Homework-1

Q1: You are given the following image:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 2 | 3 | 3 |
| 3 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 |

1. What is the image histogram?

Answer:

Image Histogram: a type of histogram that represent the distribution of pixel values. For the image above:

|  |  |
| --- | --- |
| Pixel Value (Grey Level) | Number of Pixels |
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 0 |
| 7 | 0 |
| … | … |
| 255 | 0 |

2. What would be the result of applying linear scaling for stretching the gray levels of the original image to the 0 - 255 range?

Answer:

Range: [1, 5] -> [0, 255]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pixel Value | Number (x) | (x – 1)\*(255 – 0)/(5 - 1) + 0 | Round |  |
| 1 | 1 | 0 | 0 | 1->0 |
| 2 | 2 | 63.75 | 64 | 2->64 |
| 3 | 3 | 127.5 | 128 | 3->128 |
| 4 | 4 | 191.25 | 191 | 4->191 |
| 5 | 5 | 255 | 255 | 5->255 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 0 | 64 | 64 | 128 | 128 |
| 128 | 191 | 191 | 191 | 191 |
| 255 | 255 | 255 | 255 | 255 |

3. What would be the result (image) of the histogram equalization technique applied to the original image?

Answer:

(Use the default 0 – 255 range here).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| i | h(i) | f(i) | ((f(I - 1)+f(i))/2)\*(256/15) | Floor |  |
| 0 | 0 | 0 | 0 | 0 | 0->0 |
| 1 | 1 | 1 | 8.533 | 8 | 1->8 |
| 2 | 2 | 3 | 34.133 | 34 | 2->34 |
| 3 | 3 | 6 | 76.8 | 76 | 3->76 |
| 4 | 4 | 10 | 136.533 | 136 | 4->136 |
| 5 | 5 | 15 | 213.333 | 213 | 5->212 |
| 6 | 0 | 15 | 256 | 255 | 6->255 |
| 7 | 0 | 15 | 256 | 255 | 7->255 |
| … | … | … | … | … |  |
| 255 | 0 | 15 | 256 | 255 | 255->255 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 8 | 34 | 34 | 76 | 76 |
| 76 | 136 | 136 | 136 | 136 |
| 212 | 212 | 212 | 212 | 212 |

Q2: You are given the following 4 x 5 gray level image:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 3 | 3 |
| 1 | 1 | 1 | 1 | 2 |
| 0 | 3 | 3 | 2 | 1 |
| 0 | 3 | 3 | 2 | 1 |

a. Compute its histogram.

Answer:

|  |  |
| --- | --- |
| Pixel Value (Grey Level) | Number of Pixels |
| 0 | 2 |
| 1 | 7 |
| 2 | 4 |
| 3 | 7 |
| 4 | 0 |
| 5 | 0 |
| … | … |
| 255 | 0 |

b. What is the 4 x 5 image obtained by linearly scaling the pixel values to the 0 ~ 255 range?

Answer:

Range: [0, 3] -> [0, 255]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pixel Value | Number (x) | (x – 0)\*(255 – 0)/(3 - 0) + 0 | Round |  |
| 0 | 2 | 0 | 0 | 0->0 |
| 1 | 7 | 85 | 85 | 1->85 |
| 2 | 4 | 170 | 170 | 2->170 |
| 3 | 7 | 255 | 255 | 3->255 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 85 | 170 | 255 | 255 | 255 |
| 85 | 85 | 85 | 85 | 170 |
| 0 | 255 | 255 | 170 | 85 |
| 0 | 255 | 255 | 170 | 85 |

c. What is the 4 x 5 image obtained by histogram equalization to the 0 ~ 255 range?

Answer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| i | h(i) | f(i) | ((f(I - 1)+f(i))/2)\*(256/20) | Floor |  |
| 0 | 2 | 2 | 12.8 | 12 | 0->12 |
| 1 | 7 | 9 | 70.4 | 70 | 1->70 |
| 2 | 4 | 13 | 140.8 | 140 | 2->140 |
| 3 | 7 | 20 | 211.2 | 211 | 3->211 |
| 4 | 0 | 20 | 256 | 255 | 4->255 |
| 5 | 0 | 20 | 255 | 255 | 5->255 |
| … | … | … | … | … |  |
| 255 | 0 | 20 | 255 | 255 | 255->255 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 70 | 140 | 211 | 211 | 211 |
| 70 | 70 | 70 | 70 | 140 |
| 12 | 211 | 211 | 140 | 70 |
| 12 | 211 | 211 | 140 | 70 |