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A Novel Method for Segmentation of Compound Images using the Improved Fuzzy Clustering Technique

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Abstract

The paper proposes a novel segmentation method for image analysis with classification. Analysis of the scanned compound image and medical image segmentation is greatly interrelated with the subtraction of exact text/graphics, picture and subtraction of the anatomic structures. This research paper proposes an improved fuzzy cluster based segmentation method to repeatedly divide the background and foreground of the images of compound document images and medical images. This improved FCM clustering method is designed by including the spatial neighborhood details such as, a priori probability, spatial weights of the neighboring pixels of the center pixel, fuzzy membership of the current center pixel is calculated for classification. The proposed innovative metrics are used to calculate the exact accuracy of the segmentation scheme. Since the investigation, it is experimental that the proposed metrics are most appropriate for the evaluation of segmentation accuracy. The experimental results achieved from this work, prove that the proposed system performs segmentation effectively and successfully for the different component of compound images and medical images.

Keywords: Classification, Improved Fuzzy C-Means Clustering, Medical Images, Membership Index Creation, Scanned Compound Images

1. Introduction

The scanned images and medical images are first segmented into different modules. For segmentation purpose, Layer-based and block-based techniques are the two most important methods which are recurrently used in compound images and Watershed Transform[18], Region growing techniques[19] and edge-detecting approaches, Multiscale morphological segmentation[20], FLBP[12,13] its techniques have been proposed earlier for the effective segmentation of medical images. In compound images the majority layer-based approaches use the typical 3-layer Mixed Raster Content (MRC) segmented into the background, foreground and the mask[1]. First segmentation is very complicated since it needs associated mechanism, outline cohesiveness and symbol comparison, on the other hand, the Second approach is Block-based segmentation which is used for scanned images, and this gives less complexity and more spatial resolution and medical images Watershed segmentation algorithm can be employed if the foreground and the background of the image can be recognized[2,3]. To incarcerate weak edges, watershed algorithm is moreover applied[24].

Selection of seed point is the most important drawback of this strategy; Region growing method is often a well-known technique for image segmentation that involves seed point selection. Inside segmentation

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method, the particular neighboring pixels tend to be in comparison with the first seed point factors to confirm based on several conditions; hence it takes more complexity of segmentation. Edge detection methods are commonly applied to discovering discontinuities in gray level images. Edge detection is the most general strategy for identifying significant discontinuities in the gray level. Image segmentation techniques for identifying discontinuities are boundary based methods. The main drawback of this method is pixel misclassification error[4]. Another method called Fuzzy c-mean cluster based segmentation technique is used by many researchers on scanned compound images and medical images. The clustering, image segmentation is extremely sensitive to attributes applied and kinds of objects in the image and therefore generalization of this method is not easy[5,6]. In this paper, we proposes a new Improved fuzzy c-mean clustering techniques has been proposed which gives the flexibility and more accurate segmentation results against pixel classification errors[7]. Improved Fuzzy c-mean clustering technique is used to categorize the image into smooth (picture), text, graphics (multiple color), and image blocks and the proposed algorithms are used to segment the image slices and identify the presence of nodules in the segmented slices[8].

2. Proposed Scheme

In the previous works on scanned compound images, Layer based and block based classification approaches are applied. The main drawback is the occurrence of pixel misclassification error. The existing methods are not performing well with respect to the layer and block based segmentation[9]. The disadvantages of these existing segmentation algorithms are high complexity and it takes more execution time, hence it is difficult to set the threshold values by human[16,17]. So, we propose a new technique called as IFCM, which is applied to scanned compound images. In this approach, instead of the layer or block based classification, improved fuzzy, c-mean clustering based, meaningful segmentation is performed to avoid the pixel misclassification errors.

