GUI FOR MORPHOLOGICAL PROCESSING OF MEDICAL IMAGES

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Abstract

In the paper is presented software for morphological processing of medical images and its graphic user interface (GUI). It works in the MATLAB environment and uses IMAGE TOOLBOXES defined functions. Different morphological operators and types of structuring elements with different sizes can be used, regarding to process different medical modalities of the images. The software can realize repeatedly a nonlinear filtration, by using the same operation. The GUI proposes also an interactive option to choose the type of the morphological operation, the type of the structuring element and also its parameters.

The proposed GUI can be applied to real medical images attempt to make diagnostic more precise. The presented GUI is suitable also to engineering education for studying of this processing.

1. INTRODUCTION

The most popular technologies are ultrasound (US), X-rays, Computed tomography (CT) and Magnetic resonance imaging (MRI). These images provide important anatomical information to physicians and specialist upon which can be made diagnoses [1].The goals of medical image morphological processing include improvement of the visibility and perceptibility of the various regions and tasks such as cleaning the medical image from specific types of noise.

By properly choosing of different type of operation such as: erosion, dilatation, opening, closing, motion blur filtration and top & bottom hat filtration, and suitable form of structuring element, local structures can be eliminated or local geometry of the investigated object can be modified [2].

The software is created in MATLAB 6.5 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 applied algorithm calculates also some objective quantitative estimation parameters as: Coefficient of noise reduction (CNR), Signal to noise ratio in the noised image (SNR_Y), Signal to noise ratio in the filtered image (SNR_F), Effectiveness of filtration (E_{FF}), Peak signal to noise ratio (PSNR) [3]. On the base of their analysis can be selected the most suitable morphological operator, type of the structuring element and its characteristics. It determinates more precise processing and enhancement of the different medical modalities images.

The processed image can be saved on the disk and so can be used to another processing or its visualization.

2. THE GUI FOR MORPHOLOGICAL PROCESSING OF MEDICAL IMAGES

The Fig.1 shows the GUI for morphological filtering of medical images. It is divided in several areas, where the user applies different settings, concerning morphological operators and theirs characteristics.

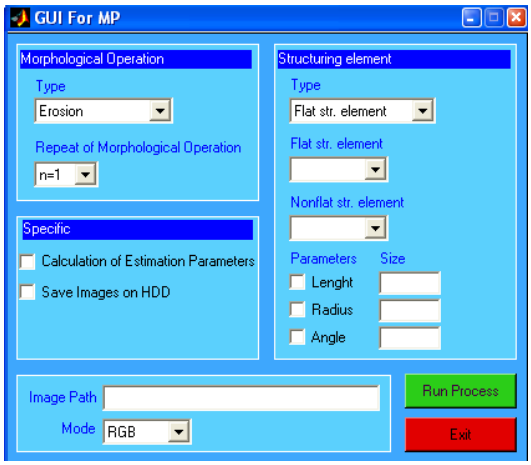

Fig. 1. GUI for morphological processing of medical images

The area "Image Path" is for entering an image file name, but without an image file extension. For example, if the file name is "pic1.jpg", the user should write "pic1". The image file for morphological processing must be in the same directory (folder), where the main program and the rest modules are. The image processing is made in two modes – RGB and YUV, chosen through the pop-up menu, default value is RGB.

The morphological operator's settings are selected in area "Morphological operation", shown in Fig. 2.

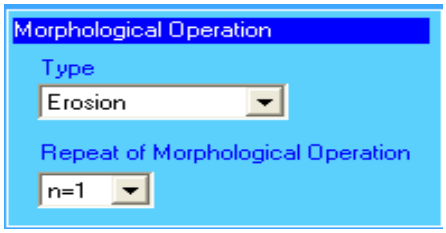

Fig. 2. Area "Morphological Operation"

Two parameters can be selected: Type of operation and the repeat of morphological operation. The repeat of morphological operation must be positive integer. Recommended values for "Repeat" from 1 to 10, because bigger values cause more noise components removal, but loosing more useful parts of the image. The type of operation can be selected such as: erosion, dilatation, opening, closing, motion blur filtration and top & bottom hat filtration and is shown on Fig. 3.

