Example SURE 440 Exam Questions

- What is the difference between numerical photogrammetry and analytical photogrammetry as discussed during the classification of photogrammetric methods?
- Outline the steps used in relative orientation (independent or two-projector method). Use a sketch in your description.
- What are the design characteristics of analytical instrumentation? Identify and describe the systematic errors associated with photogrammetric comparators. What are Abbe's comparator principles? What are "weave of the ways"? How are they caused? The measurement spindle (lead screw) has inherent problems/errors associated with it. Describe them.
- Describe first order theory. What is second order theory?
- An isogonal affine transformation was run on photo measurements with the solution being:

$$\Delta = \begin{bmatrix} 0.99905 \\ -0.00247 \\ 0.01479 \\ -0.04525 \end{bmatrix}$$

If point a had measurements of x_a = 76.098 mm and y_a = -41.988 mm, what are the transformed coordinates? The general affine transformation is shown in the following form. Derive the isogonal affine transformation and show the final formulas in a linear form. From this relationship, show how the rigid body transformation is defined.

$$x' = C_x \cdot x \cdot \cos\alpha + C_y \cdot y \cdot \sin\alpha + \Delta x'$$
$$y' = -C_x \cdot x \cdot \sin(\alpha + \beta) + C_y \cdot y \cdot \cos(\alpha + \beta) + \Delta y'$$

- All midside and corner fiducial marks are measured on a comparator. A projective transformation is to be applied to these measurements. Is this solution a unique or over determined solution? Provide justification and explanation for your answer.
- In a photograph with corner fiducial marks, the following measurements were taken:

Point	x (mm)	y (mm)
Fiducial A	0.00	0.00
Fiducial B	211.88	0.00
Fiducial C	211.90	211.96
Fiducial D	0.00	211.96
Point 1	203.28	81.38

What are the photo coordinates of point 1. Calculate the acute angle of intersection of fiducial lines for a camera is the comparator measurements of the fiducial marks were as follows:

Fiducial	x (mm)	y(mm)
A	-112.706	0.223
B	-0.174	-113.004
C	113.054	-0.445
D	0.512	112.768

- A point (a) on a photograph has coordinates x_a = 65.37 mm and y_a = 61.62 mm. From the camera calibration, the lens distortion at that point was found to be -0.014 mm. What are the corrected photo coordinates? From a camera calibration report, the radial lens distortion at given radial distances from the principal point in the following table. If an image point has coordinates x = 61.582 mm and y = -36.944 mm, what are the corrected coordinates due to effects of lens distortion?

r	20 mm	40 mm	60 mm	80 mm	100 mm	120 mm
Δr	4 μm	7 μm	7 μm	7 μm	-3 μm	-7 μm

- Discuss how the basic principle of measurement of lines can be used in camera calibration.
- Explain how film deformation is handled when correcting photographic measurements. This includes discussion on both fiducials and reseau. What was the source of the deflection of the diapositive print prepared using the electronic type of printer? How was this deformation effectively removed in the subsequent diapositive preparation?
- What is the cause of Seidel's radial lens distortion? What is the cause of decentering lens distortion? Assume one has a theoretically straight line from the object space to the film. Explain how atmospheric refraction will displace the location of the point. Explain how earth curvature will displace the location of the point. If a camera with a 152.35 mm focal length lens was used to take a picture at an altitude of 20,000' above ground, whose average elevation is 950', what is the effect of atmospheric refraction on a point where the radial distance from the principal point is 127.66 mm? Use the modified atmospheric model given as

$$K = \{13(H-h)[1-0.02(2H+h)]\}\cdot 10^{-6}$$

- The magnitude of the error due to earth curvature is dependant upon a number of variables. What are they? With all other variables being a constant, what happens to the magnitude of the earth curvature error if the variable identified in the first part of the question is increased?
- In photogrammetry, roll, pitch and yaw rotations are performed in a sequential manner. Describe each rotation explaining which axis the rotation is being performed about and how a positive rotation angle is defined. Describe the concept of direction cosines.
- The central projective equations are given by the following mathematical model. Explain in words what this model is physically doing. Identify the appropriate items within the equations when appropriate.

$$F(x) = (x - x_o) - c\frac{\Delta X}{\Delta Z}$$

$$F(y) = (y - y_o) - c\frac{\Delta Y}{\Delta Z}$$

- What is the difference between Case I and Case III theory? Case III of Numerical Resection and Orientation was the one case most applicable to the conventional surveyor. Why might this statement be true? Explain the advantages of this case and show the theory of how this is accomplished (include a narrative in this development).
- In his article on photogeodesy, D. Brown recommends red-dot targeting. Why? In place of conventional 67% overlap and sidelap uses in conventional aerotriangulation, D. Brown suggests an alternative plan. What is it and why is it important?
- Describe how the Delta-Z method of determining the perspective center coordinates is performed (include a sketch in the description). Show how the observation equations are developed and explain, in words, what that equation is intended to do (hint: use the concept of the basics of least squares).
- Describe how independent model triangulation is performed.
- What are the advantages of airborne GPS? How does the use of airborne GPS affect flight planning? When using airborne GPS alone, the photogrammetrist must consider the amount of sidelap when the camera is locked down during the flight. Explain.
- Two models for computing the aircraft trajectory were discussed in lecture: linear model and the polynomial model. Explain how the linear model is applied and show an example with numerical values. What are the advantages of the polynomial model?
- Can airborne-GPS be used without ground control for single photo resection and orientation? Explain your answer. Can airborne-GPS be used without ground control for two photo resection and orientation? Explain your answer. Some experts claim that the traditional camera calibration procedures are not adequate for airborne-GPS. What are the reasons? With airborne-GPS one can identify errors with the photogrammetry, errors with the GPS, and errors unique to the integration of GPS and the aerial camera. Describe three of these latter errors due to the integration of technologies. Describe the pros and cons for placing the GPS receiver on the planes fuselage directly over the camera. What are the disadvantages of determining the integer ambiguity using static initialization?
- When discussing the processing of airborne GPS observations, the following math model was given

