PhotoMate: Designing of a GUI for Basic Functions of Image Processing Using MATLAB Guide

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***Abstract*—Image Processing is one of the most basic and important step for any vision based applications. In this project a basic image processing viewer is developed using MATLAB Guide. The software is capable of performing basic functions of Image Processing on an image and let's the user analyze the effect of the algorithms in the image with the help of a visual output as well as histogram. It's a basic tool to study the different effects on an image and a much needed tool for educational purposes.**

***Index Terms*—Image Processing; Toolbox; Education; MATLAB Guide; GUI.**

I. Introduction

Image Processing is a method of performing some operations on an image in order to enhance it or get basic information out of it. It is often a preprocessing step for computer vision based applications or deep learning applications. It is a widely researched area and a lot has been done in this field. Digital Image Processing is a branch of Digital Signal Processing that is applied on images to perform Image Processing on digital computers. Image Processing basically includes image brightness adjustments, image contrast adjustments, cropping an image, resizing an image, image compression, image sharpening, edge enhancement, noise removal, filtering etc[1].

In this work, a graphical user interface is developed using MATLAB[2] for performing Digital Image Processing. The software is capable of loading an image, display it's histogram, add noise, filter noise, adjust brightness, adjust contrast, it can also turn an image into binary image as well as gray scale image. The utility of this software can be well understood for academic purposes. This software is capable of analyzing an image in every step of applying certain operations on the image. The software provides histogram analysis as well as visual output in every step of performing image processing operations.

Introducing the subject Image Processing to students who have no background of this filed is a hectic job. It's observed visual of Image Processing operations always help students get more insight into the subject than just theory. The main motivation behind developing this software was to make the study of image processing must easier for everyone who is starting with image processing. The software helps beginners observe changes in an image by doing it with their own hands. This reduces the job of coding for analysis of the operations of Image Processing. This also helps researchers to determine their preprocessing step before applying it into their work.

The rest of the paper is arranged in the following way, Section II speaks of the MATLAB Guide GUI builder, Section III talks about Images and some of their attributes, Section IV talks about Image Processing operations, Section V talks about noises in image, Section VI talks about different noise filters and the paper is concluded in Section VII.

II. MATLAB Guide

GUIs (also known as graphical user interfaces or UIs) provide point-and-click control of software applications, eliminating the need to learn a language or type commands in order to run the application. GUIDE (GUI development environment) provides tools to design user interfaces for custom applications. Using the GUIDE Layout Editor, one can graphically design an UI. GUIDE then automatically generates the MATLAB code for constructing the UI, which can be modified to program the behavior of the application. The figure 1 shows the basic building interface of GUIDE.

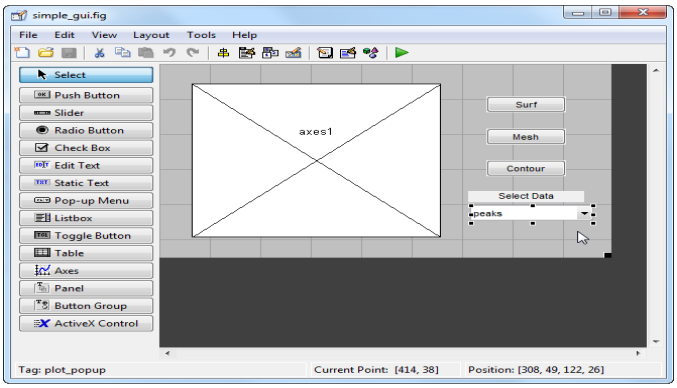

Fig. 1. MATLAB Guide GUI builder.

III. Image

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. The different types of image include red-green-blue format or grayscale format or HSV type. Images can be stored in different formats. JPEG, PNG, TIFF, RAW, BITMAP. Most commonly usage of PNG and TIFF format of image is suitable for image processing[1].

A. RBG Image

The RGB color model is an additive color model in which red, green and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue. The main purpose of the RGB color model is for the sensing, representation and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB color model already had a solid theory behind it, based in human perception of colors. The figure 2 represents an image in the RGB color model. Here each pixel has three channels R-G-B. The values of red, green and blue varies from 0-255 each for displaying various colors different combinations of RGB intensity values is used.

