

An Approach to Edge Detection in Images of Skin Lesions by Chan-Vese Model

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Abstract—Nowadays there is a great interest in the application of computational systems for the analysis of skin lesions. These systems allow the dermatologist to prevent the development of malignant lesions. The development of the systems has occurred due to the increase of skin cancer cases. In the characterization of skin lesions it is necessary to segment the images accurately. Thus the features and edges information of the lesion can be extracted and used by a classifier or by a dermatologist for a better classification. When images are acquired in a non-systematic and non-controlled way there may be a segmentation problem. In this case the skin lesion of images can have different sizes and various type of noises, such as the hair. These factors can affect the detection of the lesion edges and complicate its characterization. One solution would be to apply a smoothing filter to reduce noise before the segmentation step. Segmentation techniques adapted to each type of image can be used to solve the problem of diversified images, such as images with different sizes lesions, reflexions and light intensities. In this paper is proposed a computational method to assist the dermatologists in the diagnosis of skin lesions by digital images. It was used the anisotropic diffusion technique for the preprocessing of the images in order to remove the noises. The Chan-Vese model was used to segment the lesions. The next step consists of the application of morphological filters to eliminate outside and inside noises from the object, that remained in the segmented images, and also to smooth their edges. This approach allowed to minimize noise problems and edge detection to different cases of skin lesions images, such as melanoma, melanocytic nevi and seborrheic keratosis. The segmentation achieved 94.36% of accuracy for the three types of skin lesions.

Keywords—*Skin Lesions; Anisotropic Diffusion Filter; Chan-Vese Model; Morphological Filters*.

I. INTRODUCTION

The appearance of skin cancer can happen for several reasons, one of them is excessive exposure to the sun, a preventive action against this situation is needed. However great attention should be given to nevi (moles), that are benign lesions, being 50% of melanoma cases derived from moles [22]. It is also important to know that melanoma can resemble a mole when in its initial state. Another benign lesion that is important to analyze is seborrheic keratosis. In some cases, the diagnosis of this lesion is confused with melanoma, so the differentiation of these two types of lesion is important.

Melanoma is the most aggressive skin cancer, because it has a high mortality rate. Nevertheless when it is diagnosed early and treated properly, the cure of patients with this type of cancer can reach 69% of world average [6]. The increase in cancer cases has motivated the research and development of computational methods to assist dermatologists in the diagnosis of skin lesions. The goal is to analyze the benign lesions to prevent their development, or diagnose malignant lesions at their early stage, so they can be treated early and increase the chances of a cure.

A problem in the skin lesions segmentation step is influence of noises, such as hairs, that could impede the lesions segmentation. Another problem is the heterogeneity of database images that can decrease the efficiency of the used segmentation method. The smoothing technique is important to minimize the problem of noises in the images. In the case of heterogeneity of the database images, the use of a segmentation technique is very important to enable the efficiency of edges detection. It allows the adaptation to the problem of each individual image, such as images with different sizes lesions, reflexions and light intensities. The approach proposed in this paper to solve the presented segmentation problems is based on anisotropic diffusion technique [3] which reduce the effect of noises on the images and active contour model without edges (Chan-Vese model) [7] to identify the diseased area. This model is derived from a compilation of two techniques: the Mumford-Shah region growing technique, used to segment the images; and also the Level Set Active Contour Model, which allows topological change of the curves, used to edge detection. The use of these techniques is subject of several papers for edge detection of skin lesions [1, 2, 4, 21, 24, 25].

The objective of this paper is focused on the development of a method for edge detection of skin lesions, such as, melanoma, melanocytic nevus and seborrheic keratosis, from photographic images to assist dermatologists in their diagnoses. It is expected that this approach allows an accurate detection for most lesions and thereby the edge information can be made available to the dermatologist or use by a classifier.

The second section discusses some papers related to the theme. The third section explores the proposed method. The fourth section is a discussion of the results obtained. In the fifth section presents a conclusion of the approach developed and future work.

II. LITERATURE REVIEW

Considering the importance of early diagnosis of skin lesions there are several papers that propose automatic methods to assist dermatologists in their diagnoses. These papers show digital image processing techniques to segment different skin lesion types.

