International Institute of Information Technology, Hyderabad
(Deemed to be University)

CS7.404: Digital Image Processing – Monsoon 2024
End Semester Examination

Max. Time: 3 Hrs   **Max. Marks:150** $[15\ marks \times 10]$

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1. Reading material such as books are not allowed inside the examination hall.
2. There are 10 questions of 15 marks each. Answer all questions.

Q1. Consider the path of light from the light source to the image sensor and finally to the RGB values of a pixel in an image. Give any 5 factors (maybe physical or digital) along this path that affects the final colour (RGB values) of the pixel. Give the answer as a numbered list with a brief explanation (say 3 sentences) on how each factor affects the final colour value.

Q2. You are given two images with identical histograms. a) Does this mean that the images are identical? Why or why not? b) Prove or give a counter example for the following statement: "Given that the histograms of two images are identical, the histograms of their low-pass (Gaussian) filtered versions will also be identical".

Q3. Describe the steps in adaptive thresholding for segmentation of text characters (assume dark letters on white paper) in a document image with non-uniform illumination. What are the parameters of this algorithm that control the output and how will you determine them automatically? How does your solution change if the document has dark background with white letters?

Q4. Discuss the different types of redundancies in a video. Which of them are used by JPEG compression? Draw a block diagram of the steps in JPEG compression and explain the utility of each step along with the nature of redundancy (if any) that is exploited at each step.

Q5. Consider the following message: "$a\ b\ a\ a\ c\ b\ a\ b\ c\ a$". Carry out both Arithmetic and Huffman encoding this message. Compare the compression ratios of both schemes.

Q6. Describe the terms Robust and Fragile in the context of watermarking along with a sample application for each. Describe DCT based watermarking that was discussed in the class and how it leads to a robust watermark. Does this approach introduce any perceptible changes to the image? Why?

Q7. Prove that for any structuring element B, if $C \subset D$, then $C \circ B \subseteq D \circ B$. Give an example of the case where the resulting shapes becomes equal even when C is a proper subset of D.
[Note: $\circ$ denotes the opening operation]

Q8. Consider the image degradation equation: $G(u, v) = H(u, v)F(u, v) + N(u, v)$.
- Explain the terms in the above equation and describe how this can be used for image restoration.
- Give the relationship between the point spread function in the spatial domain and the restoration function in the frequency domain.
- If an image is degraded due to the rotation of the camera about the origin, by an amount of pi/8 radians, suggest a method to restore the image using motion blur restoration procedure.

Q9. Consider a 500 × 500 RGB image as shown below. Assume that each square (250 × 250) is fully saturated red, green and blue colours as marked an each colour is at maximum intensity. Consider the HSI equivalent of this image.

    a. Draw and describe each of the H, S and I components of the image

    b. Assume that you apply a 125 × 125 averaging filter on only the hue component of this image. How would the colours resulting image appear? (Assume that the outer border is padded by repeating the boundary row/column during the averaging process).

Green	Red
Blue	Green

Q10.   Derive the expression for H matrix in Harris corner detection. Describe how the trace of diagonals of H can act as a substitute for the smaller eigen value.