Fig. 2. Image of Lenna an example for RGB image.

B. Gray Scale Image & Binary Image

In computing a grayscale image is one in which the value of each pixel is a single sample representing only an amount of light, that is, it carries only intensity information. Images of this sort, also known as black-and-white or monochrome, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. The pixel values range from 0-255.

Grayscale images are distinct from one-bit bi-tonal black-and-white images which, in the context of computer imaging, are images with only two colors: black and white also called binary images. Grayscale images have many shades of gray in between. Binary images are represented by only 0-1.

Grayscale images can be the result of measuring the intensity of light at each pixel according to a particular weighted combination of frequencies (or wavelengths), and in such cases they are monochromatic proper when only a single frequency (in practice, a narrow band of frequencies) is captured. The frequencies can in principle be from anywhere in the electromagnetic spectrum (e.g. infrared, visible light, ultraviolet, etc.).

The designed software can be used to easily convert a RGB image to grayscale or binary image. The figure 3 shows an example of conversion of a RGB image to grayscale using the developed software also to convert an image to binary there is a button B&W in the software that converts image to binary image. To reset all changes there is a reset button present in the software.

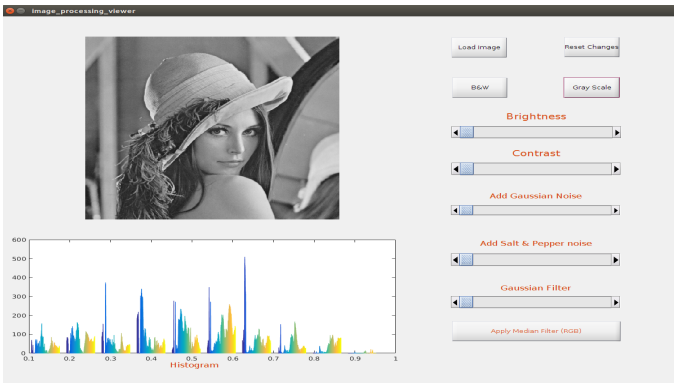

Fig. 3. Gray scale image of Lenna using the developed software.

IV. Image Processing

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps: 1) Importing the image via image acquisition tools 2) Analysing and manipulating the image and 3) Output in which result can be altered image or report that is based on image analysis.

A. Image Brightness

Brightness is a characteristics of an image. Brightness in an abstract way can be related to increasing/decreasing the light intensity values of each pixel. The effect of increasing brightness can be an over exposed image. The basic idea of adjusting brightness is scalar multiplication of the image matrix with some constant greater than 0. The developed software uses this concept of multiplication to adjust brightness of an image. The trackbar in the UI allows adjusting brightness with ease. The result of increasing brightness can be seen in figure 5. While the effect of reduced brightness in figure 4.

B. Image Contrast

Contrast is an important factor in any subjective evaluation of image quality. Contrast is created by the difference in luminance reflected from two adjacent surfaces. In other words, contrast is the difference in visual properties that makes an object distinguishable from other objects and the background. In visual perception, contrast is determined by the difference in the colour and brightness of the object

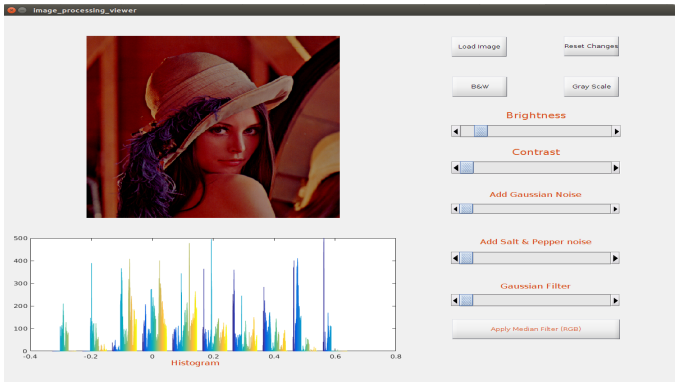

Fig. 4. Low brightness picture.

