Abstract - Image segmentation is an essential tool in image processing and can serve being an efficient front end to sophisticated algorithms and thereby simplify subsequent processing. In this paper, we proposed a statistical region growing procedure combined with hierarchical region merging. The region growing step over segments the input radar image, thus enabling region aggregation by employing a combination of the fuzzy logic and Dynamic Statistical Region Merging algorithm for performance improvement. The MATLAB is used as a tool for performing this study. The DSRM using fuzzy logic is used to optimize the results of SRM algorithm. A remote sensing image is used to perform the segmentation process and obtain the results.

Keywords - Image segmentation, Statistical Region Merging, Dynamic Statistical Region Merging, Remote Sensing Image.

I. INTRODUCTION

Image segmentation is just a low level image processing task that aims at partitioning an image into regions in order that each and every and every region groups contiguous pixels sharing similar attributes (intensity, color, etc.). The prospective of segmentation is definitely to simplify and/or change the representation of a graphic into something that's more meaningful and better to analyze. Image segmentation is usually used to find objects and boundaries (lines, curves, etc.) in images. It's a very important process because it is the first step of the image understanding process, and all others steps, such as feature extraction, classification and recognition, depend heavily on its results. Image segmentation has been the topic of intensive research, and a wide variety of image segmentation techniques have already been reported in the literature. All the pixels in a region are similar regarding some characteristic or computed property, such as color, intensity, or texture. Its performance directly determines the final consequence of some type of computer visual task. Up to now, you will find over one thousand types of segmentation approaches, which may be broadly classified as the Global-based (GB) and the Local-based (LB). The classical ways of the GB include Normalized-Cut, Efficient Graph-Based Method, Ratio-Cut, and Mean-shift and so on. The Watershed, Fractal Net Evolution Approach (FNEA), Statistical Region Merging (SRM), etc. are the LB methods. Statistical region merging (SRM) is an algorithm used for image segmentation. The algorithm can be used to judge the values within a regional span and grouped together on the basis of the merging criteria resulting an inferior list. Some useful examples could possibly be creating a group of generations within a population or in image processing grouping a group of neighboring pixels based on their shades that fall within a particular threshold. Utilizing the Statistical Region Merging (SRM) for remote sensing image segmentation, the effect is unsatisfactory. To improve the segmentation accuracy and the correctness Dynamic Statistical Region Merging (DSRM) is introduced. It tries to let probably the most similar regions to be tested first. Initially, it redefines the dissimilarity based-on regions. Then, it dynamically updates the dissimilarity and adjusts the test order during the task of merging. The accuracy of the DSRM is higher than the SRM and its computational complexity is approximately linear.

II. LITERATURE SURVEY

Jing Liu, Peijun Li et al.[3] proposed a novel image segmentation method for VHR multispectral images using combined spectral and morphological information. The method can be summarized as follows. First, a morphological derivative profile has been calculated from an original multispectral image and combined with the spectral bands to quantify spectral-morphological characteristics of a pixel, which are considered as a criterion of homogeneity of neighboring pixels. Image segmentation was conducted using a seeded region-growing procedure, which has been based on the seed points automatically generated from the gradient image and dynamically added and the similarity between a seed pixel and its neighboring pixels in terms of spectral-morphological characteristics. The obtained
segmentation result was further refined by a region merging procedure to generate a final segmentation result. The proposed method has been evaluated using three VHR images of urban and suburban areas and compared with two existing segmentation methods, in terms of visual inspection, quantitative evaluation and indirect evaluation. Experimental results demonstrate that the joint use of spectral and morphological information outperformed the use of morphological information alone. Furthermore, the proposed image segmentation method performed better than existing methods. The proposed image segmentation method was well applicable to the segmentation of VHR imagery over urban and suburban areas.

**Zhongwu Wang et al.** [8] introduced a new automatic Region-based Image Segmentation Algorithm based on k-means clustering (RISA), specifically designed for remote sensing applications. The algorithm includes five steps: k-means clustering, segment initialization, seed generation, region growing, and region merging. RISA was evaluated using a case study focusing on land-cover classification for two sites: an agricultural area in the Republic of South Africa and a residential area in Fresno, CA. High spatial resolution SPOT 5 and Quick Bird satellite imagery were used in the case study. RISA generated highly homogeneous regions based on visual inspection. The land-cover classification using the RISA-derived image segments resulted in a higher accuracy than the classifications using the image segments derived from the Definiens software (eCognition) and original image pixels in combination with a minimum-distance classifier. Quantitative segmentation quality assessment using two object metrics showed RISA-derived segments successfully represented the reference objects.

