Implementation on Feature Selection for Image Segmentation

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Abstract: ***In case of image analysis, image processing one of the crucial steps is segmentation of image. Segmentation of image concerns about dividing entire image in sub parts that may be similar or dissimilar with respect to features. Output of image segmentation has consequence on analysis of image, further processing of image. Analysis of image comprises depiction of object and object representation, measurement of feature. Therefore characterization, area of interest's visualization in the image, description have crucial job in segmentation of image. Most image segmentation algorithms optimize some mathematical similarity criterion derived from several low-level image features. One possible way of combining different types of features, e.g. color- and texture features on different scales and/or different orientations, is to simply stack all the individual measurements into one high-dimensional feature vector. Due to the nature of such stacked vectors, however, only very few components (e.g. those which are defined on a suitable scale) will carry information that is relevant for the actual segmentation task. We present an approach to combining segmentation and feature selection that overcomes this relevance determination problem. All free model parameters of this method are selected by a resampling-based stability analysis. Experiments demonstrate that the built-in feature selection mechanism leads to stable and meaningful partitions of the images. This survey explains some methods of image segmentation.***

Keywords: Segmentation, Image Segmentation, Image processing, Image Analysis, K- means Algorithm

1. Introduction

The goal of image segmentation is to divide an image into connected regions that are meant to be semantic equivalence classes. In most practical approaches, however, the semantic interpretation of segments is not modeled explicitly. It is, rather, modeled indirectly by assuming that semantic similarity corresponds with some mathematical similarity criterion derived from several low-level image features. Following this line of building segmentation algorithms, the question of how to combine different types of features naturally arises. Image segmentation is also used to differentiate different objects in the image, since our image is divided into foreground and background, whereas foreground of image is related to the region of interest, and background is the rest of the image. Hence, image segmentation will separate these two parts from one another.

Therefore, the main three approaches for image segmentation are Threshold, Edge, and Region based. According to my survey ffamous techniques of image segmentation which are still being used by the researchers are Edge Detection, Threshold, Histogram; Region based methods, and Watershed Transformation. Since images are divided into two types on the basis of their color, i.e. grayscale and color images. Therefore image segmentation for color images is totally different from grayscale images, e.g., content based image retrieval [1], [2].

Also which algorithm is robust and works well is depends on the type of image [3]. The property of a pixel in an image and information of pixels near to that pixel are two basic parameters for any image segmentation algorithm. It can also be representing as similarity of pixels in any region and discontinuity of edges in image. Edge based segmentation is used to divide image on the basis of their edges. Region based methods used the threshold in order to separate the background from an image, whereas neural network based techniques used the learning algorithm to train the image segmentation process [4].

The result taken from image segmentation process is the main parameter for further image processing research; this result will also determine the quality of further image processing process. Image segmentation algorithms play an important role in medical applications, i.e., diagnosis of diseases related to brain [5]-[8] heart, knee, spine, pelvis, prostate and blood vessel, and pathology localization. Therefore, Image segmentation is still a very hot area of research for image processing field. It is still a challenging task for researchers and developers to develop a universal technique for image segmentation [9].

2. Literature Survey

All basic image segmentation techniques currently being used by the researchers and industry will be discussed and evaluate in this section.

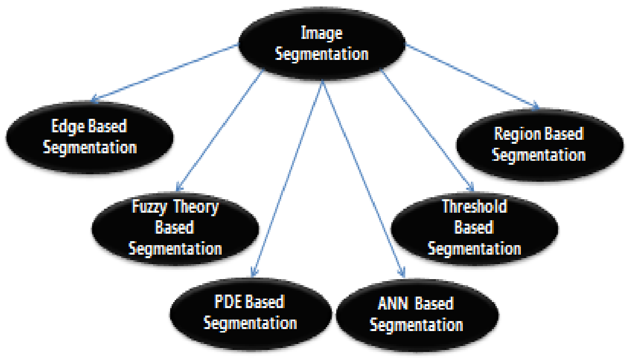

Figure 1: Image segmentation techniques

A. Edge Based Image Segmentation

Edge detection is a process of locating an edge of an image. Detection of edges in an image is a very important step towards understanding image features. Edges consist of meaningful features and contained significant information. It reduces significantly the amount of the image size and filters out information that may be regarded as less relevant, preserving the important structural properties of an image. Since edges often occur at image locations representing object boundaries, edge detection is extensively used in image segmentation when images are divided into areas corresponding to different objects. This can be used specifically for enhancing the tumor area in mammographic images or it will help to separate out Cerebrospinal fluid (CSF), White matter in MRI Images and even to indicate some present abnormalities. There are many methods of detecting edges; the majority of different methods may be grouped into these two categories:

