Enhanced Watershed Image Processing Segmentation

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ABSTRACT

Watershed is a most popular image processing method. Because image processing is emerging field and segmentation of nontrivial images is one of the very difficult tasks in image processing area. The proposed system is to enhance the watershed method.

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1) INTRODUCTION

Watershed is method of image processing segmentation. To understand watershed image processing segmentation, one need to know what is image processing and what image processing segmentation is.

A. Image processing

There are number of ways to define image processing but in simple words we can define image processing as follows:
"The field of digital image processing refers to processing digital images by means of digital computer" (Luc,1991).

B. Image processing segmentation

R. Gonzalez and R. Woods write in their widely used textbook (Digital Image Processing) that "segmentation of nontrivial images is one of the most difficult tasks in image processing. Segmentation accuracy determines the success or failure of computerized analysis procedures" (RAFAEL C, 2004).

C. Watershed image processing segmentation

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When we call watershed method, it will return a label image. In label image, all the different objects identified will have different pixel value i.e. all pixel of 1st object will have value one and all pixel of 2nd object will have value two and so on

D. Enhanced watershed image processing

Enhanced watershed image processing is to improve the results of watershed image processing. Proposed system is to enhance the watershed algorithm. Here the enhancement is in terms of robustness i.e. the outcome. For example if watershed algorithm identifies three objects from an image containing six objects. Then proposed system will try to identify four or five object from the same image containing the six objects.

2) PROPOSED METHOD FOR ENHANCEMENT

Proposed algorithm is based on merging watershed result with enhanced edge detection result (Edges are those places in an image that correspond to object boundaries.). Hence it enhances the watershed result. Simple edge detection result is not sufficient to enhance watershed result so 1st we need to enhance the edge detection result. When we enhance the edge detection, this ultimately enhances the final result but using proper algorithm to merge the both results of watershed and enhance edge detection.

For this purpose we need to make following small algorithms

A. Enhanced watershed

This is the main algorithm. It controls the all other algorithm. It calls the watershed method, edge detection method, enhances edge detection result and algorithm given below.
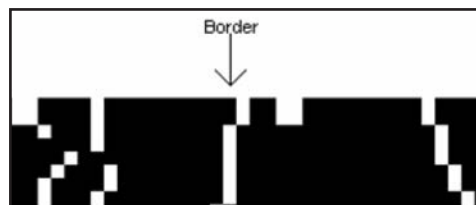
B. Connect edge with border

Fig. 1
Edges not connected with border
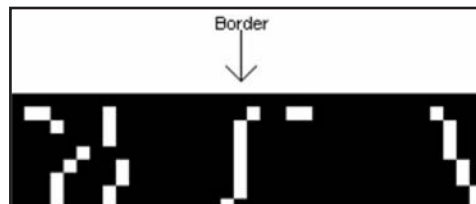
In edge detection method most edges are not connected with border line. This connects the edges with border line of image.

Fig. 2
Edges connected with border

C. Fill 1 missing pixel

Fig. 3
Missing pixel

Fill the pixel, if there is one missing pixel i.e. if there are three pixel having values 1 0 1, it convert the value of 2nd pixel from 0 to 1 if value of 1st and 3rd pixel is one
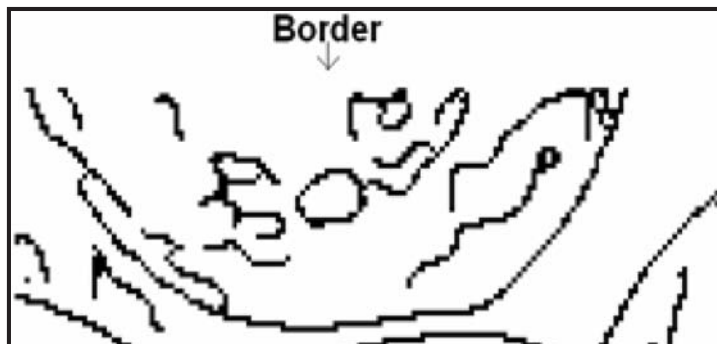
Fig. 4
Without missing pixel

