

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : DMX5314 Machine Vision
Academic Year : 2024/25
Date : 07th March 2026
Time : 0930-1230h
Duration : 3 hours

REGISTRATION NO:

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General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Seven (7)** pages.
3. Answer **all** questions.
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).

Question 01

- a. Briefly explain the working principle of a canny edge detector. (4 marks)
- b. What do you understand by the term *4-neighbors of p* with respect to image processing? (4 marks)
- c. *Spatial domain techniques* and *frequency domain techniques* are two different image processing techniques. Briefly describe the difference between them by focusing on the location of the operations. (4 marks)
- d. Name the most suitable lighting system to be used for the below scenarios. Give justifications. (4 marks)
 1. For the process of dimensioning.
 2. To identify foreign material and voids in transparent objects.
- e. Discuss 'adaptability' and 'speed of response' considering a human vision system and a machine vision system. Provide numerical values as applicable to justify your answer. (4 marks)

Question 02

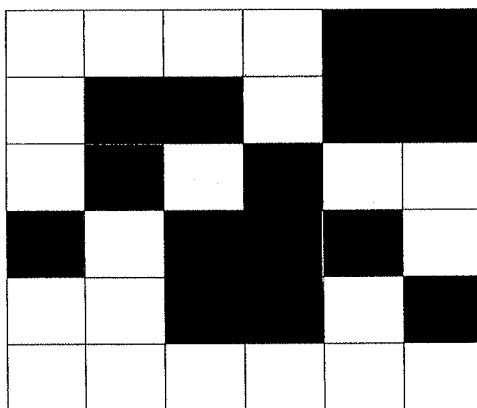
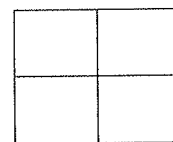
- What do you understand by the term 'magnification' with respect to optical lens of a machine vision system? Use suitable drawings to support your answer. (4 marks)
- Determine the depth of field for a vision system having a 200×200 array sensor, 7.6×7.6 mm, and a f stop of 16, and a magnification of 0.05. (4 marks)
- Consider the following machine vision system installed on a manufacturing plant to answer the questions from 1. to 2.

The vision system should facilitate to automatically pick up manufactured items from a moving conveyor belt. The item size is fixed, and the size is 40 cm x 20 cm x 10 cm. The conveyor belt moves at a speed of 20cm/s. The camera used in tracking the parcels has a frame rate of 30 frames/s. To pick up the manufactured items from the convey belt, it is necessary to locate the items with a precision of at least 3mm.

- Showing all the calculations clearly, prove that the vision system is not capable of successfully picking up the manufactured items from the convey belt. (6 marks)
- Suggest a method that can be adopted to change the system so that it will be able to pick up the items without an issue? Justify your answer with the workings. (6 marks)

Question 03

- Morphological operations are simple transformations applied to an image. Consider the image given in Figure Q3 (a) and the structuring element given in Figure Q3 (b). (6 marks)

**Figure Q3 (a)****Figure Q3 (b)**

Indicate the following three cases on the sheet provided at the end of the question paper.

1. Hit
2. Miss
3. Fit

[Note: Detach the sheet provided with the question paper and indicate your answer on the sheet. Please make sure you submit this sheet along with the answer script].

- b. With the use of a suitable example, explain **Dilation** and its applications in image processing. If needed, you may use the sheet provided at the end of the paper. (4 marks)

[Note: Detach the sheet provided with the question paper and indicate your answer on the sheet. Please make sure you submit this sheet along with the answer script].

- c. Consider the given input image matrixes with 16 gray levels. (10 marks)

$$\text{Input image matrix} = \begin{bmatrix} 15 & 15 & 1 & 1 & 2 \\ 14 & 13 & 15 & 1 & 0 \\ 1 & 0 & 8 & 14 & 14 \\ 2 & 1 & 3 & 3 & 4 \\ 15 & 13 & 14 & 11 & 11 \end{bmatrix}$$

Find the relevant output image matrix in each case, when the following operators are used

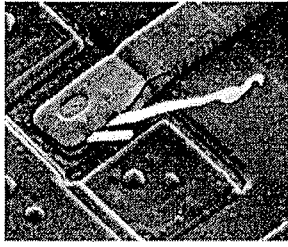
1. Inverse operator
2. Threshold operator when $q = \begin{cases} 0, & p < p_1 \\ 1, & p \geq p_1 \end{cases}$. Let $p_1 = 8$
3. Binary threshold inverter operator when

$$q = \begin{cases} 0, & p_1 \leq p \leq p_2 \\ 1, & p < p_1 \text{ and } p > p_2 \end{cases} \quad \text{Let } p_1 = 4 \text{ and } p_2 = 11$$

Question 04

- a. Filtering in the Frequency Domain can be used to enhance images. (6 marks)
1. Briefly explain each step involved in this process.
 2. Clearly mention the role of the filter function in this process with a suitable example.

