NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2018-2019

EE6222 – MACHINE VISION

November/December 2018 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) Sobel edge detection (4 Marks)

   (b) Extreme-curvature points based two-dimensional contour representation (4 Marks)

   (c) Median filtering (4 Marks)

   (d) High boost filtering (4 Marks)

   (e) Contrast stretching (4 Marks)

2. (a) Describe the template matching method. Your answer should consider variations due to illumination, orientation and scale.

(8 Marks)

(b) Compute the grey level co-occurrence matrices for the 2-bit image shown in Figure 1 for the following 2 cases:

(i) Horizontally separated by one pixel

(ii) Vertically separated by one pixel

1	1	2	2	3
0	1	2	3	3
1	0	1	3	2
1	3	2	2	0
3	0	0	2	3

Figure 1

(12 Marks)

3. (a) Based on Fisher's Linear Discriminant method, derive an objective function to achieve the optimal class separation between two classes. Subsequently, obtain an expression for the optimal projection vector. The two classes have μ_1, μ_2 and $\sum_1, \sum_2$ as their mean vectors and covariance matrices, respectively.

(10 Marks)

(b) (i) Two points were found on an image as *N*-vectors of $= \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}$, $\boldsymbol{b} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$.

Derive the *N*-vector of the line passing through $\boldsymbol{a}$ and $\boldsymbol{b}$.

(ii) A space line *L* is defined as $\{\boldsymbol{n}, \boldsymbol{p}\}$ where $\boldsymbol{n}$ is the *N*-vector of the image line and $\boldsymbol{p}$ is the *p*-vector. Obtain the line equation passing through two 3-D space points $\boldsymbol{s_1}$ and $\boldsymbol{s_2}$.

(10 Marks)

4. (a) Explain the motion parallax from correspondence of image points.

(6 Marks)

(b) When the camera motion is unknown, and large number of image points are observed, what can be obtained?

(5 Marks)

(c) A space line L has been observed twice by a moving camera as $\{\boldsymbol{n}, \boldsymbol{p}\}$ and $\{\boldsymbol{n'}, \boldsymbol{p'}\}$. Derive the ego motion $\boldsymbol{h}$.

(4 Marks)

(d) Show that quaternion is not commutative:

$$q_1 q_2 \neq q_2 q_1$$

(5 Marks)

5. (a) Find the rotation matrix of image rectification for a binocular stereo image system.

(5 Marks)

(b) Show that vanishing points on the same plane form a common vanishing line.

(10 Marks)

(c) What is the meaning of cross ratio invariance under perspective transformation?

(5 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.