# GUI FOR CONTRAST ENHANCEMENT IN MEDICAL IMAGES

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*Abstract*

*In the paper is presented software for contrast enhancement in medical images and its graphic user interface (GUI). It works in the MATLAB environment and uses IMAGE TOOLBOXES defined functions. Different contrast enhancement techniques such as increasing the contrast, histogram equalization (HE) and contrast limited adaptive histogram equalization (CLAHE) can be used, regarding to process different medical modalities of grayscale and color images. The GUI proposes also an interactive option to choose the type of the specific function and its parameters. It can be applied to real medical images attempt to make diagnostic more precise. The GUI is suitable also to engineering education for studying of this processing.*

*Some results of the experiments are presented, which were made by computer simulation in MATLAB environment..*

## 1. INTRODUCTION

Image contrast enhancement is one of the categories of medical image processing, attempt to make diagnostic more obvious. Contrast enhancement is based on emphasizing the difference of brightness in an image to improve its perceptual quality [1]. Most of these techniques are based on global histogram modifications or local contrast transformations. The current state-of-the-art method for automatic display is a variation of the technique of histogram equalization [2]. Histogram equalization (HE) is a nonlinear transformation scheme that maps image intensity values across the entire range of a display device.

CLAHE is basic local histogram-based contrast-enhancement techniques. It divides the original image into several non-overlapped sub-blocks, performs a HE of each sub-block and merges the sub-blocks using bilinear interpolation [3]. This method usually produces an undesirable checkerboard effect near the boundaries of the sub-blocks. To counter this effect, sub-blocks are overlapped generally at the expense of increased computation and memory usage. Increasing the contrast by a imadjust function in Matlab maps the intensity values of the image such that 1% of data are saturated at low and high intensities. It fails to achieve any contrast enhancement but does not introduce luminance shift or saturation. The HE and CLAHE techniques emphasize the details, but introduces saturation artifacts and color shift. Most of the image contrast enhancement techniques are applied to grayscale medical images. Techniques for color contrast enhancement are similar to those for grayscale images. Color imaging may be considered as a channel-by-channel intensity image processing scheme. This is based on the assumption that we can process each of the monochrome channels separately and finally combine the results. Independent equalization of RGB leads to a hue shift. Another approach to color enhancement is to transform the image from the RGB space to other color spaces such as the CIELAB, LHS, HSI, HVS, etc.

In the paper is presented software for contrast enhancement in medical images and its GUI. Different contrast enhancement techniques such as increasing the contrast, HE and CLAHE can be used, regarding to process different medical modalities of grayscale and color images.

The software is created in MATLAB 7.14 environment by using IMAGE PROCESSING TOOLBOX.

The graphic user interface consists of checkboxes, buttons, edit boxes, pop-up controls, which make it easy to use. Users enter or choose input data in a single form, because input information changes and visualizations are easier and faster in this way. The processed image can be saved on the disk and so

can be used to another processing or its visualization.

## 2. THE GUI FOR CONTRAST ENHANCEMENT

The GUI for contrast enhancement of medical images is shown on Fig.1. It is divided in several areas, where the user applies different settings, concerning image contrast enhancement techniques and theirs parameters and areas for universal application.


Figure 1. GUI for contrast enhancement of medical images

The area "Image and Functions" is shown on Fig.2. It is for entering an image file name with an image file extension. The user can navigate among the folders in the work folder and choose image by using "Browse" button and view the image. The user can select the contrast enhancement function from the pop-up menus and the mode for color (RGB or YCbCr) or grayscale format of the image, which will be processed. The selected image can be processed as region of interest (ROI) image, too. The user can choose in this case the function "Image cropping". "Save Image on HDD" is checked to save results from contrast enhancement in image files in 'jpg' format.

The user can select the imadjust or histogram equalizations parameters, from the area "Imadjust parameters", which is presented in Fig.3. The important parameters of these methods are minimum and maximum intensity difference (threshold) and gamma parameter's value with values between 0 and 1. It can be input automatically or manually.


