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CIVE 6374 – Optical Imaging Metrology
Spring 2023

Lab #1

Similarity Transformation

Image 1:

Linear Parameters	
A	0.011900345291064388
B	-8.201523670845944e-07

Non-Linear Parameters	
delta X	-122.02106658407746
delta Y	123.5194188719563
scale	0.011900345319326168
theta	-6.891836713359218e-05

	Residuals	
	rx	ry
	-0.02201928	0.00325566
	0.00814344	-0.00970481
	0.00749126	-0.00799414
	0.00933476	0.01244288
	-0.00948903	-0.01385582
	0.00851353	0.00640585
	-0.00071906	-0.00362487
	-0.00125562	0.01307524
RSME	0.0103624113	0.0096218145

Transformation Residuals:

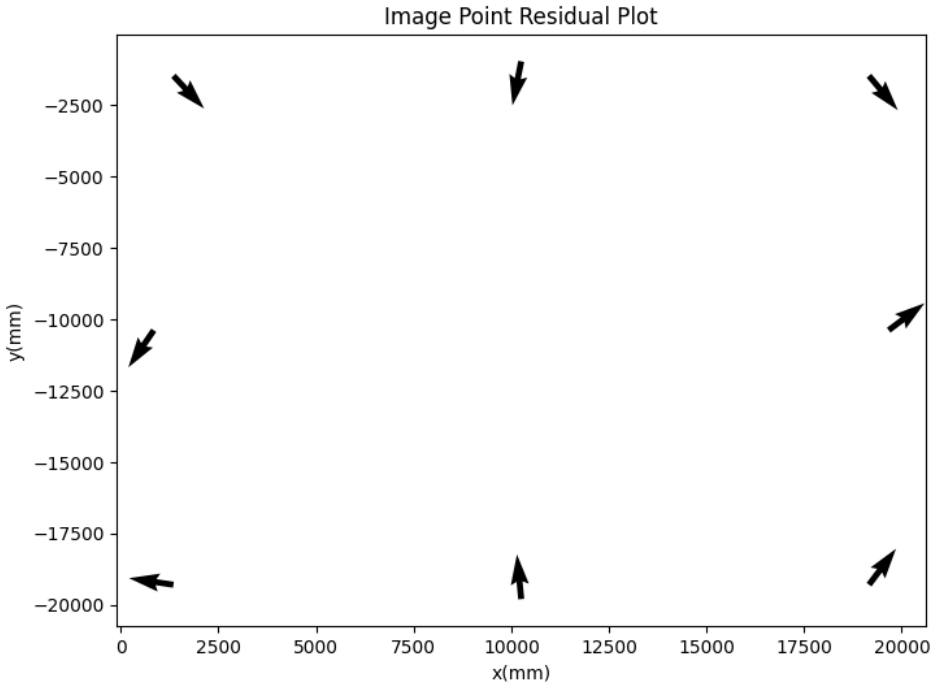


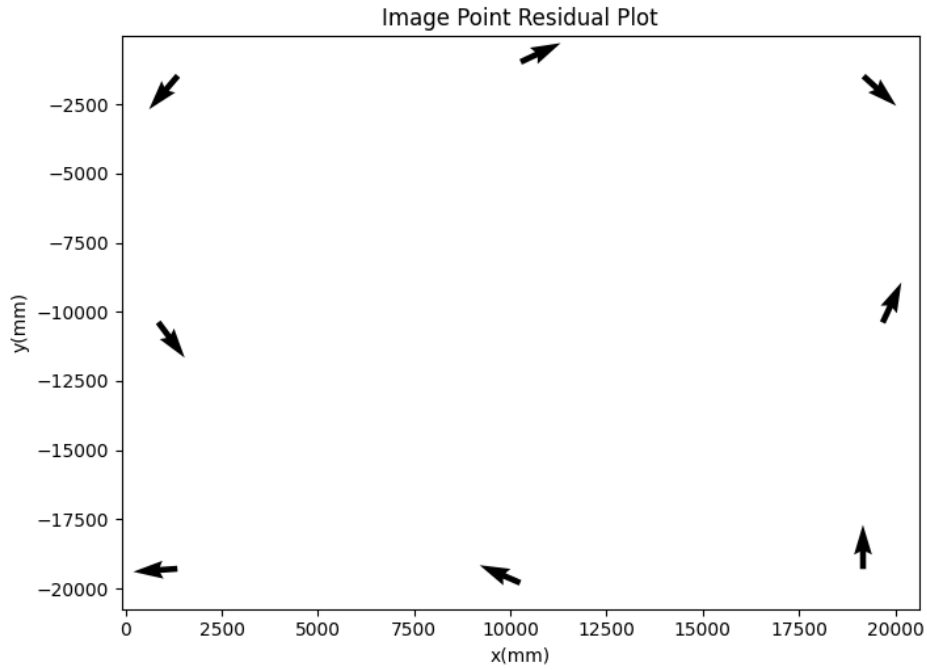
Image 2:

Linear Parameters	
A	0.011900560590614725
B	7.929957611461198e-06

Non-Linear Parameters	
delta X	-122.19148942643244
delta Y	123.50773873701652
scale	0.01190056323268441
theta	0.0006663515031398629

	Residuals	
	rx	ry
	-0.01149715	-0.00079116
	0.00952796	-0.00863624
	-0.00695469	-0.00810964
	-0.00002244	0.00958280
	0.00629211	-0.00843917
	0.00463133	0.00992026
	0.00618257	0.00291809
	-0.00815969	0.00355507
RSME	0.0073923864	0.0072766039

Transformation Residuals:



Affine Transformation

Image 1:

Linear Parameters	
A	0.011899426266928173
B	2.9976774439538446e-07
C	-1.3405013290104452e-06
D	0.011901264695956251

Non-Linear Parameters	
delta X	-122.01704301790505
delta Y	123.53429666924897
theta	-0.00011265260133301382
Scale X	0.011899426342433654
Scale Y	0.011901264699731509
delta	-8.746471147506922e-05

	Residuals	
	rx	ry
	-0.00919658	-0.00029857
	-0.00467785	-0.00615038
	0.01104291	0.00482938
	0.00578124	-0.00038110
	-0.00083769	-0.00895958
	-0.00013732	0.00150928
	-0.00561595	0.00502821
	0.00364125	0.00442276
RSME	0.0061982466	0.0048577279

Transformation Residuals:

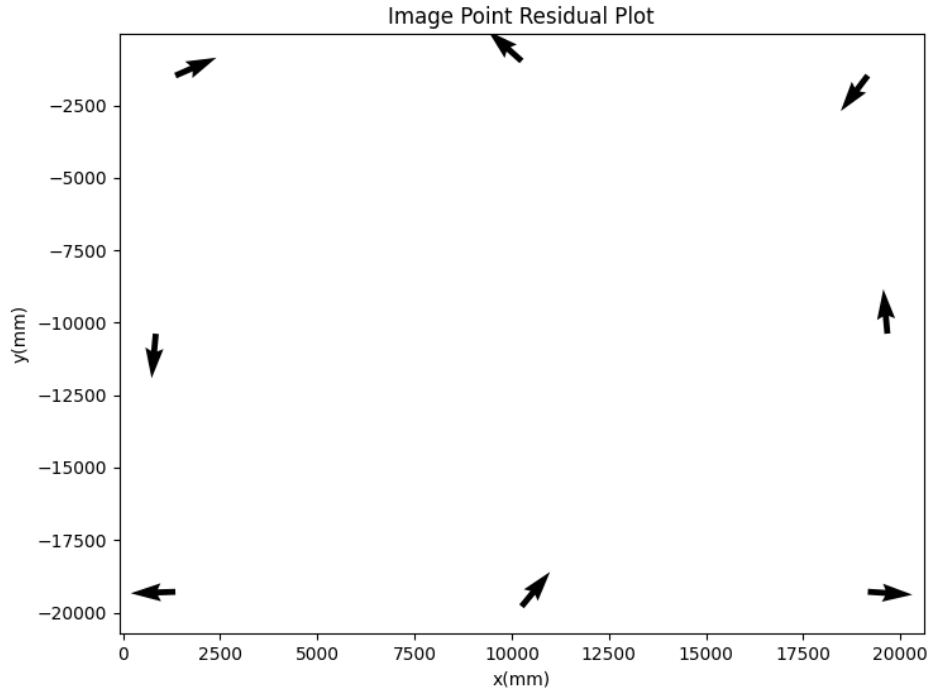


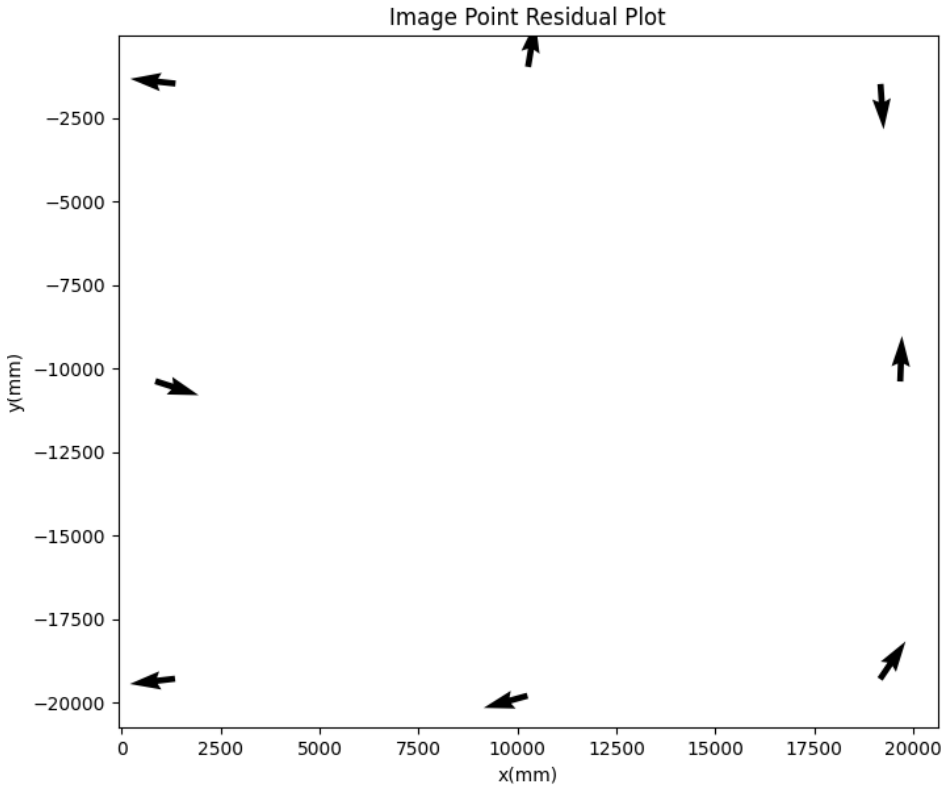
Image 2:

Linear Parameters	
A	0.011900088285313321
B	-8.456447779618067e-06
C	7.403491422691079e-06
D	0.01190103306007299

Non-Linear Parameters	
delta X	-122.19211044565907
delta Y	123.5180472905358
theta	0.0006221374404963093
Scale X	0.011900090588307996
Scale Y	0.011901036064497045
delta	-8.842661841425235e-05

	Residuals	
	rx	ry
	-0.00260047	-0.00030380
	0.00063179	-0.00912382
	-0.00744257	0.00078797
	0.00046544	0.00068544
	0.01073407	-0.00348187
	0.00018888	0.00496268
	0.00122419	0.00736117
	-0.00320133	-0.00088777
RSME	0.0048704880	0.0046924648

Transformation Residuals:



Projective Transformation

Image 1:

Linear Parameters	
A	0.011899732951937627
B	2.9978635866588186e-07
C	-1.3405211789106213e-06
D	0.011901571374376804

Non-Linear Parameters	
delta X	-122.02143728211016
delta Y	123.53441906740015
theta	-0.00011265136609824447
Scale X	0.011899733027443399
Scale Y	0.011901264699731509
delta	-8.746256126127167e-05
out of plane inclination	-1.6981132050401598e-09, -4.161073366984031e-09

	Residuals	
	rx	ry
	-0.00491437	0.00217308
	-0.00039500	-0.00367894
	0.00746852	0.00409349
	0.00220721	-0.00111716
	-0.00029656	-0.01202081
	0.00040408	-0.00155118
	-0.00686542	0.00635347
	0.00239154	0.00574805
RSME	0.0041542495	0.0056631955

Transformation Residuals:

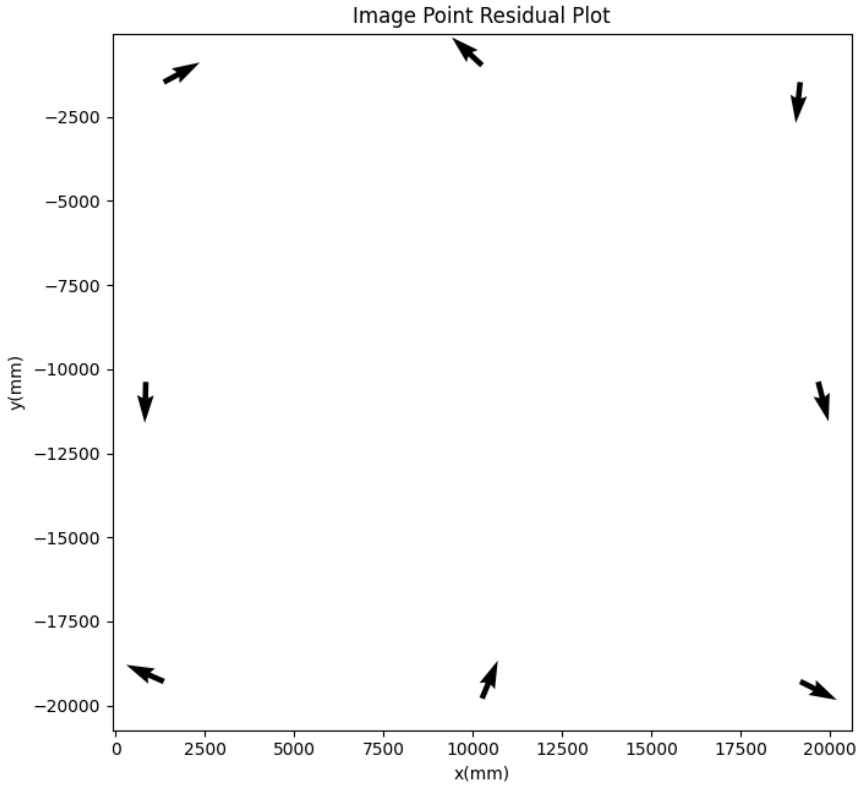


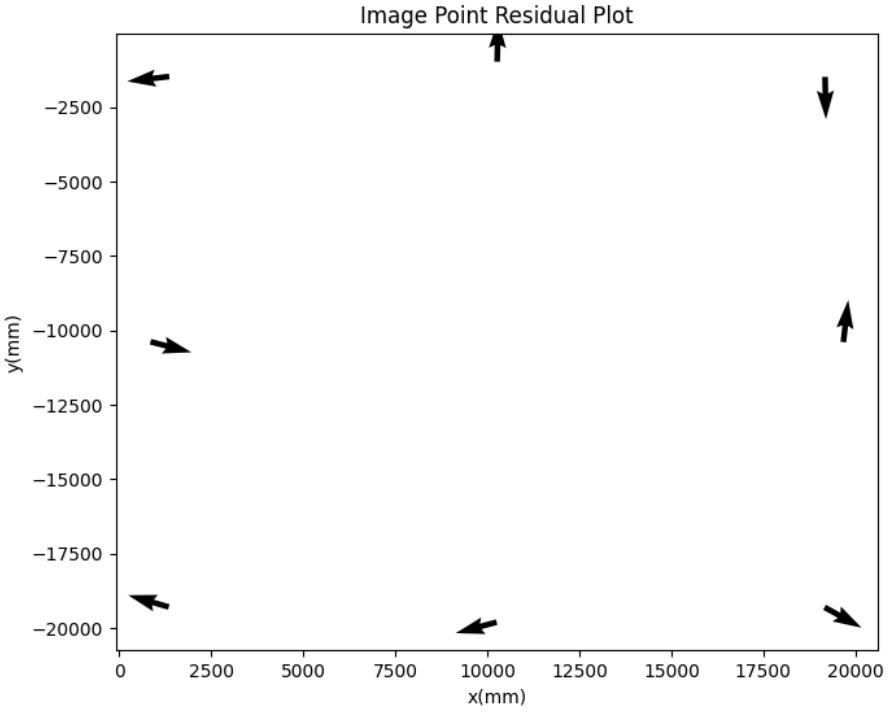
Image 2:

Linear Parameters	
A	0.011899813026750236
B	-8.456250027531595e-06
C	7.403307477712062e-06
D	0.011900757797657747

Non-Linear Parameters	
delta X	-122.19034233291353
delta Y	123.51578296663504
theta	0.0006221363735640753
Scale X	0.011899815329683743
Scale Y	0.011900760802010777
delta	-8.84275038056584e-05
out of plane inclination	-1.4380597632738742e-09, 8.063798463750913e-10

	Residuals	
	rx	ry
	-0.00306072	0.00088660
	0.00017142	-0.00793318
	-0.00638181	-0.00073841
	0.00152601	-0.00084099
	0.01119188	-0.00288934
	0.00064695	0.00555497
	0.00016583	0.00710457
	-0.00425957	-0.00114422
RSME	0.0049535563	0.0044153712

Transformation Residuals:



Questions:

1. For each of the Tasks above, are there any noticeable patterns in the residuals for any of the transformations and for any of the images?

   The RMS of the residuals (rx, ry) decrease comparing the similarity transformation to affine transformation to projective transformation.

2. Do the two images have comparable transformation parameters in each of the above tasks? If no, why would there be differences in the derived transformation values?

   Between the two images for each transformation, their linear and non-linear parameters are fairly close to each other.

3. Given the results from Tasks 1, 2 and 3, which transformation should be used for observations from this camera/comparator system? Justify your answer and explain your reasoning.

   Since the projective transformation has the smallest values in residual RMS, it would be the best transformation used for observations from this camera/comparator system. In general, projective transformation provides more information than similarity and affine transformations. Similarity transformations only has delta x and y, rotation, and scale. Affine transformations have delta x and y as well, scale in x and y, rotation, and non-orthogonality of comparator axes. Projective transformations have the same information as affine transformations but with two additional parameters, out-of-plane inclinations.