University Of Technology
Building and Construction Eng. Dept.
Final Exam 1st Attempt – 2015/2016

Class: 3ed

Subject :Photogrammetry
Branch : Geomatic Engineering
Examiner : Dr. Abass Z. Khalaf

Time : 3 Hours
Date :29 /5/2016

Answer Four Questions Only

Q1) A project area is (11 km) long in the east-west direction and (6 km) wide in the north-south direction. It is to be covered with vertical aerial photography having a flying height 3000 m. End lap and side lap are to be 60 and 30 percent, respectively. A (152.2-mm-) focal-length camera with a (23 *23 cm) square format is to be used. Prepare the flight map on a base map whose scale is 1:100,000, and compute the total number of photographs necessary for the project.

Solution

1. Fly east-west to reduce the number of flight lines.
2. Dimension of square ground coverage per photograph is

[photo scale = $\frac{152.2\ mm}{3000\ m}$=1:19710]

$$G = \frac{19710}{1} * 23\ cm = 4533\ m$$

3. Lateral advance per strip (at 30 percent side lap) is (المسافة بين خطوط الطيران)

$$W = 0.7 * (1533) = 3173\ m$$

4. Number of flight lines

$$0.5G - 0.3G = 0.2G = 0.2 * 4533 = 906\ m$$

Number of spaces between flight lines:

$$\frac{6km - 2 * 906}{3173} = 1.31\ (round\ up\ to\ 2)$$

Number of flight lines = number of spaces + 1 = 3 (عدد خطوط الطيران)

5. Adjust the percent side lap and flight line spacing.

Adjusted percent side lap for integral number of flight lines (include portion extended outside north and south boundaries):

$$2\left(0.5 - \frac{PS}{100}\right)G + (no.spaces)\left(1 - \frac{PS}{100}\right)G = total\ width$$

$$2\left(0.5 - \frac{PS}{100}\right) + 2\left(1 - \frac{PS}{100}\right) = 1.323\ m$$

$$PS = 41.925\%.$$

Adjusted spacing Wa between flight lines for integral number of flight lines:

$$W_a = \left(1 - \frac{41.925}{100}\right)G \cong 2632\ m$$

6. Linear advance per photo (air base at 60 percent end lap):

$$B = 0.4G = 0.4 * 4533 = 1813\ m$$

7. Number of photos per strip (take two extra photos beyond the project boundary at both ends of each strip to ensure complete stereoscopic coverage):

$$No.photos\ per\ strip = \frac{11000m}{1813} + 1 + 2 + 2 = 11.06\ (use\ 12)$$

8. Total number of photos:

$$\frac{12\ photos}{stip} * 3\ strips = 36$$

9. Spacing of flight lines on the map:

$$map\ scale = 1:100000$$

$$W_M = \frac{2632\ m}{100000} = 26.3\ \ mm$$

Draw the flight lines at 26.3 mm spacing on the map, with the first and last lines

Q2) A. What are the advantages and disadvantages of non-metric camera?.

The advantages are: -

1. General availability.
2. Flexibility in focusing range.
3. Some are motor drive, allowing for quick succession of photographs.
4. Can be hand-held and there by oriented in any direction.
5. The price is considerably less than for metric cameras.

The disadvantages are: -

1. The lenses are designed for high resolution at the expense of high distortion.
2. Instability of interior orientation.
3. Lack of fiducial marks.
4. Absence of level bubbles and orientation provisions precludes the determination of exterior orientation before exposure.

B. Calibration report for a metric camera are given in the following table. Compute the corrected coordinates for an image point having photo coordinates $x=-22$ mm, $y = 77$ mm.

Radial distortion	Tangential distortion	Calibrated principle point
$k_0=0.7812 \times 10^{-4}$ $k_1=-0.74125 \times 10^{-8}\ mm^{-2}$ $k_2=0.2478 \times 10^{-12}\ mm^{-4}$	$p_1=-0.9214 \times 10^{-7}\ mm^{-1}$ $p_2=0.2994 \times 10^{-6}\ mm^{-1}$	$x_p=0.005$ mm $y_p=0.007$ mm

Answer:

Compute. $\bar{x}$, $\bar{y}$ and r

$\bar{x} = x - x_p = -22 - 0.005 = -22.005$

$\bar{y} = y - y_p = 77 - 0.007 = 76.993$

$r = \sqrt{\bar{x}^2 + \bar{y}^2} = 80.075$

Compute symmetric radial lens distortion corrections δx and δy

$$\delta x = \bar{x}(k_0 + k_1 r^2 + k_2 r^4 + k_3 r^6 + k_4 r^8)$$

$$\delta y = \bar{y}(k_0 + k_1 r^2 + k_2 r^4 + k_3 r^6 + k_4 r^8)$$

$$\delta x = -0.00089$$

$$\delta y = 0.00313$$

Compute decentering distortion corrections Δx and Δy

$$\Delta x = (1 + p_3 r^2 + p_4 r^4)\,[p_1(r^2 + 2\bar{x}^2) + 2p_2\,\bar{x}\,\bar{y}]$$

$$\Delta y = (1 + p_3 r^2 + p_4 r^4)\,[2\,p_1\bar{x}\,\bar{y} + p_2(r^2 + 2\bar{y}^2)]$$

$$\Delta x = 0.00337$$

$$\Delta y = 0.00578$$

Compute the corrected coordinates x_c and y_c

$$x_c = \bar{x} + \delta x + \Delta x$$

$$y_c = \bar{y} + \delta y + \Delta y$$

$$x_c = -22.005 - 0.00089 + 0.00337 = -22.00252$$
$$y_c = 76.993 + 0.00313 + 0.00578 = 77.00191$$

Q3) The following table represent the horizontal coordinates of points (A,B) in two coordinates systems, and the coordinates of point C in system (x, y):

Point	x	y	$\bar{x}$	$\bar{y}$
A	50	30	270	280
B	-70	-55	300	500
C	170	-152	?	?

