An interactive Matlab interface for manual dermoscopic image analysis

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Abstract

Dermoscopy is a non-invasive diagnostic technique for the *in vivo* observation of pigmented skin lesions. In the last few years, several computer-aided diagnosis systems of digital dermoscopic images have been introduced in order to assist the clinical evaluation of dermatologists. These systems must be tested and validated through a ground-truth database of manually segmented images.

Therefore, in this paper, we present a graphical user interface for computer-aided manual segmentation of dermoscopic images. This tool allows building up a reliable ground truth database of manually segmented images. Besides the manual segmentation of the lesion, this tool also allows performing the segmentation of other specific regions of interest, which are essential for the development of newly computer-aided diagnosis systems.

1 Introduction

Dermoscopy (dermatoscopy, skin surface microscopy) is a non-invasive technique for the observation of pigmented skin lesions, allowing a better visualization of the surface and subsurface structures, and the recognition of morphologic structures not visible by the naked eye [1].

The dermoscopic diagnosis of pigmented skin lesions is currently performed by trained dermatologists based on a set on pattern analysis criteria such as the ABCD rule or the seven point check list. Both approaches involve a visual analysis of the skin lesion in which the lesions are evaluated according to several properties, such as the asymmetry, the border irregularity, the color, the diameter, and the presence of atypical vascular pattern or irregular diffuse pigmentation [1, 3].

Currently, there is a great interest in the development of computer-aided diagnosis systems that can assist the clinical evaluation of dermatologists, since the interpretation of dermoscopic images is time consuming and subjective (even for trained dermatologists), and also to reduce the learning-curve of non-expert dermatologists. The standard approach in automatic dermoscopic image analysis has usually three stages: (i) image segmentation, (ii) feature extraction and feature selection, (iii) lesion classification [2].

The validation of these algorithms requires a ground-truth database of manually segmented images. Therefore, this situation calls up for the development of new tools that can support the manual segmentation, making this task easier and faster to the dermatologists.

The tool presented in this paper is a preliminary version. Its final version will allow building up a reliable ground truth database of manually segmented images to be used with multiple purposes. Among these are the assessment of the accuracy of newly developed automatic segmentation methods, as well as the use in medical training. Besides the identification of the lesion borders, this tool also allows marking other specific regions of interest, such as regions with different colors, typical or atypical vascular networks, dots, globules, star burst patterns, etc, whose recognition is crucial for skin lesion classification.

This tool has some advantages with respect to other existing annotation tools, namely better freehand drawing and boundary reshaping functionalities.

2 INTERFACE DESCRIPTION

This application allows performing the manual segmentation of dermoscopic images and storing the result of segmentation. For this, the user has a set of tools to be used sequentially to achieve the desired result.

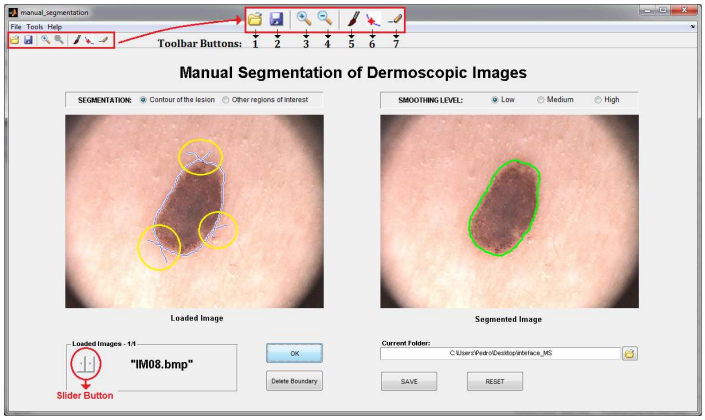

Figure 1: **Image on the left:** initial contour drawn by the user, with some undesirable extra lines (marked with circles). **Image on the right:** final contour after morphological filtering. Note that the final contour is smoother than the initial and without undesirable extra lines. **Toolbar Buttons:** 1-"Load Images"; 2-"Save as"; 3-"Zoom in"; 4-"Zoom out"; 5-"Manual segmentation"; 6-"Pointwise boundary reshaping"; 7-"Local boundary reshaping".

