University of Technology
Building and Construction Eng. Dept.
FINAL EXAM FIRST ATTEMPT– 2013/2014

Subject: Remote Sensing & GIS — Class: 3rd Year
Division: All Engineering Divisions — Time : 3 Hrs.
Examiner: Remote Sensing & GIS Comm. — Date: 05.06.2014

Note: Answer FOUR Questions Only

Q1.

A. An aerial photo was taken with camera focal length 152 mm, format dimension (23×23) cm^2, longitudinal overlap 60%, the distance between successive flight lines 2100 m and the average terrain of the pictured area was 600 m above mean sea level. A railway line (AB) with length 10.16 cm was appeared in this photo with x-coordinates for the two ends of the photo ($x_a = +50.01\,mm$; $x_b = -52.6\,mm$). In the same time this railway was appeared with a length of 2.54 cm in a map with scale 1/50000. Find: **(17%)**

1. The average altitude of the plane from mean sea level.
2. The ground coordinates for the two ends of the railway.
3. The length of the appeared railway in the pictured scene.
4. The base line (B) and the lateral overlap (sidelap) (V).

B. Distinguish between the following items: **(8%)**

1. Vertical and oblique aerial photos.
2. Active and passive remote sensing system.

Q2.

A. An satellite image with 8 gray levels and the following information:

Gray level	0	1	2	3	4	5	6	7
Frequency (No. of Pixels)	10	8	9	2	14	1	5	2

Apply Histogram Equalization Technique to enhance this image. Plot the histogram before and after enhancement process. **(15%)**

B. Define **Five Only** of the following terms: **(10%)**
LiDAR, Black Body, Atmospheric windows, Remote sensing, Relief displacement, Ground control points (GCPs), Instantaneous Field of View (IFOV)

Q3.

A. For geometric correction of Multi spectral Scanner (MSS) images, a total number of 3 GCPs were used to perform 1st order polynomial model. If the image coordinates (x, y) and grounds coordinates (X, Y) measured in pixels of GCPs with their polynomial coefficients ($a_0, a_1, a_2, b_0, b_1, b_2$) are listed in tables below. Find: **(17%)**

1. X-residual, Y-residual and
2. RMS error for each point.
3. The total RMS error.

GCP No.	x (pixel)	y (pixel)	X (pixel)	Y (pixel)
1	247.25	141.25	531.50	395.12
2	272.75	85.25	562.75	323.62
3	428.75	64.75	521.38	359.25

a_0	4991.917	b_0	-1489.042
a_1	-6.537	b_1	1.875
a_2	-3.214	b_2	1.603

B. Answer the following items: (8%)

1. What advantages do sensors carried on board satellites have over those carried on aircraft? Are there any disadvantages that you can think of?
2. How would thermal imagery be useful in an urban environment? Then list the main advantages and disadvantages of thermal imaging system.

Q4.

A. A 1:24,000 aerial photo that falls within this subscene was acquired. Starting with a field visit during the same growing season, the crops in many individual farms located in the photo were identified, of which about twelve points (12) were selected as training sites. Most were either corn or soybeans; others were mainly barley and wheat. A Maximum Likelihood supervised classification was then run. With the class identities in the photo as the standard, the number of pixels correctly assigned to each class and those misassigned to other classes were arranged in the confusion matrix (Error matrix) used to produce the summary information shown in the following table:

		Ground Data / Reference Data			
		Corn	Soybeans	Forest	Other
Map Data / Classified Data (Landsat Classes)	Corn	25	5	10	3
	Soybeans	2	50	6	5
	Forest	3	4	60	5
	Other	2	2	2	100

(17%)

1. Compute the overall accuracy?
2. Compute the Producers' and user' accuracy?
3. Compute of K_{hat} Coefficient?

B. Answer the following items: **(8%)**

1. If you wanted to detect heat from a fire, which portion of EM spectrum would you use? Why?
2. Compare a 2-bit image with an 8-bit image. List the different types of resolution.

Q5

A. Two buildings on flat terrain are separated in the range direction by a distance along the ground by 20 m. Knowing that the radar system flying with altitude (800km) has the following characteristics: a wavelength of 23cm, antenna length along track (D_{AT}) is 2m with antenna length cross track (D_R) is 1.25 m, and pulse length (duration) of 0.1 μsec. If the buildings were imaged in the near range with a depression angle of 30° and however, the same buildings were imaged in the near range with a depression angle of 60° and the grazing angle is 47.45°.

Find the following: **(17%)**

1. The ground – range resolution
2. The azimuth resolution for both cases.
3. Will these buildings be resolved in the far range and near range?
4. The swath width for radar scanning.

B. Answer the following items: **(8%)**

1. The difference between *Synthetic Aperture Radar* (SAR) and *Real Aperture Radar* (RAR).
2. Solar radiation is scattered by atmosphere. Identify and explain the types of scattering process that occur.

