Chingesm Sharon Chilombo

REVISION QUESTIONS AUGUST 2017

GEE 3622-PRINCIPLES OF DATA ACQUISITION & PROCESSING

GROUP 1

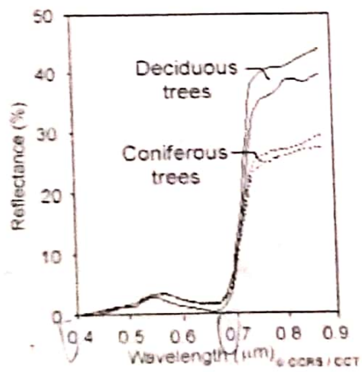
Figure 1 of reflectance curves; show the spectral response patterns of deciduous and coniferous trees.

(a) Which range of the wavelength is the visible portion of the electromagnetic spectrum? 0.4 – 0.7

(b) Which range is the near-infrared (NIR) portion? 0.7 – 0.9 (0.7 – 1.5)

(c) Explain why it would be difficult to distinguish the two types of trees in the visible portion. Low Reflectance.

(d) Explain why it would easier to distinguish the two types of trees in the NIR portion. Although both reflect a significant portion of incident radiation, it is clear & separable.



NIR – 0.7nm – 1.5nm.
MIR – 1.5 – 5.6mm
FIR – 5.6 – 1000mm

Figure 1: Reflectance curves for Deciduous trees and Coniferous trees

(a) Visible: 0.4 – 0.7 µm

(b) NIR: 0.7 – 0.9 µm

(c) The reflectance in the visible portion for both trees is low, and not clearly separable

(d) In the near-infrared, although both types reflect a significant portion of the incident radiation, they are clearly separable.

Atmospheric scattering occurs when the particals or gaseous molecules present in the atmosphere interact with the electromagnetic radiation and cause it to be redirected from its original path. Mention three types of scattering that take place and give one example for each.

(Rayleigh scattering- blue wavelengths scattered 5 times as often as red. Creates blue sky , Mie scattering smoke, dust, volcanic material and salt crystals scatter longer radiation wavelengths and Non-selective scattering- suspended aerosols (with diameters at least 10x larger than wavelengths) including all Mia particles and water droplets and ice crystals, scatter longer radiation wavelengths

State whether true or false:

Active Remote – detect only reflected sunlight or thermal IR and microwaves (False)

Passive Remote – beam own artificially produced energy to a target and record reflected component (False)

The entire range of EMR comprises the electromagnetic spectrum subdivided in divisions called wavelengths **that share common characteristics. (False – Ans. Spectral Bands)**

Three forms of energy transfer include: absorption, reflection and transmittance (False. Ans- conduction, convection and radiation)

The Sun is the minor **supplier of EM energy incident on the Earth – providing energy needed for terrestrial life and the natural processes operating in the atmosphere, water and upper layers of solid Earth.** (false)

EMR travels in a straight path at the speed of light – postulated by Albert Einstein in 1905 as ~ 300,000,000 km/sec (false. Ans. 300,000km/sec)

Electromagnetic Radiation (EMR) is light energy detected when it comes into contact with an object (False. Ans EM)

The visible portion of the EM Spectrum ranges from 4 · m to 7 · m (False. Ans. 0.4 · m to 0.7 · m)

The most common bands of the EM spectrum used for remote sensing are cosmic, gamma and x-rays. (false. Ans. ultraviolet (UV), visible, infrared (IR) and microwave.

Remote sensing depends upon operation in wavelength regions of spectrum where spectral signatures occur for identification purposes. (true)

$h_a = H - \frac{Bf}{P_a}$.

GROUP 2

The figure below shows an overlapping pair of truly vertical aerial photographs taken at equal flying height H above mean sea level (MSL) and having equal focal lenths f. The corresponding images of the ground point P are P_L on the left photo and P_R on the right photograph, respectively. The ground coordinate system XYZ has its origin at the MSL level location O of the left photo camera exposure station, i.e. the **X** and **Y** axes are parallel to the x and y axes of the photo system.

a) Derive the basic parallax equations for the ground coordinates of point P based on the illustrated geometry of the overlapping truly vertical photos.

