CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

E5 – ADVANCED PHOTOGRAMMETRY   <u>March 2019</u>

Although programmable calculators may be used, candidates must show all formulae used, the substitution of values into them, and any intermediate values to 2 more significant figures than warranted for the answer. Otherwise, full marks may not be awarded even though the answer is numerically correct.

Note: This examination consists of 10 questions on 3 pages.   **<u>Marks</u>**

Q. No		Time: 3 hours	<u>Value</u>	<u>Earned</u>
1.	a)	What are the factors that would affect the inter-point spacing for a LiDAR system?	3	
	b)	What are the factors that would affect the size of the laser beam footprint?	2	
	c)	What is the underlying assumption for using a projective transformation to relate the image and object space coordinates?	2	
	d)	Briefly explain the conceptual basis for using the Rational Functional Model to relate the image and object space coordinates.	2	
	e)	What are the main differences between the collinearity equations and Direct Linear Transformation models?	2	
2.	a)	What are the necessary input and the processing steps for the generation of an orthophoto through differential rectification?	3	
	b)	What is meant by the double mapping problem when generating orthophotos from large scale imagery over urban areas (use a sketch to illustrate your answer)? Where in the image do you expect this problem to be more pronounced? Why?	3	
	c)	Explain the conceptual basis of the Z-buffer method for true orthophoto generation.	3	
	d)	What is the main limitation of the Z-buffer method for true orthophoto generation?	1	
3.	a)	What is the main limitation of a digital frame camera when compared with an analogue one?	2	
	b)	What are the different alternatives for stereo-coverage using line cameras?	3	
	c)	How would the stereo-coverage alternatives associated with line cameras affect the Ground Sampling Distance (GSD) in the acquired scenes?	4	
	d)	What is meant by Quality Assurance (QA) and Quality Control (QC)?	2	
4.	a)	What is the objective of image matching?	2	
	b)	What is the conceptual basis of the cross-correlation-based image matching?	3	
	c)	What is meant by image resampling according to epipolar geometry? How would this process facilitate the image matching procedure (use a sketch to illustrate your answer)?	2	
	d)	What would be the contribution magnitude (i.e., significant versus insignificant) of an INS in the following situations (explain why): 1) GPS/INS-controlled photogrammetric triangulation of an image block captured by wide-angle frame camera? 2) GPS/INS-controlled photogrammetric triangulation of an image block captured by a narrow-angle line camera?	3	

5.	Compare photogrammetric and LiDAR systems with regard to the following aspects:
	   a) Geo-referencing alternatives,
	   b) Precision of derived object space in the planimetric and vertical directions,
	   c) Inherent redundancy in the reconstruction process,
	   d) Potential quality control of the derived coordinates,
	   e) System calibration procedures, and
	   f) Automation of the object space reconstruction procedure
		10	

6.	To reconstruct the object space from a LiDAR system, the following equation is used: $$r_I^m = r_b^m(t) + R_b^m(t)r_{lu}^b + R_b^m(t)R_{lu}^b R_{lb}^{lu}(t)r_I^{lb}(t)$$ Explain each term in the above equation. Also explain the nature of each of these terms (e.g., whether it is measured, derived from other measurements, derived from a calibration procedure, or unknown)	10	
7.	a) You are working in company that collects topographic data using an airborne LiDAR system. The quality control procedure that is being used by this company to verify the accuracy of the collected data is reporting the elevation difference between the LiDAR data and check points that have been surveyed by a kinematic GPS survey. Would you support the continued adoption of this procedure? Why?	4	
	b) You are working in a company specializing in LiDAR data collection and you have a client that would like to have a point cloud with an average point spacing of 50cm over an urban area. The LiDAR system you have has a maximum pulse repetition rate that would allow you to achieve such point density from a single flight line. Would you recommend a flight configuration with high pulse repetition rate and minimal overlap between neighbouring strips or a flight configuration with less pulse repetition rate and 50% overlap between neighbouring strips? Why?	4	
	c) Is there a difference between scene and image coordinates in imagery captured by a line camera? Why?	2	
8.	a) What is the impact of biases in the Interior Orientation Parameters (IOP) on the reconstruction outcome from photogrammetric triangulation aided by GPS/INS observations or GCPs? Why?	3	
	b) What would you expect from a GPS/INS-controlled triangulation and intersection procedures in terms of the quality of the reconstructed object space? Why?	3	
	c) What are the differences between direct and indirect transformation during image rectification? Tabulate the advantages and disadvantages of each method.	4	
9.	a) How would you compare the intensity image generated from a LiDAR system to an optical image?	2	
	b) For orthophoto generation, it is recommended to use wide-angle camera for DEM generation while using narrow-angle camera for the rectification process? Do you agree with this statement? Why?	4	
	c) Explain what is meant by beam divergence angle of a LiDAR system (use a sketch to illustrate your answer)?	2	

10.	a)	What is the role of the Interior Orientation (IO) in the photogrammetric reconstruction procedure?	3	
	b)	What is the role of the geo-referencing in the photogrammetric reconstruction procedure?	3	
	c)	What are the factors that should be considered when deciding on the appropriate segmentation strategy for LiDAR data?	3	
	d)	Which one of the following points (i.e., the center of the given windows) can be considered as an interest point? Why?	1	

95	94	84		23	94	84
86	12	96	or	34	22	96
100	97	87		36	22	25

| | | **Total Marks:** | 100 | |