First Semester Examination
2021/2022 Academic Session

February/March 2022

EPE462 – Industrial Machine Vision

Duration : 3 hours

Please check that this examination paper consists of SIX [6] printed pages before you begin the examination.

INSTRUCTIONS : Answer **ALL FOUR[4]** questions.

In the event of any discrepancies, the English version shall be used.

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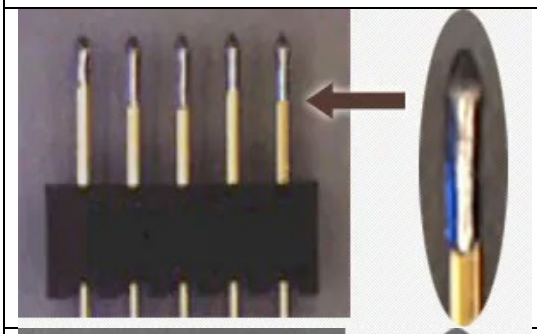
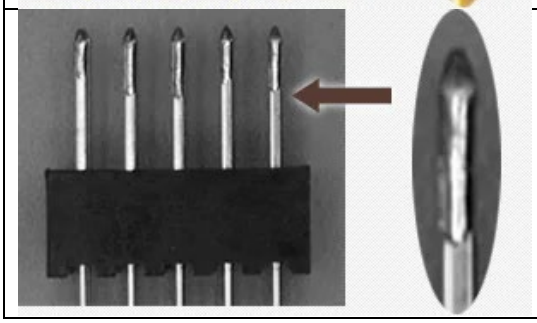
1. [a] Table 1[a] shows the example of gold product that will be used for machine vision system. Due to similar reflectiveness gold or silver appear almost the same when converted to grayscale. Proposed the suitable lighting colors gives the greatest contrast between gold or silver and justify your answer?

Table 1[a]

When using white lighting	
	Image through colour camera
	Image through monochrome camera

(30 marks)

[b] GuhTrank Cooperation is cutting tool manufacturer for aerospace industry. They produce about 5000 pcs of cutting tools for their production per day. To improve the quality inspection process, they want to install machine vision system. As a Process Engineer, propose the step of selecting the correct camera for this application. Give a justification to support your proposal.

(30 marks)

[c] Based on your knowledge and understanding of industrial machine vision, propose a vision system model to solve the issue. Used all the seven-element generic model for constructing the vision system model. Figure 1 is the detail of the cutting tools that produce by GuhTrank Cooperation.

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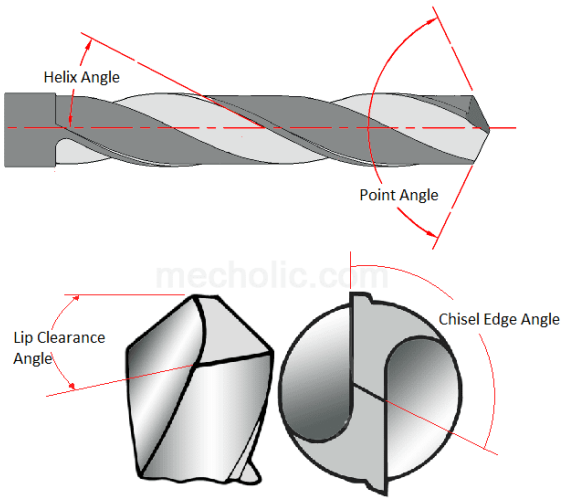

Figure 1[c]

(40 marks)

2. [a] There are three illumination types in machine vision which are (a) low angle lighting (b) dome lighting and (c) coaxial vertical illumination. Describe the principle of each illumination by graphic diagram.

(30 marks)

[b] Based on Figure 2[b], match up the following vision applications (1 through 3) to the illumination type (a, b or c) that is the most suitable lighting for each of the targets.