**Jorge E. Patino et al.** [6] discussed the applications of satellite remote sensing to regional science research in urban settings. Regional science was the study of social problems that have a spatial dimension. The availability of satellite remote sensing data has increased significantly in the last two decades, and these data constitute a useful data source for mapping the composition of urban settings and analyzing changes over time. The increasing spatial resolution of commercial satellite imagery has influenced the emergence of new research and applications of regional science in urban settlements because it is now possible to identify individual objects of the urban fabric. The most common applications found in the literature are the detection of urban deprivation hot spots, quality of life index assessment, urban growth analysis, house value estimation, urban population estimation and urban social vulnerability assessment. The satellite remote sensing imagery used in these applications has medium, high or very high spatial resolution, such as images from Landsat MSS, Landsat TM and ETM+, SPOT, ASTER, IRS, Ikonos and Quick Bird. Consistent relationships between socio-economic variables derived from censuses and field surveys and proxy variables of vegetation coverage measured from satellite remote sensing data have been found in several cities in the US. Different approaches and techniques have been applied successfully around the world, but local research was always needed to account for the unique elements of each place. Spectral mixture analysis, object-oriented classifications and image texture measures are some of the techniques of image processing that have been implemented with good results. Many regional scientists remain skeptical that satellite remote sensing will produce useful information for their work. More local research has been needed to demonstrate the real potential and utility of satellite remote sensing for regional science in urban.

**Jianyu Chen et al.** [15] proposed a new approach to multi-scale segmentation of satellite multispectral imagery using edge information. The Canny edge detector was applied to perform multispectral edge detection. The detected edge features were then utilized in a multi-scale segmentation loop, and the merge procedure for adjacent image objects has been controlled by a separability criterion that combines edge information with segmentation scale. The significance of the edge was measured by adjacent partitioned regions to perform edge assessment. The present method has based on a half-partition structure, which was composed of three steps: single edge detection, separated pixel grouping, and significant feature calculation. The spectral distance of the half-partitions separated by the edge was calculated, compared, and integrated into the edge information. The results show that the proposed approach works well on satellite multispectral images of a coastal area.

**Jianqiang Gao et al.** [9] proposed an efficient method to solve the classification problem for remote sensing image. Remote sensing image classification was different to identify the best classification model due to lack of a suitable classification method. Most traditional approaches only focused on using the spectral or spatial information to train classification model. However, these methods may ignore the related information of the image itself. Remotely data not only a mere collection of independent and identically distributed pixels. Therefore, an efficient classification method has been introduced in this paper [9]. The proposed method deals with the information provided by the remote sensing image. Based on the idea of fisher linear discriminant analysis (FLDA), a definition of the same areas and different areas are considered in images, the information of same areas associated with each pixel has been modeled as the within-class set, and the
information of different areas associated with mean pixel of each same areas has been modeled as the between-class set. Therefore, a projection matrix (PM) can be obtained by using within-class and between-class sets with the help of FLDA criterion. Then the PM was jointly used for the classification through a support vector machine (SVM) or K-nearest neighbor (KNN) classifiers formulation. An experiment on two remote sensing images was performed to test and evaluate the effectiveness of the proposed method.

Xueliang Zhang et al. [11] proposed a Boundary-Constrained Multi-Scale Segmentation (BCMS) method. Firstly, adjacent pixels are aggregated to generate initial segmentation according to the local best region growing strategy. Then, the Region Adjacency Graph (RAG) was built based on initial segmentation. Finally, the local mutual best region merging strategy has been applied on RAG to produce multi-scale segmentation results. During the region merging process, a Step-Wise Scale Parameter (SWS) strategy has been proposed to produce boundary-constrained multi-scale segmentation results. Moreover, in order to improve the accuracy of object boundaries, the property of edge strength was introduced as a merging criterion. A set of high spatial resolution remote sensing images was used in the experiment, e.g., Quick Bird, Worldview, and aerial image, to evaluate the effectiveness of the proposed method. The segmentation results of BCMS were compared with those of the commercial image analysis software eCognition. The experiment shows that BCMS can produce nested multi-scale segmentations with accurate and smooth boundaries, which proves the robustness of the proposed method.

