



Image analysis
Laboratory exercise manual

**The effect of image brightness and contrast
on the shape of a histogram**

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1. The purpose of the exercise

The purpose of the exercise is:

- getting acquainted with the interpretation of the image histogram,
- assessment of the impact of changing the brightness, contrast and gamma correction of the image on the histogram,
- acquiring practical skills in using image analysis software on the example of Vision Assistant.

2. Preliminary information

An image histogram is a graph of the incidence of subsequent pixel values in the image. It shows how many points with different degrees of brightness exists in the picture. It is assumed that the first element of the histogram has the value 0 and the last element 2^{n-1} if the color is represented by n bits. The monochrome image is saved with 256 gray levels with values from 0 to 255 (Figure 1).

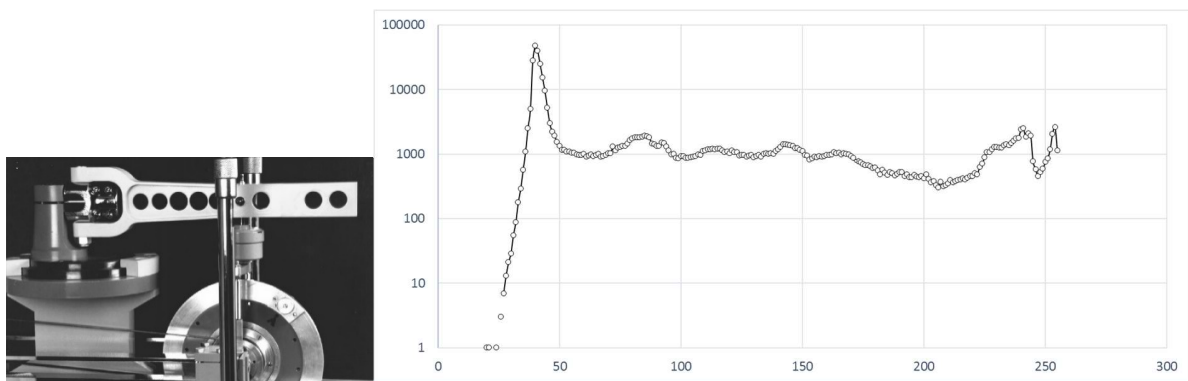


Fig. 1. Grayscale image and its histogram (logarithmic scale)

For images in which a single pixel contains several components, histograms are typically analyzed for each component. And so for a color image in RGB mode, it will be 3 histograms for the R (Red), G (Green) and B (Blue) components (Figure 2).

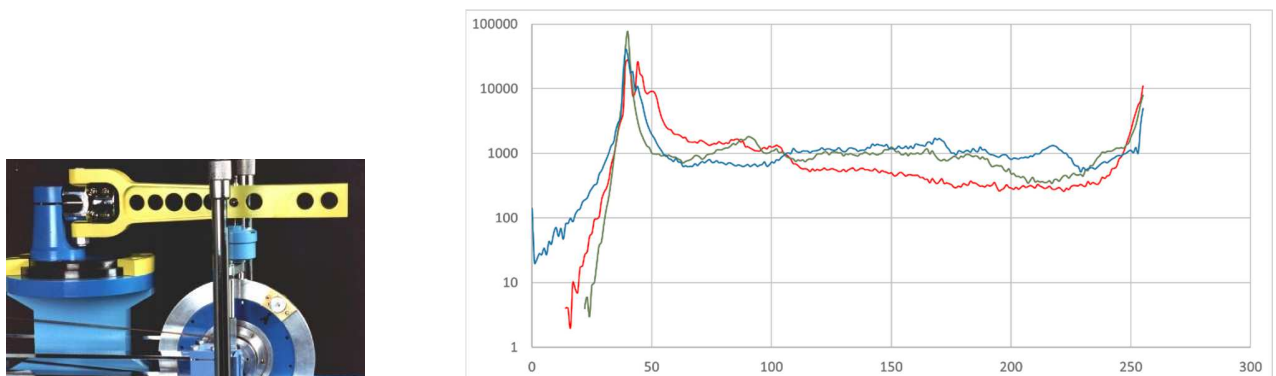


Fig. 2. Color image and its histogram (logarithmic scale)

The histogram is one of the most important image characteristics. On its basis, it is possible to evaluate the image and make transformations allowing, for example, to improve the image quality. Through the appropriate modifying functions, the number that characterizes the pixel can be calculated, e.g. brightening the image is based on increasing the value describing a given pixel.

One of the basic transformations of the image is **the extension** of the histogram.

The **histogram stretching** is performed when it does not cover the entire range of the component values of the image. The stretches lead to such a conversion of the range of component values, so

that the histogram covers all values (usually 0-255). So if the range of the component is 0 - 255, and the smallest value in the image is 30, the largest is, for example, 190, then after the stretching operation the values will be in the full range 0 - 255. So now the smallest value in the image is 0, the largest is 255. The histogram stretch operations can be performed by selecting the brightness and contrast of the image accordingly.

