

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



Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: DMX5314/ DMX5571 Machine Vision
Academic Year	: 2020/21
Date	: 17 th February 2022
Time	: 1400-1700hrs
Duration	: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Five (5)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear hand writing.
7. Do not use Red colour pen.

Question 01

- a) Discuss the advantages and disadvantages of global and local histogram equalization.
[7 marks]
- b) Explain the image degradation model and how to use inverse filters for image restoration.
[7 marks]
- c) What are some of the basic approaches to video compression? Name one or two techniques and the conceptual strategies used in each.
[6 marks]

Question 02

- a) A camera with a focal length of $f = 50\text{mm}$ is used to take a photo of a vertical column that is 12m high and is 95m away from the camera. Determine its height in the image in mm and the number of pixels. Assuming the camera has a resolution of 4000 dpi .
[7 marks]
- b) Determine the number of bytes necessary to store an uncompressed binary image of size 4000×3000 pixels.
[6 marks]
- c) Determine the actual physical measurement in millimetres of an image with 1400 rectangular pixels and a resolution of 72 dpi .
[7 marks]

Question 03

The following Figure Q3 presents applying a filter to an image.

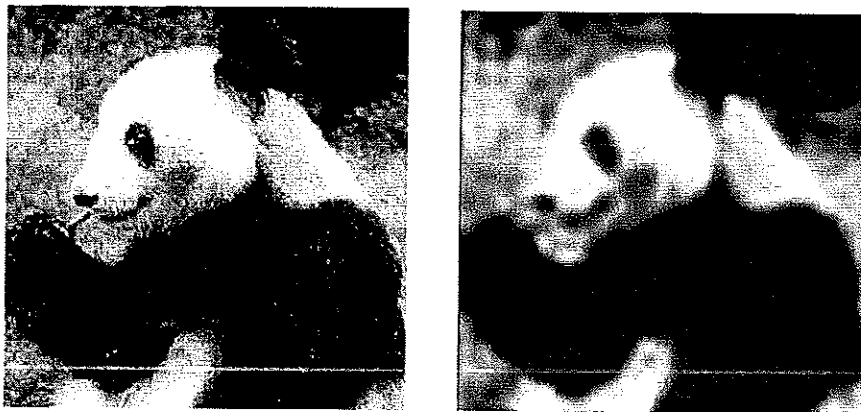


Figure Q3

- a) What type of filter do you think was used? Justify your answer. [6 marks]
- b) Describe the steps to improve the result. [14 marks]

Question 04

Consider the image is shown in Figure Q4, which shows two 5x5 square regions connected by a 1x3 pixel bridge. The aim is to eliminate the bridge connecting both squares.

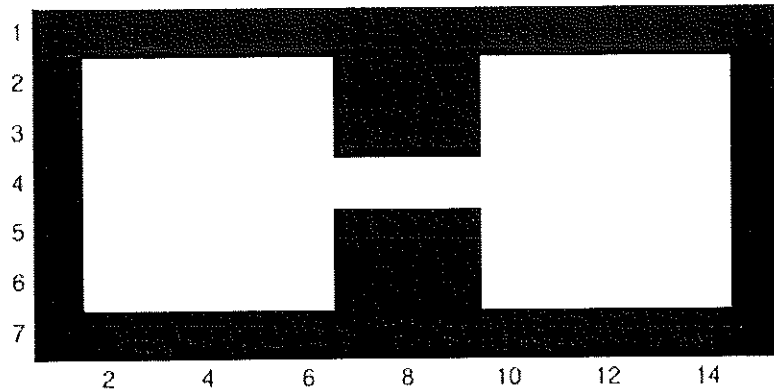


Figure Q4

- What is the most straightforward morphological operation that should be used to achieve this task without changing the size of the square regions? [5 marks]
- Provide the steps to structuring elements that to accomplish this task. [10 marks]
- How many connected components are there before and after applying the morphological operation? [5 marks]

Question 05

Character recognition is the art of detecting, segmenting, and identifying characters from the image. More precisely, character recognition detects and recognises characters from input images and converts them into ASCII or another equivalent machine editable form. It contributes immensely to the advancement of the automation process and improving the interface between man and machine in many applications. Character recognition is one of the fascinating areas of pattern recognition and artificial intelligence. Character recognition has been getting more and more attention since the last decade due to its wide range of applications. Conversion of handwritten characters is vital for making several essential documents related to our history, such as manuscripts, into machine editable form to be easily accessed. Independent work is going on in Optical Character Recognition (OCR), which

is the processing of printed or computer generated, handwritten, and manually created document processing as Handwritten Character Recognition (HCR).

- a) Describe the steps involved in Optical Character Recognition. [5 marks]
- b) Distinguish the difference between Handwritten Character Recognition and Optical Character Recognition. [5 marks]
- c) Explain the machine learning algorithm to identify handwritten characters. (*Hint: to recognize English alphabet letters individually, which are in the form of digital images*) [10 marks]

Question 06

An important application of image segmentation is processing images resulting from so-called bubble chamber events. These images arise from experiments in high-energy physics in which a beam of particles of known properties is directed onto a target of known nuclei. A typical event consists of incoming tracks, any one of which, upon a collision, branches out into secondary tracks of particles emanating from the point of collision. Propose a segmentation approach for detecting all tracks angled at any of the following six directions off the horizontal: $\pm 25^\circ$, $\pm 50^\circ$, and $\pm 75^\circ$. The estimation error allowed in any of these six directions is $\pm 5^\circ$. For a track to be valid, it must be at least 100 pixels long and have no more than three gaps, each not exceeding 10 pixels. You may assume that the images have been preprocessed so that they are binary and that all tracks are one thick, except at the point of collision from which they emanate.

Your procedure should differentiate between tracks that have the same direction but different origins. Propose a method to do this. You are free to use it any way you wish, but state all the assumptions you made in arriving at your design. [20 marks]

Question 07

Consider the following 5×5 image is shown in Figure Q7 with respective pixel values.

180	160	160	140	120
110	110	120	140	120
110	140	120	120	140
120	160	160	170	170
170	120	110	140	110

Figure Q7

- Perform histogram equalization and find the resulting image of Figure Q7. [10 marks]
- Determine the possible maximum and minimum results (pixel values) for the following linear filter when applied to an 8-bit grayscale image (with pixel values in the range [0, 255]). Assume that no clamping of the results occurs. [10 marks]

Question 08

An essential parameter of the imaging system is the Field of View (FoV). The field of view is twice the angle between the optical axis (z-axis) and the end of the retinal plane. Imagine that you have a camera system with a focal length of 16mm, the retinal plane is (16mm×12mm), and that the imaging surface is sampled 640 × 480 pixels in each dimension.

- Compute the FoV of both horizontal and vertical planes. [6 marks]
- Write down the relationship between the image coordinate and a point in the 3D world expressed in the camera coordinate system. [7 marks]
- Describe how is the size of FoV related to the focal length and how it affects the resolution in the image. [7 marks]

END