1) Gradient: The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. For example Roberts, Prewitt, Sobel operators detect vertical and horizontal edges. Sharp edges can be separated out by appropriate thresholding.
2) Laplacian: The Laplacian method searches for zero crossings in the second derivative of the image to find edges e.g. Marr Hildreth, Laplacian of Gaussian etc.

MST and Edge based Threshold method is used to perform image segmentation. Experiments are performs on multi-scale resolution images, i.e., Quick-bird multispectral images. Results have shown that their method maintain the object information and keep object boundaries while segment the image. Anna Fabijańska [15] introduced a new method uses Variance Filter for edge detection in image segmentation process. Their method found the edge position using Variance Filter.

Sobel Gradient filter with K-means is also used to extract the edges and compared with the proposed technique. The effect of filtering window size on determining edges is also discussed and it is found that if the 9×9 window is used to extract edges then edge is complete accurately match the shape of object in the image. In case of larger details images, a small filtering window is proffered. Results have shown that their proposed technique outperform Sobel Edge Detector.

B. Fuzzy Theory Based Image Segmentation

FCM algorithmic: In the way of FCM mean clustering, every data point was subjected some a clustering center in term definite fuzzy subjection degree. In this way, some clustering centers were selected stochastic, all data points were endued with definite fuzzy subjection degree to the clustering center, then continuously corrected the clustering center by the way of iterativation, it was the optimizing object that the mean of subjection degree value and the shortest distance between all data points and very clustering centers during the iterative. Bezdek extended the way to the limitless cluster of a fuzzy object function clustering and proved the astringency of this algorithmic [24][25].

C. Partial Differential Equation (PDE) Based Image Segmentation

Segmentation is one of the bottlenecks of many image analysis and computer vision tasks ranging from medical image processing to robot navigation. Ideally, it should be efficient to compute and correspond well with the physical objects depicted in the image. This also requires that segmentation gives a complete partitioning of the image such that object contours are closed and no dangling edges exist. In the last decade, much research on PDE-based regularization methods has been carried out. Although the promising results suggest that they might be attractive as a preprocessing step for many subsequent image analysis methods, little research has actually been carried out which combines PDE-based preprocessing methods with other techniques. One of the problems was that PDE-based methods have been considered as being too slow in order to become an adequate partner for other e$ efficient methods. This shows the need to further develop e$ efficient algorithms for PDE-based techniques [26].

1) Image segmentation is achieved by means of a watershed algorithm.[26] This popular morphological method is more than an edge detector: it gives a true image partitioning without dangling edges. The watershed segmentation is sufficiently fast for most applications, but it suffers from the limitation that many irrelevant minima cause an over segmentation.
2) In order to reduce the over segmentation problem: the nonlinear diffusion technique by Catte` et al. [5] which allows edge enhancement, and a no quadratic variation restoration technique of Schnook [6] and Char bonnier et al. [7] which is well-suited for edge-preserving image denoising. These methods have been chosen as simple prototypes of PDEs that are mathematically well-founded: they are well-posed in the sense of Hadamard in that they have a unique solution which is stable with respect to perturbations of the original image.
3) As an efficient algorithm for the nonlinear diffusion "lter we apply a recently developed method based on an additive operator splitting (AOS) [8]. It leads to separable and recursive "lters. For the no quadratic variation image restoration method, we develop a novel algorithm: minimization of the energy function is achieved by considering a steepest descent method that leads to diffusion} reaction PDE. This PDE is then solved by a modified AOS algorithm that is embedded in a Gaussian pyramid decomposition.