Calderero et al. [16] proposed an unsupervised region merging techniques providing a set of the most relevant region-based explanations of image at different levels. These techniques were characterized by general and non parametric region models, with neither color nor texture homogeneity assumptions, nor a set of innovative merging criteria, based on information theory statistical measures. The scale consistency of the partitions was assured through i) a size regularization term into the merging criteria and a classical merging order, or ii) using a novel scale-based merging order to avoid the region size homogeneity imposed by the use of a size regularization term. Moreover, a partition significance index was defined to automatically determine the subset of most representative partitions from the created hierarchy. Most significant automatically extracted partitions show the ability to represent the semantic content of the image from a human point of view. Finally, a complete and exhaustive evaluation of the proposed techniques was performed, using not only different databases for the two main addressed problems (object-oriented segmentation of generic images and texture image segmentation), but also specific evaluation features in each case: under- and over segmentation error, and a large set of region-based, pixel-based and error consistency indicators, respectively.

Xueliang Zhang et al. [13] proposed a hybrid region merging (HRM) method to segment high-resolution remote sensing images. HRM integrates the advantages of global-oriented and local-oriented region merging strategies into a unified framework. The globally most-similar pair of regions was used to determine the starting point of a growing region, which provides an elegant way to avoid the problem of starting point assignment and to enhance the optimization ability for local-oriented region merging. During the region growing procedure, the merging iterations are constrained within the local vicinity, so that the segmentation was accelerated and can reflect the local context, as compared with the global-oriented method. A set of high-resolution remote sensing images has been used to test the effectiveness of the HRM method, and three region-based remote sensing image segmentation methods were adopted for comparison, including the hierarchical stepwise optimization (HSWO) method, the local-mutual best region merging (LMM) method, and the multi resolution segmentation (MRS) method embedded in eCognition Developer software. Both the supervised evaluation and visual assessment show that HRM performs better than HSWO and LMM by combining both their advantages. The segmentation results of HRM and MRS were visually comparable, but HRM can describe objects as single regions better than MRS, and the supervised and unsupervised evaluation results further prove the superiority of HRM.

III. TECHNIQUES USED

3.1 Region Splitting and Merging:

The split-and-merge algorithm is composed by two steps. First, the method subdivides the entire image into smaller regions following a dissimilarity criterion. To divide the image, different strategies can be adopted such as a quad tree partition (where each region is subdivided into four equal regions) and a binary space partition (BSP) (where an optimal partition is selected to divide the region). Second, the neighbor regions obtained from the splitting step are merged if they verify a similarity criterion. These similarity and dissimilarity criteria can be based on an intensity range, gradient, contrast, region statistics, or texture. The combination of splitting and merging steps allows for the segmentation of arbitrary shapes, which are not constrained to vertical or horizontal lines, as occurs if only the splitting step is considered. Region splitting and merging divide an image initially into a set of arbitrary, disjoint regions and
then merge and/or split the regions in an attempt to satisfy the necessary conditions.

3.2 Region Growing:

It can be classified as a pixel-based image segmentation method as it involves the choice of initial seed points. This method starts with initial “seed points” and then examines neighboring pixels (using either 4-connectivity or 8-connectivity) to find out perhaps the pixel neighbors ought to be added with the region. The method is iterated on, in the exact same manner as general data clustering algorithms. The region growing algorithm is described as:

(i) Select several seed points. Seed point selection is dependent on some user criterion (for example, pixels in a particular gray-level range, pixels evenly spaced on a grid, etc.). The first region begins as the complete precise location of the seeds.

(ii) The regions are then grown from these seed points to adjacent points according to a location membership criterion.

The criterion could be pixel intensity, gray level texture or color. Due to the fact the regions are grown on the building blocks of the criterion, the image information itself is important. For instance, if the criterion were pixel intensity, examine the adjacent pixels of seed points. If they've the same intensity value with the seed points, classify them to the seed points. It is surely an iterated process until there's no change in two successive iterative stages. The suitable choice of seed points is just a significant issue.

