THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY-LEVEL 05
FINAL EXAMINATION 2009/2010

MEX5271 – MACHINE VISION

DATE: 11TH MARCH 2010
TIME: 0930-1230 HRS
DURATION: THREE HOURS

READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE ANSWERING THE QUESTION PAPER

The question paper has **eight** questions
Answer **five** questions only.

Q1

a) A photographer has taken the image below at night. 0 corresponds to black and 15 to white. In this image we can recognize one bright house in the left (the pixels with gray levels ≥ 8) and the moon on the right (the pixels with gray level ≤ 6 and ≥ 2). We want to extract a good image of the moon.

0	0	1	0	0	0	2	3	0
0	8	0	0	0	5	4	6	3
9	14	9	0	0	3	4	4	2
15	12	10	0	0	0	2	2	0
11	13	13	0	1	0	0	0	0

I. Perform the histogram of this image.
II. Design a point processing letting the moon unchanged and transforming the house and the background to black.
III. Give the histogram of the negative of the image transformed after II.

b) To add contrast to the image resulting from a). II, find the linear point processing that maps the gray levels on the moon to cover the full range of light intensities from 0 to 15.

Q2

Vision systems play a significant role in industry automation.

a) Explain the advantages of adopting vision based system to industrial applications.
b) "Adoption of factory automation techniques must be done in careful manner". Comment on this statement.
c) Briefly explain architecture of a machine vision system integrated in to product assembly line of a manufacturing environment.

d) Briefly explain the situations where
   i. Human vision
   ii. Machine vision

   Provides more accurate and reliable results.

Q3

a) You are given a RGB colour image, the background of which is dark and hence obscured. Propose a colour enhancement technique to improve the details of the image, but with minimum effects on the appearance on the colour components.

   After enhancement, the image is converted to a 256 gray levels image. Describe a process that will allow you to colour those pixels from gray levels g_1 to g_2 in constant green while keeping the remaining gray levels unchanged.

b) Consider a high-speed imaging technique to measure the speed of a bullet in flight. The method involves the use of a flash that exposes the imaging surface of a TV camera for T sec. The bullet is 2.5 cm long and 1 cm wide, and its range of speed is 750±250 m/sec. The CCD camera will produce an image in which the bullet occupies 10% of the horizontal resolution. The resolution of the sensor array is 256 by 256. Determine:
   i. The physical dimensions of the image frame, and hence the distance between pixels (in cm/pixel).
   ii. The maximum value of the flash exposure time T that will ensure that the blur from motion does not exceed one pixel (i.e. the bullet should not travel more than one pixel during exposure).
   iii. The minimum number of frames per second that would have to be taken in order to guarantee that at least two complete images of the bullet are obtained through the field of view of the camera. [Hint: the bullet should not travel more than half of the full image frame per second].

Q4

An engineer is asked to inspect a certain class of images generated by a machine vision system. He has decided to use digital image enhancement and has examined a set of representative images. He has found the following problems:

   i. Bright and isolated dots are of no interest;
   ii. Lack of sharpness;
   iii. Insufficient contrast in some images;
   iv. Shifts in the average gray- level value from a pre-determined value

He wishes to correct these problems and then colour in constant red all gray levels between a given band between I_1 and I_2, while keeping normal tonality in the remaining gray levels. Propose a sequence of processing steps that the engineer can follow to achieve the desired goal.

Q5

A micro robot is controlled based on visual information captured from an optical microscope. This microscope is equipped with a lens of 9 mm focal length, and has a rectangular 8.8mm x 6.6mm CCD sensor array with 768 x 493 pixels. The frame rate is 30 frames/seconds and the magnification is 50.

a) What is the size (in microns) of one pixel on the object plane? At which distance of the image are the objects sharp? Can an object with width 10 microns be seen completely sharp if a f-stop of 16 is used? (explain). If the object is not sharp, how can the system be modified to make it entirely sharp? Explain.

b) You know that an object has a 10 microns long straight edge. The error on this edge can be computed as

   i. At least one pixel, or

   ii. Corresponds to significantly less than 1 pixel? Explain.

   What is your answer when the edge is only 1 micron?

Q6

You have been assigned to develop a robot-vision system to automatically pick-up postal parcels. The parcels, all of the same size (40x30x15 cm) are placed on a conveyer belt moving at 20 cm/s. The camera used in tracking the parcels has a frame rate of 30 frames/second. In addition, for a successful pick-up action, the robot controller requires that a parcel should be located with a precision of at least 3 mm.

a) Can the robot grasp the parcels successfully? Explain. If the answer is no, what solution can you propose to modify the installation, and what is the best solution?

b) Which kind of camera and lighting would you use to make the system as simple as possible? Justify your answer. If some parcels have different dimensions, what kind of lighting would you use? Explain.

Q7

a) What is image compression?

b) Describe Huffman encoding and Huffman decoding.

c) Explain two types of JPEG image compression.

d) Describe about interpixel redundancy and psychovisual redundancy.

Q8

a) Explain about image thresholding.

b) Compare and contrast global thresholding and local thresholding.

c) Describe optimal thresholding.

-- END --