2.1 Improved Fuzzy-C-Mean Clustering

A similarity-based self constructing attribute clustering technique is using an incremental feature clustering method. It reduces the complexity of segmentation techniques. An improved FCM (IFCM) clustering algorithm is used to divide an individual set of data or substance into the a cluster group by using cluster analysis. The division should have two properties one of them is the homogeneity within the cluster data, which belongs to one cluster, should be as same as realistic and another one is heterogeneity among the cluster data, which belongs to dissimilar clusters, should be as dissimilar as realistic. The entire cluster is recognized by a membership function with the statistical mean value and deviation of compound image pixels. If a pixel is not similar to any existing cluster, a new cluster is created for that pixel. Finally, many numbers of clusters are created repeatedly and extract one feature from each cluster. The extracted feature equivalent to a cluster is a weighted arrangement of the pixels contained in the cluster. An improved FCM clustering method is included in the spatial neighbourhood details into the standard FCM clustering technique by a priori probability (p_{it}). The priori probability is set to specify the spatial weight of the neighbouring pixels on the center pixel in the image. The new fuzzy membership of the current center pixel is again recalculated through this probability obtained value.

The method is initialized by a known histogram based FCM algorithm. The steps are the proposed Fuzzy clustering algorithm is as follows.

Step 1: Place the cluster centroids C_i value according to the histogram of the image, Fuzzification parameter f, the value of c >0.
Step 2: Calculate the membership function by using

$$u_{ig}^{(a)} = \frac{1}{\sum_{j=1}^{c}\left[\frac{d(g,v_i)}{d(g,v_j)}\right]^{2/(f-1)\forall i,g}} \tag{1}$$

Step 3: Compute the cluster centroids by using

$$v_i^{(a+1)} = \frac{\sum_{g=M_{min}}^{M_{max}}\left(u_{ig}^{(a)}\right)^f his(g)g}{\sum_{g=M_{min}}^{M_{max}}\left(u_{ig}^{(a)}\right)^f his(g)}, \forall i \tag{2}$$

$$His(g) = \sum_{p=0}^{p-1}\sum_{q=0}^{q-1}\delta(l(p,q)-g) \tag{3}$$

Step 4: Go to step 2 and replicate until convergence
Step 5: Calculate the priori probability, by using

$$p_{it} = \frac{\neq S_t^i}{\neq S_t} \tag{4}$$

By obtaining the results of membership function and centroids

Step 6: Recalculate the membership function and cluster centroids by using the probabilities.

$$u_{it}^{*(a)} = \frac{P_{it}}{\sum_{j=1}^{c}\left[\frac{d_{it}}{d_{jt}}\right]^{2/(f-1)}} \quad (5)$$

$$v_i^{*(a+1)} = \frac{\sum_{t=1}^{n}\left(u_{it}^{*(a)}\right)^f x_t}{\sum_{t=1}^{n}\left(u_{it}^{*(a)}\right)^f} \quad (6)$$

Step 7: If the algorithm is convergence, Go to step 8, otherwise go to step 5.

Step 8: Image segmentation after defuzzification using

$$\mathbf{C_t} = \arg_{\mathbf{i}}\{\max(\mathbf{u_{it}})\}, \qquad \mathbf{i = 1, 2 \ldots, c} \quad (7)$$

Where Pit- Priori probability, U_{it} - is the degree & membership of x_t in the i_{ih} Cluster, C-Number of the cluster, f-weighting exponent on each fuzzy membership, C_i – is the prototype of the centroid of the cluster i, $d_2(x_t, C_i)$ is a distance between object x_t and cluster C_i.

The above IFCM algorithm is used to divide the scanned compound image into smooth and non smooth blocks. Fuzzy classification is the process of grouping elements into a fuzzy set whose membership function is defined by the truth value of a fuzzy propositional function. Classification is the process of grouping an individual's which is having the same characteristics in a set. Similarly, medical lung images and brain images are also taken for evaluation using IFCM method. This method efficiently extracts the affected portion of lung and brain up normal images. Finally, the IFCM result of segmentation accuracy is calculated using the proposed segmentation metrics.