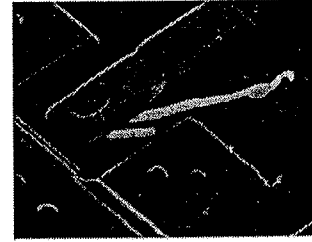
- b. Consider the three images given in Figure Q4. (a) (Original image) and Figure Q4. (b) and Figure Q4. (c). Name the filters used in each case, as to get the output images (b) and (c). **Justify your answer** (4 marks) 0031



(a)



(b)



(c)

- c. Consider the below 3-bit image (8 intensity levels) of size 4×4 pixels. Perform **histogram equalization** for the given image and obtain the equalized histogram. (10 marks)
Make sure you include the following in your answer: - the original image histogram, a table with all calculations, output image in matrix format and the equalized histogram.

$$\begin{bmatrix} 1 & 7 & 4 & 2 \\ 2 & 4 & 7 & 7 \\ 2 & 2 & 2 & 4 \\ 3 & 2 & 3 & 2 \end{bmatrix}$$

4×4 image

Gray scale = $[0,7] = 8$ intensity levels

Question 05

As the newly appointed junior engineer at **PQR automobiles**, you are given the task of ensuring the quality of the automotive components built at their latest manufacturing plant in the country. According to the PQR automobiles quality guidelines, the quality inspection process of the automotive components should be **non-contactable and a vision-based system**. The management is happy to invest in a customer-based vision system at the manufacturing plant. The current requirement is to identify the cracks that may be available in those automotive components. (20 marks)

Please note that automotive components must be quality checked when they are on the conveyor belt and are not allowed to remove it from the conveyor belt during the inspection.

Stating clearly the assumptions, write an **algorithm** (Use a flow chart) for this crack identification system. You need to address the **three main functions** of a machine vision system that are Image acquisition, Processing and Display. Describe how you are going to place the necessary components on the manufacturing cell. Briefly describe the **sensors** and **actuators** which you may use for this system. Using **clear drawings**, you need to show the places where you will install these sensors and actuators on the manufacturing plant. Explain briefly how the actuators you selected will work.

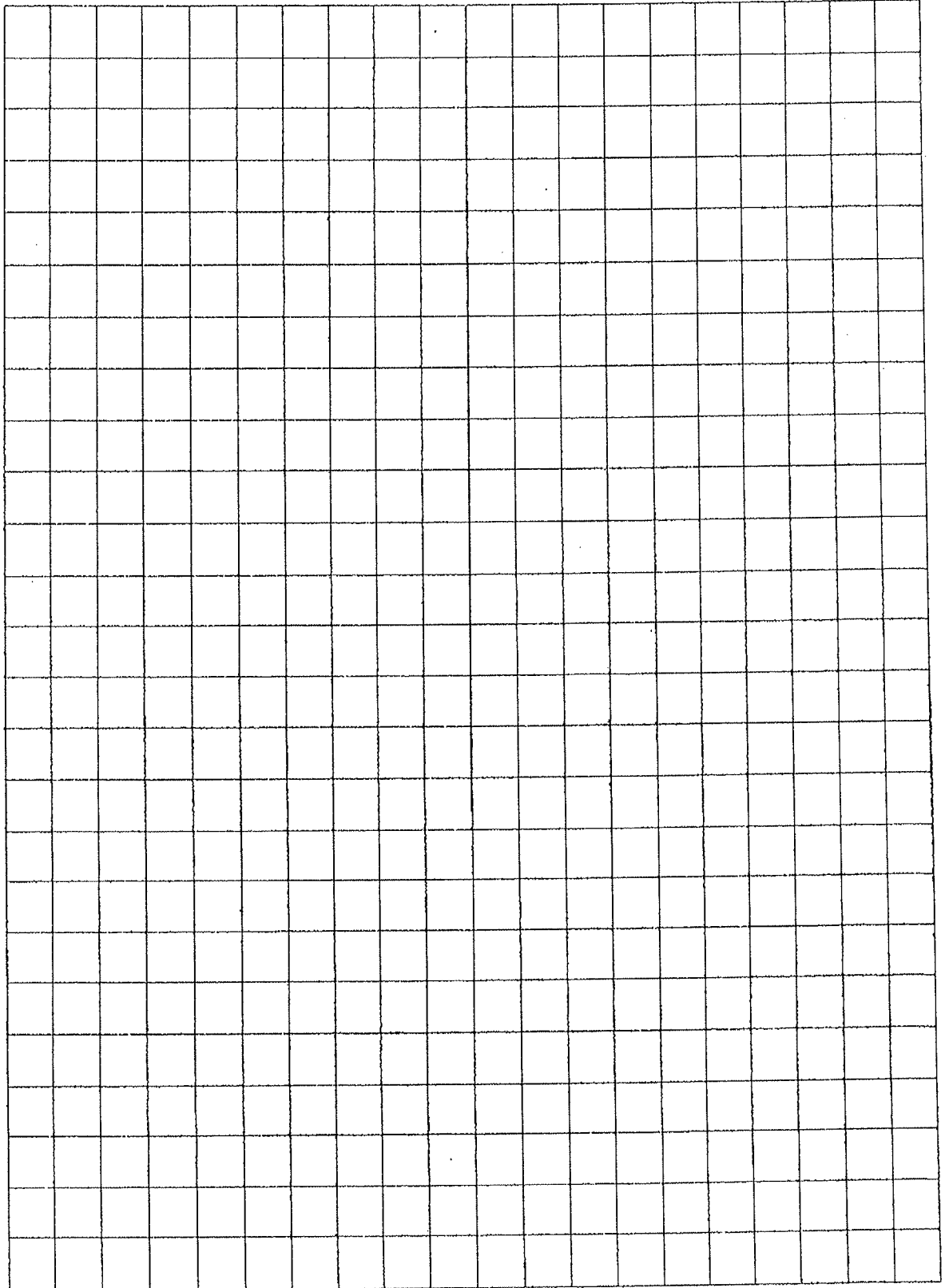
Draw a complete machine vision system for the above task, labelling all components used. (Hint: You need to assume the components that should be included considering the above scenario).