The main functionalities of this interface are:

- Image upload and display
- Manual segmentation
- Boundary reshaping
- Storage of segmented image

The interface was implemented in a MATLAB environment (7.9.0 R2009b) because of its image processing toolbox and graphical facilities.

2.1 *Image upload and display*

With this application it is possible to open one image or several images at once. For this, it is necessary to select the option "Load images" in the "File" menu, or simply press the button 1 on the toolbar, Figure 1. Then a dialog box appears that enables the user to browse and select the image to be segmented. To open multiple images, simply press CTRL key and select the desired images.

The loaded image is displayed on the left side of the interface. If several images have been loaded, the user can easily change the image that is being displayed through the slider button, Figure 1.

2.2 *Manual Segmentation*

In order to perform the manual segmentation, this application allows to draw a freehand region of interest on the loaded image. It is important to note that the manual segmentation can be performed using a pen tablet or a mouse. The user can choose between performing the manual segmentation of the lesion or other regions of interest through the radio buttons on the panel "Segmentation".

To achieve the manual segmentation it is necessary to select in the "Tools" menu the option "Manual Segmentation", or simply press button

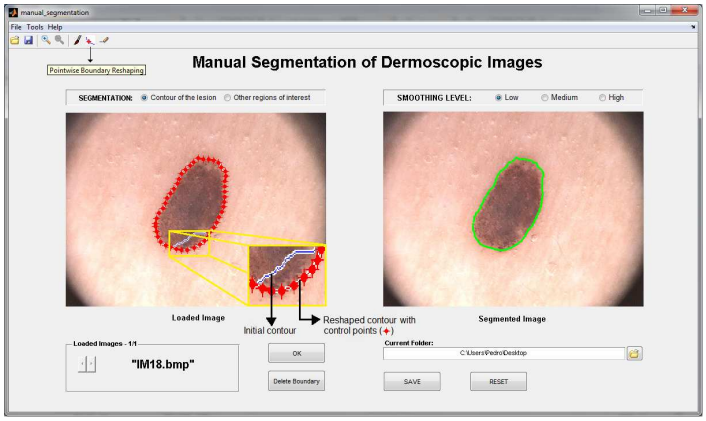

Figure 2: **Image on the left:** Initial contour (solid line) and the reshaped contour (with control points). **Image on the right:** final contour.

5 on the toolbar, Figure 1. Then, the user must click and drag the pen tablet to draw the contour of the lesion (or the contour of other regions of interest).

When the user confirms the segmentation, the image with the final contour is displayed on the right side of the interface, Figure 1. Note that the user can only confirm and complete the segmentation when a closed contour is drawn. When the user lifts the pen from the tablet before closing the contour, the contour remains open. However, while the contour is open the user has the possibility of drawing until he/she completes and closes it.

To our knowledge other available manual segmentation tools, such as ImageJ, do not have this possibility, since when the drawing is interrupted the contour is automatically closed with a straight line between the beginning and the end point.

To obtain the final contour from the initial one (drawn by user), a binary mask of the initial contour is first created, and then a morphological filtering is applied to this binary mask. The purpose of morphological filtering is smoothing and removing extra lines that do not belong to the contour. These lines may arise when the contour is drawn by means of multiple segments, especially at the points of intersection of these segments, Figure 1.

Basically, morphological filtering is divided into three stages (i) morphological erosion; (ii) selection of the biggest binary object from the image and (iii) morphological dilation. The user also has the possibility to select the degree of smoothing between low, medium and high.

The manual segmentation of other regions of interest can be done in a very similar way to the manual segmentation of the lesion. The main difference is that the contours of all segmented regions are shown on the same image with a different color. For this purpose, the user must select the "Other regions of interest" radio button in the panel "Segmentation".

