### EEE8010

# Histogram Question 2014

2

1. Explain what is meant by the term Histogram? What information, does it contain?
   1. A histogram is a graphical representation of the probability distribution of a data set. While the data may be a continuous variable, it is represented as a linear sequence of rectangles sized according to tabulated frequency counts at discrete intervals. In histograms generated for digital images, the histogram displays the distribution of intensity levels within the image. No spatial information on the location of individual pixels is retained.
2. What is histogram equalization, why is the procedure often used in image processing and what are its limitations in practice?
   1. Histogram Equalization is an image processing method whereby a source image is transformed such that the resultant image has an equalized distribution of intensity levels. I.e. it globally increases the contrast of the image. The method is useful where data in an image is represented by a subset of similar intensity values. Equalization will ‘spread’ out the most used intensity values, giving increased contrast. It is often used in scientific applications such as x-ray, thermal and satellite imagery, to pick up important details that may otherwise not be clear to the human eye. However, it can produce unrealistic effects that limits it’s use in general photography and it does not always improve image clarity in practice.
3. Over the range of interest () the probability density function is , Determine the transform T, such that produces an image with an equalised histogram.

Demonstrate that (s) is flat over the range of interest.

*Firstly, if then:*

* 1. ,
  2. or

*Secondly, via differentiation using the power rule:*

*Stating the relationship of probability density functions as follows:*

*Now, inserting values for and into equation above:*

* 1. *Simplifying and cancelling out:*
  2. = **1 (for )**
  3. **Therefore the probability distribution of s is flat over the range of interest.**

1. Determine the mapping of grey levels necessary to equalise the data distribution.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Grey level | No. Pixels | Running | Normalize | X max | Rounded |
| 0 | 100 | 100 | 0.10 | 0.70 | 1 |
| 1 | 180 | 280 | 0.28 | 1.96 | 2 |
| 2 | 250 | 530 | 0.53 | 3.71 | 4 |
| 3 | 100 | 630 | 0.63 | 4.41 | 4 |
| 4 | 90 | 720 | 0.72 | 5.04 | 5 |
| 5 | 80 | 800 | 0.80 | 5.60 | 6 |
| 6 | 70 | 870 | 0.87 | 6.09 | 6 |
| 7 | 130 | 1000 | 1.00 | 7.00 | 7 |

|  |  |  |
| --- | --- | --- |
| Original | Mapped To | No Of Pixels |
| 0 | 1 | 0 |
| 1 | 2 | 100 |
| 2 | 4 | 180 |
| 3 | 4 | 0 |
| 4 | 5 | 350 |
| 5 | 6 | 90 |
| 6 | 6 | 150 |
| 7 | 7 | 130 |

Plot the equalised distribution and comment on its shape.

The output histogram is not flat; this is due to the fact that this is a discrete approximation to a continuous image. However, it can be seen that there is in fact an improvement in the balance between the cumulative low and high intensities.

Whereas in the original the lower intensity levels (0, 1 and 2 added up to 530) dominated the higher levels (5, 6,and 7 added up to 280) in an otherwise relatively equal distribution. In the Equalized histogram the lower intensities are more in proportion to the higher ones (0+1+2=280, 5+6+7=370). Thus on a broad level the data is more equally distributed across the whole intensity range even though the data values now have greater variance amongst themselves.