Beuren and collaborators [5] propose a morphological approach to melanoma image segmentation. The filtering of images is started by applying a morphological opening process, to eliminate the hairs and others noises. Subsequently it is applied a global thresholding, where filtered images by color are binarized. The binary opening filter is used to fill gaps in the segmenting region and remove the external noises. This paper evaluates segmentation of 200 benign and malignant lesions images. They obtained 95.26% of accuracy for benign lesions and 92.62% for malignant lesions.

A method for edge detection in dermoscopic images of melanocytic and non-melanocytic lesions is proposed by Norton et al [17]. In this paper was carried out two segmentation: general lesion segmentation and the bright region segmentation. The general lesion segmentation is performed in three steps: I) segmentation of tumor area, II) correction of non-uniform lighting and III) noise reduction. For general lesion segmentation they used thresholding and to bright region segmentation, correction of lighting and noise reduction was applied morphological operators. The evaluation of this method was based on the accuracy with 84.5% for 107 images of non-melanocytic lesions and 93.9% for 319 images of melanocytic lesions.

Cudek et. al. [8] provide a method for identifying skin lesions from digital images using the ABCD rule. They used 53 images of skin lesions, which were rotated 90, 180 and 270 degree, forming a database of 212 images, which include benign nevi, blue nevi, suspicious nevi (dysplastic) and melanoma, which were transformed into gray levels. The technique of histogram equalization is used to enhance the contrast of images, and the median filter was applied to the to decrease the noise. A modification of the Otsu [19] threshold was proposed for segmentation of the skin lesions, because it was examined that this method may, in some cases, ignore regions that compose the lesion. Thus, to solve this problem it was proposed SD (Small Difference), to search pixels in the neighborhood that can be classified as regions of the lesion. The proposed segmentation obtained 92% of correct detection. In 5% of the images it was necessary to manually enter the threshold and in 3% of cases was incorrect recognition was observed.

III. METHODOLOGY

This section presents the developed approach for edges of skin lesions detection, in order to assist dermatologists in their diagnosis. The structure of the method can be seen in Fig. 1.

The method has the following processing steps: image acquisition, preprocessing, segmentation, post-processing images. Firstly images are acquired to compose the image database. The second step of the proposed method consists in the smoothing of the images using anisotropic diffusion filter to remove noise, which interfere with the following technique,

the image segmentation. Subsequently the segmentation is performed using the active contour model without edges, Chan-Vese model, to detect the lesion. Finally, morphological filters are applied in the segmented images to soften the edge and remove noise resulting from the process of segmentation.

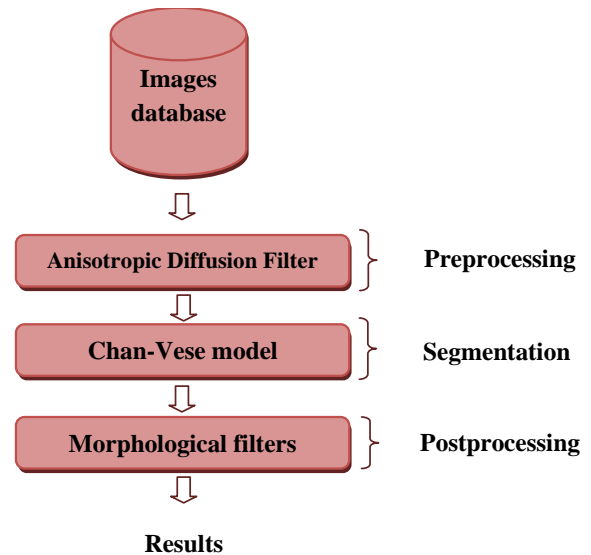


Fig. 1. Developed approach structure.

A. Image database

The first step of the developed method was image acquisition to form an image database of skin lesions, used for testing. The database of this paper consists of images of the following bases: Loyola University Chicago [15] YSP Dermatology Image Database [10], DermAtlas [9] DermIS [11] Saúde Total [22], Skin Cancer Guide [23] and Dermnet - Skin Disease Atlas [12, 13].

The database used in this paper consists of 408 images, 62 melanocytic nevi images, 86 seborrheic keratosis images and 260 melanoma images. The high amount of melanoma images arises due to the raised concern with this type of lesion, which is carcinogenic and has a high mortality rate. The dimensions of the images of the database is 200×200 pixels. Examples of each of these types of skin lesion are shown in Fig 2.