D. Artificial Neural Network (ANN) Based Image Segmentation

An artificial neural network is a scheme based on the process of biological nervous system. It resembles the functioning of our human mind. These systems are information dispensation model and are motivated by the way, the human intelligence works. The basic processing elements of neural networks are called artificial neurons [11] or simply neurons. Neurons may share some properties of biological neural networks. It is an adaptive system that changes its configuration based on internal or external information that flows from end to end through the system. Learning in genetic or biological system involves alternation

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in synaptic relations that exists among neurons. This is exact used for ANN as well. They are dominant tools for modeling particularly when the original data relationship is not recognized. ANN can learn by examples. After training, they can be used to forecast the outcome of new independent input data.

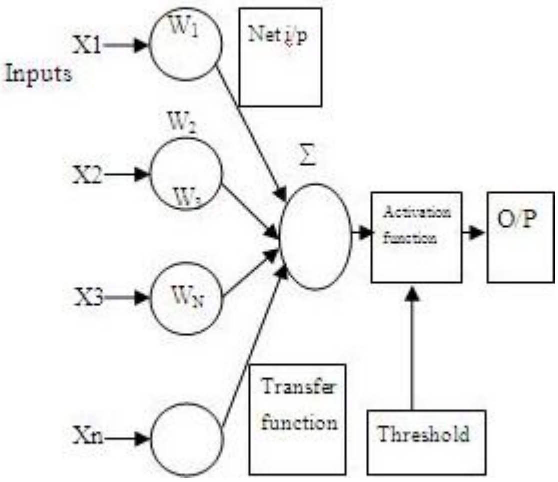


Figure 2: Artificial neural network

E. Threshold Based Image Segmentation

Image segmentation is performed by such as boundary detection or region dependent techniques. But the thresholding techniques are more perfect, simple and widely used [3]. Different binarization methods have been performed to evaluate for different types of data. The locally adaptive binarization method is used in gray scale images with low contrast, Varity of background intensity and presence of noise. Niblack's method was found for better thresholding in gray scale image, but still it has been modified for fine and better result [4]. A number of thresholding techniques have been previously proposed using global and local techniques. Global methods apply one threshold to the entire image while local thresholding methods apply different threshold values to different regions of the image. The value is determined by the neighborhood of the pixel to which the thresholding is being applied [5]. The binarization techniques for gray scale documents can be grouped into two broad categories: global thresholding binarization and local thresholding binarization [6]. Global methods find a single threshold value for the whole document. Then each pixel is assigned to page foreground or background based on its gray value comparing with the threshold value. Global methods are very fast and they give good results for typical scanned documents. For many years, the binarization of a gray scale document was based on the global thresholding statistical algorithms. These statistical methods, which can be considered as clustering approaches, are inappropriate for complex documents, and for degraded documents. If the illumination over the document is not uniform global binarization methods tend to produce marginal noise along the page borders. To overcome these complexities, local thresholding techniques have been proposed for document binarization. These techniques estimate a different threshold for each pixel according to the gray scale information of the neighboring pixels. The techniques of Bernsen, Chow and Kaneko, Eikvil, Mardia and Hainsworth, Niblack [7], Yanowitz and Bruckstein [8], and TR Singh belong to this category. The hybrid techniques: L.O'Gorman and Liu, which combine information of global and local thresholds belong to another category. In this paper we focus on the binarization of gray scale documents using local thresholding technique, because in most cases color documents can be converted to gray scale without losing much information as far as distinction between page foreground and background is concerned.

Threshold technique is one of the important techniques in image segmentation. This technique can be expressed as:

$$T=T[x, y, p(x, y), f(x, y]$$

Where T is the threshold value. x, y are the coordinates of the threshold value point. p(x,y) ,f(x,y) are points the gray level image pixels [9].Threshold image g(x,y) can be define:

$$g(x,y)=\begin{cases} 1 \text{ iff } f(x,y)>1 \\ 0 \text{ iff } f(x,y)\leq 0 \end{cases}$$

Thresholding techniques are classified as bellow

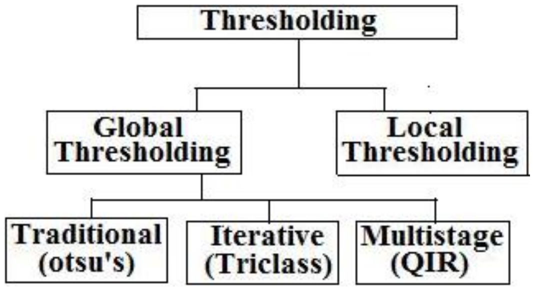


Figure 3: Thresholding Techniques

F. Region Based Image Segmentation

Informally, segmenting a range image is the process of labeling the pixels so that pixels whose measurements are of the same surface are given the same label. The general problem of image segmentation is classical, and yet in four popular computer vision and image processing textbooks [1], [14], 1151, [27], the formal definitions of the segmentation problem are slightly different. For instance, consider ([14], page 458):

