ASSIGNMENT-03

5.1 Suppose that you had a scene of three objects of different distinct intensities against an extremely bright background. What would the histogram of the corresponding image look like?

Ans. The input image's intensity histogram shows that the object being examined is black in color and is set against a light background, indicating that the histogram has a good bi-modal distribution, meaning that the pixel intensities are clustered. The background is represented by one pixel. The object is represented by one peak. The histogram is same, but the y-axis has been widened to show more detail. A threshold setting of roughly 120 should clearly segment the image nicely.

5.2 Draw annotated sketches of the histograms of the following types of images:

(i) a collection of objects of the same gray level placed on a uniform background of another gray level;

(ii) a collection of relatively dark objects on a relatively bright background, both having a spread of gray levels; Exercises 151

(iii) an under-exposed radiograph;

(iv) an over-exposed radiograph.

Ans.

5.3 Draw the look-up tables that would display the following:
(i) a band of pixels, between Thr1 and Thr2, as white (foreground) and all other pixels as black (background);

(ii) a band of pixels, between Thr1 and Thr2, as their "normal" (default) shades of gray, and all other pixels as black (background).

Suggest a possible application for each of these look-up tables.

Ans.

(i)

(ii)

5.4 Imagine you have an image taken in low light and which, as a result, has low contrast. What are the advantages of using contrast stretching to improve the contrast rather than simply scaling the image by a constant factor (i.e. multiplying all the pixel values by the constant factor)?

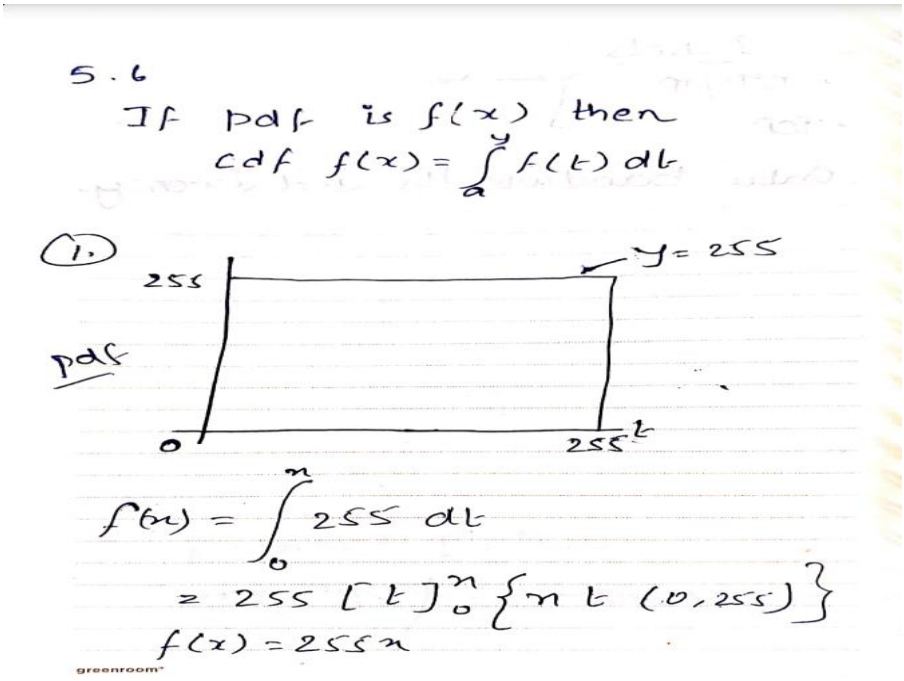
Ans. By boosting the dynamic range, both strategies boost the contrast. Contrast stretching, on the other hand, uses the entire dynamic range by stretching the dynamic range from zero to the highest achievable value (255 for an 8-bit deep image). Multiplying the pixel values will extend the pixels to their maximum value, but not to zero. Another benefit of contrast stretching is that the original, raw values are kept and simply shown with a different look-up table.

