Active Contours based SAR Image Segmentation with G^0- Statistical- Model

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Abstract— **This paper present a rapid algorithm for synthetic aperture radar (SAR) image segmentation based on the G0-Statistical-Model. The proposed approach considers the segmentation of SAR images as an intensity minimization problem in a variation framework. The energy (intensity) functional is formulated based on the statistical characteristic of SAR images. The total change regularization is used to impose the smoothness restraint of the segmentation result. To solve the problem efficiently the energy functional is firstly modified to be convex and differentiable by using convex relaxing and variable dividing techniques, and then the constrained optimization problem is change to an unconstrained one by using theG0 statistical model. Finally the energy is minimized with loss of minimization algorithm. The effectiveness of the proposed algorithm is validated by experiments on both synthetic and real SAR images.**

Index Terms— **Image segmentation, multiphase model, synthetic aperture radar(SAR),active contours.**

I. INTRODUCTION

Synthetic Aperture Radar (SAR) can penetrate clouds and work in nighttime, which make it becomes an important remote sensing field .In SAR images have been applied to increasingly wide fields such as land cover classification [2], target detection [3].and information retrieval [4]. Segmentation is a key step for interpreting Synthetic Aperture Radar (SAR) images [1]. Many applications require segmenting of the SAR images processing. In many approaches have been proposed to arrange with it, SAR image segmentation is calm a challenge task due to the complexity and low quality of SAR image.

Using of variation methods in image segmentation has been popular in past decades [5,8]. Because variation models can combine image information and prior information in a unified framework, the Segmentation results are more powerful compared to some classical Methods. Furthermore, variation methods have solid theoretic Foundation, and mature mathematical tools can be used to formulate and solve segmentation problems.

In general, to develop a variation approach for image segmentation, the energy functional is firstly defined by using various image features [9]. The minimum of the energy functional corresponds to the desired segmentation of images. the problem of image segmentation is equal to an energy minimization problem. The performance of a variation segmentation approach is decided by two factors: the ability of used features to explain the image characteristics and the efficiency of the optimization method that used to minimize the energy functional. The first one decides the effectiveness of the segmentation approach, and the second one decides the efficiency of the algorithm.
For SAR image segmentation, the statistical property of SAR image intensity or amplitude is often used to difference different regions. In [10] Gamma distribution based variation active contour models for SAR image segmentation are presented. The authors of [12] also consider using the Weibull model. The mixture model of Log-Normal model is used to disconnected land and water in SAR images. In this paper, we use the G0 model to fit SAR data . The reason is that among various Statistical models, the G0 model shows to be a very flexible one which can describe all kinds of external part of something. It is particularly suitable when SAR images become very assorted, for example, when city area presents in the image or the high resolution.

In this paper, we present a fast variation SAR image Segmentation approach based on the G0 model, a variation SAR image segmentation model which Uses a total variation regularized maximum chance of something happening formulation is proposed. Thanks to the efficiency of the G0 model, the proposed approach can deal with SAR images with different degrees of homogenous. Then a variable splitting technique is combined with to minimize G0 model the energy functional. The efficiency of the inverse problems in image processing has been demonstrated [12].

In this paper, we focus on the segmentation of SAR images within the framework of variation active contour models.First; we define the energy functional by unifying the region information and the boundary information. the G0 model is utilized to define the likelihood function. The G0 model is first proposed to model SAR images of heterogeneous and extremely heterogeneous areas .It is particularly suitable for high-resolution SAR image description. Nevertheless, research studies have shown that it can model homogeneous areas in medium- and low-resolution SAR images too. Thus, it appears to be a very

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flexible model for different classes of SAR images. By introducing the G0 model, it is hoped that the proposed model will be adequate for segmenting SAR images with different resolutions and homogeneous degrees. Moreover, unifying of regional information and edge information makes the proposed model different from the models. Which only take the statistical property into consideration? Second, unlike the level set method which uses the Heaviside function to represent regions, in the proposed approach, membership functions and region indicator functions are used for region representation. We show that, by doing this, the energy functional is convex with respect to the membership functions. Thus, the local minimum problem associated with the traditional level set method can be avoided. As the fast split Bergman iteration method [14] can be employed to solve the minimizing problem and the "re initialization" is not needed for fuzzy membership functions, the computation is easy and efficient.

II. RELATED WORK

The goal of segmentation of SAR images is to obtain regions that are homogeneous with respect to some image feature such as grayscale intensity, color, and texture. In statistical framework, it can be formulated as an ML estimation problem following the Bayes rules [11]. Obtained with our energy functional and the energy functional in [10] are compared by using a simulated high-resolution SAR image. It is observed that better segmentation result can be obtained with the G0 model than with the gamma model. This is because the G0 model can well describe the heterogeneity caused by the high resolution.

Second, the boundary information is used in our functional, which makes our energy functional different from those in [10] and [2] which also use the G model for SAR image modeling. Edge information is important information in SAR images. It has been proved by previous research studies that integrating boundary information into the energy functional will help to locate the boundary contours more precisely [5]. Thus, the segmentation accuracy will increase with the proposed model. However, although, by using level set, the regions and boundaries can be represented naturally, minimization of the energy functional (9) is computationally expensive. There are three reasons. First, the energy functional (9) is non convex with respect to level set functions; thus, no global minimum could be guaranteed. When gradient-descent-like approach (which is usually employed in level set minimization procedure procedure)is used, the curves might fall into local minimums which often correspond to undesired segmentation result. Moreover, in level set curve evolution, the speed function is diffused to the entire image domain via the Dirac functions. However, at positions that are far from a curve, the value of the Dirac function is very small (nearly zero). Thus, the curve evolution is slow since only pixels in the neighborhood of curves can be affected. Finally, to keep the level set function to be a signed distant function, the computationally expensive "re initialization" step is often added as a remedy during the curve evolution, which will dramatically slow down the algorithm. In the next section, those problems will be coped with by modifying the energy functional and adopting fast minimizing schemes.