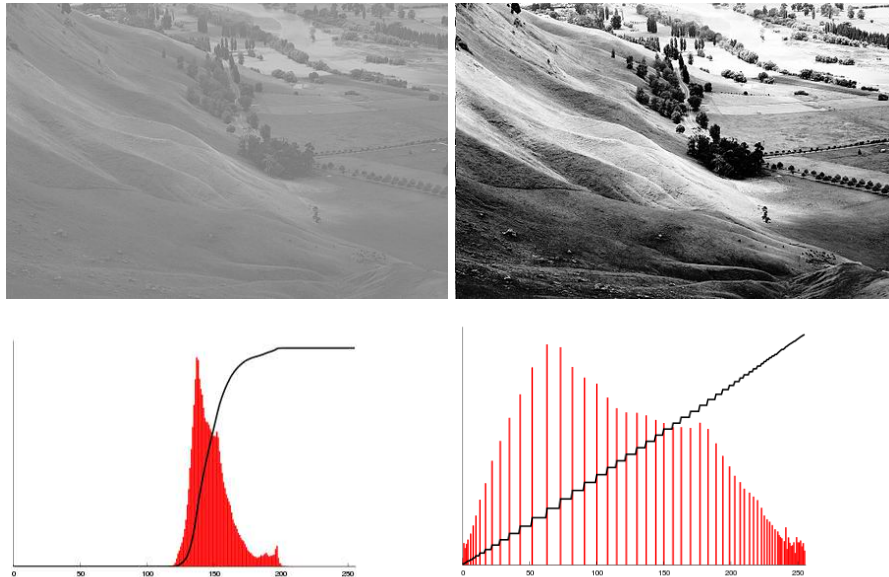
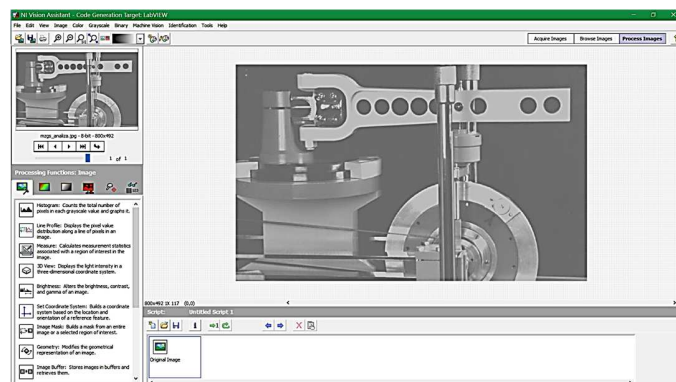
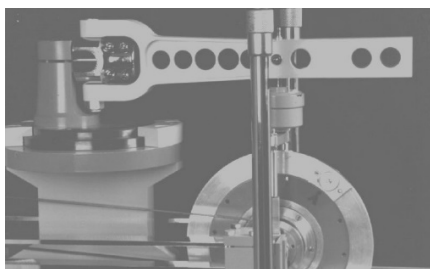


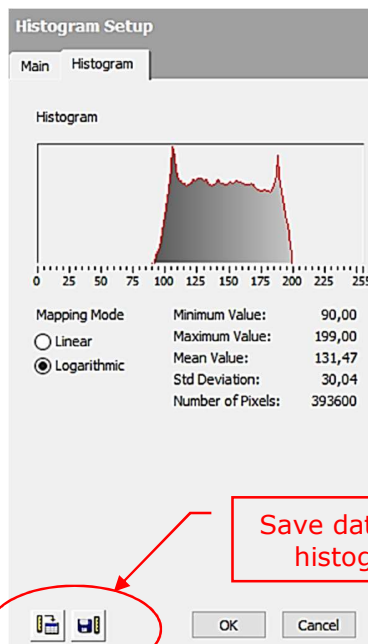
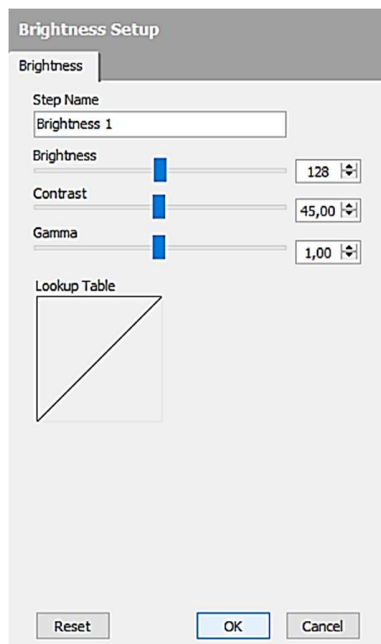
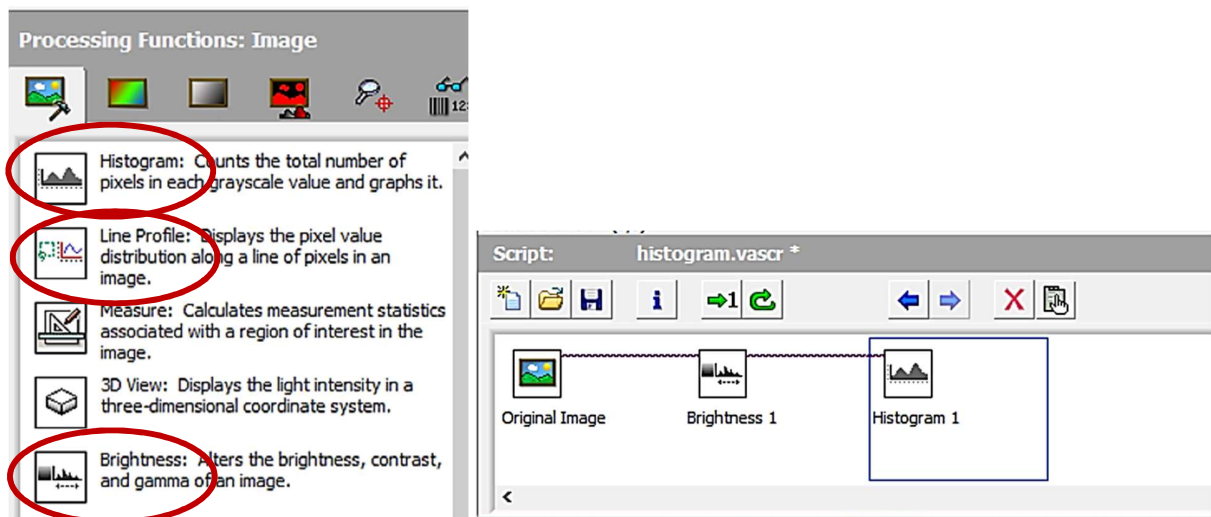
Fig. 4. Stretching the histogram [Wikipedia]

