GUI FOR EDGE DETECTION IN MEDICAL IMAGES

Veska M. Georgieva

Faculty of Telecommunications, Technical University of Sofia, Bulgaria
1000 Sofia, "Kl. Ohridsky" str.8
T. (+359 2) 965-3998; E-mail: vesg@tu-sofia.bg

Sofiya P. Shtarbova

Faculty of Computer Systems and Control, Technical University of Sofia, Bulgaria
1000 Sofia, "Kl. Ohridsky" str.8
E-Mail: sofiya_psht@abv.bg

Abstract

In the paper is presented software for edge detection and contour segmentation of objects in medical images and its graphic user interface (GUI). It works in the MATLAB environment and uses IMAGE TOOLBOXES defined functions. Different operators for edge detection and contour segmentation with different parameters can be used, regarding to process different medical modalities of the images. The GUI proposes also an interactive option to choose the type of the edge detection operator and also its parameters.

The aim of algorithms, based on edge detection, is detail preservation abilities of the different objects in medical images or in their selected region of interest (ROI). The quality of the edge detection and his stability of noises can be also estimated.

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

Edge detection is an important task in medical image processing [1]. It is a main tool in pattern recognition, image segmentation and scene analysis. An edge detector is basically a high pass filter that can be applied to extract the edge points in an image. It is realized by the convolution with a set of directional derivative masks [2], [3].

The aim of algorithms, based on edge detection, is detail preservation abilities of the different objects in medical images. By properly choosing of different type of classical operators for edge detection such as: Roberts, Sobel, Prewitt, Laplacian of Gaussian, Zerocross, Canny and their parameters different medical modalities of the images can be processed.

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

2. THE GUI FOR EDGE DETECTION IN MEDICAL IMAGES

The GUI for edge detection in medical images is shown on Fig.1. It is divided in several areas, where the user applies different settings, concerning edge detection operators and theirs parameters.

Fig. 1. GUI for edge detection of medical images

The area "Image Path" is for entering an image file name with an image file extension. The image

file for edge detection must be in the same directory (folder), where the main program and the rest modules are. The user can navigate among the folders in the work folder and choose image by using "Browse" button. The edge detection operator can be selected in area "Edge Detection Method", shown in Fig. 2.
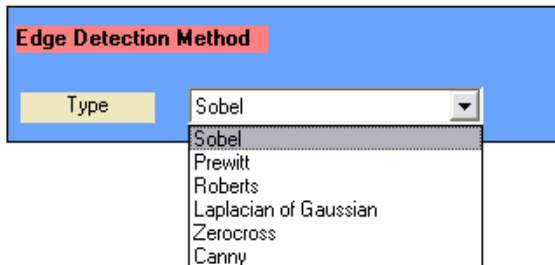

Fig. 2. Area "Edge Detection Method"

The selection is realized trough drop-down menu and it contains the following operators: Sobel, Prewitt, Roberts, Laplacian of Gaussian, Zerocross and Canny [5]. Selecting appropriate parameters is an important part in edge detection of medical images. It can be selected in area "Parameters", shown in Fig. 3.

The first parameter is the Threshold. There are two options: Automatic generation of the threshold (Automatic) or manual input of the threshold (Value). When "Automatic" radio button is selected the generated value for the threshold is visualized at the bottom of the GUI in red color.
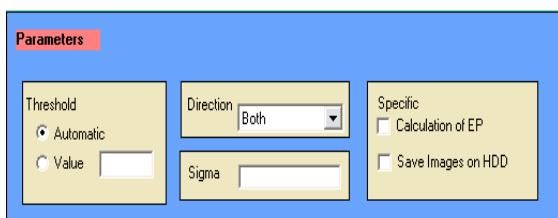

Fig. 3. Area "Parameters"

The second parameter is the Direction, shown in Fig.4. This is a drop-down menu with three values: Both, Horizontal and Vertical.
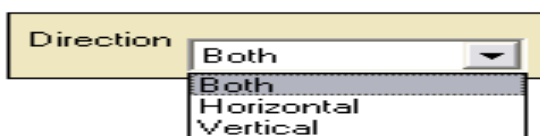

Fig. 4. Area "Direction"

Another parameter is standard deviation σ ("sigma"), which has to be manually filled in. The choice of the standard deviation for the Gaussian filter depends on the size of the objects in the image.

The area "Specific" gives an opportunity to save results in image files in 'jpg' format if 'Save Image on HDD' is checked and estimate edge detection quantitative estimation parameters if "Calculation of EP" is checked, as shown in Fig.5.
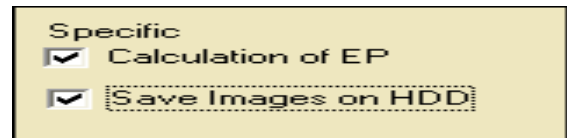

Fig. 5. Area "Specific"

Selecting check box "Image Cropping" located in area "Domain of Interest" or "Region of Interest" (ROI) is shown in Fig. 6. It gives the opportunity to process only part of the image.