2.2 Membership Index Creation

Membership index function can be defined by a mathematical representation of ì A (M_t) that assigns all data items in the location a membership degree among '0' and '1'. Let M be the universal of discourse and M_t is a component of M. A fuzzy set,

A in 'M' can be mention as

$$\mathbf{A} = \{\mathbf{M_t}, \mu\mathbf{A}(\mathbf{M_t}) | \mathbf{M_t} \in \mathbf{M}\} \quad (8)$$

Fuzzy degree of function is appropriate for identifying the white and black pixel elements and representing on segmentation using bits in the scanned and medical images. Finally, Cluster groups are formed based on membership assigned values.

3. Experimental Evaluation

The accuracy of segmentation has been evaluated in this work in order to assess the presentation of the proposed algorithm in segmenting compound images and medical images. In this section, we propose the experimental outputs of the proposed method qualitatively and meaningfully during image display and testing dimensions. It is easier to evaluate the segmentation accuracy of a method if the segmented object does not include any additional less significant objects while matched to the similar location of the new image based on summing the number of pixel elements in the new image. Experimental analysis is based on accuracy of segmentation is computed.

3.1 Metrics to Measure the Segmentation Accuracy of Proposed System

Accuracy Metrics A_{Avg} is used to measure the segmentation accuracy of medical images and scanned compound images.

In segmentation accuracy,

$$A_{Avg} = \frac{B_{sp} + F_{sp}}{T_{ip}} X\ 100 \quad (9)$$

Where,

A_{Avg} = Overall pixel segmentation average accuracy

B_{sp} = No. of segmented pixels in the background of scanned compound images.

F_{sp} = No. of segmented pixels in the foreground of scanned compound images.

T_{ip} = Overall pixel presented in the scanned compound image.

Pixel values are presented in the foreground and background is,

$$F_{sp} =$$

$$F_{sp}(low\ gradient\ pixel) + F_{sp}(high\ gredient\ pixel)$$

$$B_{sp}\ B_{sp} = B_{sp}(only\ low\ gradient\ pixel)$$

$$B_{sp}(only\ low\ gradient\ pixel)$$

Finally,

$$A_{Avg} = \frac{B_{sp}(low) + F_{sp}(low\ gradient\ pixel) + F_{sp}(high\ gredient\ pixel)}{Tottal\ image\ pixel} X\ 100 \quad (10)$$

Scanned compound images contain a grouping of Text/graphics and picture. Text/graphics pixels are occupied in the foreground and picture is occupied in the background. It consists of low and high gradient pixels. In general, high gradient pixels present in the text portions and low gradient pixels present in the picture. Correspondingly, medical image includes ground truth and anatomic structure and also structural constituent is occupied in the background and foreground. The background mask consists the only very less threshold value. In this work, six gray scale images are considered by computing the value of accuracy segmentation in this proposed method. This top equation is used for calculating the segmentation accuracy of A_{Avg} using the amount of pixels in the medical images and scanned compound images. Text/graphics and picture portions are accurately segmented from the foreground and background. Similarly the anatomic structure is separated from the background and foreground. In this paper, the experimental result of the segmentation accuracy graph is shown only for scanned compound images and medical brain images.

Table 1. Pixel Segmentations of scanned compound images

Image	Foreground			Background			Overall pixels in compound image	Overall pixel segmented	Overall pixel Unseg mented	A Comp (%)
	Total pixel	Segmen-ted pixel	Unseg-mented pixel	Total pixel	Segmented pixel	Unseg-mented pixel				
Image1	52995	51754	1241	43665	42560	1105	96660	94314	2346	97.60
Image2	40250	39460	790	41160	39958	1202	83010	81410	1600	98.07
Image3	35452	34432	1020	43652	43326	326	84210	82000	2210	97.37
Image4	40620	39730	890	43966	43966	1006	86420	84586	1834	97.87
Image5	49414	48326	1088	48396	47381	1015	97810	95707	2103	97.84
Image6	51,420	50440	980	50445	49660	785	103057	101865	1192	98.84

