The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX5271 Machine vision**
Academic Year	:	2012/2013
Date	:	01st August 2013
Time	:	9.30am – 12.30pm
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions. All questions carry equal marks.
3. Answer any 5 questions only.

Q1.

a) Discuss *human vision* vs *machine vision* considering Adaptability, Speed of response and Spectrum response.
b) Using suitable drawings to support your answer discuss *back lighting* and *front lighting.*
c) What are the two broad categories used for *image enhancement*? Briefly discuss them.
d) Discuss the uses of *image addition, subtraction* and *multiplication.*
e) Discuss the *chromatic diagram* and its applications.

Q2.

a) Using a suitable drawing to support your answer discuss *Stereo imaging.*
b) Point P, which has the coordinates of (0,0,0) in an image is mapped to point P′ by first translating P to P′ 15 rows in the same direction of y axis, and 102 columns in the opposite direction of x axis, then, by rotating P1 to P2 around the z axis by a positive 30° (clockwise), and finally by scaling the coordinates of P2 to P′ by 1.3 along x axis, and 1.6 along y axis. Find the Affine transformation matrix(A), that capture these transformation steps from P to P′.

Q3. Consider the 8×8 image shown in Figure Q3 below, with gray levels from 0 to 255.

a) Plot the histogram of this image.
b) Get the binary output image matrix if the threshold value is 126.
c) Plot the histogram of inverse of the original image.

d) Perform a Monadic one point transformation to the original image as to get an image where all gray values in the interval 100 and 153 (including 100 and 153) are converted to 0.

e) Name the operators used in b) and d).

f) Apply Gray level reduction operator to the original image to output an image which has only 15 gray levels. Write the function necessary and mention the intervals to be used.

3	148	117	148	145	178	132	174
2	176	174	110	185	155	118	165
0	100	124	113	193	136	146	108
0	155	170	106	158	130	178	170
9	196	138	113	108	127	144	139
6	188	143	183	137	162	105	169
9	122	156	119	188	179	100	151
8	176	137	114	135	123	134	183

Figure Q3

Q4.

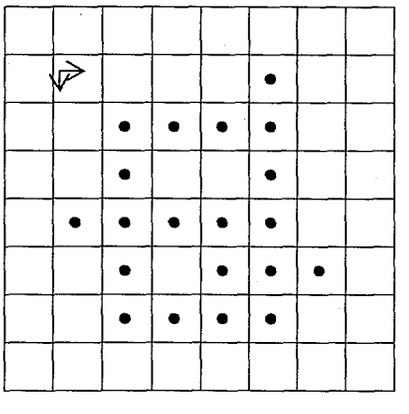
a) What is 'magnification' with respect to optical lens of a machine vision system? In conventional industrial applications what should be the range of magnification value. Give reasons for your answer.

b) Consider a vision system having a 200×200 array sensor of the size 7.6×7.6 mm. The magnification is 0.05 and the *f* stop value is 16. Determine the following
   i. Pixel size
   ii. Depth of field

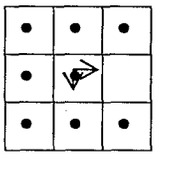
c) Consider an automated vision-based system for dimensional measurement. The system setup has an object view of 4cm × 4cm square. The solid state sensor is a 512 × 512 array arranged in a 0.8cm × 0.8cm square. If the required tolerance of the measurement is 20μm, determine whether this system setup is suitable.

Q5.

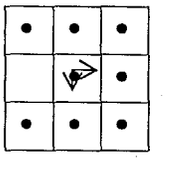
a) The duality relation between **erosion** and **dilation** of the binary images I and J is $(I \oplus J)^c = I^c \ominus \check{J}$.
Prove this theorem using the following binary images shown in Figure Q5.a.
[Note : Submit your results in the sheet provided for Figure Q5.a along with the question paper]



(I)



(J)



$(\check{J})$

Figure Q5.a

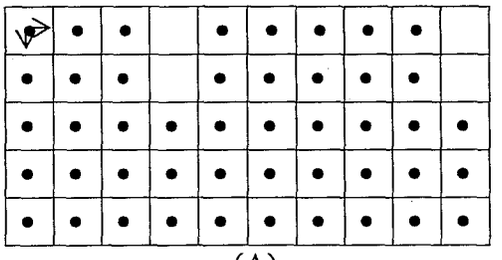
b) Figure Q5.b shows a digital image (A) and a structured element (B), respectively. Determine the digital image after the following morphological operations:

i. $A-(A \ominus B)$

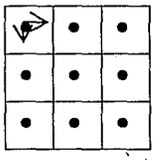
ii. $(A \oplus B)-A$

Describe the functions of each of the operations.