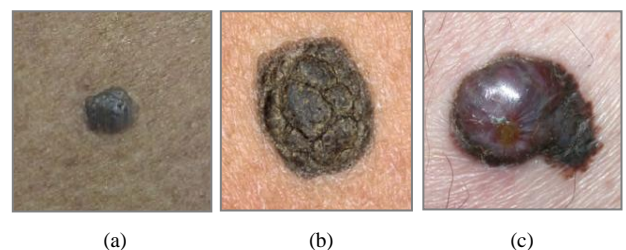


Fig. 2. Images database: (a) melanocytic nevi, (b) seborrheic keratosis and (c) Melanoma.

B. Preprocessing

In this step it was applied a smoothing technique in the database images, in order to soften the effects of noise, which may hinder the segmentation result. The nonlinear filter used to

smooth was the anisotropic diffusion, as proposed by Barcelos, Bonaventure and Silva [3]. This filter was chosen because of its good result in images smoothing and preservation the edges of the skin lesions [4]. Since one of the characteristics analyzed for the diagnosis of skin lesions is the irregularity of the edges, this filter proves to be an efficient technique to smooth the images.

The segmentation method used in this paper is applied to images in gray levels. Thus, the colored original images are converted to gray levels. Thus, the processing time is decreased since it is not necessary to smooth the three RGB components separately. The images are smoothed by anisotropic diffusion method.

The implementation of this filter is based on (1):

$$u_t = g |\nabla u| \operatorname{div} \left(\frac{\nabla u}{|\nabla u|} \right) - \lambda (1 - g)(u - I) \quad (1)$$

$$g = \frac{1}{1+k|\nabla(G_\sigma * u)|^2} \quad (2)$$

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (3)$$

where $u(x, y, 0) = I(x, y)$; u is the smoothed image; I is the original image; $t > 0$ is the smoothing scale; div is the divergence operator; ∇u is the gradient value of u ; λ is a parameter which assist in the speed of diffusion.

The term g presented in (1) is defined in (2). The term g is used for edge detection, where k is a parameter, the term G_σ is the Gaussian function that it is presented in (3) and σ is the standard deviation of G_σ . Considering a neighborhood of a point x , when the gradient ∇ has a low average, ie, there are few points (noise) in the image, the x is considered an interior point (homogeneous region) resulting in $g \sim 1$. But, if the gradient ∇ has a high average, having several points, x will be a point of a contour, $g \sim 0$.

C. Segmentation

Skin lesions segmentation is used to separate the diseased area of the healthy region, which promotes the detection of the lesion. The technique used for segmentation of the images in this paper was the active contour model without edges proposed by Chan and Vese [7] Thus, this method was applied for images in gray levels. This method is performed by energy minimization of the curve over the image. The segmentation of this model is based on region and uses the concepts of Mumford-Shah techniques [16], commonly used in image segmentation tasks. The segmentation of the model is also based in the concepts of level set active contour model [18], which allows topological changes applied on the input images. The Chan-Vese model is applied as follows:

$$F(c_1, c_2, \phi) = \mu \int_{\Omega} \delta(\phi(x, y)) |\nabla \phi(x, y)| dx dy \quad (4)$$

$$+ \nu \int_{\Omega} H(\phi(x, y)) dx dy \quad (5)$$

$$+ \lambda_1 \int_{\Omega} |u_0(x, y) - c_1|^2 H(\phi(x, y)) dx dy \quad (6)$$

$$+ \lambda_2 \int_{\Omega} |u_0(x, y) - c_2|^2 (1 - H(\phi(x, y))) dx dy \quad (7)$$

where having as fixed parameters $\mu, \nu \geq 0$ and λ_1 and $\lambda_2 > 0$ and the term u_0 is smoothed image. The constants c_1 e c_2 are the average image u_0 inside the curve C and the average outside of the curve C , respectively. that assist each term in its results, are expressed by:

$$c_1(\phi) = \frac{\int_{\Omega} u_0(x, y) H(\phi(x, y)) dx dy}{\int_{\Omega} H(\phi(x, y)) dx dy} \quad (8)$$

$$c_2(\phi) = \frac{\int_{\Omega} u_0(x, y) (1 - H(\phi(x, y))) dx dy}{\int_{\Omega} (1 - H(\phi(x, y))) dx dy} \quad (9)$$

where H e δ are the Dirac and Heaviside function, respectively, to obtain the level set energy function $F(c_1, c_2, \phi)$ [18].