Table 2. Segmentation accuracy of Image and Text/graphics in %

Image	Total image pixels in fg	S_{fg} Segmented	S_{fg} Unsegmented	S_{fg}(low) Image	S_{fg}(high) Text/graphics	A_{fg}(%)
Image 1	50445	49660	785	22150	27510	98.44%
Image 2	41160	39958	1202	19858	20100	97.07%
Image 3	43652	43326	326	21632	21694	99.25%
Image 4	43960	42960	1006	20100	22860	97.72%
Image 5	48396	47381	1015	22653	19907	97.90%
Image 6	43665	42560	1105	20334	22226	97.46%

Table 3 Segmentation accuracy of Brain in %

Image	Segmented Pixel	Overall Pixel	Accuracy in %
Image 1	40232	41882	96.06
Image 2	38002	38555	98.56
Image 3	31232	31896	97.91
Image 4	41362	42372	97.61
Image 5	30782	31356	98.16
Image 6	20994	21298	98.57

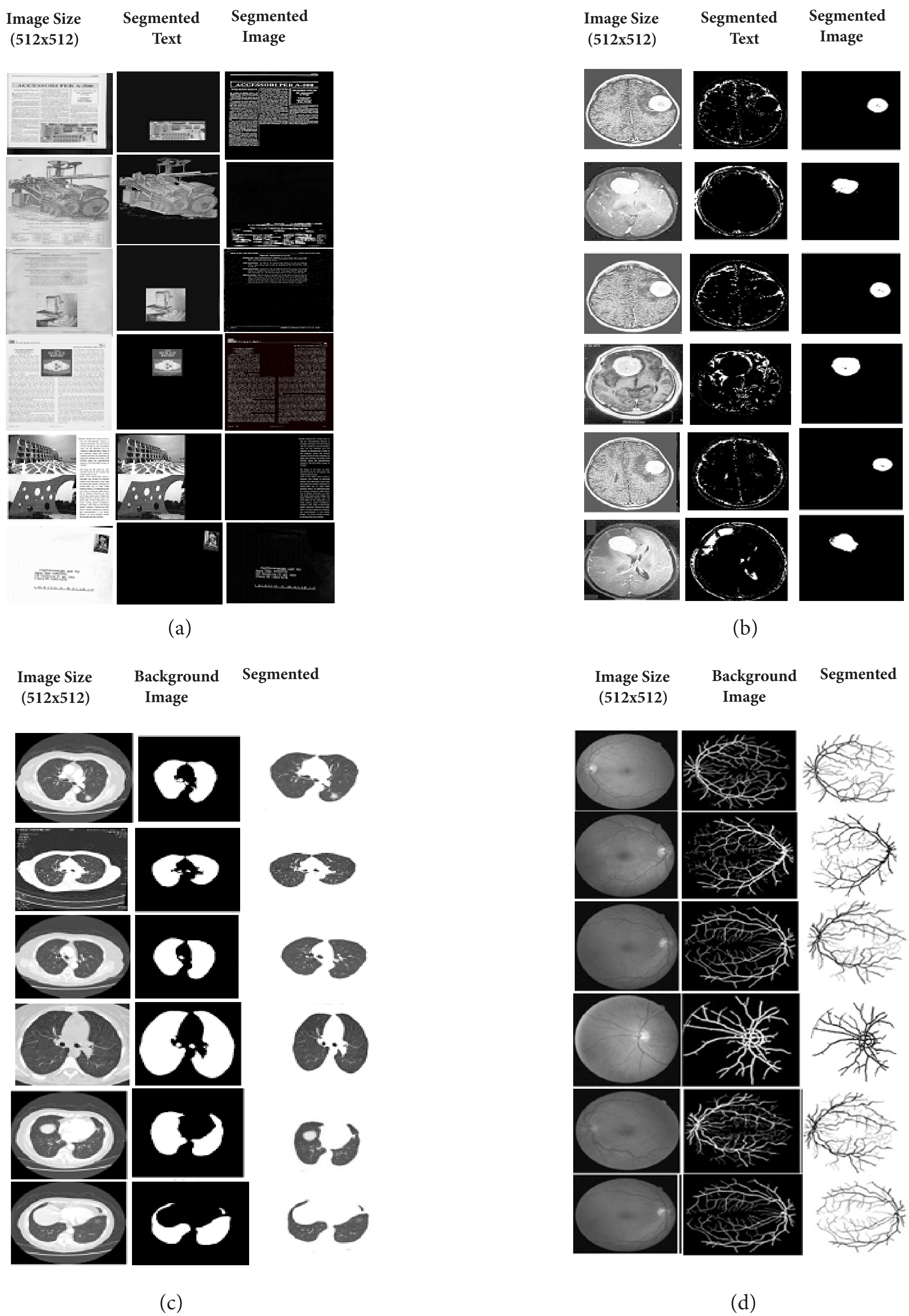

Figure 1. Results of the proposed segmentation method for (a) Scanned compound images (b) Medical brain images(c) Lung images and (d) Retina images

Table 1. shows the overall pixels presented in the scanned compound images and apply segmentation procedure to compute the total number of pixels is segmented and un-segmented. The gray scale scanned compound images and medical MRI brain, lung and retina images are tested using the proposed equation shown in (9). The proposed scheme is dissimilar because it computes the segmentation very efficient and drastically when compared to earlier segmentation scheme. The average of segmentation is equivalent to the medical image pixels average segmentation accuracy. The average pixel segmentation accuracy of 97.93% is achieved using the proposed metric scheme. Many numbers of tests were also processed in order to analysis the method's strength next to pixel miss-classification. These test results are establishing a high performance, yet for normal misclassification pixel errors Figure 1. show the outcome derived from different