The energy functional (6), the level set method is a common choice. However, it is inherently computationally expensive, making it hard to apply. Many improved methods have been proposed. The fast marching method and narrow-band method are the early efforts to reduce the computational burden for level set methods. The additive operator splitting method is utilized to replace the gradient descent method in .A large time step can be used to speed up the algorithm, but the computational complexity is still at the same level. Recently, several alternative methods for active contour minimization problems have been proposed with outstanding performance in the view of computation. In , a nearly real-time level-set-like method is proposed. However, for this method, only pixels nearby the curve are considered when evolving, and it can handle only splitting of the curve. Some methods use the fuzzy membership functions to ensure a fast iteration procedure. Other methods design the energy functional to have global minimum. Then, fast numerical schemes are proposed to obtain the global minimum of those energy functional However, most of those works are devoted to bimodal segmentation problems. Inspired by the work in [11] and , we propose in this paper a fast minimization approach for the multiphase segmentation energy functional.

In the framework of processing Synthetic Aperture Radar (SAR) images a crucial problem is defined by the need to develop correct models for the statistics of the pixel engry. In the current research report, we address the difficulty of parametric probability density function (puff) estimation for modeling the amplitude distribution for high resolution SAR images. Hitherto, several hypothetical and heuristic models for the pdf of SAR data have been proposed in the information, most of them being proven to be highly effective for some particular land-cover classification. Thus, being given some SAR image with no prior information about the topology, the choice of a single optimum SAR parametric puff becomes a hard task. In this detail, we prosper an estimation algorithm addressing the problem of puff chance by adopting a finite mixture model (FMM) for the amplitude pdf, by mixing components belonging to a given dictionary of SAR-specific puffs. The proposed method automatically merge the procedures of selection of the optimal model for each component, of limit estimation, long with the optimization of the number of components, by combining the Stochastic Expectation Maximization (SEM) iterative methodology and the recently proposed "method-of-log-cumulates" (Mold) for parametric pdf estimation for non-negative random variables. Experimental results on various real.

III. G0 MODEL OF SAR IMAGES

In a SAR images are inevitably corrupted by speckle noise. The existence of the inherent speckle noise humiliates the quality of SAR images. The edges and decreases the contrast between different regions. The multiplicative in non-Gaussian nature is adopting the state-of-the-art algorithms that designed to deal with optical images, in

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which the noise is often assumed to be additive Gaussian. To develop in good condition and effective algorithms for SAR image segmentation. Statistical modeling of SAR images has been an important. A Goodman derived several models for SAR images: the Rayleigh distribution for single-look amplitude images, the Nakagami distribution for most looker amplitude images and the Gamma distribution for most looker intensity images. His models are prevalent they are limited to middle resolution SAR images of homogenous external. Many other models have been proposed for SAR images, In a Waybill distribution and the K distribution. However, none of them are flexible enough to model all kinds of surfaces. In this paper, we use the G0 model to describe the statistical property of SAR images. The probability distribution function of the G0 model for amplitude and intensity SAR images, where L is the number of the looks, is the scale parameter, and is the parameter related to the homogeneity of the observing scene: more heterogeneous scene has bigger value .The G0 model has been proven to be a flexible model which can model areas With different degrees of homogeneity. Especially, it has the ability to model extremely heterogeneous areas, for which other distributions have timing performance.

A. ENERGY FUNCTIONAL MODIFICATION

In our process the level-set-based energy functional is local minimums exist and the segmentation result depends on the guess of the initial curve position. The bad initial guess leads to bad segmentation result. So we introduce the membership function N−1 to replace the Heaviside functions in level set formulation. The membership functions are constrained as larger uk(**x**) means that pixel **x** more likely belongs to region and vice versa.

B. NUMERICAL MINIMIZATION

We should needs to minimize the required area to perform the segmentation. The classical gradient-decent-based methods are utilized in this process. However, those methods are slow as the time step is constrained to be small to keep the algorithm stable. Here, we follow the split Bergman method. In technique for solving general L1-regularized problems. This method potential in geometric applications such as demising, segmentation, and surface reconstruction. The basic idea of the split Bergman method is to “decouple” the variables into the TV term and data-based fidelity term. Then, the Bergman iteration is used to minimize the energy functional efficiently without using regularization.

IV. CONCLUSION

An active contour model based approach for SAR image segmentation. The *G*0 statistical model is used to energy functional which makes the proposed method suitable to cope with different classes of SAR images. The energy functional is curving outward with admiration given by others to each membership function. In a fast minimizing course of action which is based on the split Bergmann redundancy can be choose to solve the energy minimization problem for ordain the segmentation. The effect brought about by something on Synthetic radar and real SAR images verify good accomplishment of the proposed method.

V. FUTURE WORK

The G^0 model, can describe the regions only with particular understandable elements of larger object and a few certain types of a statistical model has the so-called “regional” distinguishing. For the abundant - scale event, whose capacity are complex and landscape types are greatly, numerous, it is unrealistic to use the statistical models with a few parameters to defend the whole image. However, models with too many limits also cause situation requiring great effort in applications. Wherefore, it is a current to form a statistical model accompanying the “regional” distinguishing. Usually, Billingsley determine the fit of Rayleigh, Waybill, log-normal, and *K*-distributions to pixel magnitudes in clutter data and show via the *K-S* test that none fit strong accomplished the whole range of importance.

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