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A NEW APPROACH FOR IMAGE SEGMENTATION BASED ON WATERSHED METHOD

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Abstract:

Neutrosophy studies the origin, nature,scope of neutralities, and their interactions with different ideational spectra. It is a new philosophy to extend the fuzzy logic and is the basis of neutrosophic logic, neutrosophic probability, neutrosophic set, and neutrosophic statistics. Image segmentation isa key step for image processing, pattern recognition,computer vision. Many existing methods for image description, classification, and recognition highly depend on the segmentation results. In this paper, neutrosophy is applied to image processing by defining a neutrosophic domain, which is described by three subsets T, I, and F. Then we employ watershed algorithm to perform segmentation of the image in the neutrosophic domain. The experiments show that the proposed method can get better results comparing with that obtained by the existing methods.

Introduction:

Neutrosophy is a branch of philosophy which includes four fields: philosophy, logics, set theory and probability/statistics. It can solve some problems that cannot be solved by the fuzzy logic. Image segmentation is one of the most criticaltasks of image analysis. Image segmentation is a process of partitioning an image into multiple regions. It is typically used to locate objects and boundaries (lines, curves, etc.). The goal of segmentation is to make the representation of an image more meaningful and easier to analyze [6]. The popular approaches for image segmentation are histogram-based methods, edge-based methods, region-based methods, model based methods, and watershed methods. The original idea of watershed came from geography. It is a powerful and popular image segmentation method and can potentially provide more accurate segmentation with low computation cost [16]. The watershed algorithm splits an image into areas based on the topology of the image.The Value of the gradients is interpreted as the elevation information.

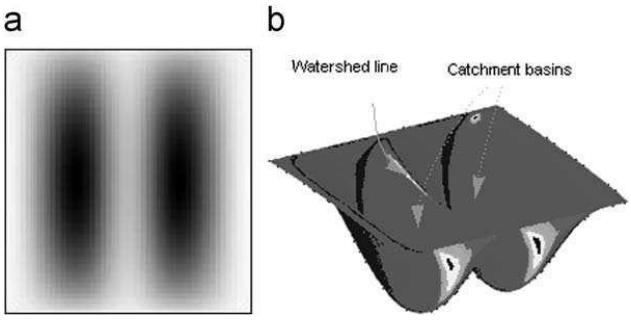

fig1 watershed concept (a)two dark blobs and (b)3Dview of the watershed image of (a)

After successively flooding the grey value, the watersheds with adjacent *catchment basins are constructed.* Fig. 1(a) is an image with two dark blobs synthetically generated by Matlab, and Fig. 1(b) is the 3D watershed image obtained by applying the watershed method on Fig. 1(a). Because the watershed methods work better on uniform images, our approach mainly deals with uniform image with blurry edges. However, our watershed method can also work better on non-uniformed images than other watershed methods.

In this paper, Then the neutrosophic logic is applied to convert the image into a binary image. Finally, the watershed algorithm is used to segment the converted image. We compare our proposed approach with the pixel-based method (embedded confidence), edge-based method (Sobel), region-based method (mean-shift), and two watershed methods (watershed in Matlab and toboggan-based) in theexperiments.

3. Proposedmethod

Watershed image segmentation is good for handling uniformed background and objectswith

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blurry edges. In this paper, objects are T and back ground is F. The blurry edges are gradually changed from objects to background, and there are no clear boundaries between the objects and edges or between the background and edges. The blurry boundaries are defined inI.

Map image and decide{T,F}:

Given an image A, P(x, y) is a pixel in the image and (x, y) is the position of this pixel. A 20x20 mean filter is applied to A for removing noise and making the image uniform. Then the image is converted by using the S-function.

Enhancement

Use intensification transformation to enhance the image in the new domain and it is use for remove the noise from the image. After then it will give good image from the previous image.

Fig. 2(c) is the result after enhancement

3.3 Thresholding:

The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image.

The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industryincluding the maximum entropy method, Otsu's method (maximum variance), andet al. k-means clustering can also beused.

3.4. Define homogeneity in intensity domain and decide {I}

Homogeneity is related to the local information, and plays an important role in image segmentation. We define homogeneity by using the standard deviation and discontinuity of the intensity. Standard deviation describes the contrast with in a local region, while discontinuity represents the changes in gray levels. Objects and background are more uniform, and blurry edges are gradually changing from objects to background. The homogeneity value of objects and background is larger than that of the edges.