test medical and scanned compound image of size (512×512) and also it gives the results of the proposed IFCM method when progress on the brain, retina and lung data items[21,22]. The brain, retina and lung images shown in the primary portions are original images and the images shown in the second and third portions are the segmented images given by preceding the proposed method. From these figures, it is experimental that the proposed medical images produce large amount smoother results than the previous segmentation techniques used indifferent medical images.

It is also experimental that approximately with some of the organ images and compound images and hence segmenting several organs is troubled in which there is corresponding of intensities in medical images.

Finally, Table 2. shows the results of accurate image and text/graphics portions and also average segmentation accuracy is 97.97%. While increasing the segmentation accuracy pixel loss cannot occur in the original scanned compound images. Table 3 shows the accuracy of brain images and it has given average accuracy is 97.81%. The Compound images and medical brain images segmented and un-segmented segmentation accuracy graphs are shown in Figure 2 and 3. All the experimental results are derived using a Matlab tool. The presentation of the proposed segmentation method was analyzed with the use of dissimilar data sets. We have applied to a set of 350 compound images and 220 medical images. It has been taken from a world famous architect database and medical database[10,11].

Finally, the proposed segmentation accuracy is compared with compound images and segmentation of IFCM with medical brain, retina and lung images[14,15]. It has been given average segmentation accuracy is 97.81%, 97.22% and retina images provides 97.87%[23].