3. The exercise.

Start the **Vision Assistant** program and use the File / Open Image option to load a file named **mzgs_analiza.jpg**:



Using the **Processing Functions palette: Image** create a script by adding the functions **Brightness**, **Histogram**.

**Note:**

remember the **initial settings** of the Brightness function:

Brightness = 128

Contrast = 45

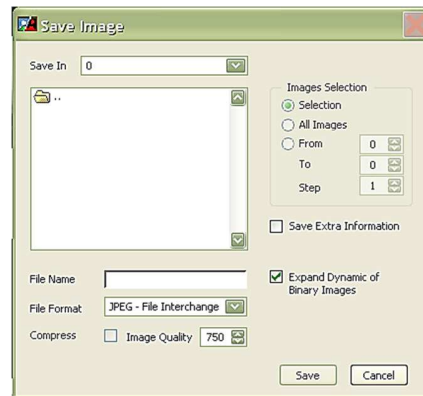
Gamma = 1

and in the **Histogram configuration window** select the **Logarithmic** option.

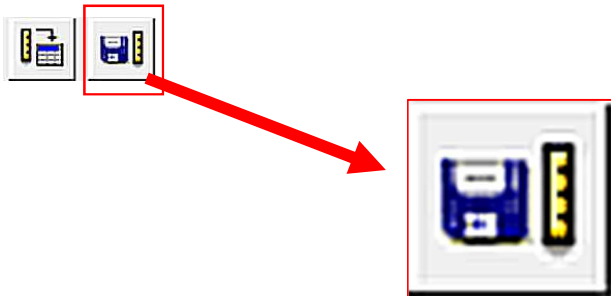
Note!

While completing tasks, save observations, performed operations, results and photos.

It is possible to save the current image to a file using the **File / Save Image** menu function. Next, we specify the location of the directory with files, the file name and graphic format (e.g. jpg)



Data for charts can be saved as a **text file (.txt)** containing data columns. The chart should be made with another external program (eg Excel).
The data is saved using the **Save Results icon** in the lower **left corner** of the program interface.



Histogram analysis

Analyse and compare histograms according to the following settings:

1. impact of **Brightness** parameter on the histogram
 - a) **Contrast=45 Gamma=1 Brightness=30**
 - b) **Contrast=45 Gamma=1 Brightness=120**
 - c) **Contrast=45 Gamma=1 Brightness=220**
2. impact of **Contrast** parameter on the histogram
 - a) **Brightness=128 Gamma=1 Contrast=10**
 - b) **Brightness=128 Gamma=1 Contrast=45**
 - c) **Brightness=128 Gamma=1 Contrast=75**
2. impact of **Gamma** parameter on the histogram
 - a) **Brightness=128 Contrast=45 Gamma=0,3**
 - b) **Brightness=128 Contrast=45 Gamma=1**
 - c) **Brightness=128 Contrast=45 Gamma=2**

4. Report

1. The report should include parameter values and images obtained after the transformations together with their histogram.
2. Describe the **visual impression** of the effects of transformations: whether the image has brightened / darkened, or the sharpness of the boundaries of the elements on the elements with a marked difference in saturation and on those where the neighbouring elements have similar saturation.
3. Describe the effect of individual parameters on histograms, what happens to histogram graphs when changing brightness, contrast and gamma correction. How big are the changes (describe quantitatively).