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Multi Objective Detection from High Resolution Satellite Images using Segmentation and Morphological Operation

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***Abstract*—** The proposed method breaks the color image into its individual color component and then fuzzy filter based canny Edge detection technique is applied. This technique depends on the fuzzy rule-based system using 2 X 2 window mask which is used to modify membership value of the image in different fuzzy sets (which means it will smoothen the image), and this filtered image is given as input to canny edge detection technique and finally after this morphological processing is used. The Performance Parameter becomes better by combining Fuzzy and Canny Edge Detection and also morphological operations. The results were compared with other edge detection techniques like interactive image segmentation by maximal similarity based region merging (MSRM) and Image segmentation using transition region. Therefore it is evident that the developed Algorithm provides Improved Performance parameters for detecting the edge against the wide range of Applications.

Keywords: **-** Image Segmentation, Fuzzy-canny Method, Morphological Operation, Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR)

I. INTRODUCTION

Over the past few years, Earth Remote Sensing (RS) data acquisition has increased significantly. The large numbers of satellite images are generated from variety of sources. With the advancement in sensor technology, different sensor systems are also on rise. Eventually, in the past decades, the spatial resolution of satellite imagery has been substantially improved [1]. The increase in spatial resolution has increased the amount of spatial content available in satellite imagery. This has facilitated various application areas such as Urban planning, Farming, Traffic Control, Agricultural mapping, etc. But, such high resolution imageries require a large amount of data storage [2, 3]. At the same time, image processing on such huge data sets require more computation time. The need for such huge datasets has motivated the researchers to optimize the satellite image processing algorithms to better process satellite images.

Satellite images hold information about the geographic features. But this information is extracted by the experts as per the requirement of the application domain. To extract out the information in an efficient manner the image segmentation, classification and feature extraction algorithms have always been in research over a few years. The advancement in sensor technology in providing higher spatial and spectral sensors has triggered the image processing domain to develop better methods to extract relevant information efficiently. Last decade has seen an impressive growth in the integration of various interoperable technologies coming together for information extraction [4].

The increase in spatial resolution has increased the scope for feature extraction. Extracting out the desired ground feature information from the satellite image is dependent on the context of the underlying layers. The satellite image consists of various geographic features and every feature shows certain characteristics. Thus contextual information is necessary to be considered while extracting out the desired feature. At the same time to extract out a feature from an image, the image should be segmented in such a way that the underlying segment showcases the required characteristics or properties. Segmentation thus helps in dividing the image into homogenous sections where each segment shows certain characteristics. For identifying the objects, segmentation helps in exploring the granularity of the image. Famous techniques which are still being used by the researchers are Edge Detection, Threshold, Histogram, Region-based methods, and Watershed Transformation [5].

The use of HR and VHR satellite imagery has provided a lot of contextual based segmentation methods to come up where the image object attributes are taken into consideration rather than the traditional segmentation approaches which were mostly pixel-based. The image segmentation process of RS imagery purely depends on the

problem domain and no such technique can be completely ruled out [6].
Fundamental steps in digital image processing are shown in Figure 1 Picture securing digitizes the picture caught by camera. Picture improvement is the way toward controlling a picture so the outcomes are progressively appropriate for explicit applications.

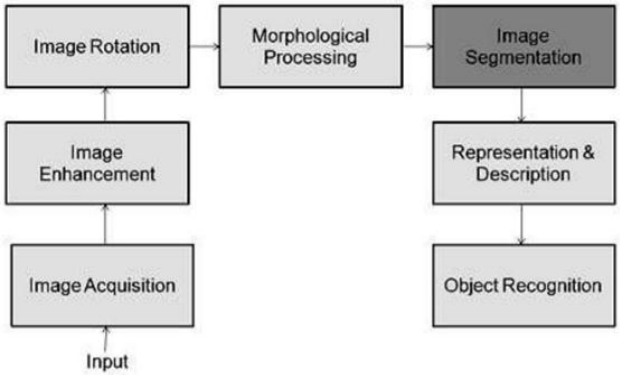

Figure 1: Fundamental Steps in Digital Image Processing

Picture rebuilding improves an appearance of a picture which watches out for probabilities model of picture debasement Morphological procedures are the devices of extricating picture segments that are helpful in the depiction and introduction of a picture. Picture division is the most troublesome ask in computerized picture handling which isolates objects from the foundation. Portrayal settles on the choice whether to speak to information as limit or as a total district. Acknowledgment is the procedure that doles out mark to an article dependent on data given by its descriptor.