Compute the horizontal coordinates of point C in $\overline{xy}$ system using the two dimensional conformal transformation.

$\bar{x} = ax - by + Tx$
$270 = 50a - (30)b + Tx$
$Tx = 270 - 50a + 30b \ldots 1$
$\bar{y} = bx + ay + Ty$
$280 = 50b + (30)a + Ty$
$Ty = 280 - 50b - 30a \ldots 2$
For point 2
$\bar{x} = ax - by + Tx$
$300 = (-70)a - (-55)b + Tx \ldots 3$
$0 = -300 - 70a + 55b + 270 - 50a + 30b$
$0 = -30 - 120a + 85b$
$b = 0.3529 + 1.41176a \ldots 4$
$\bar{y} = bx + ay + Ty$
$500 = (-70)b - 55a + Ty$
$0 = -500 - 70b - 55a + 280 - 50b - 30a \ldots 5$
$0 = -220 - 120b - 85a \ldots 6$
$0 = -220 - 120(0.3529 + 1.41176a) - 85a$
$0 = -262.348 - 254.4112a$
$a = -1.0311$
$b = -1.10276$
$Tx = 288.4722$
$Ty = 366.071$
$\bar{x} = ax - by + Tx$
$\bar{x} = (170) * -1.0311 - (-152) * -1.10276 + 288.4722 = -54.434$
$\bar{y} = bx + ay + Ty$
$\bar{y} = (170) * -1.10276 + (-152) * -1.0311 + 366.071 = 335.329$

Q4) The following table represent the refined photo coordinates and ground coordinates (in a local vertical system) of four (A,B,C,D) ground control points for a vertical aerial photograph taken with a 153.2 -mm focal-length camera:

Point No.	Ground Control points			Photo Coordinates	
	X	Y	Z	x	y
A	249.06	460.2349	100.505	-51.4794	56.2198
B	454.1929	452.506	100.188	53.1384	52.3852
C	464.5433	235.2659	100.538	58.4171	-58.5144
D	249.2316	242.4636	100.225	51.3919	-54.8436

Compute the approximate value of the flying height Z_O.

$$(AB)^2 = \left[\frac{x_b}{f}(H - h_B) - \frac{x_a}{f}(H - h_A)\right]^2 + \left[\frac{y_b}{f}(H - h_B) - \frac{y_a}{f}(H - h_A)\right]^2$$

$$(2932.549)^2 = \left[\frac{53.1384}{153.2}(H - 100.188) + \frac{51.4794}{153.2}(H - 100.505)\right]^2 + \left[\frac{52.3852}{153.2}(H - 100.188) - \frac{56.2198}{153.2}(H - 100.505)\right]^2$$

$$(205.278)^2 = (0.68285H - 68.5228)^2 + (-0.025H + 2.6241)^2$$

$$0.466905\mathrm{H}^2 - 93.712705H - 37436.982 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$a = 0.466905$

$b = -93.712705$

$c = -37436.982$

$\mathrm{X1} = 400.775$ m

$\mathrm{X2} = -200.06$ m

Q5) The flowing table represent the exterior orientation parameters (EOP) of two aerial photograph taken with a 153.1 mm focal-length camera:

EOPs / Photo	ω^o	φ^o	κ^o	$X_O(m)$	$Y_O(m)$	$Z_O(m)$
1	0	0	0	6203.066	87467.764	4029.321
2	0	0	0	9868.226	87469.365	4029.332

The photo coordinates of two points (1,2) appear in the two photos are as follow:

Point No.	Photo 1		Photo 2	
	x	y	x	y
1	64	58	-16	58
2	27	-2	-53	-2

Compute the initial (approximate) values of the 3D ground (X,Y,Z) coordinates of point (1).

M1

1		0	0
0		1	0
0		0	1

M2

1	0	0
0	1	0
0	0	1

For photo 1

$x_1 = m_{11}x' + m_{12}y' + m_{13}z'$

$x_1 = 64$

$y_1 = m_{21}x' + m_{22}y' + m_{23}z'$

$y_1 = 85$

$z_1 = m_{31}x' + m_{32}y' + m_{33}z'$

$z_1 = 153.1$

For photo 2

$x_2 = m_{11}x' + m_{12}y' + m_{13}z'$

$x_2 = -16$

$y_2 = m_{21}x' + m_{22}y' + m_{23}z'$

$y_2 = 85$

$z_2 = m_{31}x' + m_{32}y' + m_{33}z'$

$z_2 = 153.1$

فيتم استخدام المعادلات التالية في ايجاد القيم التقريبية|$(Yo1 - Yo2)$| اكبر من قيمة |$(Xo1 - Xo2)$|اذا كانت قيمة

$$Z = \frac{X_{o2} - Z_{o2}\frac{x_2}{z_2} + Z_{o1}\frac{x_1}{z_1} - X_{o1}}{\frac{x_1}{z_1} - \frac{x_2}{z_2}} = 11043.523$$

$$X = X_{o1} + (Z - Z_{o1})\frac{x_1}{z_1} = 9135.194$$

$$Y = Y_{o1} + (Z - Z_{o1})\frac{y_1}{z_1} = 901250016$$

Good Luck