Fig. 5. High brightness picture.

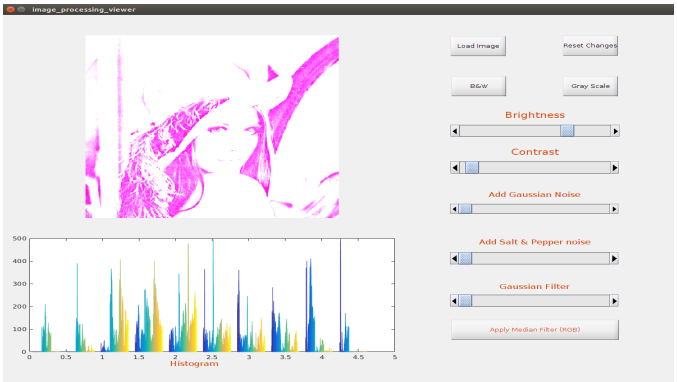

Fig. 6. High contrast picture.

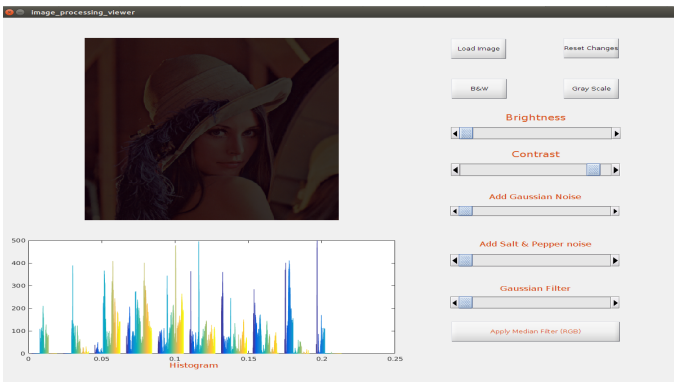

Fig. 7. Low contrast picture.

with other objects. Our visual system is more sensitive to contrast than absolute luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions. Many algorithms for accomplishing contrast enhancement have been developed and applied to problems in image processing.

The developed software uses the following equation 1 to change contrast. The trackbar in the UI for contrast adjust makes the adjusting of contrast easier. The effect of high contrast can be seen in figure 6 while the effect of reducing contrast can be seen in figure 7. Usually having a high contrast makes the colors in the image more bolder.

$$newimage = \frac{image - min(image)}{max(image) - min(image)} \tag{1}$$

C. Image Histogram

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance. The figure 8 shows the histogram of the image 2.

The horizontal axis of the graph represents the tonal variations, while the vertical axis represents the number of pixels in that particular tone. The left side of the horizontal axis represents the black and dark areas, the middle represents medium gray and the right hand side represents light and pure white areas. The vertical axis represents the size of the area that is captured in each one of these zones. Thus, the histogram for a very dark image will have the majority of its data points on the left side and center of the graph. Conversely, the histogram for a very bright image with few dark areas and/or shadows will have most of its data points on the right side and center of the graph.

Fig. 8. Histogram of the image.

The developed software has provisions to create a histogram of the image being edited using the inbuilt MATLAB function hist(). The histogram plots the number of pixels in the image (vertical axis) with a particular brightness value (horizontal axis). Algorithms in the digital editor allow the user to visually adjust the brightness value of each pixel and to dynamically display the results as adjustments are made. Improvements in picture brightness and contrast can thus be obtained.

In the field of computer vision, image histograms can be useful tools for thresholding. Because the information contained in the graph is a representation of pixel distribution as a function of tonal variation, image histograms can be analyzed for peaks and/or valleys. This threshold value can then be used for edge detection, image segmentation, and co-occurrence matrices.

V. Noise

Noise is an unwanted disturbance in the signal or image. Noise is usually high frequency components in the signal and it is undesired. Noise can hide essential information from an image and there by it is important to remove them. In general there are different pattern of noise Additive white Gaussian noise, Salt pepper noise so on and so forth.