D. Get big object no

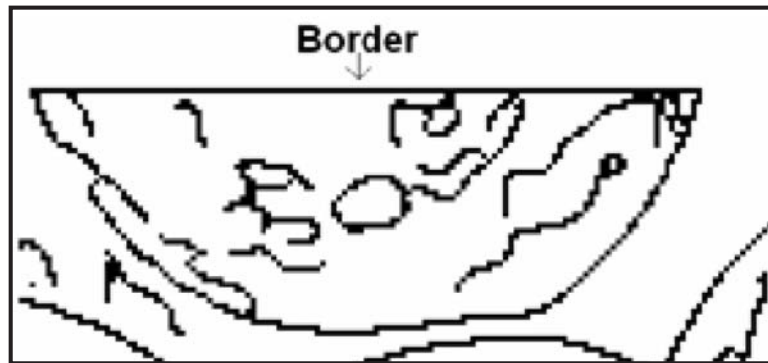Read the whole label image and return the biggest object number.

E. Connect object with border

Fig. 5
Object not connected with border

Connects the start/end pixel of object at border i.e. if object two has start pixel position 24 and end pixel position 33 at border then this will connect there two pixels with a line at border

Fig. 6
Object connected with border

F. Get minimum object size

Read the label image and return the size of minimum object in label image.

G. Get object start pixel

This will return the starting pixel of an object i.e. if we give object number two then this will return starting pixel of object two.

H. Get object no

This method will get the x, y values and give the object number at that pixel.

I. Get object size

This method will get the object number and return the size of that object.

J. Get select object

This method will get the object number and return the image having only pixel of this object.

3) PROPOSED ALGORITHM

I proposed the following method for enhancing watershed result

1. Read image
2. Convert image to gray scale, if required
3. Perform canny edge detection and get edges
4. connect edges with border
5. Fill missing pixel in edges
6. make edges logical (i.e. 0/1)
7. Complement the image
8. Perform labeling function on edges and get label 1 and total objects in label 1
9. Get biggest object number in the label 1
10. Connect objects with border
11. Perform labeling function again and get label 1 and total objects in label 1

12. Get biggest object number again in the label 1
13. Perform existing watershed method and get the label 2
14. Perform labeling function on label 2 and get total objects in label 2
15. Get biggest object number in the label 2
16. Get the size of minimum object in label 2
17. loop through 1st object to total object in label 1

    a. if current object number is equal to biggest number in label 1 then continue
    b. Get the current object's start pixel in x and y variable from label 1
    c. Get the object number at x and y position in label 2
    d. if object number is equal to the biggest object number of label 2 then

        i. Increase the value of total objects in label 2 by one
        ii. Find the rows and columns pixels of current object in label 1
        iii. Find the total pixels (i.e. total rows or columns) in above find rows and columns
        iv. Loop through 1st pixel to the last pixel of current object in label 1

            1. Change the current pixel value at label 2 to total objects value in label 2
            2. if there is other objects pixel in between rows then change the pixel to total objects value

        v. continue the loop at 17

    e. Get the current object size from label 1
    f. Get the size of object number (see 17.c
    g. If current object's size is greater than object number's size then

        i. Find the rows and columns pixels of current object in label 1
        ii. Find the total pixels (i.e. total rows or columns) in above find rows and columns
        iii. Loop through 1st pixel to the last pixel of current object in label 1

            1. Change the current pixel value at label 2 to object number value (see 17.c)

        iv. continue the loop at 17

    h. if current object's size is greater than double size of minimum object in label 2

        i. Find the rows and columns pixels of current object in label 1
        ii. Find the total pixels (i.e. total rows or columns) in above find rows and columns
        iii. Increase the value of total objects in label 2 by one
        iv. Loop through 1st pixel to the last pixel of current object in label 1