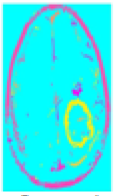
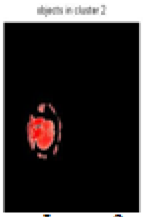
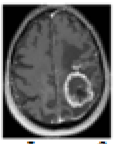
Let R represent the entire image region. We may view segmentation as a process that partitions R into y1 sub-regions, RI, R,, . . ., R,, such that
1) U:=, Ri = R,
2) Ri is a connected region, i = 1,2, . . ., n,
3) R, n Rj= 0 for alliand j, igj,
4) P(RJ = TRUE for i = 1,2, ..., n, and
5) P(R, U R,) = FALSE for i fj,
where P(R,) is a logical predicate over the points in set R, and 0 is the null set.

Item 5 of this definition must be modified to apply only to adjacent regions, as non-bordering regions may well have the same properties; let this be called item 5a. In (111, p. 1501, item 5a was advanced only as a possible criterion. In ([27], p. 388), item 5a was included, but item 2 was left out.

In ([15], p. 509), the formal definition was abandoned in favor of informal rules.

Besides these inconsistencies, there are technical difficulties in using this definition for range image segmentation. Some range pixels do not contain accurate depth measurements of surfaces. This naturally leads to allowing non-surface' pixels (areas), perhaps of various types. Regarding the above definition, non-surface areas do not satisfy the same predicate constraints (items 4 and 5) as regions that represent surfaces.2 It is also often convenient to use the same region label for all non-surface pixels in the range image, regardless of whether they are spatially connected. This violates item 2 of the above definition. Finally, we also require that the segmentation be "crisp." No sub-pixel, multiple or "fuzzy" pixel labeling are allowed.

Table: Comparative Analysis of All Segmentation Method and Feature Extraction

Method to be Apply	Image in Detection of Feature	Pixel Sizing (Mxn)	Area of Feature Region
1. Correcting No Uniform Illumination	 Image: 1	128x128	25%
2. K-Mean Clustering Method	 Image: 2	256x256	30%
3. Texture Segmentation	 Image: 3	128x128	80.312%
4. Watershed Segmentation	 Image: 4	128x128	83.22%

3. Proposed Work

There are various methods of image segmentation are studied, and evaluate main image segmentation techniques used for the purpose of image analysis. It is found that there is no perfect method for image segmentation because the result of image segmentation is depends on many factors, i.e., pixel color, texture, intensity, similarity of images, image content, and problem domain. Therefore, it is not possible to consider a single method for all type of images nor all methods can perform well for a particular type of image. Proposed method is based on hybrid solution consists of multiple methods for image segmentation problem. This Hybrid solution is made-up with the k-means algorithm

Integrated K-Means Algorithm:

Edge detection is having a significant role in pattern recognition. We have combined the successful clustering algorithm called K-Means clustering algorithm with the edge detection algorithms like LoG filter and Prewitt filter. The images used for this purpose are both satellite images [2] and synthetic datasets. The image is classified with the K-Means algorithm and Log Filter combination as well as K-Means algorithm and Prewitt filter combination. Image classification includes two steps:

a) Segmentation step
b) Classification step

In this paper, the image segmentation and classification have done using K-Means and Laplacian of Gaussian filters or Prewitt Filter. Proposed algorithm has no specific requirement of prior knowledge of any parameters and the mathematical details of the data sets. We have tested our algorithm on number of synthetic dataset as well as real world dataset. The experimental results are shown in section IV for visual judgment of the performance of the proposed algorithm. We have used known data sets as well as some real world data sets for the testing. The manuscript is organized as follows.