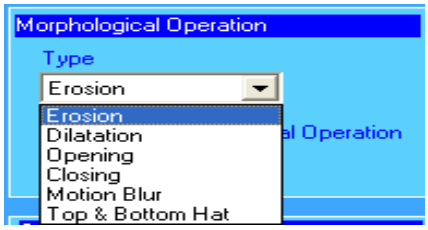

Fig. 3. Type of Morphological Operation

Selecting appropriate structuring element is an important part in morphological processing of medical images. It can be selected in area "Structuring element", shown in Fig. 4.

There are two types of structuring elements: flat or nonflat [4]. By creating of flat structuring element for morphological filtering can be used many common shapes, such as line, diamond, octagon, pair, rectangle, square and disk, shown in Fig.5. The goal is to choose the suitable form of structuring element, according to modality of medical diagnostic image. The most used elements for medical applications are: diamond, line and disk [5].

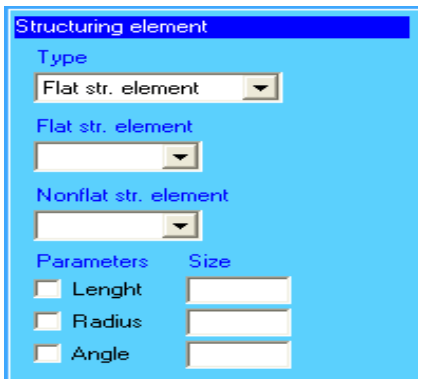

Fig. 4. Area "Structuring element"

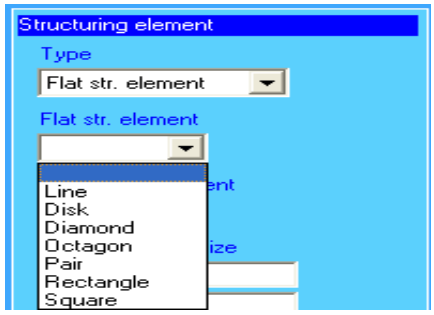

Fig. 5. Type of flat structuring element

If the structuring element is nonflat, the user can select one from two types: arbitrary or ball. In addition the size of the structuring element can be also selected: length, angle and radius. The length of the line is approximately the distance between the centers of the structuring element members at opposite ends of the line, for example LENGHT=5. The angle (in degrees) of the line is measured in a counterclockwise direction from the horizontal axis, for example DEG=0 (DEG=45) [4]. By selecting of disk or diamond-shaped structuring element, the user must determinate its radius R, where R specifies the distance from the structuring element origin to the points of the disk or the diamond.

The area "Specific" gives an opportunity to save results in image files in 'jpg' format if 'Save Images' is checked and estimate morphological processing if "Calculate of estimation parameters" is checked, as shown in Fig. 6. On the base of analysis of some objective quantitative estimation parameters can be selected the form and size of the structuring element. The condition is: minimum value for CNR and maximum values for PSNR and E_{FF} .

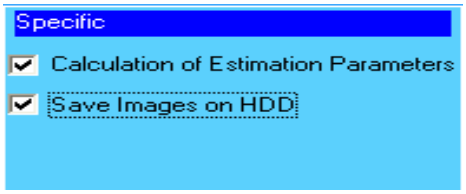

Fig. 6. Area "Specific"

After choosing all input information the procedure of morphological processing begins, when the user clicks on button 'Run'. Then the final result is shown – original image, and processed image. When button "Exit" is pressed the user is asked whether he wants to quit the program. If he chooses 'Yes', the program can be closed, if he chooses 'No', he continues working with the program.

3. TASKS CARRIED OUT FROM THE MAIN PROGRAM

The basic algorithm that works behind is shown in Fig. 7.