There are several advantages of this method, which allows its use to provide good results. It allows the detection of different objects with different intensities and also with blurred boundaries; it allows the curve topological change; it allows object detection where the contour has no gradient, due to the stop criteria of the curve evolution until the desired boundary not depending on the image gradient; and it allows objects detection in noisy images [7].

The first stage of segmentation using the Chan-Vese model is the definition of a curve over the image, which will be minimized to the border of the object. This model has features like the ability to place the curve anywhere on the image, representing it in various forms and different sizes.

In this paper the initial shape of the curve was a square and it was positioned close to the image center, so a small number of iterations are performed for the curve involve lesion which reduces the processing time. Initially, the curve was defined as 140×140 pixels, whereas most images, approximately 64% are composed of larger lesions, in other words, they represent a large number of pixels. This tends to occur when the distance at the acquisition time is very close to the lesion. However, we observed that closer the curve better the results and lesion detection. Moreover smaller is the chance to find false edges, such as those caused by reflections and shadows. Therefore, considering the significant amount of small lesions, it was necessary to define a smaller curve for small lesions and a bigger curve for large lesions. Two curves were established with different sizes: 40×40 pixels and 140×140 pixel to put them over small and large lesions, respectively. The definition of the size of the curve should be informed by the user as needed.

With the intention of automating the definition of the curve for the segmentation process by Chan-Vese model, a method was analyzed to establish the curve according to the size of the lesion.

For the definition of the threshold that is used to establish the curve, we considered only images composed by small lesions, in which the use of the curve with size 40×40 pixels obtained better results by applying the Chan-Vese model. Firstly, it is made to count only those pixels that are part of the lesion from the segmented image, ie, the black pixels. After this step, the average and the standard deviation of the pixels pertaining to all images of small lesions is calculated. The sum of the average with standard deviation define the threshold (L). The threshold enables to differentiate the small lesions in the large segmented images. Considering the dimensions of the images of the database 200×200 pixels, the images are composed of 40,000 pixels. The result of the threshold was 6345 pixels, which represents the amount of pixels comprising the images with small lesions.

Considering the definition of the threshold by analysis of manual segmentation using the Chan-Vese model, it was possible to automate the definition of the curve for images segmentation. So, the thresholding technique is applied, by the method Otsu [19]. For each binarized image is counted the number of pixels (TP) corresponding to the lesion. For the definition of the curve it is analyzed the threshold. If the total number of pixels is less than or equal to the threshold ($TP \leq L$), the curve defined over the lesion is small, 40×40 pixels. If the value is greater than the threshold ($TP > L$), the curve will be large, 140×140 pixels, for the application of the Chan-Vese model.

D. Postprocessing

After performing the segmentation step by Chan-Vese model, the morphological filters was applied on the binarized images. The use of filters eliminates inside and outside noise from the segmented regions. These noises, such reflexes, can cause the definition of the false border by the segmentation method.

The filters used in this paper were "opening filters" and "closing filters" [14]. The structuring element has the shape of ellipse, the two radiuses are equal to four. The filter application allowed to smooth the edge and eliminate internal or external noises of the lesion.

IV. RESULTS AND DISCUSSIONS

The goal of the tests is to evaluate the approach of the method for edge detection of skin lesions, which will assist the dermatologist in their diagnosis. All database images were used to evaluate results. In this stage were applied the anisotropic diffusion technique to smooth images and Chan-Vese model for the segmentation of skin lesions. The contours established by the method were evaluated visually by dermatologist Dr. Ricardo Rossetti Baccaro.

A. Anisotropic diffusion

The implementation of this filter was based on the discretization of (1), which has the following parameters: Δt determines the size of the temporal evolution, wherein each iteration of the diffusion will be executed; and the parameter σ is the standard deviation of the Gaussian function G_σ ; the parameter λ assist reinforce the edge; k assist the Gaussian function to define if the point is part of the edge or not. If it is

the edge point, this point will be less smoothed. This smoothing will be in accordance with the number of iterations NI .

