MMTE-003

Assignment Booklet

MACS (Masters with Applications in Computer Science)
Pattern Recognition and Image Processing
(January 2021 to December 2021)

It is compulsory to submit the assignment before filling in the exam form.

School of Sciences
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New Delhi

Dear Student,

Please read the section on assignment in the Programme Guide for elective Courses that we sent you after your enrolment. A weightage of 20 per cent, as you are aware, has been earmarked for continuous evaluation, **which would consist of one tutor-marked assignment** for this course. This assignment is in this booklet.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully.

2) On top of the first page of your answer sheet, please write the details exactly in the following format:

ROLL NO.:……………………………………………

ADDRESS :……………………………………………

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COURSE CODE : …………………………….

COURSE TITLE : …………………………….

ASSIGNMENT CODE : …………………………..…

STUDY CENTRE : …………………………..….. **DATE.……………………………….……….**

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

3) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

4) Leave 4 cm margin on the left, top and bottom of your answer sheet.

5) Your answers should be precise.

6) While solving problems, clearly indicate which part of which question is being solved.

7) This assignment is valid only upto 31^{st} December, 2021. If you have failed in this assignment or fail to submit it by 31^{st} December, 2021, then you need to get the assignment for the next session and submit it as per the instructions given in the programme guide.

We strongly suggest that you retain a copy of your answer sheets.

Wish you good luck.

TUTOR MARKED ASSIGNMENT

Course Code: MMTE-003
Assignment Code: MMTE-003/TMA/2021
Maximum Marks: 100

Q1. (a) A common measure of transmission for digital data is the baud rate, defined as the number of bits transmitted per second. Generally, transmission is accomplished in packets consisting of a start bit, a byte (8 bits) of information, and a stop bit. Using these facts, answer the following:

i) How many minutes would it take to transmit a 1024×1024 image with 256 intensity levels using a 56k baud modem?

ii) What would the time be at 3000K baud, a representative medium speed of a phone DSL (Digital Subscriber Line) connection? (6)

(b) Develop an algorithm for converting a one-pixel-thick 8-path to a 4-path. (4)

Q2. (a) Give a single intensity transformation function for spreading the intensities of an image so the lowest intensity is 0 and the highest is L – 1, where L is the number of intensity levels in the image. (5)

(b) Two images, f(x, y) and g(x, y), have histograms h_f and h_g. Give the conditions under which the histograms of the following can be determined.

i) $f(x,y)+g(x,y)$

ii) $f(x,y)-g(x,y)$

iii) $f(x,y)\times g(x,y)$

iv) $f(x, y) \div g(x, y)$ (5)

Q3. (a) Consider the continuous function $f(t)=\sin(2\pi nt)$.

i) What is the period of f(t)?

ii) What is the frequency of f(t)?

The Fourier transform, $F(\mu)$, of f(t) is purely imaginary, and because the transform of the sampled data consists of periodic copies of $F(\mu)$, the transform of the sampled data, $\tilde{F}(\mu)$, will also be purely imaginary. Draw a diagram of Fourier transform of the function and answer the following questions based on your diagram (assume that sampling starts at t = 0).

iii) What would the sampled function and its Fourier transform look like in general if f(t) is sampled at a rate higher than the Nyquist rate?

iv) What would the sample function look like in general if f(t) is sampled at a rate lower than the Nyquist rate?

v) What would the sample function look like if f(t) is sampled at the Nyquist rate with samples taken at $t = 0, \Delta T, 2\Delta T, K$? (6)

(b) Consider a linear, position-invariant image degradation system with impulse response

$$h(x-\alpha, y-\beta) = e^{-\left[(x-\alpha)^2+(y-\beta)^2\right]}$$

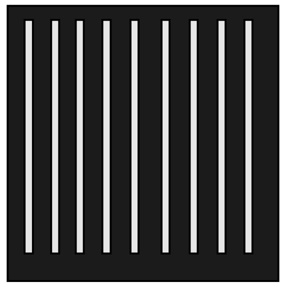
Suppose that the input to the system is an image consisting of a line of infinitesimal width located at x = a, and modeled by $f(x,y)=\delta(x-a)$, where δ is an impulse. Assuming no noise, what is the output image g(x, y)? (4)

Q4. (a) The white bars in the test pattern shown are 7 pixels wide and 210 pixels high. The separation between bars is 17 pixels. What would this image look like after application of

i) A 3×3 arithmetic mean filter?

ii) A 7×7 arithmetic mean filter?

iii) A 9×9 arithmetic mean filter? (4)



(b) Repeat above problem using a harmonic mean filter. (3)

(c) Repeat above problem using a median filter. (3)

Q5. (a) Write a general procedure for decoding exponential Golomb code $G_{exp}^{k}(n)$. (4)

(b) Consider Huffman encoding pairs of pixels rather than individual pixels. That is, consider the image to be produced by the second extension of the zero-memory source that produced the original image. What is the entropy of the image when looked at as pairs of pixels? (6)

Q6. (a) The compass gradient operators of size 3×3 are designed to measure gradients of edges oriented in eight directions: E, NE, N, NW, W, SW, S, and SE.

i) Give the form of these eight operators using coefficients valued 0, 1 or -1.

ii) Specify the gradient vector direction of each mask, keeping in mind that the gradient direction is orthogonal to the edge direction. (6)

(b) Using the Hough transform

i) Develop a general procedure for obtaining the normal representation of a line from its slope-intercept form, $y = ax + b$.

ii) Find the normal representation of the line $y = -2x + 1$. (4)

Q7. (a) Given a four symbol source {**a, b, c, d**} with source probabilities {0.1, 0.4, 0.3, 0.2}, obtain encoded sequence corresponding to **bbadc**.

i) Using Huffman coding.

ii) Using arithmetic coding. (6)

(b) What is the entropy of this source? Compare it with the data rate obtained using the two encoding schemes and comment on the result. (4)

Q8. (a) Draw the block diagram of a typical motion compensated video encoder. (4)

(b) How many computations are required to find the optimal motion vector of 8×8 macro block, with maximum allowable displacement of 8 pixels using

i) Single pixel precision.

ii) ¼ pixel precision. (6)

Q9. Given a 8×16, 3-bit image with the following histogram [32, 32, 32, 32, 0, 0, 0, 0].

i) Apply histogram equalization and obtain the equalized histogram.

ii) Apply histogram specification to obtain the following histogram [0, 2, 2, 4, 8, 16, 32, 64]. What is the resulting histogram? (10)

Q10. (a) A 50×50 image (binary) contains a 10×10 white block in the center against a black background. Following distortion occurs in the image:

The four vertices of the white block become (15, 28), (22, 35), (22, 21), (29, 28). Obtain the parameters of the affine transformation that caused this geometric spatial transformation. (6)

(b) Explain the difference between forward and reverse map in Affine Transformation. (4)