$$\begin{bmatrix} X_L \\ Y_L \\ Z_L \end{bmatrix} = \begin{bmatrix} X_a \\ Y_a \\ Z_a \end{bmatrix} + M_E M_M \begin{bmatrix} DU \\ DV \\ DW \end{bmatrix}$$

The advantage of this model is that photo observations do not have to be processed through the collinearity condition equations. True or False. Explain your answer.

- In the lecture on airborne-GPS an observation equation was presented as follows. Explain how this equation is used in aerotriangulation (i.e., is it used with other math models?) and, secondly, how is this equation applied to the data over a block of photos.

$$\begin{bmatrix} X_{A_{GPS}} \\ Y_{A_{GPS}} \\ Y_{A_{GPS}} \end{bmatrix}_i + \begin{bmatrix} V_X \\ V_Y \\ V_Z \end{bmatrix} = \begin{bmatrix} X_O \\ Y_O \\ Z_O \end{bmatrix} + R(\varphi, \omega, \kappa)_i \begin{bmatrix} X_{PC}^A \\ Y_{PC}^A \\ Z_{PC}^A \end{bmatrix} + \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}_j + dt \begin{bmatrix} bx \\ by \\ bz \end{bmatrix}_j$$

- Adding parameters to the adjustment weakens the solution. To strengthen the problem one can introduce more horizontal ground control, but this defeats one to the advantages of airborne-GPS. Identify three approaches to reducing the instability of the block (include a sketch) while still using only four horizontal control points.
- What is the "edge effect" and how is it caused?
- Once inertial equipment (IMU) is placed in an aircraft it is subject to a host of effects. Describe them. Describe the two major limitations of inertial systems. What is a ZUPT and how is it performed? What are the disadvantages of using a ZUPT within a mobile mapping system? Describe how GPS and IMU are complementary navigation systems for mobile mapping.
- There is no need to perform aerotriangulation with direct platform (or sensor) orientation. Discuss this statement. What are the advantages of direct sensor orientation over conventional aerotriangulaion? While direct sensor orientation alleviates the need for aerotriangulation, an integrated DSO/AT system has merit. Explain.
- The georeferencing process can be defined mathematically in the formula below. Explain what is happening along each step of this equation.

$$r_i^m = r_{INS}^m(t) + R_b^m(t)\left(R_c^b \cdot s_i \cdot r^c + a^b\right)$$

- Define mobile mapping. Describe the purposes of the calibration required within a mobile mapping system. Describe how calibration is performed within a mobile mapping system. What are the disadvantages of GPS within mobile mapping system?
- What are the disadvantages of using the in-flight calibration approach in mobile mapping systems? The accuracy of a mobile mapping system is a function of a number of variables. What are they? Describe the two components in the boresight transformation and identify how the boresight calibration is generally performed.
- How are lidar systems that work over land different than those that work over water? Describe how a lidar system measures a DTM. What are the disadvantages of DEM data collection with lidar?
- Describe the disadvantages in using a rotating mirror to acquire imagery in a laser altimetry (lidar) system. Describe how the nutating mirror (Palmer scan) captures laser scanner data. What is the advantage of this type of scanner?
- The center of a laser signal footprint can be described mathematically by the next formula. Describe what is happening in this relationship.

$$p = c + R_e R_i$$

- Describe the effect of a timing bias from a laser profile over horizontal terrain. How are interpolation errors affected through the vegetation point removal process?
- What is an orthophoto? What factors affect the accuracy of a digital orthophoto? Discuss how magnification affects the image quality of a digital orthophoto. What data are needed for the creation of an orthoimage? Identify the production cycle processes that affect image quality of a digital orthophoto. Describe three problems associated with digital orthophotos.

Why is it impossible to obtain a truly orthographic projection in areas with sharp vertical relief using conventional orthophotographic processing?

- While height determination with a small format camera is 3-5 times poorer than the accuracy of the horizontal coordinates, it can be improved. Explain how.
- When discussing the digital image model, we were introduced to the following mathematical relationship: $I(x, y) = O(x, y)*P(x, y) + N(x, y)$. Explain what this equation means, including a description of all variables. Most of the high frequency signal is lost in a digital image. Why? A digital image has a minimum DN of 25 and a maximum of 65. A particular pixel, P, has a value of 42. What is the DN value for pixel P if a linear stretch contrast enhancement is applied to the image? Describe how the spectral transformation is applied in convoluting a digital image.
- Describe the difference between anaglyphic and alternating shutter stereovision capabilities in softcopy photogrammetry. What are the disadvantages of using a moving floating mark and fixed image in softcopy photogrammetry? What is an epipolar line and what does it mean for conjugate imagery? Describe the concept of epipolar resampling.
- Describe the three different techniques used in digital image matching. What is the significance of the correlation coefficient in image matching? Explain how digital image matching is performed using normalized cross-correlation.

This page is maintained by Bob Burtch and was last updated on 2 November 2003.