Figure 2. Area "Image and Functions"


Figure 3. Area "Imadjust parameters"

The area "CLAHE Parameters" is shown on Fig.4. The CLAHE contrast enhancement technique can be applied on grayscale or on color medical images, too. The desired histogram shape for the image tiles can be selected by pop-up menu. There are 3 possibilities of distribution functions: 'uniform' for flat histogram; 'Rayleigh' for bell-shaped histogram; 'exponential' for curved histogram.

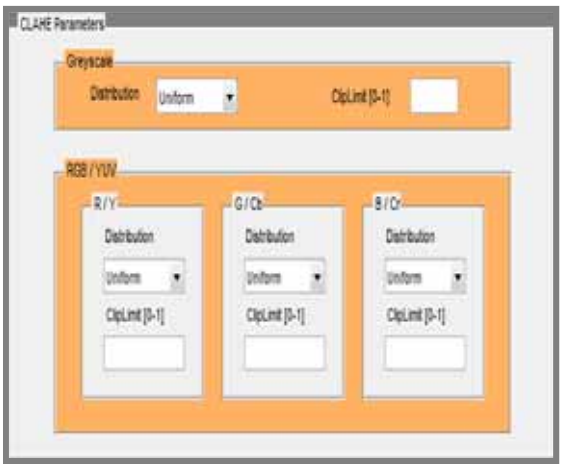


Figure 4. Area "CLAHE Parameters"

The other important parameter is 'ClipLimit' factor. It is a contrast factor that prevents over-saturation of the image specifically in homogeneous areas.

After choosing all input information the procedure of processing begins, when the user clicks on button "Run Process". Then the final result is shown – original image, and processed images. When button "Exit" is pressed the program can be closed.

## 3. TASKS CARRIED OUT FROM THE MAIN PROGRAM

The basic algorithm that works behind is shown in Fig. 5.

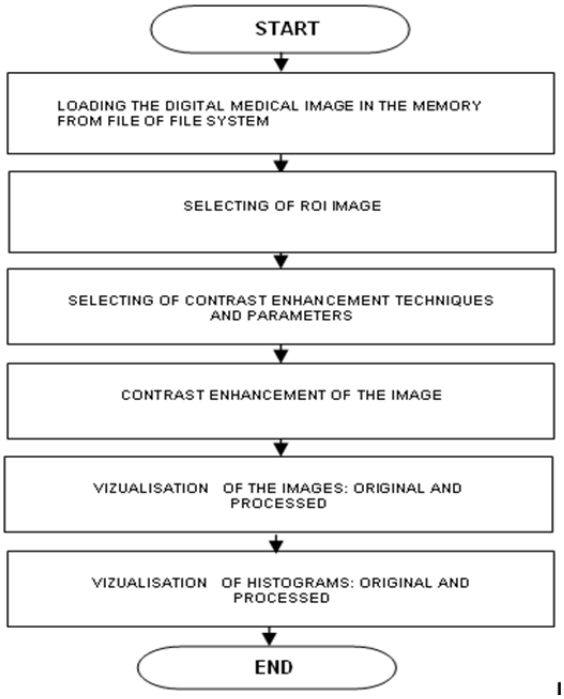


Figure 5. Block diagram of the algorithm

By acting of component from GUI can be implemented a callback-function from the main program. Every graphic component can be treated to object. Every object can be referred to handle. The objects referred a complex of attributes, which can be manipulated from the software. The multifarious attributes can be leaved for using in MATLAB environment, such as "Enabled", "Value", "Visible", "On", "Off" etc. [4]. Every attribute can be enabling in the presence of corresponding handle or reference to the object. Every graphic component can be reiterated to a cycle of events for the MATLAB environment by initialization of the graphic application.

It submits addresses of the callback-functions, associated to a given event, which are important. By its identification can be called out a corresponding callback-function. One of the important tasks that the main program has is input data validation. The execution is canceled if an error concerned with wrong information occurs. Another essential purpose of is presenting the input information in appropriate data structures. It is necessary for the next steps in the processing strategy, in this step the processing is made with appropriate input data. Wrong information prevents contrast enhancement from carrying out or may lead to wrong output.