II. MORPHOLOGICAL OPERATIONS

The morphological operations can be applied to both binary as well as gray scale images. The fundamental morphological set operations consist of union, intersection and complement. The operands of the set operations are the original data and data translated from the original with a reference shape called a Structure Element (SE). Given an object A which contains pixels a, that share some common property:

$$A = \{a \mid \text{property } (a) = \text{true}\} \quad (1)$$

and a vector x, the translation A+x is defined as:

$$A+x = \{a+x \mid a \in A\} \quad (2)$$

The morphological transformation must possess the following properties. Let F(y), be the morphological transformation, m{F(Y)} be the measure that describes the aspects of the object nature.
Translation invariance:

$$F(Y_z) = [F(Y)]_z \quad (3)$$

Where Y_z is the translation of 7 by a vector z
Scale invariance:

$$F_{\Lambda}(Y) = [\Lambda F(\Lambda^{-1}Y)] \quad (4)$$

Local Knowledge:
The transformation ^(Y) must require only information within a local neighborhood for its operation.
Semi continuity: The morphological transformation F{Y} must posses certain continuity properties.
The mathematical morphology has been developed into three aspects: Theoretical aspect, practical aspect including software and hardware and the applications of mathematical morphology in more domains. Geodesic transformations, morphological filters and the uses of multiscale morphology in image segmentation are the three theoretical concepts that have to be discussed.

Some of the salient features of mathematical morphology are given below:

- Morphological operations maintain the soundness of the significant geometric attributes for the methodical modification of the geometric substance of a picture.
- A well-created morphological polynomial math exists to utilize for portrayal and streamlining.
- Digital calculations can be communicated by little class of crude morphological tasks.
- There exist thorough portrayals hypotheses by methods for which one can acquire the outflow of morphological channels as far as the crude morphological activities.

Image Segmentation
An image is a collection of measurements in two-dimensional or three-dimensional space. Image may be acquired in the continuous domain such as on X-ray film, or in discrete space as in satellite. The location of each measurement is called a pixel in 2D discrete images whereas in 3D images, it is called a voxel. Segmentation subdivides an image into its non-overlapping constituent regions or objects which are homogeneous with respect to some characteristics such as intensity or texture. If the entire spatial region is represented by R, then the segmentation problem can be defined as to determine the segments (regions) $S_k \in R$ whose union is the entire image R.

There are different ways for segmentation process of satellite images that can be classified into the three strategies as follows:

Foreground segmentation: It focuses on the single object in the image. A good partitioning of foreground object is generally created using some specific segmentation criteria; whereas the quality of background partitioning has not so much relevance. That's why foreground segments are used for further processing. Some model knowledge is incorporated into the strategy for separating foreground segments from the background.

Hierarchical segmentation: A multi-resolution concept for gradual refinement is applied in hierarchical segmentation. Various smaller segments which are smaller than the smallest object are obtained in the first segmentation process. At the next level, some of these segments are merged into larger segments according to some domain knowledge about object appearance. Meaningful segments should be defined by a common criterion for the successful application of this strategy.

Multilayer segmentation: In this segmentation strategy, a common segmentation criterion is set up where scale factor varies throughout the image. Segmentation is performed at different scales and produces layer of segments. Unlike previous strategy, scale of a criterion varies for different structures in an image. As appropriate scale for every segment has to be established independently from other segments, the analysis of multilayer segmentation is quite difficult.

