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A Watershed Based Segmentation Method for Overlapping Chromosome Images

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***Abstract*—Chromosome segmentation affects the performance of the chromosome automatic analysis systems. Watershed algorithm is a widely used segmentation method. Applying it to segment chromosome images can overcome the difficulty caused by overlapping chromosomes. But the vice of the algorithm is its over-segmentation results. An algorithm based on watershed was presented in this paper. The overlapping chromosome images were obtained by a series of pretreatments. Then the distance transform was used to treat these images. The results of the transformation were used as input images for the watershed algorithm. The experiment proved that this algorithm can segment the overlapping chromosomes successfully.**

Keywords- chromosome; segment; watershed

I. INTRODUCTION

Human chromosome analysis is an essential task in cytogenetics, especially in prenatal screening and genetic syndrome diagnosis, cancer pathology research and environmentally induced mutagen dosimetry[1]. A computer-assisted system usually includes four processing steps: (1) image enhancement, (2) chromosome segmentation (detection) and alignment, (3) feature computation and selection and (4) chromosome classification[2].In these steps, chromosome segmentation is the most important one because this step affects the performance of these systems.

Since in almost every metaphase image partial touching and overlapping of chromosomes are a common phenomenon, finding solutions for automated separation of chromosomes is difficult yet vital. Early studies found that a number of automated classification systems were somewhat successful in karyotyping the chromosomes under favorable imaging conditions. The typical case error rate was approximately 20%[3]. If the chromosomes were touching, overlapping or deformed as shown in the majority of images acquired in the clinical laboratories, the classification error rate was substantially increased[4].

In this paper a method for segmentation of the overlapping chromosome images based on watershed is presented. The method uses the watershed transform to segment the overlapping chromosome images. The experiment proves that this algorithm can segment the overlapping chromosomes successfully.. The detailed description of the algorithm, along with the experimental results and the analysis of the problems occurred in the experiment, is presented here.

II. MATERIALS AND METHODS

A. Acquiring the Overlapping Chromosomes

The overlapping chromosomes images used in this paper were acquired from the results of our preliminary study[5]. Firstly, the histogram equalization was used to treat with the input image to improve the contrast of the image. Then, the image was transformed into binary image by threshold algorithm. After that , the binary image was eroded, which can delete the little light objects in the image. The labeling algorithm was used to sign an exclusive label to every object in the image. Based on the given qualification, the labeled noise objects were deleted. After that, the overlapping chromosomes have been acquired.Fig.1 shows some samples of acquired overlapping chromosomes images.

Figure 1. Samples of overlapped chromosomes images

B. Watershed Algorithm

The watershed transform is a morphological gradient-based segmentation technique. The gradient map of the image is considered as a relief map in which different gradient values correspond to different heights. If we punch a hole in each local minimum and immerse the whole map in water, the water level will rise over the basins. When two different body of water meet, a dam is built between them. The progress

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continues until all the points in the map are immersed. Finally the whole image is segmented by the dams which are then called watersheds and the segmented regions are referred to as catchment basins. Its fast implementation method proposed by L.Vincent and P.Soille in [6] is widely used in the image segmentation field. But the severe oversegmentation problem still exists. The new algorithm will use watershed transform for presegmentation, which has been proved to be very useful in [7]. Although the image is oversegmented , the real boundary is contained in the obtained edges. The advantage of watershed transform is that the resulted small pieces all have closed boundaries. It is very useful for the initialization of the level set method. A threshold can be added to reduce the region numbers.

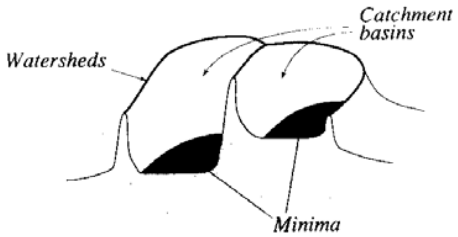

Figure 2. Minima, catchment basins and watersheds

C. Distance Transform

Distance transform is the operation which binary image is translated into gray image. Distance transform counts the distance between pixels that value is 0 and nonzero pixel that is the nearest[8]. Distance measure is defined as follows:

suppose pixels p, q, and r, with coordinates (x1, y1),(x2, y2) , and (x3, y3), respectively, if

(a) $D(p, q) \geqslant 0$ ($D(p, q) = 0$, if fp = q),

(b) $D(p, q) = D(q, p)$, and

(c) $D(p, r) \leqslant D(p, q) + D(q, r)$

D is a distance measures. The segmented object in this paper belongs to overlapping chromosome objects, so the Euclidean distance measures is adopted. The Euclidean distance between p and q is defined as

$$D(p,q) = [(x_1 - x_2)^2 + (y_1 - y_2)^2]^{1/2}$$

Fig. 3 shows some results of distance transform.