Useful Equations:

$BV_{i,j,ratio} = \frac{BV_{i,j,k}}{BV_{i,j,l}}$; $BV_{out} = \left(\frac{BV_{in} - min_k}{max_k - min_k}\right).quant_k$; $k_i = \sum_{i=0}^{quant_k} \frac{f(BV_i)}{n}$;

$HFF_{5,out} = (2 \times BV_5) - LFF_{5,out}$; $LFF_{5,out} = int\left[\frac{\sum_{i=1}^{9} c_i \times BV_i}{n}\right]$; $Sobel_{5,out} = \sqrt{X^2 + Y^2}$;

$[X = (BV_3 + 2BV_6 + BV_9) - (BV_1 + 2BV_4 + BV_7)$; $Y = (BV_1 + 2BV_2 + BV_3) - (BV_7 + 2BV_8 + BV_9)]$;

$x = a_o + a_1X + a_2Y$; $y = b_o + b_1X + b_2Y$; $A = S.E.(1 - V\%)$;$B = S.E.(1 - U\%)$; $< P_r \geq P_t\left[\frac{G^2.\lambda^2}{(4\pi)^3.R^4}\right].\sigma_0$; $h \leq \frac{\lambda}{25 \sin\gamma}$; $h \geq \frac{\lambda}{4.4 \sin\gamma}$; $h = \frac{\lambda}{8 \sin\gamma}$; $\delta_R = \frac{c.\tau}{2.\cos\gamma}$; $\delta_{AT} = \frac{\lambda}{D_{AT}}.\frac{c.\tau.\cos\gamma}{2}$; $\varepsilon = \frac{M_R}{M_B} = \frac{T_{rad}^4}{T_{kin}^4}$;

; GCP's No. $= \frac{((t+1)(t+2))}{2}$; $d = \frac{v.t}{m} = \frac{v\,t\,f}{H}$; $h = \frac{dH}{r}$; $X_A = \left(\frac{H - h_A}{f}\right).x_a$; $Y_A = \left(\frac{H - h_A}{f}\right).y_a$; $C_f = \frac{H}{C_i}$;

$R^3 = GMT^2/4p^2$; ; $K_{hat} = [N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} x_{i+}\, x_{+i}]/[(N^2 - \sum_{i=1}^{r} x_{i+}\, x_{i+1})]$;

$RMS\ error = \sqrt{XR_i^{\ 2} + YR_i^{\ 2}}$; $W = \sigma\varepsilon T^4$; $\lambda_{max} = \frac{2897 mm°K}{T_{rad}°K}$; $W_g = \frac{R_f - R_n}{\cos\psi}$

...GOOD LUCK...

Typical Answers of Set 1 -2013-2014

Q1 A- An aerial photo was taken with camera focal length 152 mm, format dimension (23×23) cm^2, longitudinal overlap 60%, the distance between successive flight lines 2100 m and the average terrain of the pictured area was 600 m above mean sea level. A railway line (AB) with length 10.16 cm was appeared in this photo with x-coordinates for the two ends of the photo ($x_a = +50.01\ mm$; $x_b = -52.6\ mm$). In the same time this railway was appeared with a length of 2.54 cm in a map with scale 1/50000. Find:

1- The average altitude of the plane from mean sea level.
2- The ground coordinates for the two ends of the railway.
3- The length of the appeared railway in the pictured scene.
4- The base line (B) and the lateral overlap (sidelap)(V).

Solution:

1)

$$photo\ scale = \frac{dis.\ on\ photo}{dis.\ on\ map} \times map\ scale$$

$$photo\ scale = \frac{10.16\ cm}{2.54\ cm} \times \frac{1}{50000} = \frac{1}{12500}$$

$$Scale = \frac{C}{Hav. - h_{av.}}$$

$$\frac{1}{12500} = \frac{0.152\ m}{Hav. - 600\ m}$$

$Hav. = 2500\ m$ The average altitude of the plane from mean sea level

2)

$$X_A = xa\left(\frac{Hav. - h_{av.}}{C}\right) = +50.01\left(\frac{2500-600}{152}\right) = +625.125\ m$$

$$X_B = x_b\left(\frac{Hav. - h_{av.}}{C}\right) = -52.6\left(\frac{2500-600}{152}\right) = -657.5\ m$$

3) To solve railway line (AB length), either use photo scale or map scale

$$Photo\ Scale = \frac{ab}{AB}$$

$$\frac{1}{12500} = \frac{10.16}{AB}$$

$$AB = 1270\ m$$

$$Map\ Scale = \frac{ab}{AB}$$

$$\frac{1}{50000} = \frac{2.54}{AB} \qquad AB = 1270\ m$$

4)

B = S×E (1−U %)

B = 0.23× 12500 (1− 0.6) = 1150 m the base line length

A=S×E (1−V %)

2100= 0.23× 12500(1−V %)

2100= 2875− 2875V%

2875 V%= 775

V%= 0.269≈ 27% Lateral Overlap (Sidelap)

B. Distinguish between the following items:

1. **Vertical and oblique aerial photos.**

   Vertical photograph: A photograph with the camera axis perfectly vertical (identical to plumb line through exposure center). Such photographs hardly exist in reality (True). **Near vertical photograph** A photograph with the camera axis nearly vertical. The deviation from the vertical is called tilt which is usually less than two to three degrees.

   Oblique photograph: A photograph with the camera axis intentially tilted between the vertical and horizontal. A **high oblique photograph**, depicted in Fig. 3.5(c) is tilted so much that the horizon is visible on the photograph. A **low oblique** does not show the horizon (Fig.). The total area photographed with obliques is much larger than that of vertical photographs. The main application of oblique photographs is in reconnaissance.

2. **Active and passive remote sensing system.**

   A *passive* **Remote Sensing system** records the energy naturally radiated or reflected from an object