NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2019-2020

EE6222 – MACHINE VISION

November / December 2019 Time Allowed: 3 hours

INSTRUCTIONS

1. This paper contains 5 questions and comprises 3 pages.
2. Answer all 5 questions.
3. All questions carry equal marks.
4. This is a closed book examination.

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1. Describe the following operations in detail:

   (a) Split-and-merge image segmentation

   (4 Marks)

   (b) Binary morphological opening operation

   (4 Marks)

   (c) Local binary patterns (LBP)

   (6 Marks)

   (d) Histogram of oriented gradients (HOG)

   (6 Marks)

2. The following two-dimensional observations belonging to two classes are given as (Dimension 1, Dimension 2):

   Class 1: (2, 2), (2, 5), (1, 4), (3, 4)

   Class 2: (5, 6), (6, 5), (6, 6), (7, 5)

Note: Question No. 2 continues on page 2.

(a) Classify an unlabeled test data (3.5, 5) by using the 3-NN method.

(4 Marks)

(b) Obtain the Minimum Distance Classifier's decision boundary and classify the unlabeled test data (3.5, 5).

(6 Marks)

(c) Obtain the optimal projection vector $\widehat{W}$ by using the Fisher's linear discriminant analysis (LDA) method.

(8 Marks)

(d) After applying the projection vector obtained in part 2(c) to all 8 observations, how will you classify the unlabeled test data (3.5, 5)?

(2 Marks)

3. (a) Describe the Hough Transform method in detail in the context of detecting parametric lines in an edge image.

(10 Marks)

(b) (i) Show details of solving the fundamental matrix from two images.

(ii) What are the differences between Fundamental Matrix and Essential Matrix ?

(10 Marks)

4. (a) In parallel binocular stereo image settings, the object depth Z can be obtained from disparity using the following equation:

$$Z = f\frac{B}{dx}$$

where f is the focal length, B is the baseline, and dx is the disparity. If one takes two images from a video sequence with pure translation, show that the motion parallax is identical in depth estimation:

$$Z = \frac{h_1}{\frac{m_1}{m_3} - \frac{m'_1}{m'_3}}$$

Note: Question No. 4 continues on page 3.

where the full translational motion is $\boldsymbol{h} = (h_1, h_2, h_3)^T$, and the image points are given in N-vector notations as $\boldsymbol{m} = (m_1, m_2, m_3)^T$, and $\boldsymbol{m}' = (m_1', m_2', m_3')^T$.

(10 Marks)

(b) The rotation angle can be estimated from two image snaps when the camera has performed pure rotation. Show your solutions with working details.

(10 Marks)

5. One pinhole camera has the following properties:

Focal length: 1000 pixels
Aspect ratio: 1
Image resolution: 2000 × 3000 (rows × columns)
Image centre: (1000, 1500)

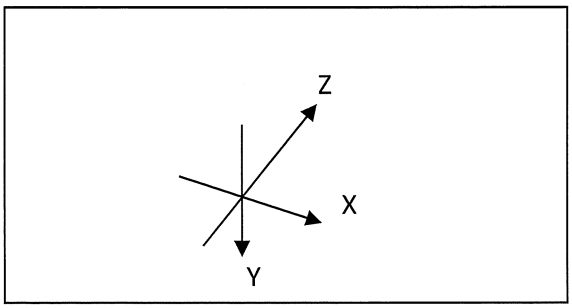

Figure 1

(a) A person is found at (*X, Y, Z*) = (1, -1.5, 20) m as shown in Figure 1. Show this location's image point, and its N-vector.

(5 Marks)

(b) This person is 1.75 m tall. The person's height in image is detected as 50 pixels. The person's feet is at location row=1000, column=1200. What is the distance of this person to the camera? Determine the person's location in the real world coordinates.

(15 Marks)

END OF PAPER

EE6222 MACHINE VISION

Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.