Step 1: Read Image
Read in hestain.png, which is an image of tissue stained with hemotoxylin and eosin (H&E). This staining method helps pathologists distinguish different tissue types.

```
he = imread('hestain.png');
imshow(he), title('H&E image');
text(size(he,2),size(he,1)+15,...
'FontSize',7,'HorizontalAlignment','right');
```

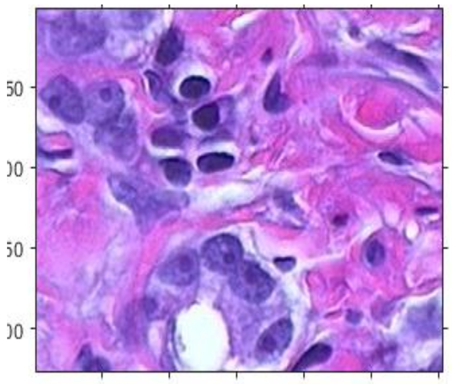


Figure 4: H&E image

Step 2: Convert Image from RGB Color Space to L*a*b* Color Space
How many colors do you see in the image if you ignore variations in brightness? There are three colors: white, blue, and pink. Notice how easily you can visually distinguish these colors from one another. The L*a*b* color space (also known as CIELAB or CIE L*a*b*) enables you to quantify these visual differences.
The L*a*b* color space is derived from the CIE XYZ tristimulus values. The L*a*b* space consists of a luminosity layer 'L*', chromaticity-layer 'a*' indicating where color falls along the red-green axis, and chromaticity-layer 'b*' indicating where the color falls along the blue-yellow axis. All of the color information is in the 'a*' and 'b*'

layers. You can measure the difference between two colors using the Euclidean distance metric.

Convert the image to L*a*b* color space using make c form and apply c form.
c form = make c form('srgb2lab');
lab_he = apply c form(he,cform)
Step 3: Classify the Colors in 'a*b*' Space Using K-Means Clustering
Clustering is a way to separate groups of objects. K-means clustering treats each object as having a location in space. It finds partitions such that objects within each cluster are as close to each other as possible, and as far from objects in other clusters as possible. K-means clustering requires that you specify the number of clusters to be partitioned and a distance metric to quantify how close two objects are to each other. Since the color information exists in the 'a*b*' space, your objects are pixels with 'a*' and 'b*' values. Use k-means to cluster the objects into three clusters using the Euclidean distance metric.

```
ab = double(lab_he(:,:,2:3));
nrows = size(ab,1);
ncols = size(ab,2);
ab = reshape(ab,nrows*ncols,2);
nColors = 3;
% repeat the clustering 3 times to avoid local minima
[cluster_idx,cluster_center]=
kmeans(ab,nColors,'distance','sqEuclidean', ...'Replicates',3);
```

Step 4: Label Every Pixel in the Image Using the Results from KMEANS
For every object in your input, kmeans returns an index corresponding to a cluster.
The cluster_center output from kmeans will be used later in the example. Label every pixel in the image with its cluster_index.

```
pixel_labels = reshape(cluster_idx,nrows,ncols);
imshow(pixel_labels,[]), title('image labeled by cluster index');
```

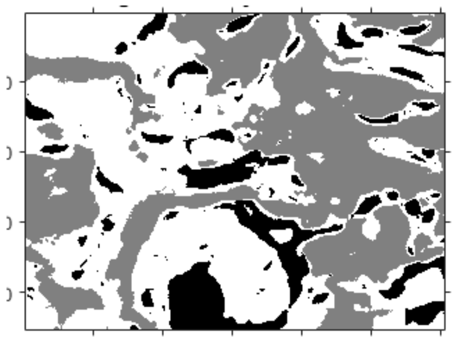


Figure 5: Image labeled by cluster index

Step 5: Create Images that Segment the H&E Image by Color.
Using pixel_labels, you can separate objects in hestain.png by color, which will result in three images.

```
segmented_images = cell(1,3);
rgb_label = repmat(pixel_labels,[1 1 3]);
for k = 1:nColors
   color = he;
   color(rgb_label ~= k) = 0;
   segmented_images{k} = color;
end
imshow(segmented_images{1}), title('objects in cluster 1');
```

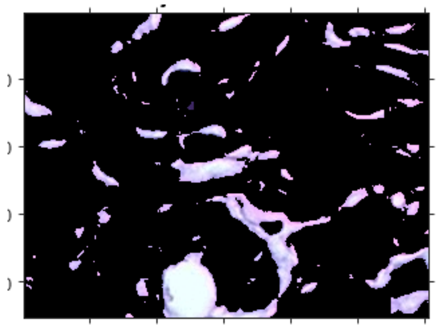


Figure 6: Objects in cluster 1

```
imshow(segmented_images{2}), title('objects in cluster 2');
```

