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NATIONAL INSTITUTE TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Semester End Exam, dated 10.11.2024

CSPE 74 IMAGE PROCESSING & APPLICATIONS

Attend all questions

(a) Which book & mention author name did you referred for Image Processing and Application ? **(1)**

(b) Explain any one unit which you thoroughly know in IPA with mathematical explanation & diagram supporting the concepts. **(4)**

(c) **Given Data:** **(4)**

The following discrete signal is represented as a set of equations:

$$f_1 = 1x + 2y + 3z + 4k$$

$$f_2 = 2x + 4y + 6z + 8k$$

$$f_3 = 3x + 6y + 9z + 12k$$

$$f_4 = 4x + 8y + 12z + 16k$$

Each equation corresponds to one row of a 4×4 discrete signal matrix.

Tasks:

1. **Matrix Representation:** Represent the given set of equations in matrix form $f(x,y)$ suitable for 2D DFT computation.
2. **Exact DFT Kernel:** Write the exact 1-D DFT kernel for $N = 4$:

$$K(u,x) = e^{-j\frac{2\pi}{4}ux} = e^{-j\frac{\pi}{2}ux},$$

where $u, x = 0, 1, 2, 3$.

Construct the row kernel matrix K_r and column kernel matrix K_c.

(d) Given an automated unmanned car (say Tesla) explain the Image Processing tasks going beath (explain mathematical formulation if necessary) (explain the concepts within the scope of IPA) **(5)**

(e) A large shopping mall operates 50 CCTV cameras, each recording in Full HD (1920×1080 pixels) at 30 frames per second to ensure every detail-such as customer movement and cash counter activities-is captured.

Each uncompressed frame requires 24 bits per pixel, resulting in a massive data rate of about 1.49 Gbps per camera. Storing such data continuously would require over 16 TB of storage per camera per day, making it impractical and extremely expensive.

To solve this, the security team applies H.264 video compression, which reduces the bitrate to 8 Mbps per camera while maintaining acceptable visual quality. This drastically reduces daily storage per camera to about 86 GB, allowing a month's footage to fit within the mall's network video recorder (NVR) capacity.

However, during a theft investigation, officers noticed that the high compression level caused slight blurring in fast-moving scenes, making it difficult to read a license plate from a distance. This raised an important question about the trade-off between compression and clarity in security systems.

Questions: **(5)**

- Calculate the compression ratio achieved for each CCTV camera.
- Estimate how much total storage (for all 50 cameras) is needed per day before and after compression.
- Explain how compression affects image quality and forensic reliability in CCTV footage.
- Suggest one optimization technique to balance storage needs and image clarity.

(f) Given two images one generated from AI & another one actual images taken from, digital camera and both images belong to same context (say a man walking in garden or any other context). Your task is to differentiate characteristics of both the images and suggest a solution to make the AI image a realistic one using and within the scope and concepts of IPA. **(5)**

(g) Explain with an application & its code (minimal logical code & not the complete code) which you proposed for designing a real-time application as discussed in Unit 5. **(5)**

(h) Design a flowchart or algorithm or a idea to count numbers of objects in an image (you may provide python code but not mandatory). Explain the concepts pertaining to it. **(5)**

(i) An image has 3-bit intensity levels ($L = 8$), and the following histogram is obtained: **(5)**

Gray Levels (r_k)	0	1	2	3	4	5	6	7
No. of Pixels (n_k)	790	1023	830	656	329	245	122	81

Compute histogram equalization for above points.

(j) Explain genuinely why you chose this subject and what you aspire to achieve from it in your upcoming career. **(1)**