3.5 Convert the image to a binary image based on {T, I, F}

In this step, we first divide the given image into three parts: objects (O), edges (E), and background (B). T(x,y) represents the degree of being an object pixel, I(x, y) is the degree of being an edge pixel, and F(x,y) is the degree of being a background pixel for pixel P(x, y), respectively.

3.6. Apply the watershed to the converted binaryimage:

Watershed algorithm is good for finding the optimal segmentation boundaries. The following is the watershed algorithm for the obtained binary image:

(1) Get regions R1; R2; . . . ; Rn, whichrepresent the objects and background and havevalue0.

(2) Dilate these regions by usinga 3x3 structure element.

(3) Buildadamattheplacewheretworegionsget merged.

(4) Repeat step(3)until all regions mergetogether

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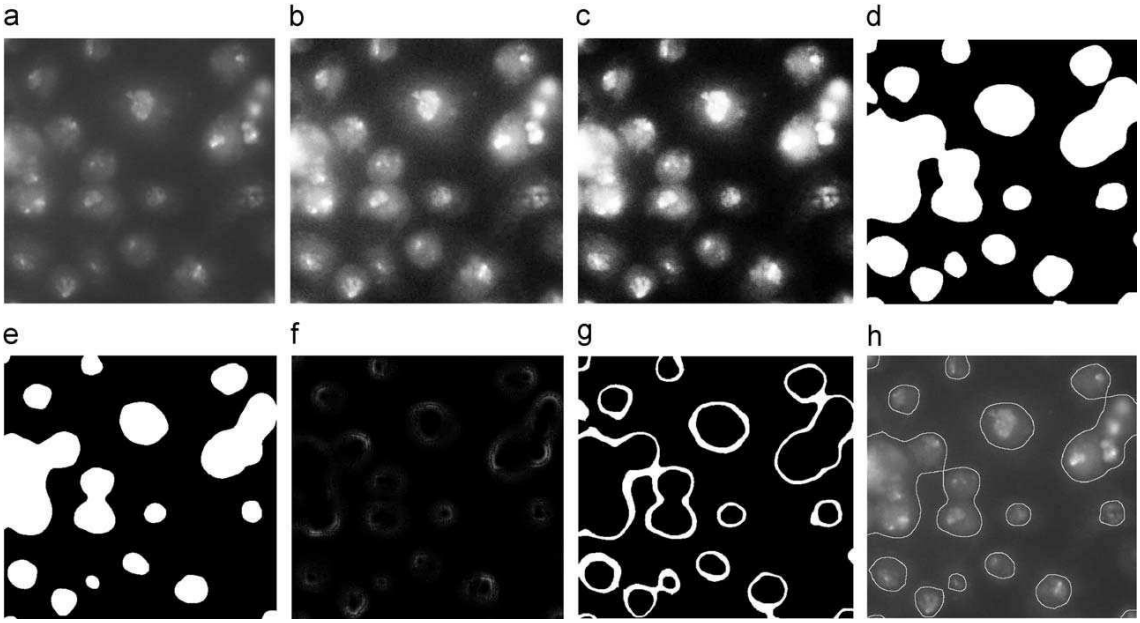

Fig.2. (a) Cloud image.(b)Result after applying the Sfunction.(c)Result after enhancement.(d)Image by applying threshold tt. (e)Image by applying threshold tf. (f)Homogeneity image in domain I. (g)Binary image based on { T; I; F}. (h)Final result after applying the proposed watershed method.

4. Experimental results

Watershed segmentation is good for processing nearly uniformed images, and it can get a good segmentation and the edges are connected very well. But this method is sensitive to noise and often has over-segmentation problem. We will compare our method with the pixel-based, edge-based, region-based, and other two watershed methods.

5. Featuresmethod:

A) pixel based method(Embeddedconfidence)

B) edge basedmethod(Sobel)

c) region based method(meanshift)

Pixel basemethod:

The pixels comprising a region information from points of corresponding objects or its part. Since different object or different parts of the same objects have diff characterstics .if we map the feature values at every pixels to a feaure space, we except to find distinct clusters formed corresponding to types of regions in the images.

