International Institute of Information Technology, Hyderabad

CS7.404: Digital Image Processing

End Semester Examination

Max. Time: 2.5 Hrs **Max. Marks: 120** **[12 × 10]**

1) Assume you are imaging a fast-moving pendulum such that the image plane is parallel to the plane of oscillation. You need to capture two images at times t_0 and t_1, separated by 0.1 seconds. Your goal is to find the exact location of the centre of the pendulum at each time instant. What steps will you take to improve the accuracy of the location during:
   a. Image Acquisition (Focal Length, Aperture, Shutter Speed, Resolution, etc.)
   b. Image Enhancement/Restoration
   c. Image Segmentation.

2) Histogram Matching
   a. Describe the steps of matching the histogram of a source image to a target image.
   b. Can you always achieve perfect matching of histograms between any pair of images? Why or why not?
   c. Give an application of Image enhancement, where histogram matching is an excellent choice.

3) Given a grayscale image $f(x,y)$, apply Fourier transform to get $F(u,v)$. $F(u,v)$ is complex i.e. $F(u,v) = R(u,v) + jI(u,v)$.
   a. Set $I(u,v) = 0$, compute inverse transform, describe how the image looks like with mathematical explanation.
   b. Set $R(u,v) = 0$, and repeat a.

4) Computing FT:
   a. Find Fourier transform of the function $f(t) = te^{-a|t|}$ for $a > 0$.
   b. Provide an example of a function $f(x)$ for which Fourier transform doesn't exist, substantiate.

5) Huffman and Arithmetic Coding:
   a. Provide an example where Huffman coding fails to achieve any compression or achieves a very low compression ratio
   b. In case of a noisy communication channel, which encoding would you prefer? Huffman or Arithmetic coding? Substantiate.

6) Image Compression:
   a. Provide an example where LZW fails to achieve compression
   b. Does resaving a jpeg file again result in poor quality? Substantiate
   c. Why DCT is used in JPEG instead of DFT?

7) Harris Corner Detector:
   a. What is the criterion to decide whether a point is a corner or not used by Harris Corner detector and how the H-matrix is derived to capture this criterion?
   b. How is the trace of this matrix equivalent to the criterion using eigen values?

8) With the help of a diagram, explain how foreground-background segmentation is posed as an optimization problem on a graph using MRF. What is the weight assigned to each edge? What is the function being optimized? Give an example of the algorithm used to optimize this criterion and comment on its correctness and efficiency.

9) A microscope has captured the image of a solution containing some red circular cells and some pink elongated fibres. The image is also corrupted by severe gaussian noise. Propose the steps you will do to count the number of circular cells in the image.

10) Describe the steps of the Robust DCT Watermarking scheme (Cox et al.) that was discussed in the class. What information (in addition to the image) is required to decode the watermark at the receiver's end? Based on the above steps, describe how the watermarking achieves:
   a. Robustness
   b. Low Perceivability