The result of applying this filter can be seen in Fig. 3. The parameters were determined by tests, considering the parameters already defined in the paper [4], with the following values $\Delta t = 0.1$, $\sigma = 1$, $\lambda = 1$, $k = 0.0008$ and $NI = 100$.

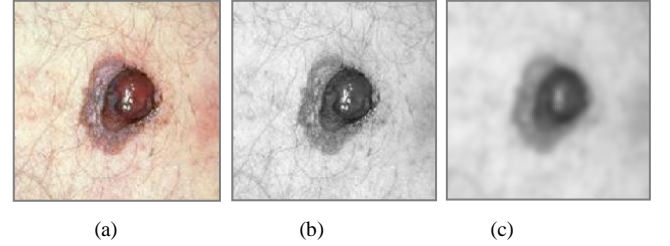


Fig. 3. Result of applying the anisotropic diffusion filter. In (a) original image, (b) gray levels image and (c) smoothed image.

The original image (a) of Fig. 3 is converted to gray level image, which can be seen in the image (b). In (c) we have gray levels image, smoothed by anisotropic diffusion filter. We can see that the filter removed the presence of hairs in the images, yielding promising results. In the case of images having shadows or reflections areas, as in this case, the filter did not permit to eliminate influences thereof, although their presence was ameliorated.

B. Chan-Vese model

In the application of the Chan-Vese model the discretization of (4) is used for the evolution of the curve. In which the parameters were defined by tests, considering the parameters already defined in the paper [7]:

- $\mu = 0.2$, parameter that controls the length of the curve;
- $\nu = 0$, influence in the area inside the curve;
- $\lambda_1 \text{ e } \lambda_2 = 1$, assists in locating the object inside and outside the curve respectively;
- $h = 1$, assists in detection of inner contour;
- $\Delta t = 0.1$, is the time of evolution of the curve.

500 iterations were applied to the evolution of the curve, in other words, the minimization of the curve occur until the number of defined iterations or when the curve is located on the object. In Fig. 4 is shown the result of applying the Chan-Vese model from smoothed image (b), that allowed the image to be binarized, as it can be seen in the image (c).

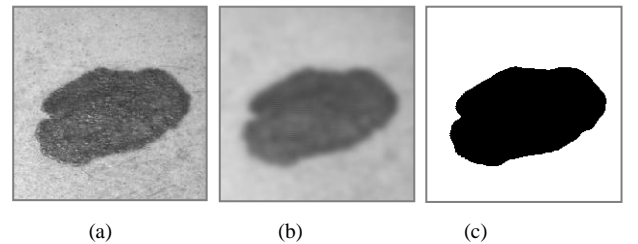


Fig. 4. Result of applying the Chan-Vese model. In (a) gray levels image, (b) smoothed image and (c) binarized image.

Some images resulting from the segmentation process present: holes inside of the lesion area and the outside noise, caused by reflections, shadows or some other noises that were not eliminated in the step of smoothing. These factors are addressed in the next step of post-processing of images.

C. Morphological filters

In (c) of Fig. 5 can be seen the effect of the application of morphological filters resulting from "opening" followed by "closing" the segmented image (b) by Chan-Vese model. We can see that the lesion holes of the image (b) were eliminated and it also softened the edge without losing its features.

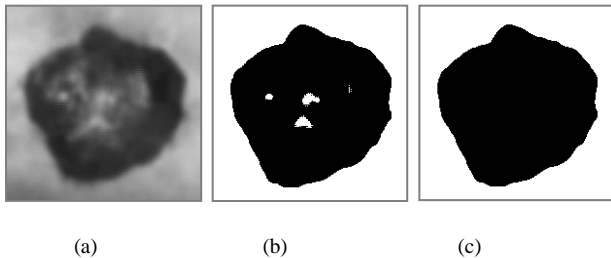


Fig. 5. Application of morphological filters. In (a) smoothed image, (b) binarized image and postprocessed image.

D. Edge detection

After performed post-processing step in the skin lesion images, its edge is defined. The edge represents the boundary and irregularities lesion, allowed the separation of the diseased region from the healthy region.