Some results from simulation, which illustrate the working of the program, are presented in the next figures below. In Fig.6 is shown the original X-ray image of hand of size 640x480 pixels and its computed histogram.

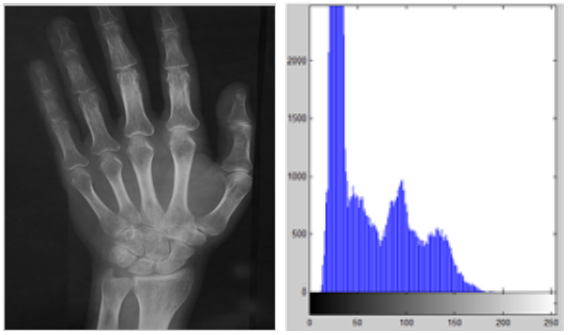

Figure 6. Original X-ray image and its calculated histogram

In Fig.7 are presented the modification of the X-ray image, obtained by HE, in Fig. 8, obtained by 'imadjust' function and in Fig.9. by CLAHE and the corresponding computed histograms.

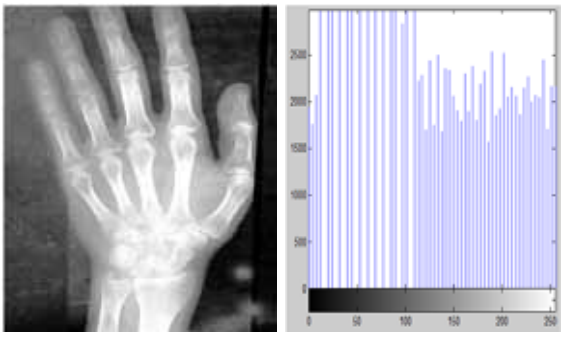

Figure 7. Processed by HE X-ray image and its calculated histogram

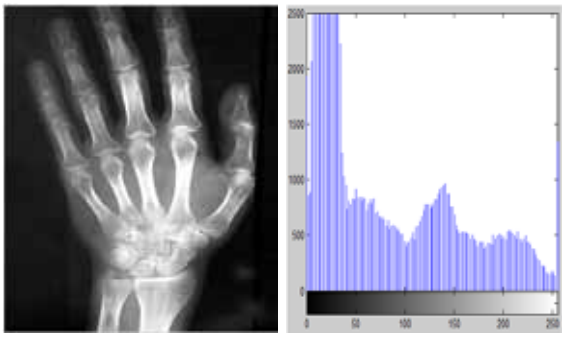

Figure 8. Processed by 'imadjust' X-ray image and its calculated histogram

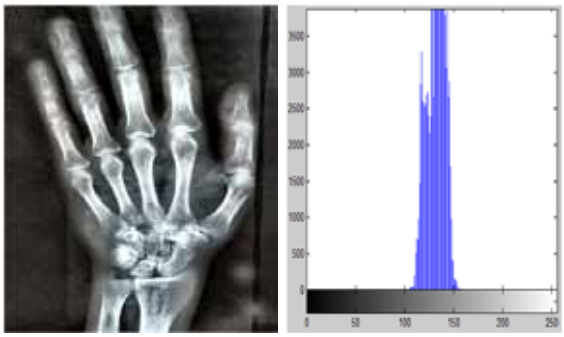

Figure 9. Processed by CLAHE X-ray image and its calculated histogram

## 4. CONCLUSION

In the paper is presented a GUI for contrast enhancement of medical images. It uses MATLAB defined function and works in MATLAB 7.14 environment. The GUI can be used in engineering and education for studying this process. It can be used also in real time to provide important anatomical information in medical images to physicians and specialist upon which can be made diagnoses of different diseases.

## References

[1] Gonzalez RC, Woods RE, Digital Image Processing Prentice Hall, Upper Saddle River, NJ; 2002.

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[3] Lamberti F, Montrucchio B, Sanna A, CMBFHE–a novel contrast enhancement technique based on cascaded multistep binomial filtering histogram equalization. IEEE Trans Consum Electron, 52(3): 966-974, 2006.

[4] MATLAB User's Guide. Accessed at: www.mathwork.com