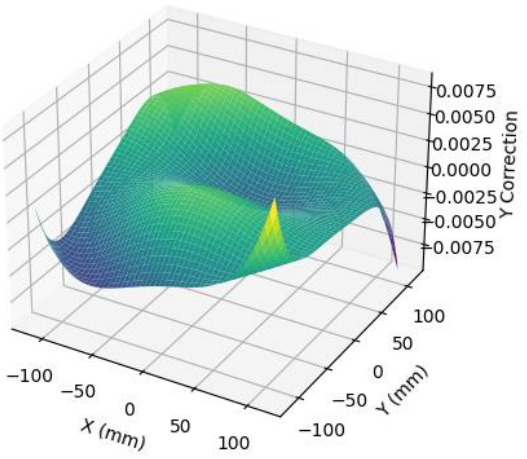

X Radial Distortion Correction
X Correction
0.004
0.002
0.000
−0.002
−0.004
X (mm)
−100
−50
0
50
100
Y (mm)
−100
−50
0
50
100


Y Radial Distortion Correction
Y Correction
0.004
0.002
0.000
−0.002
−0.004
X (mm)
−100
−50
0
50
100
Y (mm)
−100
−50
0
50
100

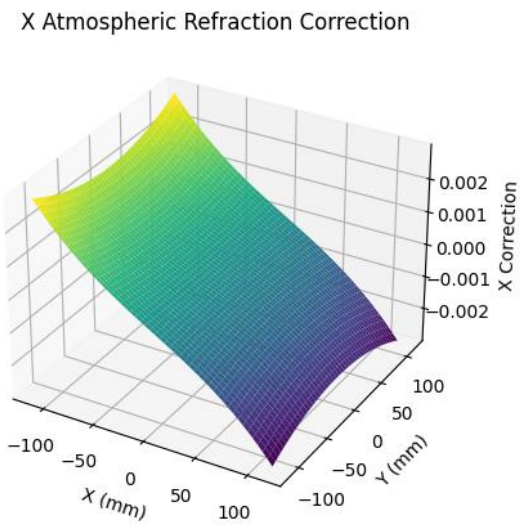

X Tangential Distortion Correction
X Correction
−0.001
−0.002
−0.003
−0.004
−0.005
−0.006
−0.007
X (mm)
−100
−50
0
50
100
Y (mm)
−100
−50
0
50
100

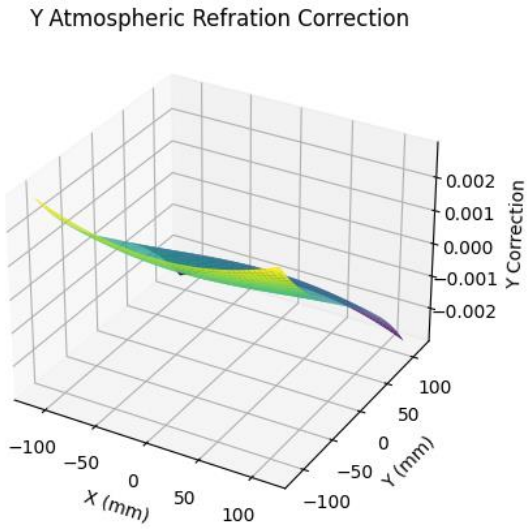

Y Tangential Distortion Correction
Y Correction
0.002
0.001
0.000
−0.001
−0.002
−0.003
−0.004
X (mm)
−100
−50
0
50
100
Y (mm)
−100
−50
0
50
100


X Combination Correction
X Correction
0.000
−0.002
−0.004
−0.006
−0.008
−0.010
−0.012
X (mm)
−100
−50
0
50
100
Y (mm)
−100
−50
0
50
100


Y Combination Correction
Y Correction
0.0075
0.0050
0.0025
0.0000
−0.0025
−0.0050
−0.0075
X (mm)
−100
−50
0
50
100
Y (mm)
−100
−50
0
50
100

Task 7:





Questions:

Given the results from task 5. Which of the corrections are significant, and why? What are the magnitudes of these corrections in ground coordinates?

Pixel size is approximately 6-7 µm and looking at all three corrections are in the millimeters, all three of them are significant. Multiplying the coordinate with the scale number of 5000, we get:

Max Magnitude (Ground)	
max radial distortion x	27.6427163783777
max radial distortion y	27.6427163783777
max tangential distortion x	36.7687006560000
max tangential distortion y	20.7829906920000
max atmospheric refraction x	14.5867855067042
max atmospheric refraction y	14.5867855067042