The edge is define by pixels where sudden changes occur in the intensity of binarized images. In this paper the lesions are represented by black color and the skin are represented by white color. Scanning the image pixel by pixel, when there is a change in color, the pixel at the same position in the original image receives white color to define the edge of lesion.

In order to obtain a result that best represents the edges of the lesion, tests were conducted to evaluate two techniques for skin lesions segmentation: the thresholding and the Chan-Vese model. Both techniques were applied to the smoothed images by anisotropic diffusion. Then it was defined the edges of the lesions from the postprocessed images by morphological filters.

The image segmentation by thresholding technique is applied by OTSU threshold [19]. The lower intensities of the threshold are defined by "0" to represent the lesion. Whereas, greater intensities of the threshold receive "1" to represent the skin. In the case of segmentation by Chan-Vese model, it was used the same parameters mentioned above for the evolution of the curve. The curve is established depending on the size of the lesion. If the lesion is small, the size of the curve is defined by 40×40 pixels, and if the lesion is big, the curve is defined by 140×140 pixels. The proposed method for automating the definition of the curve also was evaluated. This method utilizes the amount of pixels that composes the lesion returned by thresholding method to define the size of the curve based on a threshold. The threshold is established by mean and standard deviation of points belonging to the lesion, that were

returned by application of the most appropriate Chan-Vese model to the large and small images.

In Fig. 6 is showed the results of the three segmentation methods in the original image (a). The segmentation result using thresholding technique is presented in the image (b), the result of applying the Chan-Vese model can be seen in the image (c) and in (d) the contour was obtained by using the automating method for definition of the curve by Chan-Vese model. We can observe in the image (c), where it was applied the Chan-Vese model, that the edge surrounded better the lesion than in the image (b) obtained by thresholding technique. Some regions of the lesion in the image (b), were not completely detected. In the case of image (d), the result was the same as the edge of the image (c), since the same size was determined to the curve by automated method, using Chan-Vese model.

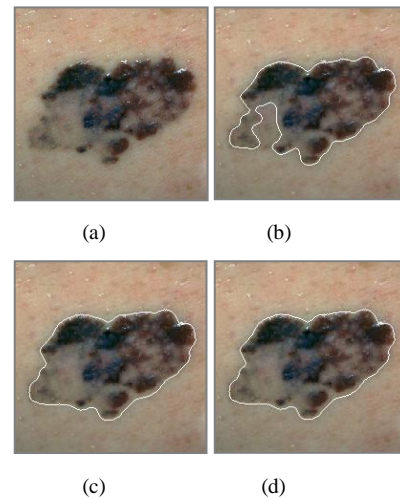


Fig. 6. Results of segmentation methods. In (a) original image, (b) result using thresholding technique, (c) result using Chan-Vese model and (d) result using the automating method for definition of the curve by Chan-Vese model.

The results of the Chan-Vese model surrounded better the regions with intensities closer to skin color than the thresholding technique. In some cases, the method for establishing an automatic curve does not detect correctly the lesions due to the wrong definition of the size of the curve. For example, when the curve should be smaller, 40×40 , the amount of pixel that comprises the lesion obtained by thresholding method was greater than the threshold. For this reason, there are cases in which correctly detects the lesion, but also identified other regions, due to the size of the curve.

For very noisy images, Chan-Vese model also achieved good results with the influence of the anisotropic diffusion filter, unlike the results of applying thresholding technique with which most lesions were not detected (Fig.7).

The images that have some regions of the skin such as redness, shadow and reflection, can influence the detection of the edges of the lesion. In such cases the regions are regarded as belonging to the lesion by thresholding technique, unlike the Chan-Vese model which detected only the skin lesion.

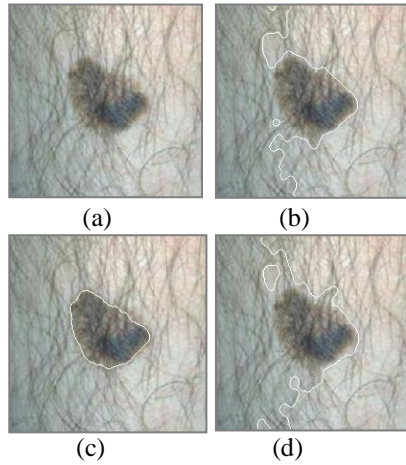


Fig. 7. Segmentation of noisy images. In (a) original image, (b) result using thresholding technique, (c) result using Chan-Vese model and (d) result using the automating method for definition of the curve by Chan-Vese model.

