Indian Institute of Space Science and Technology Trivandrum

I SEMESTER , **2023**

ExamType: Quiz 1

DEPARTMENT OF AVIONICS

Digital Image Processing

(Time allowed: ONE hours)

NOTE: Read all questions first. **There are questions worth 15 marks.** If something is missing in a problem description, clearly mention your assumptions with your solution. If required, use sketches to illustrate your findings.

1. Assume that you are given a greyscale image with pixel intensities between [37..209]. (2 marks)

(a) What point operation is necessary to map the pixels to the [0..255] range?

(b) What point operation is necessary to go from [0..255] back to [37..209]?

(c) Do you think you will get the same image back again? Explain.

2. Write the difference between convolution and correlation. Write commutative, associative, and distributive properties for convolution and correlation. (2 marks)

3. Let f be an image of size $M \times N$, and w is the filter kernel of size $m \times n$. Now, refer to the equation for the convolution operation (Linear Spatial invariant)in discrete form.

$$(f * w)(x, y) = \sum_{s=-a}^{a} \sum_{t=-b}^{b} w(s, t) f(x - s, y - t)$$

where the minus signs align the coordinates of f and w when one of the functions is rotated by 180 degrees. Write the computational complexity (number of mathematical operations) of this operation. Now consider if the kernels are separable. Write the revised computational complexity. Thus, write the expression for the computational advantage of performing convolution with a separable kernel instead of a nonseparable one. (3 marks)

4. Explain Bilateral filtering. How it is different than that of the Non-local means filter. What drawbacks of the Gaussian filter bilateral filter overcomes? (3 marks)

5. What is histogram equalization, and what is this use in image processing? Suppose that a digital image is subjected to histogram equalization. Show that a second pass of histogram equalization (on the histogram-equalized image) will produce exactly the same result as the first pass. (Show mathematically) (2 marks)

6. An image with intensities in the range $[0, 1]$ has the PDF, $p_r(r)$, shown in the following figure. It is desired to transform the intensity levels of this image so that they will have the specified

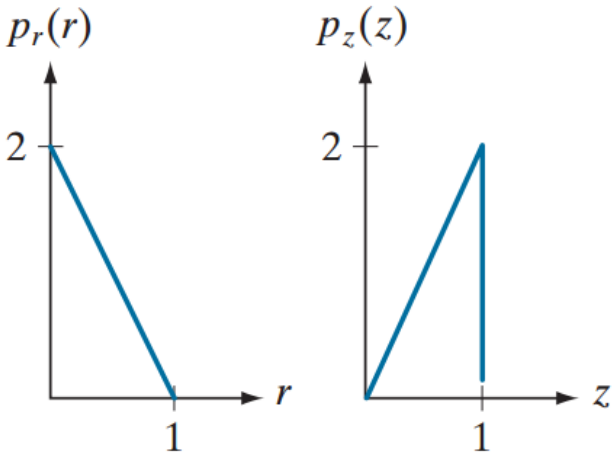

Figure 1: histogram specification

$p_z(z)$ shown in the figure. Assume continuous quantities and find the transformation (expressed in terms of r and z) that will accomplish this. (3 marks)