2.3 *Boundary reshaping*

Even after finishing the manual segmentation it is possible to make some adjustments in the contour, if necessary. Two distinct methods were implemented to reshape the contour previously done, namely "Pointwise boundary reshaping" and "Local boundary reshaping".

To our knowledge other available manual annotation tools, for instance ImageJ, do not offer this possibility.

2.3.1 *Pointwise boundary reshaping*

This method must be used to make small adjustments in the contour, because the reshaping is done point-by-point. For this the user must select the option "Pointwise Boundary Reshaping" in the "Tools" menu, or simply press button 6 on the toolbar, Figure 1. Forthwith the boundary turns red with some control points. From these points it is possible to change the shape of the contour. For this, the user must click and drag the control points to their new positions, Figure 2.

2.3.2 *Local boundary reshaping*

Local boundary reshaping must be used when it is necessary to make great adjustments to the initial contour. For this, the user must select the option

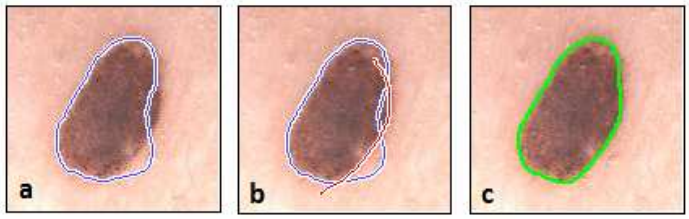

Figure 3: Local boundary reshaping: Initial contour (a), Initial contour and a new line to reshape the contour (b) and Final contour (c).

"Local Boundary Reshaping" in the "Tools" menu, or simply press button 7 on the toolbar, Figure 1.

Basically, this method allows the user to draw a line to define the new shape of the contour. The line must intersect the initial contour at least in two points to form a closed contour. This can be used to increase or reduce the size of the initial contour. Note that it is possible to increase and reduce the size of the contour with a single line, Figure 3.

2.4 *Storage of segmented image*

Finally, this interface also allows storing the result of manual segmentation. The segmentation result is saved as a binary image, where pixels with intensity value of 1 correspond to the segmented object, while pixels with value 0 correspond to the background.

3 CONCLUSIONS

A graphical user interface was presented in this paper, for manual segmentation of dermoscopic images (that can easily be adapted to other medical images). This tool will allow constructing a ground truth database, in a very simple and fast way, to be used in the assessment of the automatic segmentation methods. Moreover, this tool also allows segmenting other specific regions of interest, whose recognition is essential in image classification and pattern recognition.

Besides the manual segmentation, one of the most interesting tool is the boundary reshaping, with which the user can correct the shape of the contour previously done. For this purpose, two distinct methods were implemented, namely "Pointwise boundary reshaping" and "Local boundary reshaping".

This prototype version was set up based on the requirements and suggestions of dermatologists and is currently under evaluation in clinical environment. Some suggestions, as future work, have already been made by clinicians. For instance: to include by default the possibility of labeling the different regions of interest.

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References

[1] G. Argenziano, H. Soyer, V. D. Giorgio, D. Piccolo, P. Carli, M. Delfino, A. Ferrari, R. Hofmann-Wellenhof, D. Massi, G. Mazzocchetti, M. Scalvenzi, and I. H.Wolf. Dermoscopy, an interactive atlas. EDRA Medical Publishing, 2000. [ONLINE]. Available at: `http://www.dermoscopy.org`.

[2] T. Mendonca, A. R. S. Marcal, A. Vieira, J. C. Nascimento, M. Silveira, J. S. Marques, and J. Rozeira. Comparison of segmentation methods for automatic diagnosis of dermoscopy images. *Proc. IEEE Int. Conf. Engineering in Medicine and Biology Society*, pages 6572–6575, 2007.

[3] M. Silveira, J. C. Nascimento, J. S. Marques, A. R. S. Marcal, T. Mendonca, S. Yamauchi, J.i Maeda, and J. Rozeira. Comparison of segmentation methods for melanoma diagnosis in dermoscopy images. *IEEE Journal of Selected Topics in Signal Processing*, 3(1), February 2009.