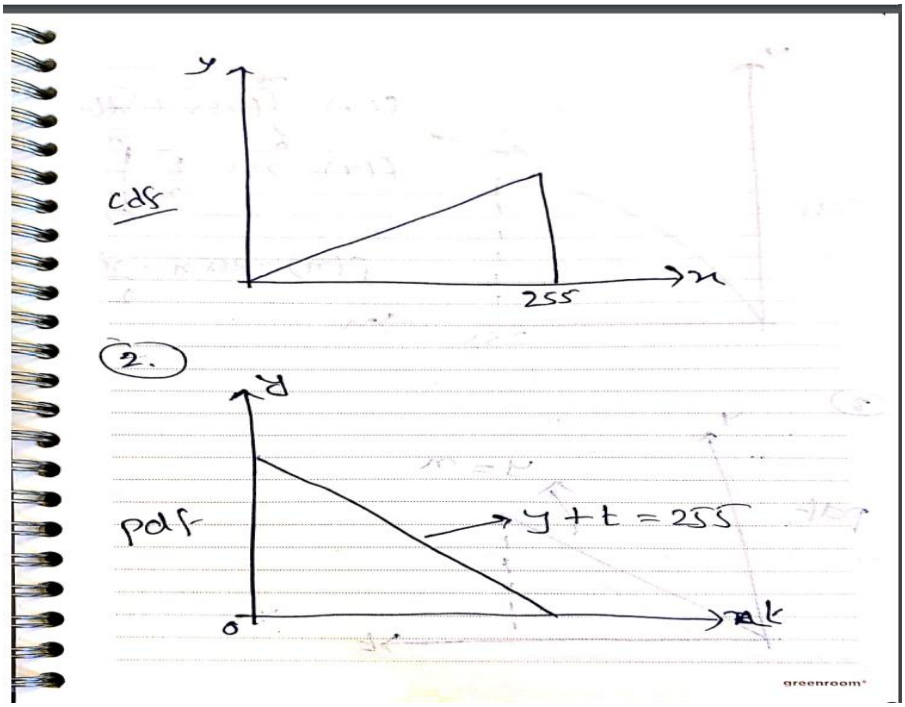
5.5 Explain the advantage of using a logarithmic look-up table to view astronomy images.

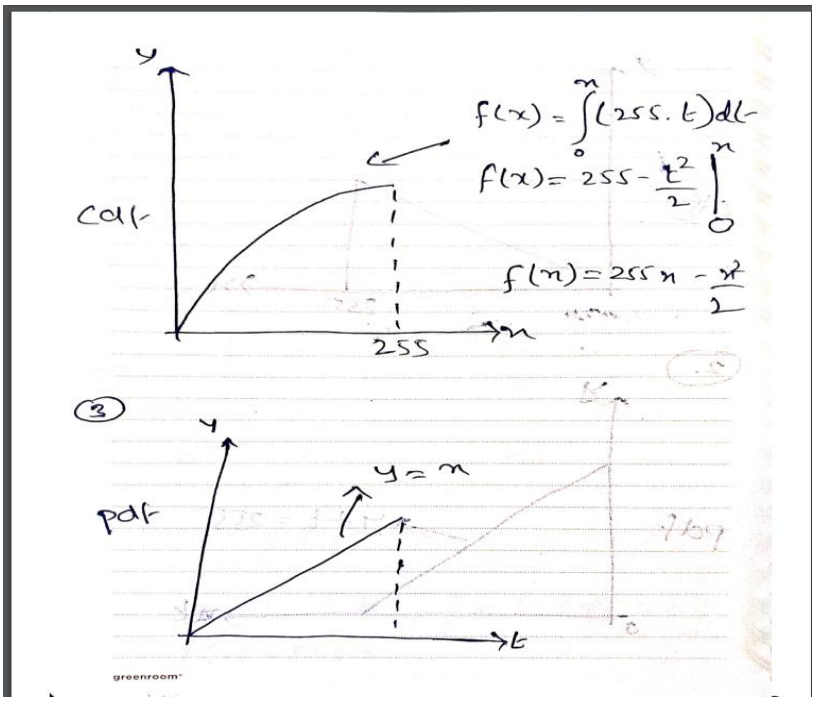
Ans. A logarithmic LUT extends the brightness of the image's dark end while compressing the brightness of the image's light end. It also reduces the image's dynamic range. Both of these functions may be useful when working with astronomical images because, in the first case, less bright features may be hidden by brighter features (smaller, more distant stars hidden by larger, closer stars) and, in the second case, the image may have a dynamic range that the human eye cannot handle. In a single look, the human eye can accommodate a dynamic range of roughly 10,000:1. If the logarithms of the luminance are used, higher ranges can be handled.