We evaluated the results based on all images of database: 62 melanocytic nevi, 86 seborrheic keratosis and 260 melanoma. The images were analyzed by an expert to identify if the skin lesion edge was detected or was not detected by segmentation techniques: thresholding, Chan-Vese model and also with the application of the automatic curve. The lesions were considered detected by dermatologist in the cases where the lesion have been fully engaged by the edge.

According to the results shown in Fig 8, the application of Chan-Vese model gave best results for the segmentation of skin lesions than the other techniques also analyzed. This model allowed to correctly detect 94.36% of the images. The thresholding technique had the least significant result, with 80.39% of the images correctly detecting the edge of the skin lesions. This result occurred due to the difficulties in the segmentation of images with noise, such as shadows, even though using the anisotropic diffusion smoothing method,

The proposed method to define a automatic curve in the segmentation by Chan-Vese model, achieved a better result than the threshold technique. Approximately 14% of the images were not detected due to incorrect setting of the size of the curve, which is based on the thresholding technique. This problem usually happen when the lesions are considered small which requires a small curve for its detection. In these cases it is defined a large curve because the thresholding method does not correctly detect the lesion which determines a large area in the segmented images. This large area becomes greater than the threshold needed to establish a small curve in the image.

The incorrect definition of the curve, caused error in the segmentation of certain images, not allowing proper detection of the edges lesions, due to the lower number of iterations for this type of situation. For this case, the minimization of the curve require more iterations and could also detect other false objects in the image due its proximity to the curve.

The seborrheic keratosis lesions type present higher detection errors, due to similar colors between the lesions and the skin, which make the lesions difficult to detect. Another examples where the lesions are not detected, where the images where reflections and shadows were not eliminated in preprocessing.

The proposed method proved to be a promising technique for images with many hairs and intensities near of skin color. In some images were there found a few false edges, due to some stains or noises, when those were not completely eliminated by the smoothing filter.

The papers discussed previously [5, 8, 17], which apply the segmentation by thresholding techniques and the results of this study using the Chan-Vese model are shown in Table I. It is also presented the references of papers, years of their publications, methods of segmentation, types of lesions addressed and their accuracy, respectively.

TABLE I. RESULTS OF PAPERS FOR SEGMENTATIONS SKIN LESIONS.

Source	Year	Segmentation	Images	Accuracy
Proposed approach	2012	Chan-Vese model	Melanocytic nevus	96.77%
			Seborrheic keratosis	93.02%
			Melanoma	94.23%
[5]	2011	Thresholding	Benign lesions	95.26%
			Malignant lesions	92.62%
[17]	2010	Thresholding	Non-melanocytic lesions	84.5%
			Melanocytic lesions	93.9%
[8]	2010	Thresholding	Benign and malignant lesions	92%

In the first paper [5] the authors obtained 95.26% of accuracy for benign lesions and 92.62% of accuracy for malign lesions. For the second study [17], the authors segmented the melanocytic and non-melanocytic lesions, which received 84.5% and 93.9% of accuracy, respectively. In the third study [8], the authors evaluate the accuracy for benign and malignant lesions, and obtained 92% accuracy considering the two classes. In this paper, the proposed method achieved 96.77% of accuracy in segmentation melanocytic nevi, 93.03% of accuracy for the class of seborrheic keratosis and 94.23% of accuracy for the class of melanoma.

It was impossible to perform a comparison between the different studies because of several factors. The images database used in which study were different, the addressed skin lesions were not of the same type as well as the application of the segmentation techniques which was shown to be also different.

The results presented in this study show that the developed method achieved promising results in segmentation through the Chan-Vese model for skin lesions of melanocytic nevus, seborrheic keratosis and melanoma types.

