National Exams May 2012

04-GEOM-A4, Photogrammetry

3 Hours Duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a CLOSED BOOK exam.

3. Eleven questions constitute a complete paper.

   Part A: Answer ALL questions from #1 through #8;
   Part B: Answer ONE of questions #9 or #10;
   Part C: Answer ONE of questions #11 or #12;
   Part D: Answer ONE of questions #13 or #14.

4. The marks assigned to each question are shown in brackets in the left margin.

PART A - PLEASE ANSWER ALL QUESTIONS FROM #1 THROUGH #8

(15) 1) 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 lengths f. The corresponding images of the ground point P are p_L on the left photograph 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, that is the X and Y axes are parallel to the x and y axes of the photo system.

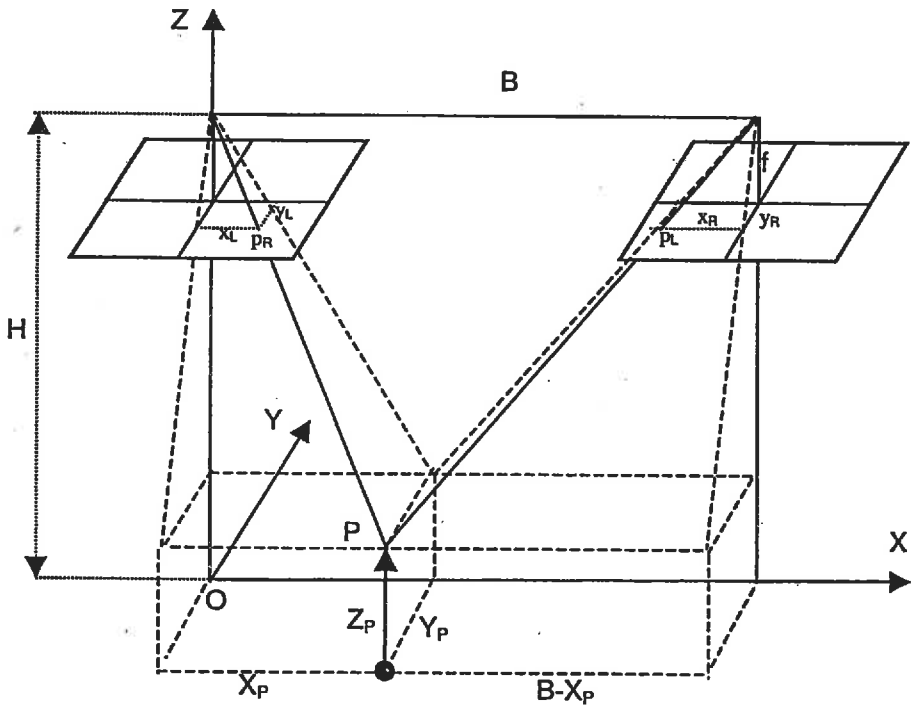
a. Derive the basic parallax equations for the ground coordinates of point P based on the illustrated geometry of the overlapping truly vertical photos.

b. Compute the ground coordinates 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= -50.00mm.



(7) 2) a) Define the x- and y-parallaxes.
b) What does the existence of y-parallax mean?
c) What procedure is used to eliminate the y-parallax?
e) What do changes in the x-parallax mean?

(8) 3) a) Name the instrument usually employed to measure the position of a point in a photograph.
b) What are the systematic errors contained in the measured photo-coordinates, that disturb the ideal linear relation between the perspective center, the image point and the ground point?

(10) 4) Define the following photogrammetric terms, give the number of the corresponding parameter elements required for their determination and name them.

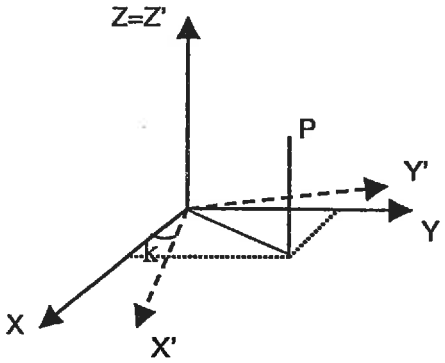
a. Basic interior orientation
b. Relative orientation
c. Absolute orientation
d. Exterior orientation

(8) 5) Provide the definitions of the independent and the dependent methods of the relative orientation. Name the projector elements used in each of them.

(9) 6) Provide the definition of the collinearity condition and give its mathematical expression. Explain the terms used in the mathematical expression.

(9) 7) Provide the definition of the coplanarity condition and give its mathematical expression. Explain the terms used in the mathematical expression.

(10) 8)



Let X, Y, Z be the coordinates of point P in the XYZ coordinate system. If the coordinate system is rotated around the Z-axis by a rotation angle k,

a) show that the X', Y', Z' coordinates of point P in the new X'Y'Z' coordinate system ($Z \equiv Z'$) are expressed as a function of the rotation matrix R_k. That is,

$$\vec{P}' = R_k \vec{P}$$

b) show that the rotation matrix R_k is orthogonal.

PART B - PLEASE ANSWER ONLY ONE OF QUESTIONS #9 OR #10

(9) 9) a) Provide the definition of space resection.
b) How many and which are the unknown parameters for space resection?
c) What mathematical expression is used to determine the unknown parameters of the space resection?
d) What is required to be known to solve for the unknown parameters?

(9) 10) a) Provide the definition of space intersection.
b) How many and which are the unknown parameters for space intersection?
c) What mathematical expression is used to determine the unknown parameters of the space intersection?
d) What is required to be known to solve for the unknown parameters?

PART C - PLEASE ANSWER ONLY ONE OF QUESTIONS #11 OR #12

(8) 11) For the absolute orientation of a stereo-model the selected ground control points are all located along the sides of a straight stretch of a highway going through the model. Could this distribution of the control points cause any problem? If yes, what is the problem and how can a solution be obtained?

(8) 12) For the determination of the position and orientation of a single photograph the selected ground control points and the camera location all almost lie on a spherical surface. Could this geometry cause any problem? If yes, what is the problem and how can a solution be obtained?

PART D - PLEASE ANSWER ONLY ONE OF QUESTIONS #13 OR #14

(7) 13) Provide the definition of overcorrection and explain how is applied during the process of relative orientation on an analogue photogrammetric stereo-plotter.

(7) 14) Provide the minimum number and type of ground control points required for the absolute orientation of a photogrammetric stereo-model.