

Lab #1

Similarity Transformation

Image 1:

Linear Parameters:

```
A: 84.03117383330671  
B: 0.005791291298088197
```

Non-Linear Parameters:

```
delta X: 10254.288911500238  
delta Y: -10378.775218001623  
scale: 84.03117403286988  
theta: 6.89183671336947e-05
```

Residuals: (rx, ry)

```
Residuals:  
[[ 1.85042661 -0.27334797]  
 [-0.68446068  0.81535776]  
 [-0.62944383  0.67161202]  
 [-0.78444016 -1.04554209]  
 [ 0.79740163  1.16437559]  
 [-0.71547267 -0.53834041]  
 [ 0.0604022  0.3044985 ]  
 [ 0.10558689 -1.0986134 ]]
```

RSME:

```
x RMS 0.8708227782471497  
y RMS 0.8084707794736097
```

Transformation Residuals:

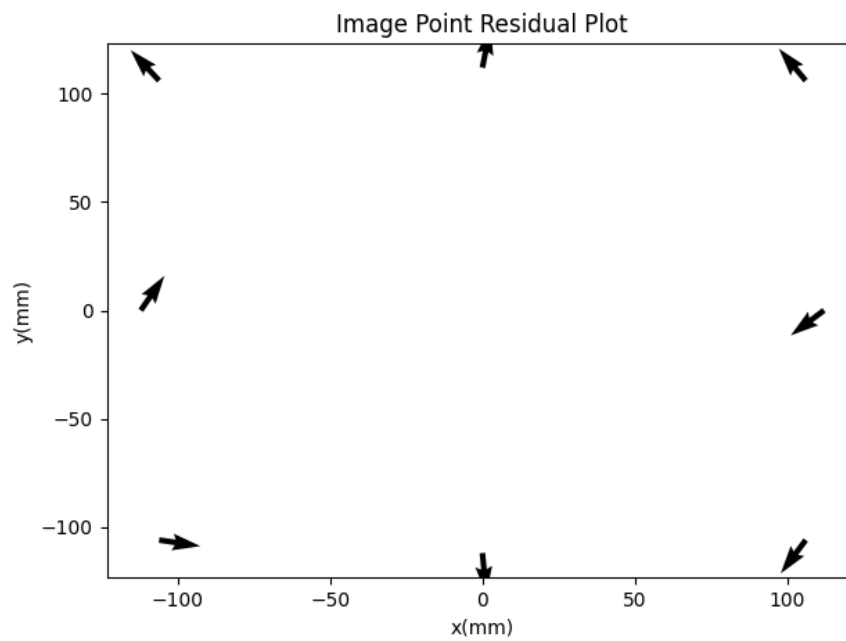


Image 2:

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Linear Parameters:

```
A: 84.02961711056915  
B: -0.05599326995735865
```

Non-Linear Parameters:

```
delta X: 10260.788531573624  
delta Y: -10385.149961133862  
scale: 84.02963576616963  
theta: -0.0006663515031399287
```

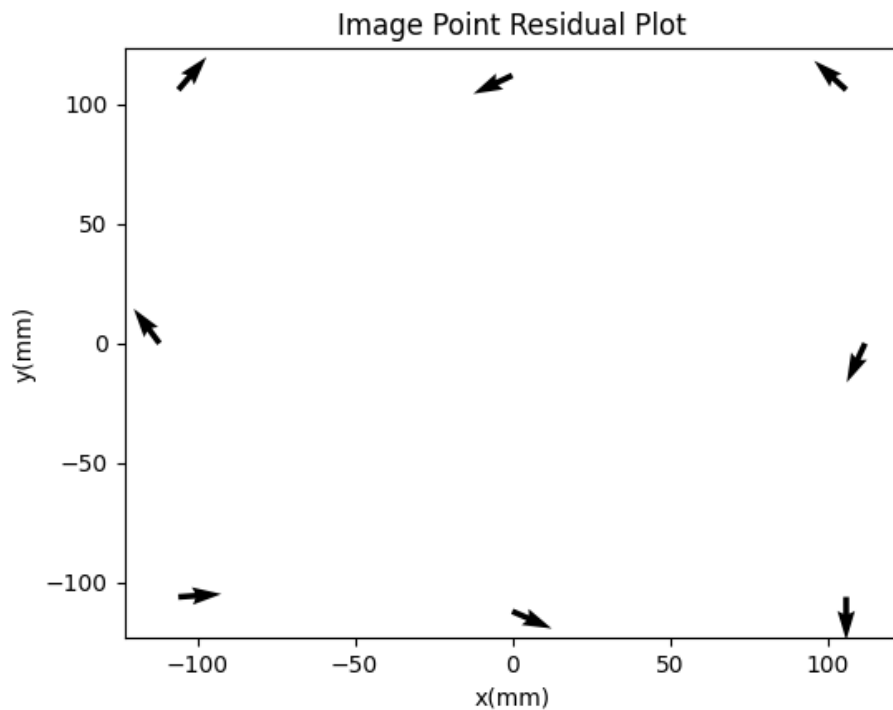
Residuals: (rx, ry)

```
Residuals:  
[[ 0.96620006  0.06589187]  
 [-0.80020168  0.72617893]  
 [ 0.58490841  0.68100576]  
 [ 0.00129405 -0.8051853 ]  
 [-0.52819286  0.70949242]  
 [-0.38978239 -0.83333601]  
 [-0.51968215 -0.2449174 ]  
 [ 0.68545656 -0.29913027]]
```

