A new method of image segmentation based on Snake model and topological alignments

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Abstract

In order to improve the accuracy of image edge detection, this paper proposes a novel image processing algorithm. This algorithm is based on the active contour method and topological alignments were combined with the method, the purpose is to improve the accuracy of image detection process. This algorithm presents a new technology to integrate topology route and the respective advantages of active contour method. Based on the topology of the initial route segmentation boundary as Snake model input signals, we gradually evolved into the final segmentation boundary. The experimental results show that the proposed algorithm can handle, the low contrast image and graphics unit, indicating that the weak edge image segmentation accuracy, can improve the accuracy of image detection technology.

Keywords

Image Segmentation; Snake Model; Topological Alignments; Boundary Detection; Segmentation Enhancement.

1. Introduction

Image segmentation is a very important procedure in the lots of multidimensional signal processing and related application technology. Image texture analysis is essential in a lot of assignments, such as: shape detection, scene analysis, and image processing. To determine the best location of image points in the process of image segmentation which is on the basis of the shape information. The algorithm based classifier has been applied to some organs in medical image detection, for example, heart image and brain image. Image segmentation belongs to the field of computer vision research. It is an implementation process to get the digital image divided into some special application and meaningful region. An important purpose in image segmentation process is to get the pixels of the image concentrated in the marked image region. It is a very important execution step in pattern recognition---a series of important process understanding of the image of the whole. The approach to establish the group possessing specific meaning region can be used to confirm the gray level, color, texture , shape and other properties of region and attributes similarity. The segmentation based on image measurement is gray level, color, texture, depth or scheme. Image segmentation applications include determining the object detection, including the object recognition using the size or scene shape of the object. To perform object recognition in motion scene based on video compression of objects. The object recognition performed at different distances is to use measurement of the depth of laser range finder senor to get the path planed of mobile robot.

Image segmentation techniques can be used for object recognition, block motion recognition, stereo system, image editing or image database query etc.

In the mathematical, the image named I is a group of pixel segmentation ,the image is divided n disjoint partitions by I,the set are R1,R2...RI,Rn,called segments or regions,and the calculation result of each region is equal to I: $I = R_1 \cup R_2 ..... \cup R_n$.

2. Related Works

It is very important to accurate image segmentation and boundary detection in the study of microscopic picture imaging. For example, the analysis of white blood cells image segmentation is an important basis for treatment and prevention of many common diseases, and it is also very important for understanding and successful treatment of inflammation. Sensitive trajectory tracking of mobile cells is important[1], and suitable for mathematical modeling of cell movement. Zimmer[2] modified active contour model to detect the mobility of the motor cells, and also provides initial segmentation of the first frame to deal with cell division.

Mukherjee[3] used traditional image level set to apply the threshold to decompose the calculation. At the same time, it is also used for issue tracking and image segmentation algorithm. Li [4] developed an image detection algorithm with two levels, a motion filter and a level set tracker for processing cell detection and cell migration. Coskun[5] used image data to solve the problem of anti-modeling, to determine the correlation cell mobility analysis. Some researchers recently attempted to create a fully automated algorithm to detection and tracking cells from microscopic picture, such as Melange [6], Mignotte[7], Krinidis[8].

This paper introduces the new technologies of image segmentation and cell edge detection.

3. Algorithm

Topology routes and Snake model have been applied to the image processing, especially in object boundary positioning, they have their own advantages and disadvantages. The active contour can position object boundary dynamically and automatically from the original contour. The main advantages of the active contour model is that additional processing is needless and describe piecewise linear case of the object's shape in the convergence time. However, active contour model depends largely on finding a good image gradient to derive contour profile. Because the weak image boundary frame and low contrast images automatic segmentation lack of accuracy, this situation will greatly limit their effect. In order to solve the problems in the process of using active contour model for image segmentation, this article uses topological route methods to improve performance of cell tracking image segmentation and increase accuracy of cell tracking the results. This method wants to contact between the segments of the next frame and each frame, reducing the probability of the false detection and false track .

This section presents the new algorithm based on topology routes and Snake model . This paper presents a new image segmentation and tracking system based on active contour model. This method need to combine the advantages of topology routes and Snake model to obtain more accurate tracking methods. This article introduces this tracking system to detect and analyze the mobility of active cells.

This method is divided into two steps: first, the initial segmentation of topological route method is used to improve cell tracking and segmentation performance and improve cell tracking results. In the second step, the output information is transformed into the input information, and the cell boundary evolution and analysing of cell fluidity are initiated.

We have tested this algorithm using images of human blood cells by using the greyscale images from Rodrigo 2007 (from CellAtlas.com reference library , open cell image database) . The proposed algorithm in this paper was realized on the Windows10 operating system, using C++ programming language, and the OpenCV library (Bradskiet [9]) was used in image processing.