A. Gaussian Noise

Gaussian noise is statistical noise having a probability density function (PDF) equal to that of the normal distribution, which is also known as the Gaussian distribution. In other words, the values that the noise can take on are Gaussian-distributed. The figure 9 shows an image with Gaussian noise. In image processing noise reduction is an important pre-processing step.

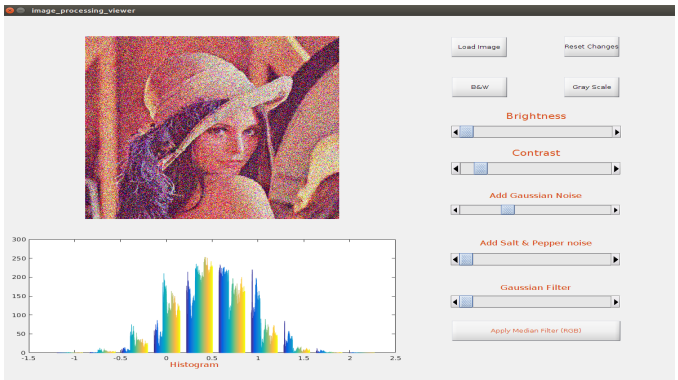

Fig. 9. Gaussian noise.

B. Salt and Pepper Noise

Salt-and-pepper noise is a form of noise sometimes seen on images. It is also known as impulse noise. This noise can be caused by sharp and sudden disturbances in the image signal. It presents itself as sparsely occurring white and black pixels. An effective noise reduction method for this type of noise is a median filter or a morphological filter. The name is given as salt and pepper because it presents it self as if salt and pepper has been sprinkled over the image. The distribution is random and follows no specific order. The image with salt and pepper noise looks something like in the figure 10.

Fig. 10. Salt and Pepper noise.

VI. Filters

An image filter is a technique through which size, colors, shading and other characteristics of an image are altered. An image filter is used to transform the image using different graphical editing techniques. The developed software has two noise reduction filters the Gaussian filter to remove Gaussian noise and the median filter to remove salt and pepper noise. In image processing, a kernel, convolution matrix, or mask is a small matrix. It is used for blurring, sharpening, embossing, edge detection, and more. This is accomplished by doing a convolution between a kernel and an image.

A. Gaussian Filter

A Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. In MATLAB imgaussfilt(A,sigma) is utilised for applying a Gaussian filter with changing sigma value. The figure 11 shows a image after application of Gaussian filter. Another way of applying

Fig. 11. Applying Gaussian filter.

Gaussian Filter is by using the kernel method. Using a moving

window of Gaussian kernel over the image and convolving the image with that kernel Gaussian filtering can be achieved.

B. Median Filter

The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise (but see discussion below), also having applications in signal processing. The figure 12 shows the image after median filtering for removal of salt and pepper noise.

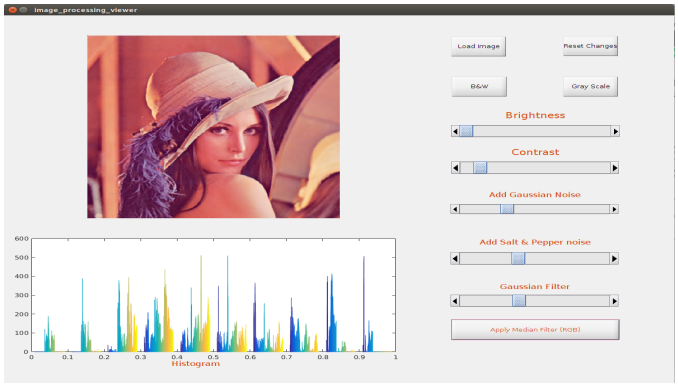

Fig. 12. Applying Median filter.

The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the ”window”, which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as ”box” or ”cross” patterns).

VII. Conclusion

In a nutshell, this educational software for demonstration of image processing to new adopters of this field is not only a handy material while teaching but also a pre-processing sequence testing tool for complex vision applications.

References

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[2] MATLAB, *version 13.10.0 (R2016a)*. Natick, Massachusetts: The MathWorks Inc., 2016.