Now can appropriate set of boundary functions can isolate each cluster from the others. consequently, pixels in the image are classified into various region. Thus the image is segmented. If we consider a single feature then the distribution of pixel values in the features space is degenerated to a feature histogram and the boundary function to a threshold. One of the simplest kind of features in gray level images is gray level at a pixel. Thus image can be segmented by simple gray level thresholdingmethod.

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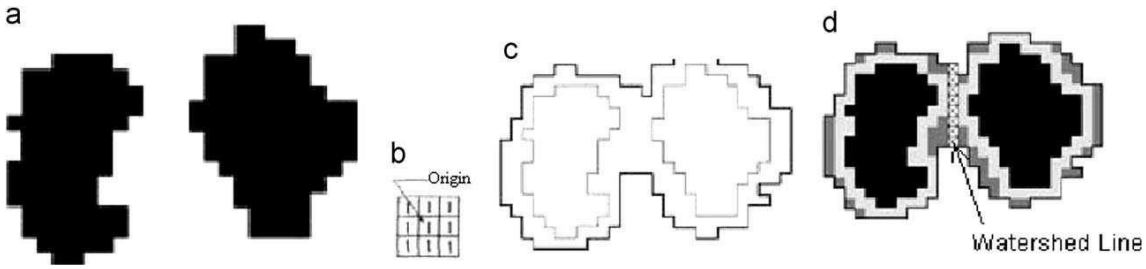

Fig 3(a) two regions which have value 0 (b) 3x3 structure element (c) dilation of the two regions (d) dam construction

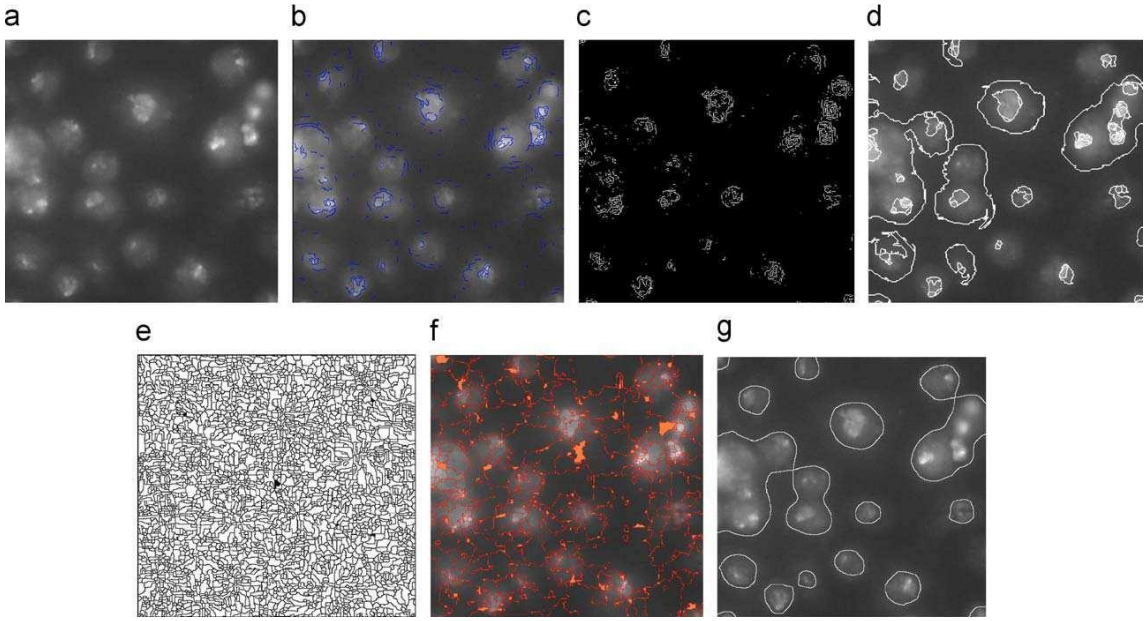

Fig.4. (a) Original image. (b)Result using the embedded confidence method. (c)Result using the Sobel operator. (d)Result using the mean-shift method. (e) Result using the watershed in Matlab. (f)Result using toboggan based watershed. (g)Result using the proposed method.