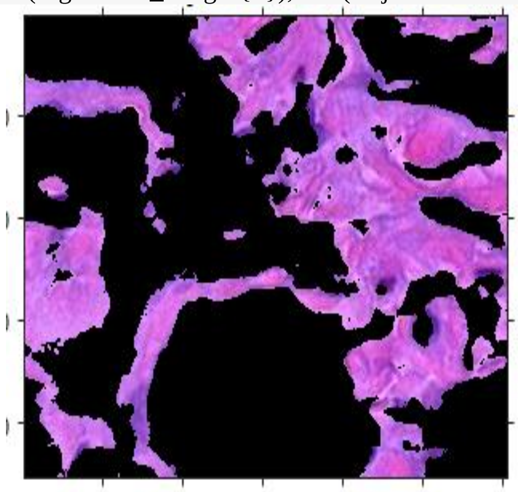


Figure 7: Objects in cluster 2

```
imshow (segmented_images{3}), title('objects in cluster 3');
```

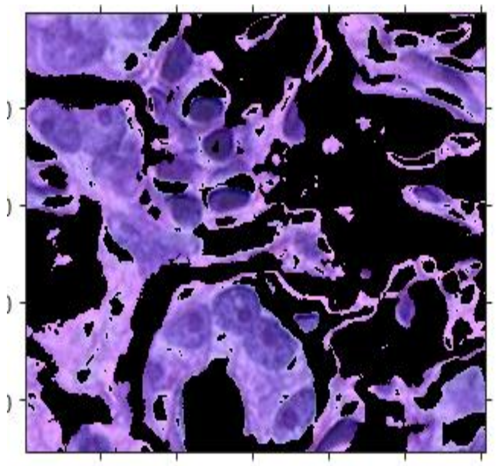


Figure 8: Objects in cluster 3

Step 6: Segment the Nuclei into a Separate Image
Notice that there are dark and light blue objects in one of the clusters. You can separate dark blue from light blue using the 'L*' layer in the L*a*b* color space. The cell nuclei are dark blue.

Recall that the 'L*' layer contains the brightness values of each color. Find the cluster that contains the blue objects. Extract the brightness values of the pixels in this cluster and threshold them with a global threshold using imbinarize.

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You must programmatically determine the index of the cluster containing the blue objects because kmeans will not return the same cluster_idx value every time. You can do this using the cluster_center value, which contains the mean 'a*' and 'b*' value for each cluster. The blue cluster has the smallest cluster_center value (determined experimentally).

```
mean_cluster_value = mean(cluster_center,2);
[tmp, idx] = sort(mean_cluster_value);
blue_cluster_num = idx(1);

L = lab_he(:,:,1);
blue_idx = find(pixel_labels == blue_cluster_num);
L_blue = L(blue_idx);
is_light_blue = imbinarize(L_blue);
```

Use the mask is_light_blue to label which pixels belong to the blue nuclei. Then display the blue nuclei in a separate image.

```
nuclei_labels = repmat(uint8(0),[nrows ncols]);
nuclei_labels(blue_idx(is_light_blue==false)) = 1;
nuclei_labels = repmat(nuclei_labels,[1 1 3]);
blue_nuclei = he;
blue_nuclei(nuclei_labels ~= 1) = 0;
imshow(blue_nuclei), title('blue nuclei');
```

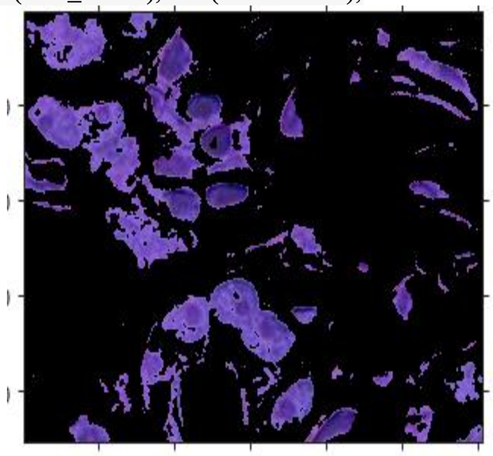


Figure 9: Blue nuclei

The result of image segmentation is depends on many factors, i.e., pixel color, texture, intensity, similarity of images, image content, and problem domain etc. Hence, it is good to use hybrid solution consists of multiple methods for image segmentation problem.

