TU Delft Delft University of Technology

Faculty of Architecture and the Built Environment

Final Exam

Course: Photogrammetry and 3D Computer Vision (GEO1016) – 5 EC

Location: ROOM NUMBER (differs from years)

Time: XX/XX/XXXX, 09:00 - 11:30 AM

Responsible teacher: Liangliang Nan

1. This exam is closed-book, but **you're allowed to bring a cheatsheet with no more than 3x A4 papers** (you can choose to print on both sides, and thus no more than 6 printed pages). **You must answer the questions alone** without any help from anybody else.
2. **Electronic devices are forbidden**, including cell phones, iPads, headphones, laptops, and calculators.
3. This exam consists of three parts (starting on the next page):
   (a) 10 multiple-choice questions with a single correct answer (20 points);
   (b) 8 multiple-choice questions with at least 2 correct answers (24 points);
   (c) 6 open questions (56 points).
4. The total number of points is 100, and the minimum number of points to pass this exam is 55. Your grade is determined by dividing the total number of obtained points by 10.
5. **Write your answers on the printed exam papers**. The provided space is **more than sufficient** for complete answers. **Attention: any text on additional papers will not be considered for grading**.
6. If you think a question is ambiguous, mark what you think is the best answer. As always, we will consider written regrade requests if your interpretation of a question differed from what we intended.
7. Before starting,
   (a) check if all pages (5 pages in total) and questions are present. If not, ask the teacher.
   (b) fill out your **student ID** and **full name**.
   (c) read the instruction at the beginning of each part before you answer the questions.
8. **You have 2.5 hours**. Schedule your time so you can attempt to answer all the questions.
9. The exam questions are confidential and breaching this confidentiality agreement can be penalized.

Student ID: _____ **Name**: _____

Part 1 Multiple choice (with a single correct answer) *[20 points]*

- *Every question has 4 choices and only 1 correct answer*
- *Every question counts for 2 points and the grading is based on*
  - *Answer is correct: 2 points*
  - *No answer is provided or 'not sure' is indicated: 0 point*
  - *Answer is wrong: -1 point (to discourage random guessing)*

1. The mathematical formulation of projecting a 3D point p in the world coordinate system to a 2D point x in the image coordinates can be expressed by $x = Tp$. Which of the following is NOT encoded in T?
   A. The intrinsic matrix of the camera.
   B. The fundamental matrix of the camera.
   C. The focal length of the camera.
   D. The orientation of the camera.

   Answer: _____

2. Which of the following factors does NOT affect the intrinsic parameters of a camera?
   A. Focal length.
   B. An offset of the optical centre.
   C. Exposure.
   D. Image resolution.

   Answer: _____

3. Regarding the input to camera calibration, which of the following statement is correct?
   A. Camera calibration requires at least 6 3D-2D point correspondences.
   B. Camera calibration requires at least 8 3D-2D point correspondences.
   C. Camera calibration requires at least 6 pairs of corresponding image points.
   D. Camera calibration requires at least 8 pairs of corresponding image points.

   Answer: _____

4. More questions to be continued...

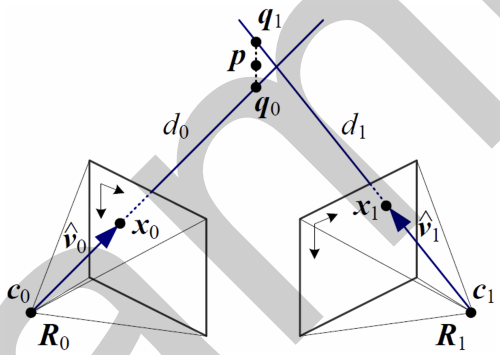
Part 2 Multiple choice (with multiple correct answers) *[24 points]*

- *Every question has 4 choices and at least 2 correct answers*
- *Every question counts for 3 points and the grading is based on*
  - *Answer is complete and correct: 3 point*
  - *Answer correct but not complete: 1 point*
  - *No answer or answer contains one or more wrong choices: 0 point*

1. What is the necessary input information for recovering 3D geometry from a set of images?
   A. Image size (i.e., width and height).
   B. Camera intrinsic parameters.
   C. Camera extrinsic parameters.
   D. Sufficient corresponding image points.

   Answer: _____

2. In the following figure, x_0 and x_1 denote the image points of a 3D point p in two camera views and c_0 and c_1 are the corresponding camera centres.



   In theory, the two rays $\overrightarrow{c_0x_0}$ and $\overrightarrow{c_1x_1}$ intersect at p. What could be the reason that the two rays don't intersect in reality?
   A. The coordinates of image points cannot be measured with arbitrary accuracy.
   B. Geometric noise from lens distortion.
   C. The interest points detection error.
   D. The limited floating-point precision.

   Answer: _____

3. More questions to be continued...

Part 3 Open questions *[56 points]*

- *No point will be awarded without a valid explanation*
- *Keep your answers as concise as possible*

1. What are the differences between the ideal pinhole camera model and the perspective projection camera model (Hint: think about how the camera models were derived)? *[6 points]*

2. Given a camera mounted on a drone, design a working pipeline to reconstruct a 3D surface model of the entire building of the Faculty of Architecture and the Built Environment (see the figure below).

Your answer should include:

(1) The requirement on the data (i.e., images) acquisition. *[3 points]*

(2) The purpose, input, and output of each major step in the reconstruction pipeline (assume the hardware information for the camera is not available). *[7 points]*

3. More questions to be continued...