III. PROPOSED ALGORITHM

In gray-level images, edges have been typically modelled as brightness discontinuities. From an instinctive sense, it very well may be said that an edge is an obvious limit between two pixels with essentially unique splendor esteems. Here "fundamentally unique" may rely upon nearby pixel splendor insights for instance. This variety more often than not happens in light of the fact that an edge for the most part speaks to a physical limit between two items having various forces.

The word edge is used to refer to a location on the image where the brightness value appears to jump. These jumps are associated with high values of the first derivative and are the kinds of edges that were originally detected by Roberts.

Image segmentation is probably the most important task in image understanding. It is the dividing of a picture into a lot of non-covering areas whose association is the whole picture. The motivation behind picture division is to deteriorate the picture into parts that are significant concerning a specific application. Without good image segmentation, it is not possible to process the image appropriately and, therefore, to understand what it represents.

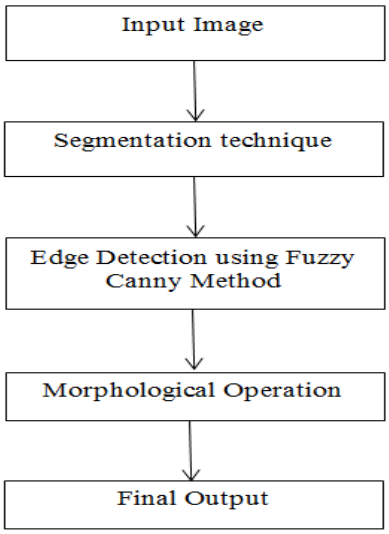

Figure 2: Flow Chart of Proposed System

The Remote Sensing symbolism should be changed over into valuable data to be utilized with other GIS. To extract meaningful information it is important to explore the granularity of image. Since the picture is comprised of pixels, it is significant how we separate the data from pixel information. The underlying work comprised of pixel by pixel investigation. With the increasing spatial resolution due to advent of new sensors in the 21st century, the pixel size has gradually reduced. Over the previous decade a great deal of study has been into item examination as opposed to the pixel investigation. This is because of the increase in spatial resolution of satellite imagery. The HR satellite imagery is able to hold more detailed information due to this. It is difficult to work just on a pixel by pixel premise as a solitary ground object when caught by the HR sensor currently holds significantly more data as gathering of pixels. In this manner these pixels together will in general display comparable qualities.

IV. SIMULATION RESULT

The error, smoothness, uniformity and processing time are obtained from the proposed image segmentation using fuzzy canny method algorithm. To properly classify the ground objects in satellite imagery it is important to perform field study. Since the work involves the use of satellite data, the field survey includes the identification of ground objects by visiting few points on the image. The location of these points is collected with the help of GPS handheld unit and the relevant ground features are captured through photographs.