Fig. 6. Area "ROI"

It is possible to apply additive white Gaussian noise on the image by selecting the check box "Imnoise picture" located in area "Gaussian white noise", shown in Fig. 7. This option requires standard deviation parameter σ for the Gaussian white noise, which has to be manually filled in and the value has to be between 0.001 and 0.1.
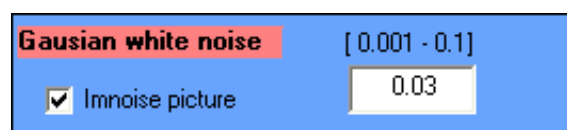

Fig. 7. Area "Gaussian white noise"

After choosing all input information the procedure of edge detection processing begins, when the user clicks on button 'View images'. Then the final result is shown – original image, and processed images.

3. TASKS CARRIED OUT FROM THE MAIN PROGRAM

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.. 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 the main program 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 edge detection from carrying out or may lead to wrong output.

Some of the classical edge detectors do not work well with noisy images, because their SNR is not maximized through the detection filter [3]. The applied algorithm calculates also some objective quantitative estimation parameters as: 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}), PSNR [4]. On the base of their analysis the quality of the edge detection and his stability of noises can be also estimated.

In Fig. 8 is shown an original gray scale ultrasound image (US) with size 640x480 pixels from urethra. In Fig. 9 are shown respectively the visualizations of its original and noised ROI images with size 210x150 pixels and their modifications by processing of three different classical edge operations: Sobel, Zerocross and Canny operator. The thresholds for all operators are automatic selected from the program. The noise is additive Gaussian white noise with standard deviation $\sigma = 0.03$.

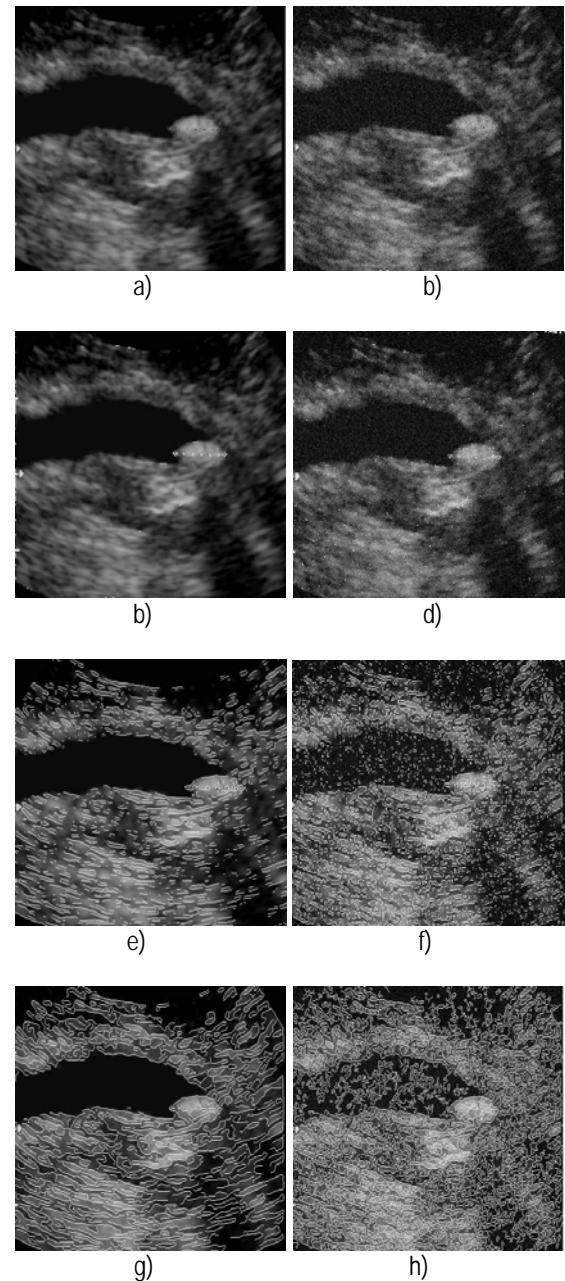**Fig. 8.** The original US Image

Fig. 9. US ROI Images: a) original; b) noised; c) original image by processing with Sobel operator; d) noised image by processing with Sobel operator; e) original image by processing with Zerocross operator; f) noised image by processing with Zerocross operator; g) original image by processing with Canny operator; h) noised image by processing with Canny operator

4. CONCLUSION

In the paper is presented a GUI for edge detection in medical images. It uses MATLAB defined function and works in MATLAB 6.5 environment. The pre-processing can realize a contour segmentation by using of different classical type of edge detection operators and its parameters. The GUI can be used in engineering education for studying this process. It can be used also in real time to pro-

vide important anatomical information in medical images to physicians and specialist upon which can be made diagnoses of different diseases.

References

[1]   M. Smith, A. Docef, "Transforms in telemedicine applications", Kluwer Academic Publishers, 1999.

[2]   R.M.Haralik, "Digital step edges from zero crossing of second directional derivatives", IEEE trans. Pattern Anal. Machine Intell., Vol.PAMI-6,No.1, pp.58-68, 1984

[3]   J.Canny," A computational approach to edge detection", IEEE trans. Pattern Anal. Machine Intell., Vol.PAMI-8, pp.679-698, 1986

[4]   R.Gonzalez, R. Woods, Digital Image Processing, Addison Wesley Publishing, 1992.

[5]   W.Pratt, Digital Image Processing. New York: John Wiley and Sons, 2001

[6]   MATLAB, User's Guide, www.mathwork.com