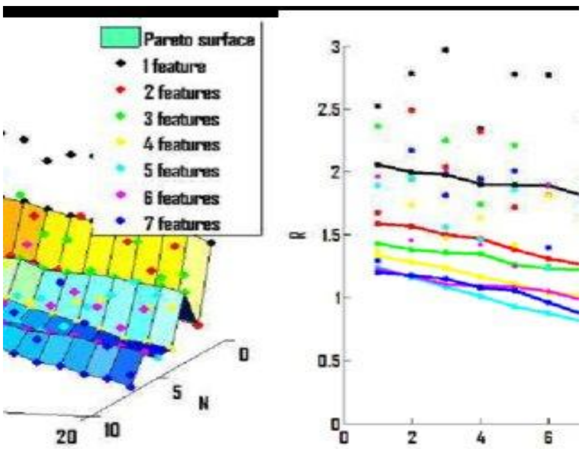
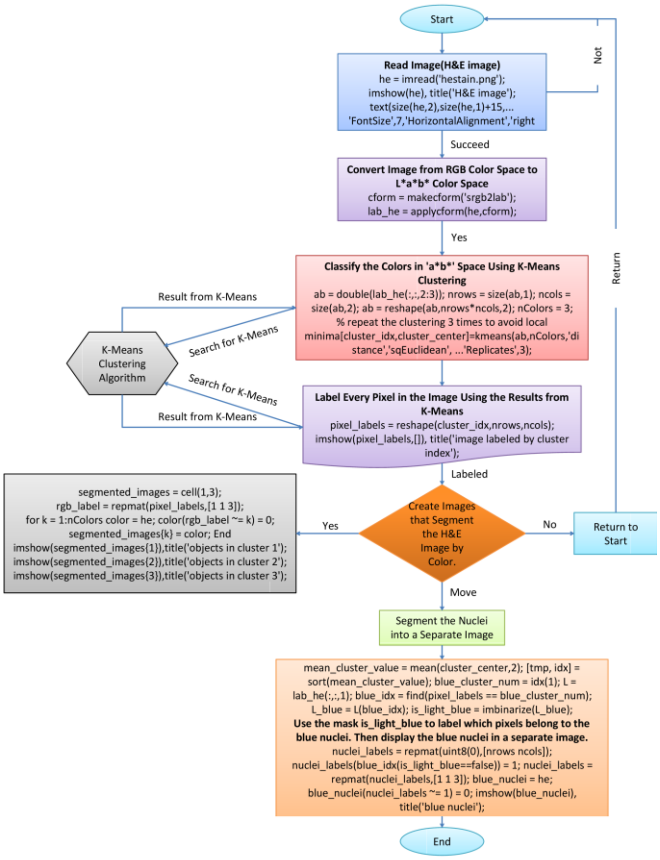


Figure 10: A Hybrid method on feature selection for Image Segmentation

4. Flow Chart



5. Result

The experiment uses the result of K-means clustering in this paper. For every object in your input, k-means returns an index corresponding to a cluster. The cluster_center output from kmeans will be used later in the example. Label every pixel in the image with its cluster_index. First, the resulting image (Fig. 5) is complemented and Create Images that Segment the H&E Image by Color, a new image obtained, as shown in (Fig. 6). Then the area size of every closed region is calculated, as shown in (Fig. 7). Then the image in next cluster calculated, as shown in (Fig. 8). Finally, the contours of every object are treated as edges and segmented. The result is shown in Fig. 7(d).

6. Conclusion

In this paper we used a hybrid method on feature selection of image segmentation, and evaluate main image segmentation techniques used for the purpose of image segment. We have combined K Means algorithm with different algorithm and compared that with the combination of K Means algorithm with Prewitt Filter. The integrated novel clustering algorithms for image classification are tested with different images including satellite images. We found that the latter is performing well compared to the earlier. These algorithms are robust and very effective in producing

Lots of novel image segmentation methods might be designed in upcoming days. Image segmentation is a wide area for researchers to do work in future.

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