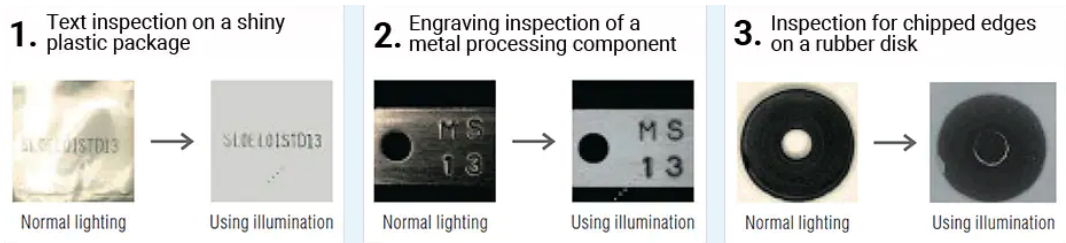

Figure 2[b]

(20 marks)

[c] Testing on the target has confirmed that for the abnormalities to be properly detected, a field of view of 100 mm is needed. In addition, the image processing time taken to conduct the inspection using this field of view was 25 ms. Suggest the maximum line speed that detection can occur under these conditions without missing any abnormalities?

Figure 2[c]

(20 marks)

[d] For this example, the image sensor has a field of view of 100 mm, and the CCD size is 500 × 500 pixels. The target will pass the image sensor at a speed of 1000 mm/second. Which of the following shutter speeds would be best to keep the image (Figure 2[d]) in focus under the optimum lighting conditions?

Figure 2[d]

(30 marks)

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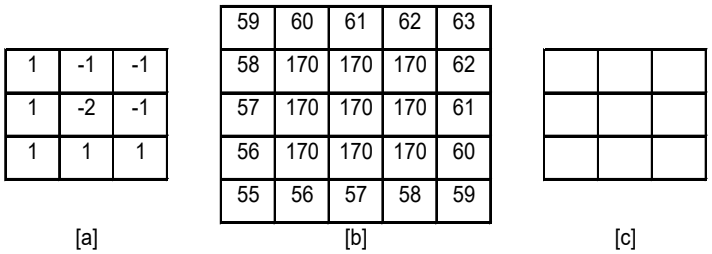
3. [a] Figure 3[a] shows one of the Prewitt gradient templates. Apply the template on the image which has the pixel value shown in Figure 3[b] and write the resulting image pixel value in Figure 3[c]. Set the threshold value to determine edges and indicate the pixels that become the edges.



1	-1	-1
1	-2	-1
1	1	1

[a]

59	60	61	62	63
58	170	170	170	62
57	170	170	170	61
56	170	170	170	60
55	56	57	58	59

[b]

[c]

Figure 3[a]

(40 marks)

[b] Three data points had been extracted from an image and plotted on a Cartesian plane as C (4, 14), D (8, 10) and E (16, 2). Using Hough transform technique,

(i) Determine the equation for each point in the Hough space in polar coordinates (r-ϕ) and plot the equations in the Hough space graph.

(ii) Hence, prove that these three points are laid on the same straight line.

(60 marks)

4. [a] In a classification task, two features, area and aspect ratio, had been extracted from training samples and tabulated in Table 4.

Cluster/*kluster*	Area/*luas* (pixel/*piksel*)	Aspect ratio/ *nisbah aspek*
A	23.5	0.74
	24.0	0.69
	24.0	0.80
B	24.0	0.60
	25.0	0.57
	24.5	0.50
C	25.5	0.72
	25.0	0.79
	25.5	0.61

Given an unknown pattern, X with area = 24.5 pixel and aspect ratio = 0.7, demonstrate classifications of X using the following methods and comment on the classification outcomes.

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(i) discriminant function analysis, and

(ii) k-nearest neighbor classification technique, with k = 3, 5 and 7.

(60 marks)

[b] With suitable sketch of training progress plot, briefly explain the following terms used in the training of a neural network for image classification task.

(i) State of convergence
(ii) Underfitting
(iii) Overfitting

(40 marks)

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