b) Compute the ground coordinates $\mathbf{X_p Y_p Z_p}$ of point **P** using the previously derived parallax equations for the photo stereo pair, whose
focal length **f**=152mm, the air base **B**=1815m and the flying height **H**=3000m;
and the photo-coordinates of point **P** are:
for the left photo: x_L = +80.00mm y_L = -50.00mm, and
for the right photo: x_R = -20.00mm, y_R = -50.00

left − Right

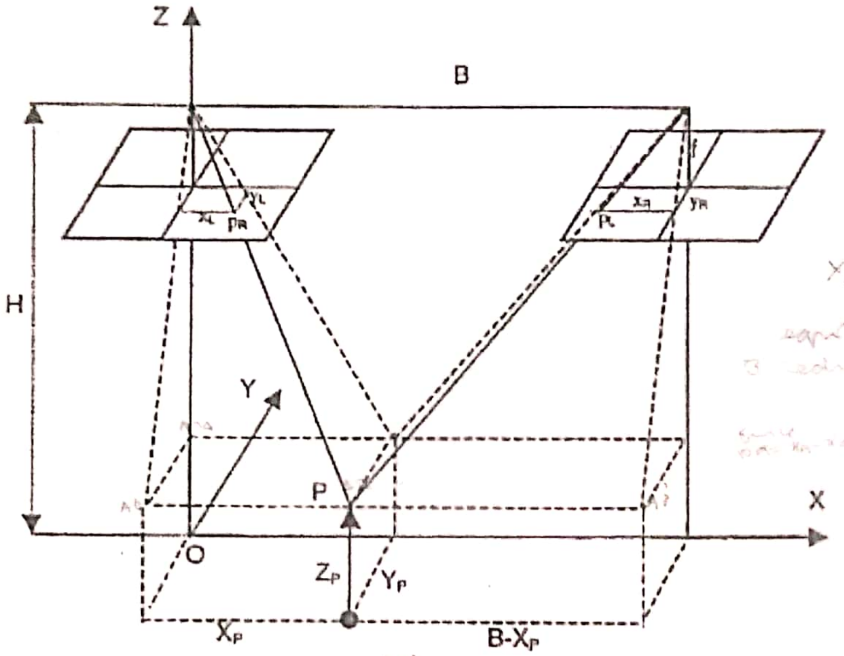
$Pa = xa - x'a$

$Pa = 100$

$H_A = H - \frac{BF}{Pa}$

$X_p = B \frac{xa}{Pa}$

$= \frac{1815(80.00)}{100}$



a) Given that the elevation of point C is 200m above MSL and that the parallax reading for the same point is 11.89mm and that of point A is 10.96mm, the parallax constant is 80.71mm. Calculate the parallax difference between the two points and the elevation of point A if the flying height for a pair of photos is 1000m.

b) A mapping project is designed to use aerial photography at a scale of 1:10000 for a preliminary design of a development project covering an area of 20 x 15km. If a 15/23 camera is used with end and side overlaps of 60% and 30% respectively, calculate the following parameters if a flight plan along the longer side of the project boundary is to be prepared at a map scale of 1:20,000;

i. total number of flight lines

ii. total number of photographs to cover the project area

iii. total number of models

GROUP 3

What is Photogrammetry?

Photogrammetry is the science and technology of obtaining spatial measurements and other geometrically reliable derived products from photographs.

Explain the main differences between perspective and orthogonal projections.

Perspective projection is obtained by projecting an object to a projection plane with a bundle of rays from projection center located in finite distance from the projection plane, Angular relations between object features and image features are not the same.

Orthogonal projection is the parallel projection of an object to the chosen plane (map)

Name three (3) instruments used to measure image coordinates and briefly outline the measurement process involved.

i. Monocomparator- each photo is measured separately
ii. Stereocomparator- simultaneous identification and measurement of image points on two photographs
iii. Analytical plotter- projective relations between each model point and corresponding image points are implemented analytically

GROUP 4

Explain the term depth of perception with respect to stereoscopic viewing.

Stereoscopic depth perception is a function of the parallactic angles. Parallactic angle is the angle of intersection of optical axes that converge on a certain point.

The nearer the object the greater the parallactic angle and vice versa. The depth between object A and B (DB-DA) is perceived as the difference in their parallactic angles (QA-QB)

a) Given that the shortest distance of clear stereoscopic depth perception for an average eye base of 65mm is 250mm, calculate the maximum Parallactic angle.

Stereoscopic Depth Perception

NB.