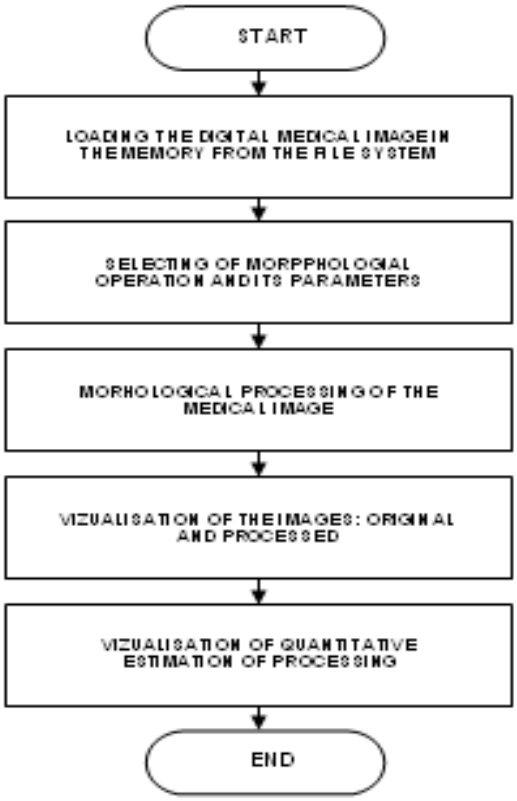

Fig. 7. Block diagram of the algorithm

By acting of component from GUI can be implemented a callback-function from the main program [6]. 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.. Every attribute can be enable 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 the main program is presenting the input information in appropriate data structures [6]. 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 morphological processing from carrying out or may lead to wrong output.

The applied algorithm calculates also some objective quantitative estimation parameters as: Coefficient of noise reduction (CNR), Signal to noise ratio in the noised image (SNR_Y), Signal to noise ratio in the filtered image (SNR_F), Effectiveness of filtration (E_{FF}), Peak signal to noise ratio (PSNR) [3]. On the base of their analysis can be selected the most suitable morphological operator, type of the structuring element and its characteristics. It determinates more precise processing and enhancement of the different medical modalities images.

In Fig. 8 are shown respectively the visualizations of original CT images of size 256x256 pixels from the brain and it's modifications by processing of erosion, opening and n=8 times closing with disk structuring element by R=3.

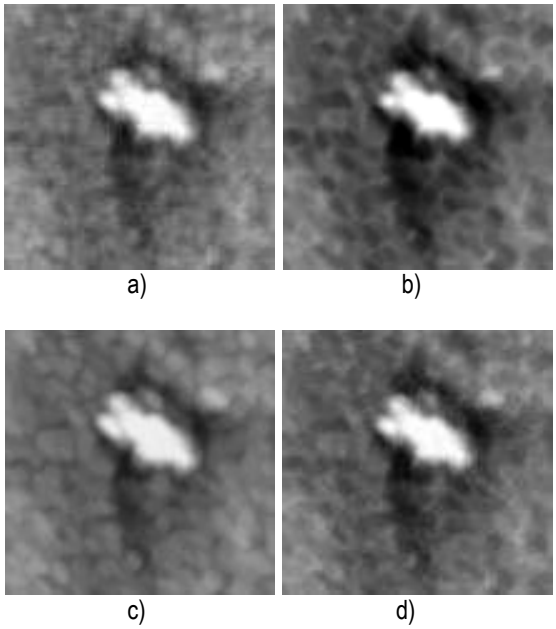

Fig. 8. CT images: a) original; b) after erosion; c) after opening; d) after closing n=8

4. CONCLUSION

In the paper is presented a GUI for morphological processing of medical images. It uses MATLAB defined function and works in MATLAB 6.5 environment. The pre-processing can realize a nonlinear filtration by using of different type of operators and its parameters. The GUI can be used in engineering education for studying this pre-processing. It can be used also in real time to provide important anatomical information to physicians and specialist upon which can be made diagnoses of different diseases.

References

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