RSME:

```
x RMS 0.6211705711851453  
y RMS 0.6114594881174636
```

Transformation Residuals:



Affine Transformation

Image 1:

Linear Parameters:

```
A: 84.0376645345848  
B: -0.0021168248123863975  
C: 0.00946550579867278  
D: 84.02468309158996
```

Non-Linear Parameters:

```
delta X: 10254.288862572017  
delta Y: -10378.775192131347  
theta: 0.00011263408866805789  
Scale X: 84.03766506765412  
Scale Y: 84.02468311825443  
delta: 8.744119612681325e-05
```

Residuals: (rx, ry)

```
Residuals:  
[[ 0.77290775  0.02520836]  
 [ 0.39305353  0.51679452]  
 [-0.92798058 -0.40590589]  
 [-0.48587194  0.03198078]  
 [ 0.07041988  0.752844  ]  
 [ 0.01150161 -0.12682591]  
 [ 0.4719517  -0.42246576]  
 [-0.30598195 -0.37163009]]
```

RSME:

```
x RMS 0.5208828517294353  
y RMS 0.408187999682545
```

Transformation Residuals:

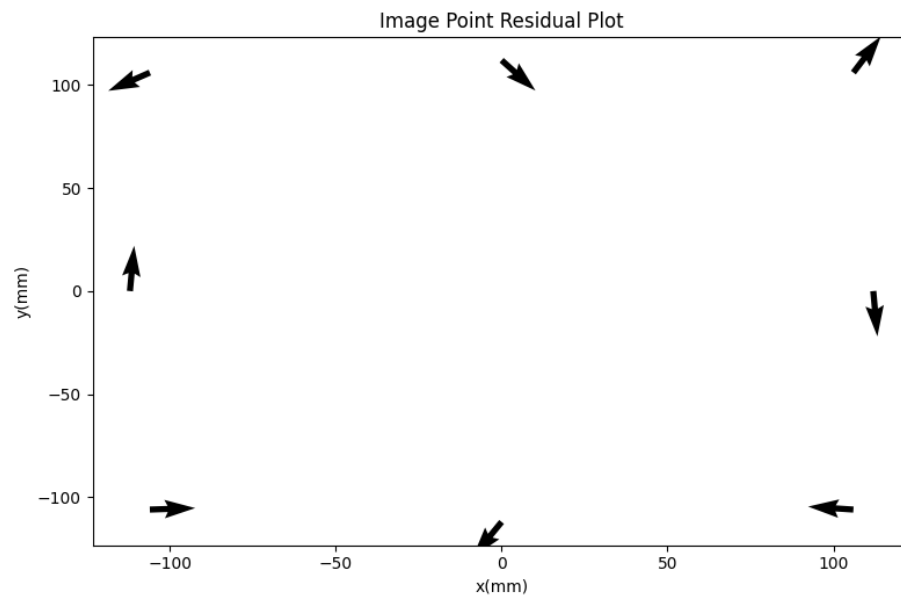


Image 2:

Linear Parameters:

```
A: 84.03295263417834  
B: 0.05971084808390614  
C: -0.05227586039988097  
D: 84.02628161507539
```

Non-Linear Parameters:

```
delta X: 10260.788494996665  
delta Y: -10385.149955156652  
theta: -0.000622087550392181  
Scale X: 84.03296889425984  
Scale Y: 84.02630283096678  
delta: 8.853342301314178e-05
```