① Shortest distance of clear Stereoscopic depth perception for the average eye base of 65mm is 250mm

∴ Max parallactic angle will be

$$\phi(max) = 2\tan^{-1}\frac{32.5mm}{250\,mm} \approx 15^\circ$$

b) Given that the maximum distance at which the stereoscopic depth perception is possible is approximately 600m, calculate the minimum Parallactic angle.

$$= 2\tan^{-1}\frac{32.5}{600000}$$

$$= 0^\circ 0' 22''$$

② Maximum distance at which the stereoscopic depth perception is possible is approx 600 m

$$\phi(min) = 22''$$

List at least three examples of close range photogrammetry in each of the following applications

I. Information System - Image database, building facility management, project planning, Building information system

II. Engineering - measurement of large civil engineering sites
- pipeline and tunnel measurements, mining, deformation measurements

III. Automotive, machines and shipbuilding industries - inspection of tooling jigs, Reversing of engineering design model, manufacturing control, Robot calibration

IV. Medicine and Physiology
Plaster casts, tooth measurements, spinal deformation.

V. Forensic including Police work
- accident recording, scene of crime measurement
- person measurement

GROUP 5

a) In analytical photogrammetry, we often deal with matrix rotations in a plane for image points that must satisfy the orthogonality conditions. Given the following transformation:

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} 0.36 & 0.69 \\ 0.19 & 0.27 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

With the help of unit vectors

$$\mathrm{i} = \begin{pmatrix} \cos\alpha \\ \sin\alpha \end{pmatrix}, \qquad \mathrm{j} = \begin{pmatrix} -\sin\alpha \\ \cos\alpha \end{pmatrix}$$

State **three** (3) orthogonality conditions that must be satisfied for an orthogonal matrix and prove that the above transformation does not represent a rotation.

(i) $i^T i = \cos^2\alpha + \sin^2\alpha = 1$ where $i^T i = r_{11}^2 + r_{21}^2$
$R = (i, j)$, $R = \begin{pmatrix} r_{11} & r_{12} \\ r_{21} & r_{22} \end{pmatrix}$

(ii) $j^T j = \sin^2\alpha + \cos^2\alpha = 1$ where $j^T j = r_{12}^2 + r_{22}^2$

(iii) $i^T j = -\cos\alpha\sin\alpha + \sin\alpha\cos\alpha = 0$ where $r_{11}r_{12} + r_{21}r_{22} = 0$

case (i) $i^T i = r_{11}^2 + r_{21}^2$
$i^T i = 0.36^2 + 0.19^2 = 0.1657 \neq 1$

The figure below shows four models (1-4) which are observed

Case 2 (ii) $r_{12}^2 + r_{22}^2$
$= 0.69^2 + 0.27^2 = 0.549 \neq 1$

$j^T j$

independently

Case (iii) $r_{11} r_{12} + r_{21} r_{22}$
$i^T j = (0.36)(0.69) + (0.19)(0.27) = \neq 0$

Scanned with CamScanner

Mention at least five (5) sources of errors that are normally taken into account in aerial triangulation

- Film shrinkage
- Principle point displacement
- Lens distortion
- Atmospheric refraction
- Earth curvature
- Instrument error
- Observation errors

Outline at least three (3) advantages of control extension by aerial triangulation

i. Reduction in the amount of Field data
ii. Inaccessible areas can be accommodated
iii. Photo control is established in best location with the stereomodels
iv. Model setup time is reduced

Calculate

Total number of observation

(32)

Total number of Unknowns

(26)

Number of redundant observations

(6)

Which points represent the tie-points

(5,6,7,8,9)

Which points represent the control points

(1,2,3,4)

Briefly, define the adjustment involved in these models?

The models are:

displaced (two translations, Xu,Yu) — Y_u, X_u, K, m

rotated (rotation angle, k) and

scaled (scale factor,m)

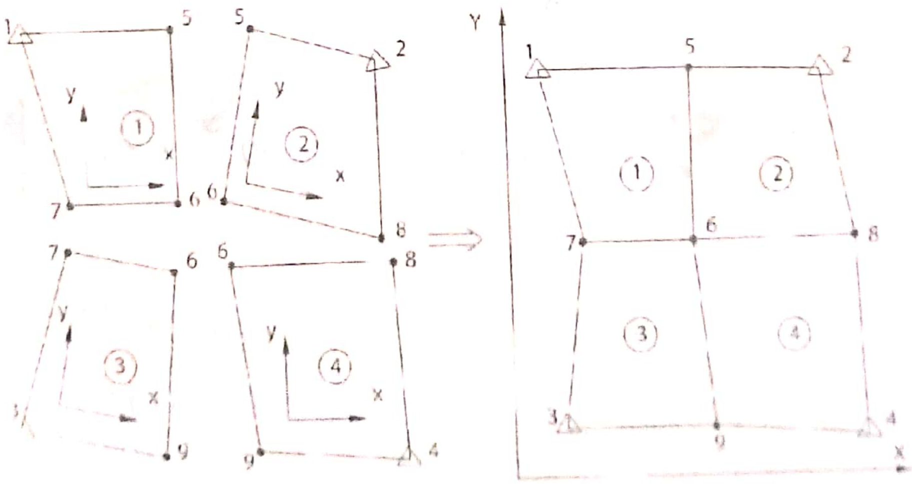
So that:

the tie points fit together as well as possible and

the residual discrepancies at the control points are as small as possible.