Edge BasedMethod:

That among these operators, the ordinary operators is not symmetric. Prewitt operator can detect vertical edges better than that by sobel operator; while sobel operator is superior to prewitt operator in detecting diagonal edges. Third, ordinarily, Roberts and 4-neighbour operators are sensitive to noise. Effect of noise is reduced in case of prewitt and sobel operators by inherent averaging of neighouring pixels. Therefore to achieve the desire result, gradient operators are usually preceded by noisecleaning.

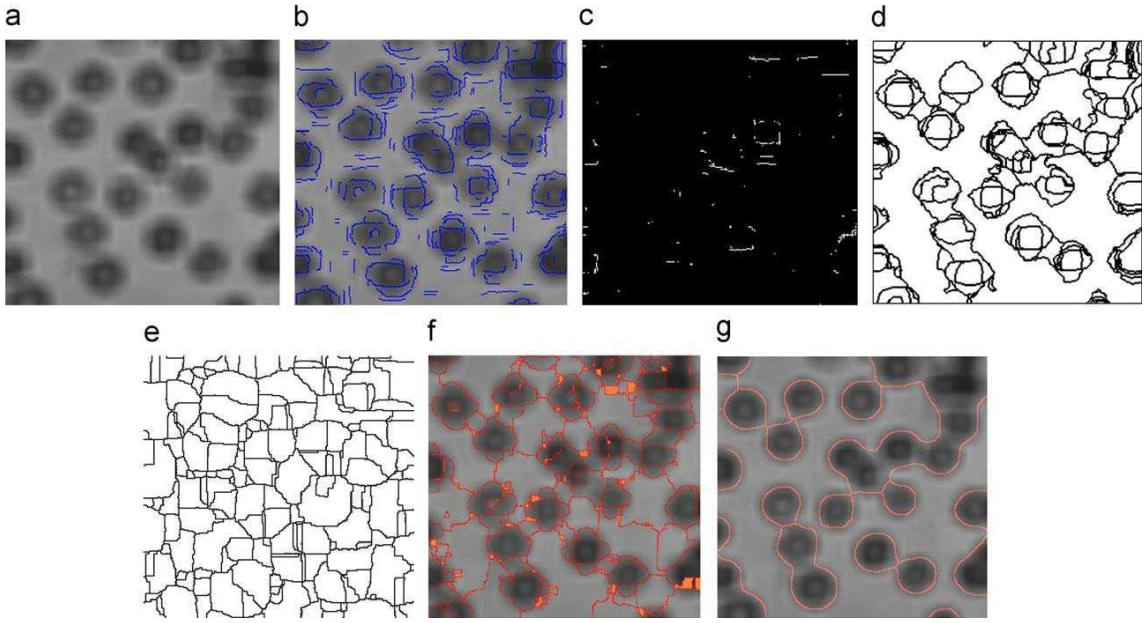

Fig.5.(a) Blurry cells image. (b)Result using the embedded confidence edge detector. (c)Result using the Sobel operator. (d)Result using the mean-shift method. (e)Result using the watershed in Matlab. (f) Result using the toboggan-based watershed. (g)Result using the proposed method.