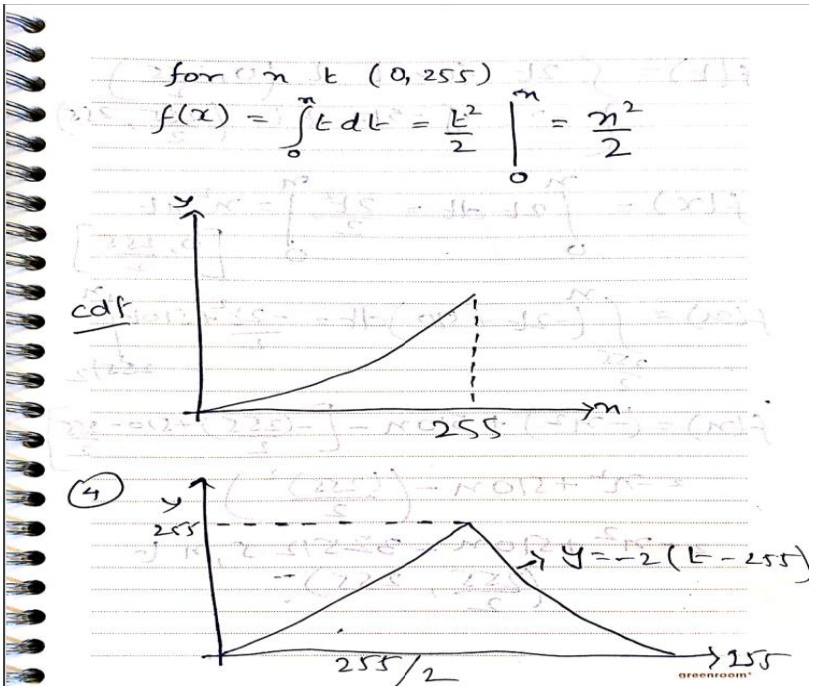
5.6 Sketch the corresponding cumulative distribution functions, CDFs, for the probability density functions, PDFs, shown in Figure E5.1.

Ans.






y
cdf
$f(x) = \int_0^x (255 - t)\,dt$
$f(x) = 255 - \frac{t^2}{2}\Big|_0^x$
$f(x) = 255x - \frac{x^2}{2}$
255
x
(3)
y
pdf
y = x
t
greenroom


for x ∈ (0, 255)
$f(x) = \int_0^x t\,dt = \frac{t^2}{2}\Big|_0^x = \frac{x^2}{2}$
y
cdf
255
x
(4)
y
255
$y = -2(t - 255)$
255/2
255
greenroom

$$f(t) = \begin{cases} 2t & \text{for } t \in \left(0, \frac{255}{2}\right) \\ -2t + 510, & t \in \left(\frac{255}{2}, 255\right) \end{cases}$$

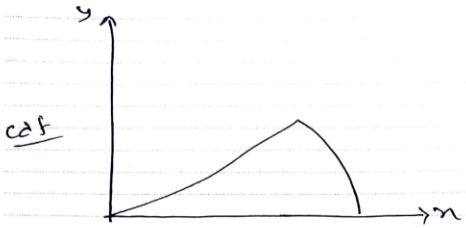
$$f(x) = \int_0^x 2t\,dt = \frac{2t^2}{2}\Big|_0^x = x^2, \; x \in \left[0, \frac{255}{2}\right]$$

$$f(x) = \int_{\frac{255}{2}}^{x} (-2t + 510)\,dt = \frac{-2t^2}{2} + 510t \Big|_{255/2}^{x}$$

$$f(x) = (-x^2) + 510x - \left[-\frac{(255)^2}{2} + 510 - \frac{255}{2}\right]$$

$$= -x^2 + 510x - \left(\frac{(255)^2}{2}\right)$$

$$= -x^2 + 510x - 32512.5, \; x \in \left(\frac{255}{2}, 255\right)$$



5.7 Table E5.1 gives the number of pixels at each of the gray levels in a 4-bit deep (i.e. 16 gray levels) image. Draw the gray-level histogram, perform histogram equalization and draw the resulting histogram. What is the objective of histogram equalization?