            1. Change the current pixel value at label 2 to total object value
            2. if there is other objects pixel in between rows then change the pixel to total objects value

        v. continue the loop at 17

18. Convert the label2 to RGB and display the final enhanced watershed result
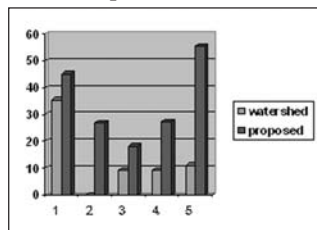
4) ENHANCED RESULTS

A. Set 1

Following is set 1 summary of segmentation results

Fig. 7
Segmentation Results on Set1

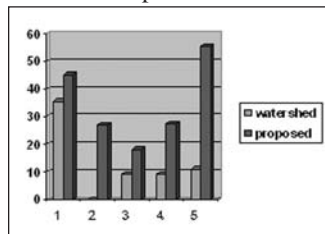| Image	Watershed%	Propose%
1	35.48%	45.16%
2	0%	26.67%
3	9.09%	18.18%
4	9.09%	27.27%
5	11.11%	55.56%

Following is bar chart & graph comparison

Fig. 8
Comparison on Set 1

*At X-axis- Image Number
*At Y-axis Percentage

Fig. 9
Comparison on Set 1

B. Set 2

Following is set 2 summary of segmentation results

Fig. 10
Segmentation Results on Set2

Image	Watershed%	Propose%
1	0	24.21
2	36.36	45.45
3	11.76	11.76
4	0	20
5	25	75

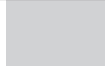Following is bar chart & graph comparison

Fig. 11
Comparison on Set 2
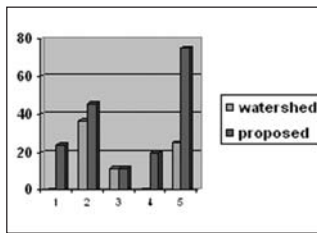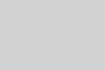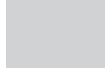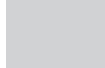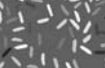
Fig. 12
Comparison on Set 2
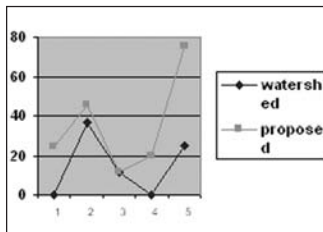
C. Set 3
Following is set 3 summary of segmentation results

Fig.13
Segmentation Results on Set3

Image	Watershed%	Propose%
 1	 20	 40
 2	 11	 33
 3	 7.14	 10.71
 4	 0	 52.63
 5	 25	 78.35

Following is bar chart & graph comparison

Fig. 14
Comparison on Set 3

Fig. 15
Comparison on Set 3

5) CONCLUSION

The evaluation of the segmentation is done by comparing the each object in true segmentation with the object in marker-co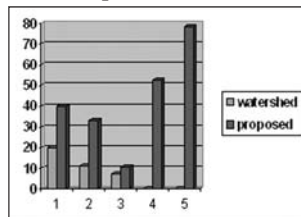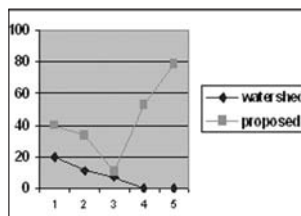ntrolled watershed segmentation or proposed method. So on the basis of this, percentage is calculated on different sets of images and draws the comparison graph between marker-controlled watershed and proposed method. Conclusion is that the proposed method enhances the result of marker-controlled watershed.

6) FUTURE WORK

Image processing is very hot field which needs extensive research and hard work. Following are the suggestions for future work.
" Improve the speed by using parallel processing either on clusters system or multi-processor system
" Merge this technique with some other technique to get the better results
" Fill missing pixel technique can be useful for other purposes
" Implement the same method on C++ for efficiency reasons

7) REFERENCES

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