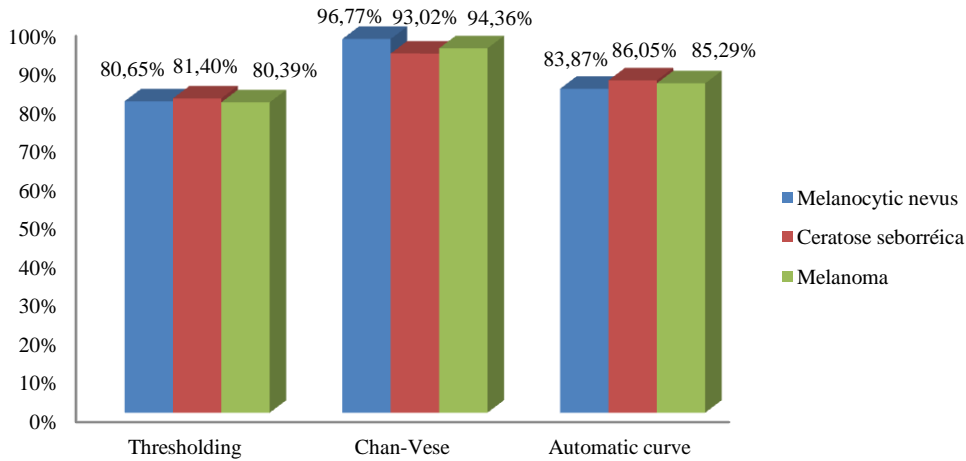


Fig. 8. Comparison of segmentation methods.

V. CONCLUSIONS AND FUTURE WORK

This paper presented a method for edge detection of skin lesions, using the Chan-Vese model to provide information about the edges of the skin lesions, in order to assist the dermatologist in his diagnosis. To minimize the presence of noise on the images was used the anisotropic diffusion non-linear filter. The active contour model without edges was applied in order to establish a better edge to the lesion.

The application of anisotropic diffusion filter was held to smooth images without losing the rough edge. The noises were partially eliminated, except in cases with presence of reflections and shadows. This filter was essential to obtain a better segmentation of images with many hairs.

The segmentation of images through the active contour model without edges (Chan-Vese) allowed to locate most images with regions close to the skin color and also very noisy images, such as the scalp. Using the same model, in the case of composed images of a large area of shadow or reflection inside the lesion area or over border, it was not possible to detect the edge of lesions in some of these images or they were not defined correctly.

Due to the lesions different size on the images, ie, according to their proximity in time of acquisition, the definition of the curve on the image, applying the Chan-Vese model, establishes the accuracy detection of the lesions border. Better results are obtained with curves closer the lesion, thus the lesion is detected quickly and decreases the possibility of detecting false edges, such as those caused by reflections. Therefore, the definition of a curve of 140×140 for larger lesions and of 40×40 for small lesions is important since it will influence the results for detected lesions. It can be considered another method to define a ideal curve for the segmentation of a specific lesion, such as using another technique for the establishment of an initial contour nearest the shape and size of each lesion.

The use of morphological filters gave a better definition of the lesion, because allowed the treatment of segmented images, with the presence of external noise, interior holes as well as irregular edges. For some images, the application of this filter, did not allowed the correct elimination of external noise neither large inner holes. This was not possible since it can not be defined an element structure too large because of the subsequent harm of the irregular border.

The method developed in this paper allowed the segmentation and definition of the edge of the skin lesions. Considering the visual analysis performed by a dermatologist, the method obtained 94.36% of accuracy. Through the Chan-Vese model, the methodology proposed showed promising results on the detection of skin lesions edge. Information obtained by this method can be available to the dermatologist in order to assist him in the diagnosis of skin lesions.

The assessments made by the dermatologist to evaluate the results of segmentation can influence the final results of the detection if they are evaluated by another experts. The proposed method may achieve more significant results of those presented in this study, with the improvement of these techniques used to solve the encountered problems, such as the heterogeneity of the base images.

Having in account the need to improve the encountered problems and the possibility of continued development of the method, the following tasks can be analyzed for the progression of the methods related to detection and classification of medical images: study or development of methods that treat reflections and shadows, without restricting the acquisition of images, allowing acquire images even by mobile devices, which have good image quality; consider a method to define a curve next to the lesion, so it can be detect quickly and accurately by use of the Chan-Vese model; analyze other segmentation technique such as the use of fuzzy logic to be compared with the Chan-Vese model; finally use other types of skin lesions.

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