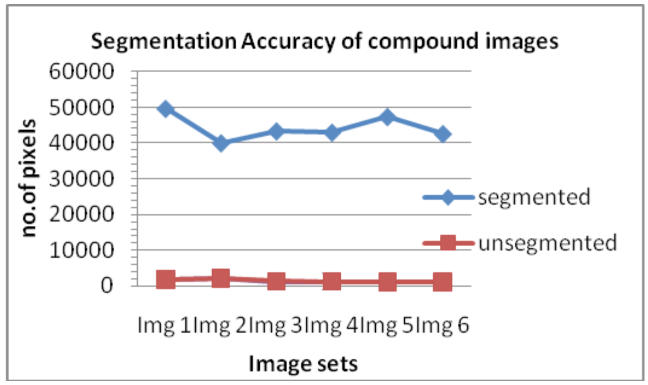

Figure 2. Accuracy of compound images segmentation.

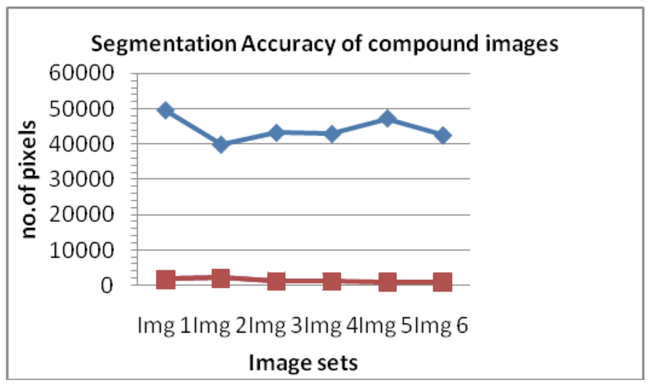

Figure 3. Accuracy of brain images segmentation.

The above graph shows the segmentation accuracy result of several tested, scanned compound images and medical brain images with same size (512×512). From these, it is proved that the proposed segmentation scheme accuracy is enormously high and also a less significant amount of complexity in the segmentation[25].

3.2 Comparison of Segmentation Accuracy

Several techniques have been shown in the literature for segmenting the multiple medical images and compound images. Among them, the primarily used schemes are block segmentation and layer based segmentation for compound images. The key drawback of this segmentation scheme is a pixel misclassification error and it has been given extremely less accuracy. In medical image segmentation a new approach called IFCM is proposed. This new IFCM method is applied to medical images and scanned compound images in this work and it has been proved efficient segmentation in medical images.

Table 4. Proposed segmentation accuracy of compound image with medical images

Segmentation accuracy of Approach– IFCM	
Images	**Accuracy in %**
Brain image	97.81 %
Lung image	97.22%
Scanned compound image	97.93 %
Retina images	97.87%
Average	97.71%

Table 4. shows the overall evaluation of the proposed scheme with a selection of computed tomography images such as brain, lungs and retina images with proposed scanned compound images. From the table, it can be experimental that the segmentation accuracy of the proposed methodology is superior when compared to the other obtainable approach for segmenting organs from the various Computed tomography images with various compound images[26].

Table 5. Segmentation accuracy for different techniques

Segmentation Accuracy of Lung image	
Approaches	**Segmentation in %**
watershed transform	95.30%
Graph cut method	96.41%
Atlas based method	96.85%
FLBP	97.58%
Proposed IFCM	97.71%

Table 5. shows the comparison of segmentation accuracy of the proposed scheme with some of the existing segmentation techniques used in medical lung images.

4. Conclusions

This paper proposes a novel Improved Fuzzy c-mean clustering technique is used to segment the scanned compound images, text and image portions similarly anatomic structure from medical images. Text and image portions are segmented from compound images using cluster analysis and it is used to improve the accuracy of clusters under noise. To evaluate the segmentation accuracy, segmentation metric has been proposed. The experimental result of this algorithm provides more segmentation accuracy of (97.71%). This system overcomes the disadvantages of obtainable methods where the complete grayscale value of pixel intensity is measured. To compute the measurement of the proposed segmentation scheme, a new metric is proposed by measure the segmentation accuracy depending on the amount of pixels, categories and segmented and un-segmented pixel ratios. The most important contributions of this paper are an algorithm for accurately segmenting the various scanned compound images and computed tomography medical images.

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