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CIVE 6374 – Optical Imaging Metrology
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Lab #4

Tasks 1:

Initial Conditions:

tX (m)	79.9847
tY (m)	-631.04195
tZ (m)	1854.9692
omega (dd)	0.0000
phi (dd)	0.0000
kappa (dd)	-90.1947
lambda	4.9793

Unknowns after Convergence:

tX (m)	99.4938
tY (m)	-628.5518
tZ (m)	1842.1882
omega (dd)	-1.4761
phi (dd)	-0.1841
kappa (dd)	-90.1956
lambda	4.9791

Task 2:

$Tol_{coords} = \frac{S\sigma_{obs}}{10} = 0.0075$

$Tol_{tilt} = \frac{\sigma_{obs}}{10c} = 9.781035224768191e-09$

$Tol_{scale} = 1e-5$

S = 5000, σ_{obs} = 15 µm

c = 153.358 mm

For all the angles, I compared the difference of the old values with the new updated values. For the translations, I also compared the difference of the old values with the new updated values. The scale criteria is a small number, 1e-5 If the difference of the angles are less than Tol_{tilt} AND difference of translations are less than Tol_{coords} AND the scale difference is less than Tol_{scale}, then we have reach convergence. All angles, translation, and scale values must meet the tolerance criteria for convergence. We reach convergence after **3 iterations**.

Task 3:

Transformed Object Points:

ID	Xo (m)	Yo (m)	Zo (m)
100	-399.2691	-679.7163	1090.9599
104	475.5403	-538.2132	1090.4999
105	517.6187	-194.4005	1090.6500

Residuals and RMS

ID	vX	vY	vZ
100	0.01093	0.003701	-4.7602e-06
104	-0.009621	-0.033198	-1.1104e-05
105	-0.001309	0.029496	1.5864e-05
RMS	0.008441	0.02573	1.151293e-05

Task 4:

Object Space Coordinates for PC

Image	Xm (mm)	Ym (mm)	Zm (mm)	Xo (m)	Yo (m)	Zo (m)
Left	0.00	0.00	0.00	99.5015	-628.5543	1842.1882
Right	92.00	-1.422	-1.287	73.1077	-170.529950	1852.1839

Task 5:

Transformed Object Points:

ID	Xo (m)	Yo (m)	Zo (m)
200	-466.3736	-542.2893	1091.6683
201	42.6833	-412.1639	1091.0363
202	320.9841	-667.4234	1083.7335
203	527.6329	-375.7416	1092.1459

Residuals and RMS

ID	vX	vY	vZ
200	0.01639	0.02067	0.1183
201	-0.04667	0.02610	0.2163
202	-0.1059	0.02662	0.2435
203	-0.1471	-0.02161	0.14590
RMS	0.09395	0.02390	0.1880

Task 6:

$\sigma_x = S\sigma_{obs} = 0.075\ m$ S = 5000, σ_{obs} = 15 µm

$\sigma_y = S\sigma_{obs} = 0.075\ m$

$\sigma_H = \frac{\sqrt{2}S}{B/H}\sigma_{obs} = 0.1768$ B/H = 0.6

The RMSE values of from Task 3 are generally smaller than Task 5 except in the y direction, where they are very similar. The z residual from Task 3 is significantly smaller than Task 5's. Point 203 x residual is almost twice the expected error, but it may not be an outlier.

Task 7:

Correlation Coefficient Matrix							
	Ω	**Φ**	**K**	**tx**	**ty**	**tz**	**Λ**
Ω	1.0000	-0.7500	0.0043	-0.9289	0.7358	0.2499	0.0000
Φ	-0.7500	1.0000	-0.0027	0.6995	-0.9820	-0.4311	0.0000
K	0.0043	-0.0027	1.0000	-0.1198	0.0395	0.0008	0.0000
tx	-0.9289	0.6995	-0.1198	1.0000	-0.6863	-0.2886	-0.0722
ty	0.7358	-0.9820	0.0395	-0.6863	1.0000	0.3787	-0.0590
tz	0.2499	-0.4311	0.0008	-0.2886	0.3787	1.0000	0.7596
Λ	0.0000	0.0000	0.0000	-0.0722	-0.0590	0.7596	1.0000

The omega (Ω) is highly correlated with tx and phi (Φ) is highly correlated with ty, which are the rotation angles in their respective axes. To reduce correlation, we can add more points that are placed more randomly on the images, as opposed to points located on the same side of the image or points that form close to a straight line. For instance, the y coordinates of point 104 and 105 are close to each other.

Task 8:

Extracted Angles from M (o to i):

Left	w (dd)	-0.1892
	p (dd)	1.4755
	k (dd)	90.1957

Right	w (dd)	-0.4573
	p (dd)	0.4970
	k (dd)	88.4680