Now, consider the function of Image Processing of the system you selected.

Briefly describe the **Image enhancement methods** and **Feature extraction methods** that you can apply to this system.

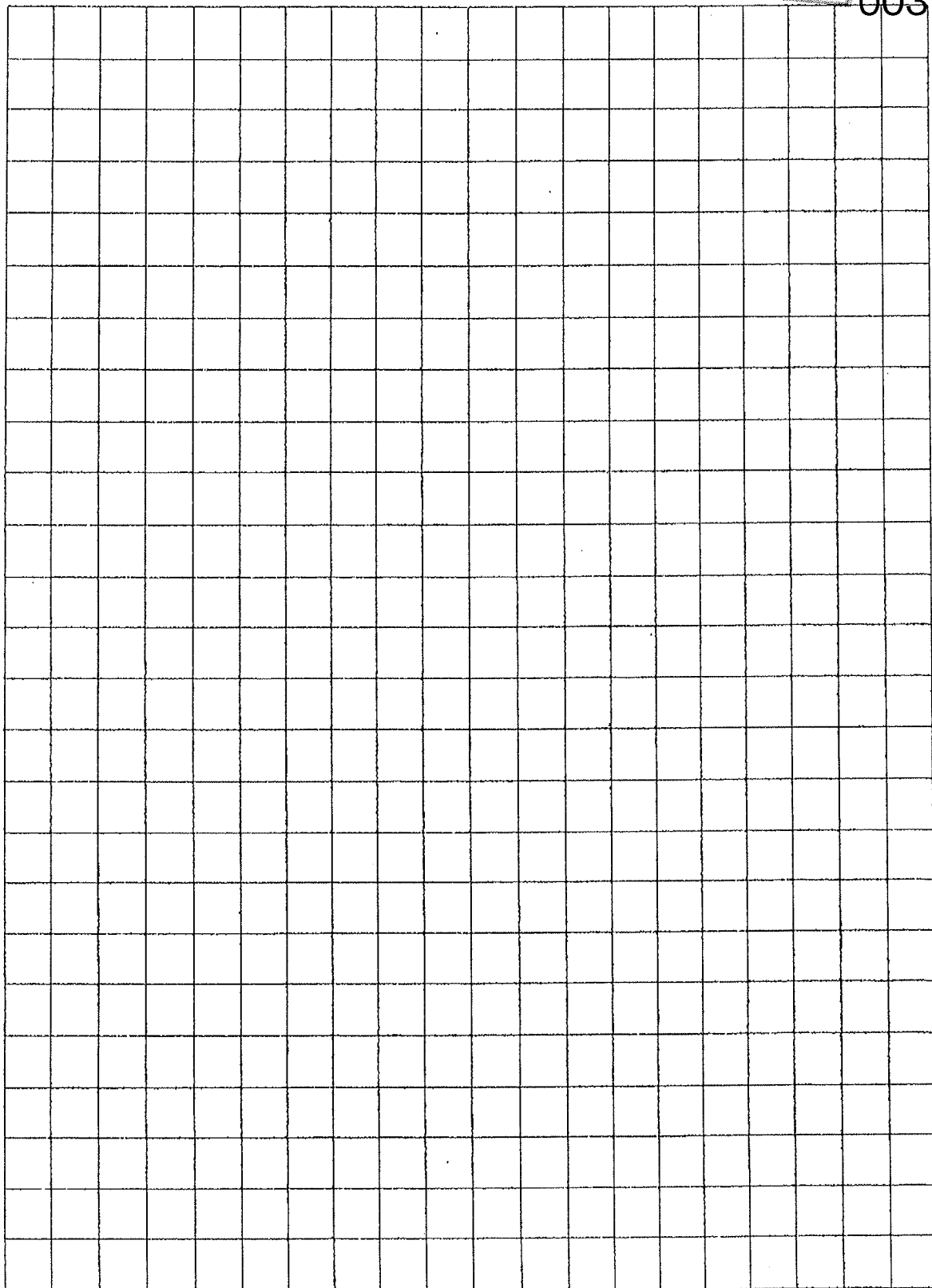


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