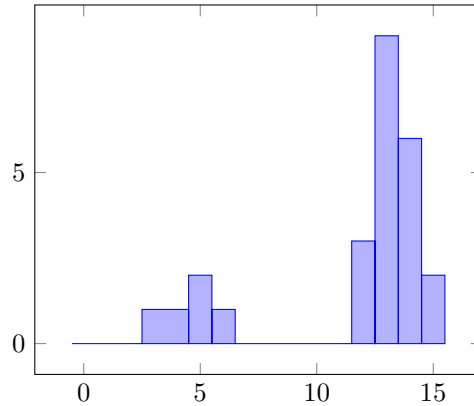# Computer Vision
Assignment №9

Theoretical Questions
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1   Image Threshold

1.1   Histogram of image

1.2   Mean, Median, Mode and Variance of image

Calculating requested parameters based on the histogram of pixel intensities.

1.2.1   Mean

$$mean = \frac{1}{n} \sum_{i=1}^{n} a_i \Rightarrow mean = \frac{290}{25} = 11.6$$

1.2.2   Median

The median is the $(n+1)2^{th}$ value of the sequence.

$$med. = (n+1)2^{th}value \Rightarrow med. = 13^{th}value = 13$$

1.2.3   Mode

Mode is the most repeated value of the sequence.

$$mod. = 13$$

1.2.4   Variance

Note: Because we are calculating variance over a population (not a sample data set), 0 degree of freedom is used for variance (wherever in this document), hence the divisor is $n - degree = n - 0 = n$

$$var. = \frac{\sum_{i=1}^{n}(a_i - \mu)^2}{n} \Rightarrow var. = \frac{\sum_{i=1}^{n}(a_i - 11.6)^2}{25} = 13.04$$

1.3   Threshold by 12

1.3.1   Group 1: < 12

$$Mean = 4.6, Median = 5, Mode = 5, Variance = 1.03\bar{9}$$

1.3.2   Group 2 : ≥ 12

$$Mean = 13.35, Median = 13, Mode = 13, Variance = 0.7275$$

1.4   Optimal Value

Generally, there are 15 values for pixel intensities, so a total of 15 values of σ_w^2 must be calculated.

First Group: values less than threshold, Second Group: values equal or greater than threshold

- **1:** 13.04
- **2:** 13.04
- **3:** 13.04
- **4:** 9.958
- **5:** 7.334
- **6:** 2.749
- **7:** 0.79
- **8:** 0.79
- **9:** 0.79
- **10:** 0.79
- **11:** 0.79
- **12:** 0.79
- **13:** 4.639
- **14:** 9.735
- **15:** 12.034

The minimum value of σ_w^2 corresponds to threshold of 7, so the optimal value of **7** is selected as the final threshold, meaning values which are less than 7 are first group and greater or equal than 7 are the second group.

Because pixel intensities for values of 7 to 12 are zero, any value selected between 7 to 12 as threshold would be similar in terms of final result. Also when computing the optimal threshold, we can skip these values because it does not make any difference.