(i) 255 255

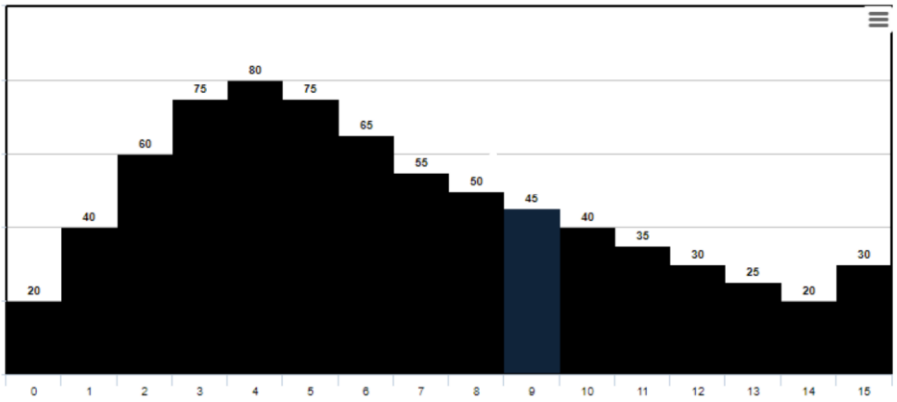
(ii) 0 0

(iii) 255 0

(iv) 255

Figure E5.1 152 Fundamentals of digital image processing Gray level Number of pixels 0 20 1 40 2 60 3 75 4 80 5 75 6 65 7 55 8 50 9 45 10 40 11 35 12 30 13 25 14 20 15 30 5.8 Suppose that you histogram-equalize a digital image. Explain why histogram equalizing the result does not lead to any significant change.

Ans.



Histograms provide better information of image without loss of any data.

5.8 Suppose that you histogram-equalize a digital image. Explain why histogram equalizing the result does not lead to any significant change.

Ans. Histograms are a useful tool for presenting numerical data. It displays or offers us a notion of the general structure of the data, as well as its frequency values. The histogram is a grayscale image, often known as a black and white image, in which each pixel has only one value: the pixel's intensity, which can range from 0-255. A grayscale image is made up of numerous shades of gray, or light shades of black and darker shades of white with a high intensity. There are four primary contrasts or colors in the histogram.

(i.) dark
(ii.) light
(iii.) low contrast
(iv.) high contrast

gray level and pixel values are supplied in the histogram, and these values are used to modify the image.

formula:

pr(rk)=nk/MN

where MN is the total number of pixels in the image and nk is the number of pixels that have intensity rk.

The histogram is a technique for improving contrast by altering image intensities. Histograms can be created by computing the probabilities between pixels and frequencies, or by plotting

pixels intensities and frequency on two distinct axes in a two-dimensional plane. The range of pixels is extended by using a histogram method, and the image appears to be more spread out.

BUT, while histogram does not improve the contrast of some images, it can change their temperature or add noise, which is generally not acceptable because it ruins the original image; it can also increase brightness or darkness, which causes some areas to become clear while others that were previously clear to become darker, so it is best not to make the change. As a result of these undesirable impacts, some digital photographs' histograms exhibit low or no effects.

5.9 Perform histogram equalization on the image of a cell colony (Fig. E5.2) and describe the resulting image. Can you obtain a better result by using histogram stretch and parameters of your choosing? (In what way do you think the image is better?) When the contrast is improved, it becomes more apparent that the illumination of the field of view was uneven. Can you think of a way to improve this unevenness? Figure E5.2 Exercises 153

Ans. When Histogram Equalize was applied, the darker greys appeared to be stronger, but the entire image also appeared to darken. Instead, a 7% histogram stretch produces a considerably crisper image, with more distinct cells.

5.10 What is the dynamic range of the image shown in Figure E5.3? Use whichever method you consider gives the best improvement in contrast, and comment on the resulting image. Figure E5.

Ans. The grayscale range of the figure at the start is fairly boring and lacks diversity, making the actual image unreadable. The image grew clearer after applying a Histogram Equalize, revealing that it was a landscape photo of an alpine woodland and mountain valley. I also duplicated the original shot and stretched the Histogram by 7% to produce the image below. The dynamic range is only approximately 1.11, which is incredibly poor (i.e., 100-111).

After Histogram Equalization

After Contrast Stretch

In this situation, contrast stretch outperforms histogram equalization, resulting in a less noisy image.