[Note : Submit your results in the sheet provided for Figure Q5.b along with the question paper]



(A)

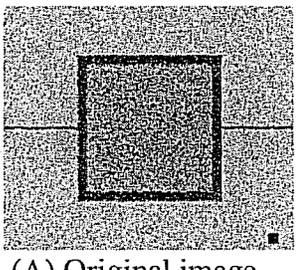


(B)

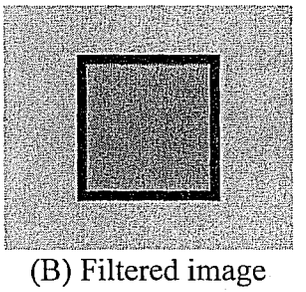
Figure Q5.b

Q6.

a) The Figure Q6. (A) is filtered using a smoothing filter. The filtered image is given in Figure Q6. (B). The small black square on the lower right hand corner of the original image shows the size of the mask that was used. This small black square is not part of the image. The filter used was one of these: averaging filter, Ideal lowpass filter, Gaussian lowpass filter or median filter.



(A) Original image



(B) Filtered image

Figure Q6

i. For each of the four possible filters listed above, give at least one reason why you think it was, or was not, the filter actually used.

ii. Write the matlab coding necessary for the above filter.

b) Imagine that you are assigned to develop a vision based non contactable system for identifying the vehicle pass of the company you are working. The vehicle pass must be identified at the gate of the company building. If only the company logo available in the car pass is identified, the gate of the car park will be opened. **Stating clearly the assumptions** write an algorithm for a vehicle pass identification system. You need to address the three main functions of a machine vision system that are Image acquisition, Processing and Display.

[Note: You may use a flow chart for this purpose. Try to avoid ideal situations whenever possible and focus on a real system setup.]

Q7. 000

a) 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. Shift 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 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.

b) Describe how one could determine, with the aid of structured lighting, the depth of the groove of a channel shown in Figure Q7. Use an appropriate sketch to illustrate your method.

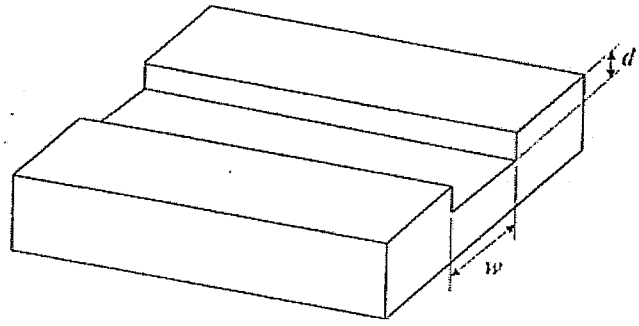


Figure Q7

Q8. For a spatially discretised M x N image, denoted by $f(i,j)$, the p^{th}, q^{th} moment is given by: $m_{pq} = \sum_{i=0}^{M} \sum_{j=0}^{N} i^p \, j^q \, f(i, j)$

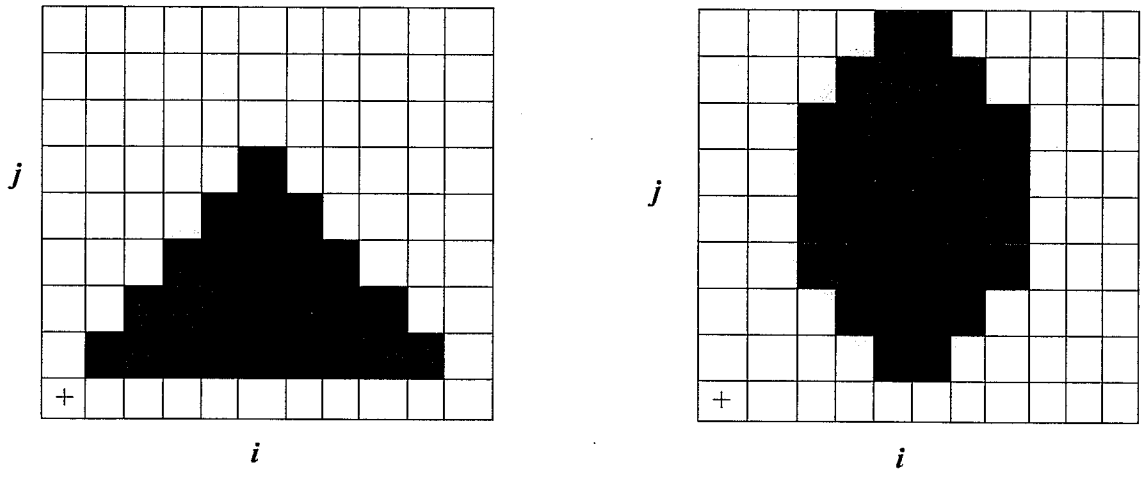


Figure Q8

Figure Q8(A) and Figure Q8(B) shows digital images of a triangle and an octagon. 00020
The '+' in the diagrams indicates the origin. Use an intensity of 1 for gray pixels and 0 for white pixels in finding the following.

a) For each object image, determine the moments m_{00}, m_{10} , m_{01} and comment on your results.
b) Find the central moments μ_{20}, μ_{02} and μ_{11} for each object image.
c) An invariant moment ϕ_1 is defined as $\phi_1 = \eta_{20} + \eta_{02}$ and

$$\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}^{\gamma}}$$

$$\gamma = 0.5 \times (p+q) + 1$$

Calculate the invariant parameter ϕ_1 for each image shown in Figure 8(A) and Figure 8 (B), and give your comments on the results.

END

Index No:-

NOTE:- Please use this sheet to answer the question related to Figure Q5.a.