3.3 Fuzzy C-Means Algorithm:

In fuzzy clustering (also referred to as soft clustering), data elements can belong to more than one cluster, and associated with each element is a set of membership levels. These indicate the strength of the association between that data element and a particular cluster. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters. One of the most widely used fuzzy clustering algorithms is the Fuzzy C-Means (FCM) Algorithm. The FCM algorithm attempts to partition a finite collection of N elements into a collection of c fuzzy clusters with respect to some given criterion. Given a finite set of data, the algorithm returns a list of C cluster centres and a partition matrix W.

In fuzzy clustering, every point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster may be in the cluster to a lesser degree than points in the center of cluster. The algorithm minimizes intra-cluster variance as well, but has the same problems as k-means; the minimum is a local minimum, and the results depend on the initial choice of weights. Using a mixture of Gaussians along with the expectation-maximization algorithm is a more statistically formalized method which includes some of these ideas: partial membership in classes. Fuzzy c-means has been a very important tool for image processing in clustering objects in an image.

3.4 Dynamic Statistical Region Merging:

Statistical region merging (SRM) is an algorithm used for image segmentation. The algorithm can be used to judge the values within a regional span and grouped together based on the merging criteria resulting a smaller list. Using the Statistical Region Merging (SRM) for remote sensing image segmentation, the result is unsatisfactory. To improve the segmentation accuracy and the correctness Dynamic Statistical Region Merging (DSRM) is introduced. It tries to let probably the most similar regions to be tested first. Initially, it redefines the dissimilarity based-on regions. Then, it dynamically updates the dissimilarity and adjusts the test order during the task of merging. The accuracy of the DSRM is higher than the SRM and its computational complexity is approximately linear.

IV. PROBLEM FORMULATION

Gaps in literature

1. The segmentation performance relates closely to the scale but the scale is selected manually in majority of the existing research.

2. The use of fuzzy logic to find automatic scale value is not used in existing research.

Problem Definition

Using the Statistical Region Merging (SRM) for remote sensing image segmentation, we produce poor result. To enhance segmentation accuracy and the correctness, a Dynamic Statistical Region Merging (DSRM) has also been considered. It tries to let probably the most similar regions to be tested first. Initially, it redefines the dissimilarity based-on regions. Then, it dynamically updates the dissimilarity and adjusts the test order during the process of merging. To remove the problem of manual scale selection, this dissertation will use the combination of fuzzy logic and Dynamic Statistical Region Merging (DSRM) in order to automatically select scale value. Different kind of remote sensing images will also be considered for experimental purpose.

V. OBJECTIVES

1. To evaluate the performance of remote sensing image segmentation using dynamic statistical region merging algorithm.
2. To design an algorithm by using a combination of fuzzy logic and dynamic statistical region merging in order to automatically select scale value.

3. To draw comparison between existing (DSRM) and proposed technique following parameters will be considered.
   - Accuracy
   - Geometric Accuracy
   - F-Measure
   - Sensitivity
   - Specificity

VI. TOOL USED

MATLAB is a tool for numerical computation and visualization. The basic data element is a matrix, so the user need a program that manipulates array-based data. It is fast to write and run in MATLAB as it provides interactive environment for design and problem solving. It provides vast library for linear algebra, statistics. Filtering, optimization and solving ordinary differential equations.

VII. METHODOLOGY

The Flow chart of the proposed methodology is explained below:

Start

Read Remote Sensed Image

Evaluate Scale Value using Fuzzy logic

Apply Dynamic Statistical Region Merging (DSRM) algorithm using Fuzzy based Scale value

Evaluate Parameters

End

CONCLUSION AND FUTURE SCOPE

In this paper, a survey on various image segmentation techniques has been done. The dynamic statistical region merging algorithm creates an initial partition of segments, which are listed in an area of adjacency graph to be forward processed by the proposed hierarchical merging technique. It has been concluded that the segmentation performance relates closely to the scale but the scale is selected manually in majority of the existing research. Also, the use of fuzzy logic to find automatic scale value is not used in the existing research. Therefore, in future an algorithm is designed using a combination of fuzzy logic and dynamic statistical region merging (DSRM) in order to automatically select scale value.

REFERENCES