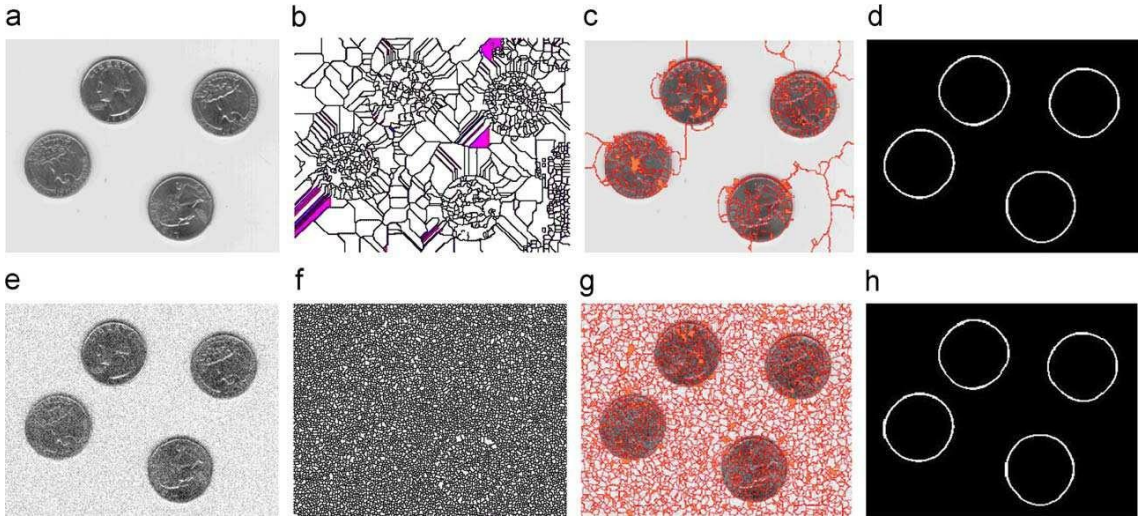

Fig6.(a) Original image. (b)Result using the watershed in Matlab on the original image.(c)Result using the toboggan-based watershed on the original image. (d)Result using the proposed method on the original image. (e)Image added with Gaussian noise. (f)Result using the watershed in Matlab on the noisy image. (g)Result using the toboggan-based watershed on the noisy image. (h)Result using the proposed method on the noisy image.

Region based method:

Image segmentation algorithm describe so far are parallel in nature. i.e. every pixel is treated independently. In other words , all the pixels can be processed simultaneously and the result at any pixel position does not depend on the resultsat

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other positions. Moreover , the decision that a pixel belongs to some region, once taken, is final and is not updated.

Fig. 4(a) is a cloud image which has blurry boundaries, and Fig. 4(b) is the result by using the pixel-based embedded confidence method, which determines the threshold value of a gradient image and consequently performs edge detection. The resulting image is under- segmented and it only detects part of the boundaries. Fig. 4(c) uses Sobel operator which is an edge-based method, it has under-segmentation and the boundaries are not connected well. Fig. 4(d) is the result by using edge detection and image which applies mean-shift region-based method. Fig. 4(d) are well connected but not smooth, the result is over-segmented. Fig. 4(e) utilizes the watershed method in Matlab, and the result shows heavy over-segmentation. It is hard to find distinguishable objects. Fig. 4(f) is the result by a modified watershed method (toboggan-based method). It can efficiently group the local minima by assigning them a unique label. The result is better than Fig. 4(e), but the background and objects are still messed together. Fig. 4(g) applies the proposed method, and it gets clear and well connected boundaries. The result gives an improvement better than those obtained by other methods used in Figs.4(b–f).

Fig. 5(a) is a blurry cells image. The objects and boundaries are not clear. The edges detected by the embedded confidence method in Fig. 5(b) are discontinued. The Sobel operator in Fig. 5(c) almost loses all boundaries. The mean-shift method in Fig. 5(d) (spatial bandwidth=7, color=3, minimum=10) produces few connected edges, and the edges are not well detected. Two watershed methods in Figs. 5(e,f) produce over-segmentation. The result in Fig. 5(g) using the proposed method has well connected and clear boundaries tosegment the cells from the backgroundbetter.

One drawback of the watershed methods is noise sensitive. However, the proposed method is very noise- tolerant. Fig. 6(a) is a noise-free coin image, and Figs. 6(b–d) are the results by employing the watershed method in Matlab, toboggan-based watershed method, and the proposed neutrosophic watershed method, respectively. Fig. 6(e) is the image by adding Gaussian noise (mean is 0, and standard variance is 2.55) to Fig. 6(a). Figs. 6(f–h) are the results by applying the above three watershed methods to Fig. 6(e). We can see that the Gaussian noise has a big impact on the results using the existing watershed methods, and causes heavy over- segmentation. But the proposed neutrosophic watershed method is quite noise-tolerant.

5. Conclusions

In this paper, we propose a novel watershed image segmentation approach based on neutrosophic logic. In the firstphase, we map a given image to three subsets T, F, and I, which are defined in different domains. The thresholding and neutrosophic logic are employed to obtain a binary image. Finally, the proposed watershed method is applied to get the segmentation result. We compare our method with the pixel-based, edge-based, region-based segmentation methods, and two existing watershed methods. The experiments show that the proposed method has better performance noisy and non-uniform images than that obtained by using other watershed methods, since the proposed approach can handle the uncertainty and indeterminacy better. It may find more applications in diverse fields of control theory, image processing, computer vision, and artificial intelligence.

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