Figure 3. Result of distance transform

III. EXPERIMENTAL RESULTS

After all the above treatments, the watershed transform was then used to the acquired images. To validate the effect of this algorithm , the watershed algorithm was also used to the original images directly. Fig.4 shows the compare of these results.

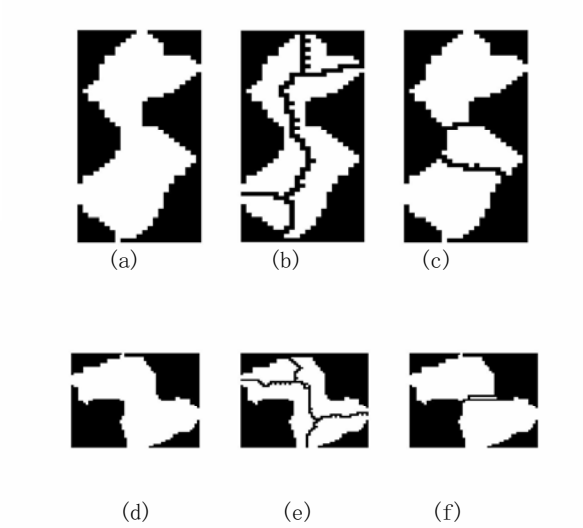

Figure 4. Compare of the segmentation results. (a, d) Original image,(b, e) segmentation result of using watershed directly,(c, f) segmentation result of using this algorithm

IV. CONCLUSION

In this paper, after deeply researching of the watershed algorithm, a method for segmentation of the overlapping chromosome images based on watershed was presented. The overlapping chromosome images were obtained by a series of pretreatments. These pretreatments can not only eliminate the little holes may occur in the images ,but also segment some slightly overlapped chromosomes, which will facilitate the next processing. Then the distance transform was used to treat these images. The experiments showed that this transform was important for overcoming the oversegmentation problem. The results of the transformation were used as input images for the watershed algorithm. The experiment proved that this algorithm can segment the overlapping chromosomes successfully.

Though this algorithm can segment the overlapping chromosome images. There are still some problems during the experiment. For example, when some chromosomes are overlapped together very tightly, the segmentation result is not satisfied. So more research is needed to settle these problems.

REFERENCES

[1] A. Carothers and J. Piper, " Computer-aided classification of human chromosomes: A review", Stat. Comput., vol. 4,1994,pp.161-171.

[2] X. Wang, B. Zheng, M. Wood, et al. "Development and Evaluation of Automated Systems for Detection and Classification of Banded Chromosomes: Current Status and Future Perspectives." J. Phys. D: Appl. Phys, vol. 38,2005,pp.2536-2542.

[3] Wu Q, Suetens P and Oosterlinck A . “On knowledge-based improvement of biomedical pattern recognition—a case study.” Proc. 5th Conf. on Artificial Intelligence for Applications, 1989,pp.239-44

[4] Pantaleao C H et al, “Development of a computerized system for cytogenetic analysis and classification.” Proc. 2nd Joint of 24th Annual Conf. and the Annual Fall Meeting of the Biomedical Engineering Society .vol 3, 2002,pp 2211-12

[5] Yan Wenzhong, Shen Shuqun. “An Automatic Counting Algorithm for Chromosomes.” The 2nd International Conference on Bioinformatics and Biomedical Engineering (iCBBE2008), 2008,pp.2492-2494.

[6] L.Vincent and P.Soille, “Watersheds in digital spaces: an efficient algorithm based on immersion simulations.” IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 13, no. 6, June 1991,pp.583-598.

[7] J.R.Cheng, S.W.Foo, and S.M.Krishnan, “Watershed presegmented snake for boundary detection and tracking of left ventricle in echocardio graphic Images.” IEEE Trans. On Information Technology in Biomedicine, vol. 10, no. 2, Apr. 2006.

[8] Ning Lu, Xizheng Ke, “A Segmentation Method Based on Gray-Scale Morphological Filter and Watershed Algorithm for Touching Objects Image .” IEEE Fourth International Conference on Fuzzy Systems and Knowledge Discovery (FSKD 2007),2007.