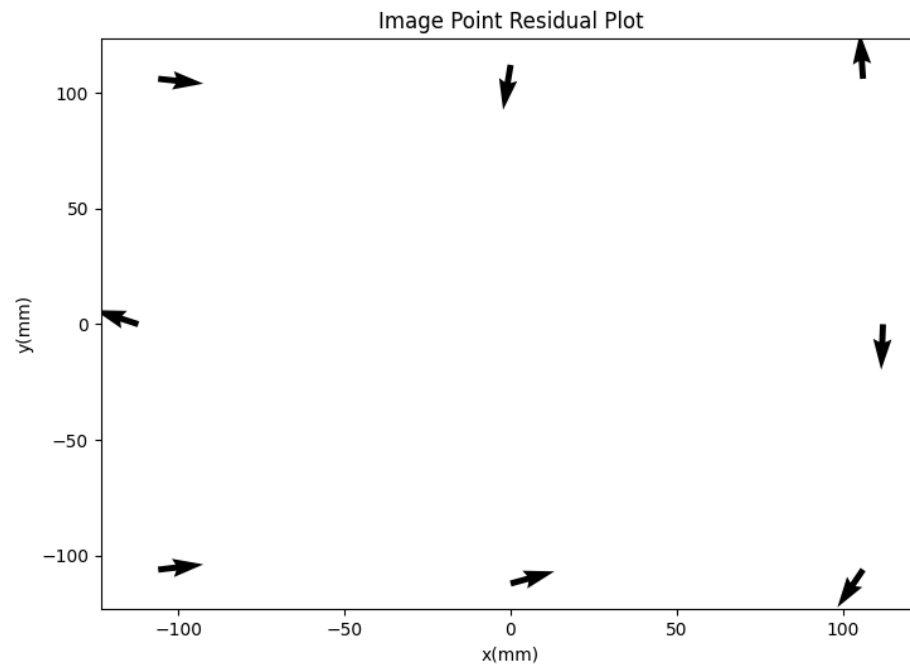
Residuals: (rx, ry)

```
Residuals:  
[[ 0.21856329  0.02540943]  
 [-0.05256639  0.76665599]  
 [ 0.62540307 -0.06662622]  
 [-0.03918169 -0.05754346]  
 [-0.90178206  0.29312518]  
 [-0.01619428 -0.41698121]  
 [-0.10330728 -0.61849168]  
 [ 0.26906534  0.07445197]]
```

RSME:

```
x RMS 0.4092277818254644  
y RMS 0.39433933547086514
```

Transformation Residuals:



Projective Transformation

Image 1:

Linear Parameters:

```
A: 84.0391280093
B: 0.0014697340292997296
C: 0.007984370049809897
D: 84.02105344953287
```

Non-Linear Parameters:

```
delta X: 10254.393843649943
delta Y: -10378.517907639103
theta: 9.500776858254347e-05
Scale X: 84.0391283885886
Scale Y: 84.0210534623875
delta: 0.00011250021802002426
out of plane inclination: (1.4270727798516153e-07, 3.4975702409456824e-07)
```

Residuals: (rx, ry)

```
Residuals:
[[ 0.4128675 -0.18249796]
 [ 0.03302846  0.30909455]
 [-0.62748752 -0.34408471]
 [-0.18537108  0.09380655]
 [ 0.0249727  1.01010993]
 [-0.03398113  0.1304292 ]
 [ 0.57694961 -0.53385085]
 [-0.20097854 -0.4830067 ]]
```

RSME:

```
x RMS 0.34905140247539196
y RMS 0.47587615934126515
```

Transformation Residuals:

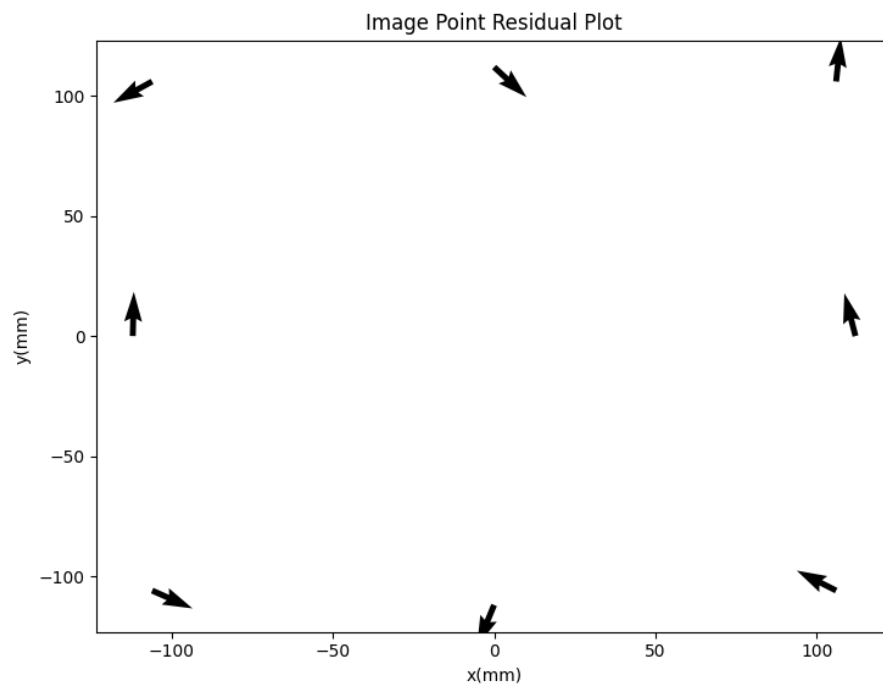


Image 2:

Linear Parameters:

```
A: 84.03419231019731
B: 0.05901736731686125
C: -0.053530451812230595
D: 84.02698344363786
```

Non-Linear Parameters:

```
delta X: 10260.877337342234
delta Y: -10385.199726052404
theta: -0.0006370079023800215
Scale X: 84.0342093598583
Scale Y: 84.02700416941589
delta: 6.535406747198951e-05
out of plane inclination: (1.2081137997855054e-07, -6.75840988384234e-08)
```

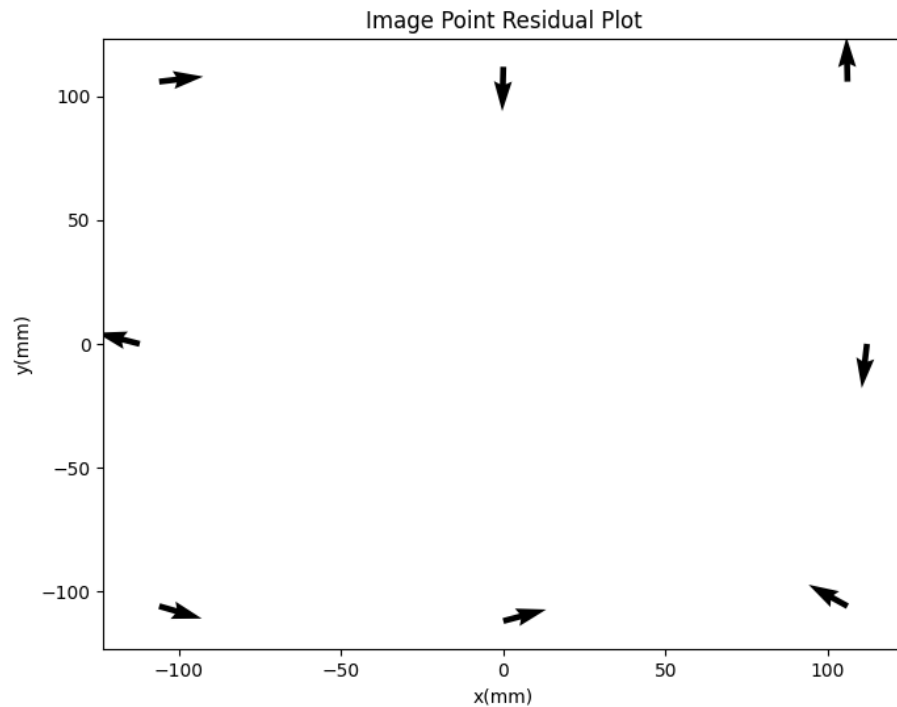
Residuals: (rx, ry)

```
Residuals:
[[ 0.25710905 -0.07458177]
 [-0.01401394  0.66666561]
 [ 0.5364645  0.0615931 ]
 [-0.12811822  0.0706746 ]
 [-0.94028663  0.24343158]
 [-0.05470349 -0.46668055]
 [-0.01441198 -0.59702405]
 [ 0.35796071  0.09592149]]
```

RSME:

```
x RMS 0.4162308392264894
y RMS 0.3710596984280994
```

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 (r_x , r_y) 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 has delta x and y as well, scale in x and y, rotation, and non-orthogonality of comparator axes. Projective transformations has the same information as affine transformations but with two additional parameters, out-of-plane inclinations.