Figure 3: Original Satellite Image

Figure 4: Original Gray Satellite Image

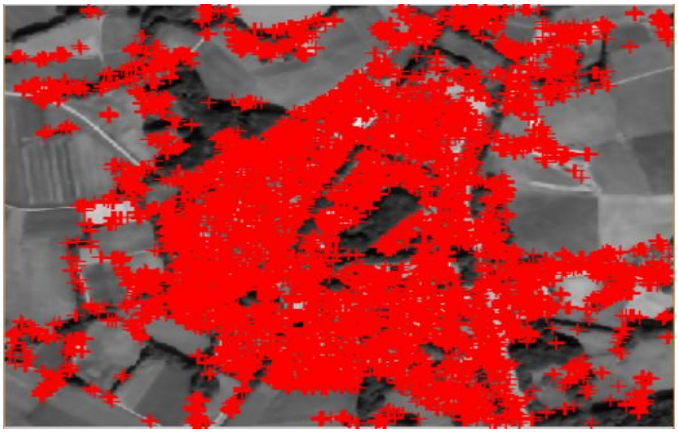

Figure 5: Filtering Image

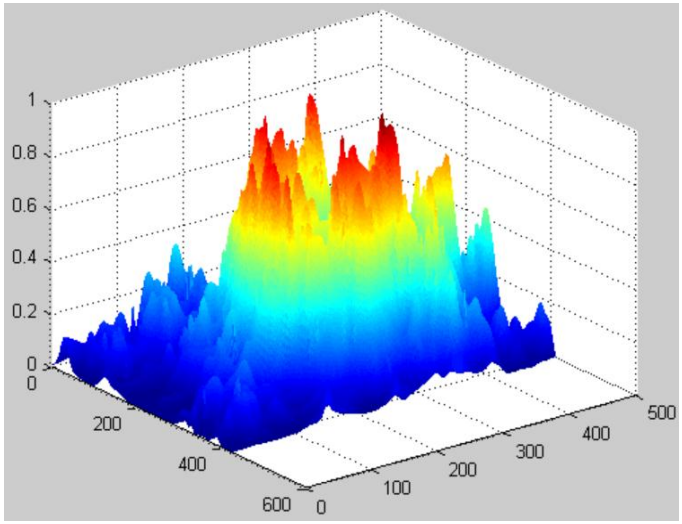

Figure 6: Histogram Image

Figure 7: Noise Free Multipoint Detection

Figure 8: Multi Objective Detection

Table 1: Comparison Result for MSE

Image	Previous Algorithm	Proposed Algorithm
Satellite-I	12.567	8.893
Satellite-II	11.903	8.445
Satellite-III	13.893	9.002

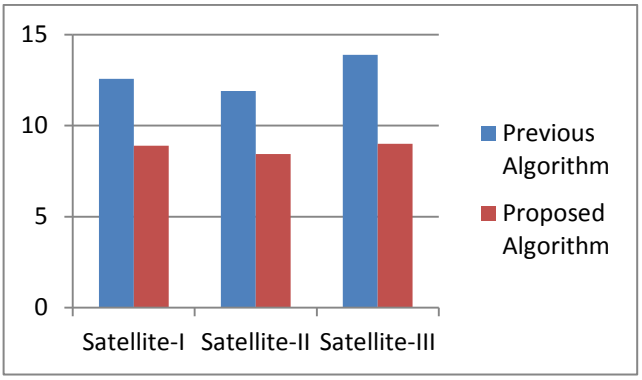

Figure 9: Bar Graph of Previous and Proposed Algorithm

Table II: Comparison Result for PSNR

Image	Previous Algorithm	Proposed Algorithm
Satellite-I	37.904 dB	43.076 dB
Satellite-II	36.990 dB	44.904 dB
Satellite-III	36.102 dB	42.792 dB

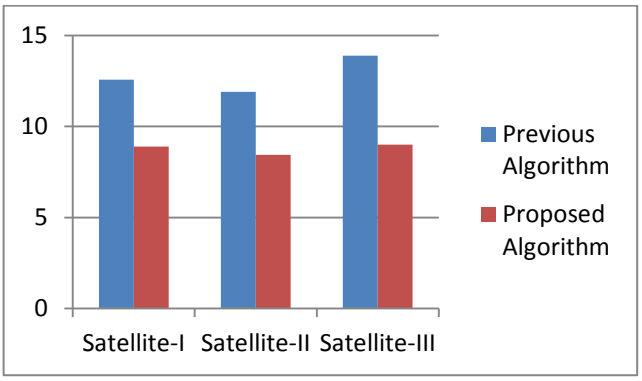

Figure 9: Bar Graph of Previous and Proposed Algorithm

V. CONCLUSION

In this paper a new segmentation technique is review using morphological operations. In first step edge is detected using Fuzzy Canny method which can give better results compared to classical techniques of edge detection and in second stage, after edge detected, basic morphological operators are applied which are dilation and erosion and also flood fill is used to segment the image. The developed image segmentation based morphological operation algorithm is providing improvised SNR, Smoothness, and Uniformity for different images compared with previous algorithm. The overall system performance is improved in terms of error.

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