Why is the similarity (conformal) transformation used in the Block adjustment by independent models?

- The scale, position and orientation of the models may be changed but not its shape



unknowns: $4 \times 4 = 16$ transformation X_0, Y_0, θ, b

$5 \times 2 = 10$ tie point coordinates X, Y

observation: 32 model

control points (1, 2, 3, 4)

$4 \times 2 = 8$

tie point 5 = 2×2 4   Σ = 32

6 = 4×2 8

7 = 2×2 4

8 = 2×2 4

9 = 2×2 4

Redundancy: $n - m$

$= 32 - 26 = 8$

3c. Contact printing, emulsion side of a (?) negative is in direct contact with the unexposed emulsion contained on printing material placed together in a contact printer & exposed with emulsion of the positive facing light source.
Projection : negative is placed in the projector of the printer and illuminated from above.

Question 2 [10+9+6 marks]

a) With the help of a sketch, explain the term 'Parallactic angle' and state how it is related to stereoscopic depth perception.

b) In an ideal optical system, all rays of light from a point in the object plane would converge to the same point in the image plane, forming a clear image. The influences which cause different rays to converge to different points are called aberrations. Mention and briefly explain 3 types of aberrations

c) The image distance for a photograph of an object, which is located 4.5 meters from the camera, is 76.5mm. What image distance is required for perfect focus if the object is in infinity?

Question 3 [8+10+7 marks]

a) Mention two effects on the aerial photo image when a photo is taken at a height of 2500 m above the terrain with a 300-mm lens, compared to a photo taken with a 150-mm lens (assume the same flying height above the terrain and same film in both cases).

b) A single ray of light travelling through air (index 1.0003) enters a glass lens (index 1.575) having a radius of 47.5 mm. If the light ray is parallel to and 9.5 mm above the optical axis of the lens, what are the angles of incidence and refraction?

c) Briefly distinguish between contact printing and projection printing of a photographic emulsion.

SECTION B

Question 4 [16+9 marks]

a) Define the following photogrammetric terms:
- Filter :- only allows certain wavelengths of energy to pass through lens and expose film
- Density
- Contrast
- Resolution of a lens - sharpness of lens.

b) Explain briefly,
- 'Depth of field' - Area of focus behind & infront of object (subject
- The principle difference between a 'map' and a 'photo'

Question 5 [10+15 marks]

a) Discuss the characteristic curve H and D, or D-log- E curve.

b) Discuss the darkroom procedure for black and white emulsion. Explain when and why a 'safe' light can be used in a darkroom

The University of Zambia
School of Engineering
Department of Geomatic Engineering
2018/2019 Academic Year
Second-Half Year Term Test

GEE 3622: Principles of Data Acquisition and Processing (Photogrammetry)
Friday 6th September 2019
Time: Two (2) Hours
Instructions

1. This TEST is **Closed Book**
2. Calculators are permitted
3. Time allowed is Two (2) Hours
4. **Answer: ALL QUESTIONS FROM SECTION (A) AND ONE FROM SECTION (B)**
5. Show <u>all</u> the work leading to the solution
6. Total marks for this TEST paper is 100

SECTION A

image plane during exposure

Question 1 [9+9+7 marks]

a) Define the following photogrammetric terms:
- Aperture – A hole / opening through lens where light travels
- Latent image – An emulsion exposed to light containing an invisible image of obs
- Illuminance – Brightness or amount of light recieved per unit area of a
- Principle point – intersection of lines joining opposite fiducial marks.
- fog
- Brightness factor – ratio of d over f or $\sqrt{\frac{d^2}{f^2}}$ / diameter of camera ~~image distance~~ to focal l
- Epipolar plane
- Principle distance
- Flying height – altitude of camera

b) What are the relationships between?
- F-number and shutter speed
- Film speed and emulsion grain size
- Resolution and emulsion grain size

c) An aerial camera makes an exposure at a shutter speed of 1/1,000 sec. If the aircraft speed is 500 miles per hour, how far will the aircraft travel during the exposure?

* film speed & emulsion grain: Large grain size require a faster film speed while small grain require slower film speed.
* Resolution and emulsion grain: Large grain produce to lower resolution (sharpness) of image while small grains produce higher resolution of image.
* fnumber & shutter speed: Are both inversely proportional to one another. when aperture is widened, shutter speed is increased