3.1 Active Contour Model

The aim of this paper is to do image segmentation by puting the original outline into the interesting object boundaries . This is achieved by using a method to get the original image achieved variant , and this way can reduce the energy function at utmost. This way is defined as outline in the Kass [10], Ray [1], Zimmer [2] and Sacan [11]. Energy functional consists of two parts : the first part is the internal potential energy ,it is very small when the image edges coincide with contours ; the second part is the internal deformation energy, it is very small when contour smoothing . In the case of image

smoothing, termination function can realize the calculation of the gradient direction. The parameters of active contour model can be expressed as $v(s) = (x(s), y(s))$, in which the energy functional can be expressed as :

$$E = \int_0^1 E_{\text{int}}(v(s))ds + \int_0^1 E_{image}(v(s))ds + \int_0^1 E_{ext}(v(s))ds \quad (1)$$

Eint represents internal energy of curved sample, Eimage causes the image force , Eext generates external constraint forces . a (s) and B (s) control sample energy . Therefore, the internal energy of the sample can be expressed as :

$$E_{\text{int}} = \frac{(a(s)|v_s(s)|^2 + B(s)|V_{ss}(s)|^2)}{2} \quad (2)$$

The universal image energy can be expressed as a weighted combination form of three energy functions:

$$E_{image} = w_{line}E_{line} + w_{edge}E_{edge} + w_{term}E_{term} \quad (3)$$

Active contour model can be divided into two models: the regional base model and the edge area base model. The choice between the two models depends on the different image features, The main advantage of the active contour model is no additional processing. In the time of convergence, the segmentation of object shape can achieve linear description. But active contour model depends largely on finding strong image gradient to promote profile. Because the lack of accuracy caused by the weak image edge frame and low contrast images automatic segmentation, this greatly limits their role.

3.2 Topology Route Method

The method connects two consecutive frames in video sequence. Miura [12], Danuser [6], Zimmer [2] and Ersoy [13]. From the output of the segmentation process, the method finds the maximum weighted solutions between two frames and then matching the segment.

the method applies the index set $P = \{1,...,m\}$ and $Q = \{1,...,n\}$ to determines the segmentation of two images m and n.

This method assumes that the cells are properly moved between two consecutive frames , and the relative overlap between p and q is their right , formally defined as:

$$w(p,q) := |A(p) \cup A(q)| / |A(p) \cup A(q)| \quad (4)$$

Obtaining a relative overlapping sectional set, it is more likely to be considered as a unit. But combineing the relative overlap and zero overlap do not means to form a sectional set. According to these weights , we can determine concept of the topology route . We represent a set family which come from all L partitions of PL (M) of the finite set M and the set S represented, and the subset determination of L: $S = (S_1,...,S_L)$.

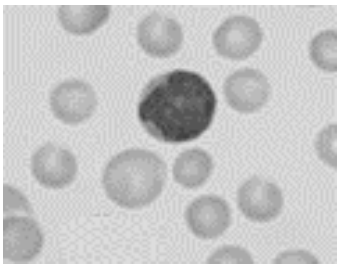
This allows us to state the route for finding these partitions S and T, and these partitions achieve maximize in the objective function. The method of topology route by explicitly considering (a segment completely covered two units) the divided inherent problems, improves the performance of the cell division tracking, also allows the detection performance of cell division. This method connects each frame and the next frame, and reduces some false detections and false trajectories .

4. Application of Image Segmentation Method

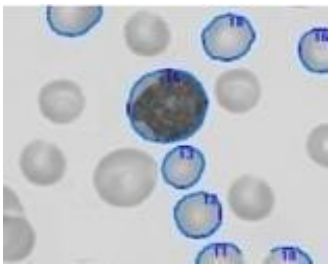
In order to obtain the validation of this method, we have used gray image of human blood cells from Rodrigo 2007(From CellAtlas.com1 reference library, open cell image database) to test this algorithm. In this paper, we used 70 kinds of images were tested. The OpenCV library (Bradskiet [9]) was used in image processing. Figure 1 expounded some of the segmentation results. In these results, the processing of original images which have an important contribution to the new technology, have

be defined as a better contrast, standardized image contour. So there is a better division of cellular images. The experimental results show that the proposed algorithm can improve the image superiority with a better and accurate segmentation to detect the effect of cell contour.

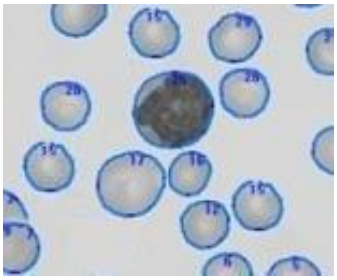
The experimental results show that the use of topology route can improve the segmentation performance and improve the cell detection results. According to the image segmentation effect from figure 1, the results of this study reveal a better and more accurate segmentation of white blood cell detection and the ability to improve the handing of low contrast image segmentation system and the processing power of the image segmentation system which improves the low contrast.



(a) Original image



(b) The effect picture by using Snake model



(c) The effect picture by using algorithm in this paper

FIG.1 Segmentation effect of grayscale instance image

5. Conclusion

This paper compares the proposed algorithm with the traditional Snake algorithm. Experimental results show that the algorithm can improve the accuracy of image segmentation under fuzzy image edge conditions. According to the segmentation of the above white blood cells, this algorithm can solve most of the cell detection problems and provide accuracy in the cell detection technology. Experimental results show that the algorithm can deal with low contrast image and shape cells and improve the accuracy of image edge segmentation under fuzzy conditions. This paper has obtained better image segmentation and image edge detection, as well as improved the system processing power of low contrast and automatic segmentation.

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