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Research Article

Measurement of land using Satellite Images

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Abstract

In this method, image taken from satellite is used as input. Input image is preprocessed for removing noise and contrast adjustment. After preprocessing, detection of ROI is done for irregular and perfect region. Then region growing segmentation is used for accurate estimation of region that is for finding exact and accurate edges of ROI. This region is classified in different types such as land, water, forest etc. using SVM Classifier. Measurement of region is done in terms of pixels and these pixels are converted into actual measurement units.

Keywords: *region of interest, support vector machine.*

1. Introduction

Traditional way of land measurement requires human operators and this process is very complicated and time consuming. The images captured from satellite can be used for accurate measurements of land. It can be used for perfect shapes like square, circle as well as irregular shaped land measurements. It can be used for forest land measurements which are helpful for reducing unnecessary conflict and corruption in the field that have historically been connected to issues of land rights. In this project the images taken from satellite are used for accurate measurements of land. First the images are captured from satellite are pre-processed for noise removal & contrast adjustment. Then measurement of region is done in terms of pixels and these pixels are converted into actual measurement units such as mm^2, m^2, sq.fts etc. Using these method measurements can be done in very less time. There is no need to go to that place and take measurements; we can take land measurements from any place. The use of high resolution cameras installed on satellites like IKONOS, Worldview, Quick Bird, GeoEye-1 and 2 provided by commercial companies like DigitalGlobe, GeoEye and Rapid Eye having resolution ranging from 0.6 meters to 4 meters. This has created the need to detect objects for variety of applications like as site selection, flood management,

Military, urban and rural mapping of natural resources and of natural disasters, tax mapping, agriculture and forestry analysis, mining, engineering, construction, and change detection. These satellites transmit thousands of images per unit time, and there is a need to process these images automatically without human intervention. The segmentation process is one of the first steps in the remote sensing image analysis. The image is partitioned into regions which best represent the relevant objects in the scene. Region attributes such as area, shape, statistical parameters and texture can be extracted and used for further analysis of the data. The segmentation task can be accomplished in two ways. It is dividing up the images into a number of homogeneous regions, each having a unique label and determining boundaries between homogeneous regions of different properties. These segmentation techniques are known as region-based segmentation and edge detection, respectively. Region-based segmentation always provides closed contour regions which are a requirement in many applications. Simple and effective in many applications. Errors in the regions boundaries are the main drawback of this approach: edge pixels might be joined to any of the neighbouring regions. Among region-based segmentation approaches are region growing methods.

2. Literature Survey

2.1 Old Methods of Land Measurement

Using Gunter's chain

Gunter chain was designed and introduced in 1620 by English clergyman and mathematician Edmund Gunter (1581–1626).The chain is divided into 100 links, marked off into groups of 10 by brass rings which simplify intermediate measurement. Each link is 7.92 inches long, with 10 links making slightly less than 6 feet 8 inches. The full length of the chain is 66 feet. A square link is exactly one hundred-thousandth of an acre and one ten-thousandth of one square chain or

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0.0404685642 m^2. It is about 62¾ square inches.

Using metal tapes

To measure distances, land surveyors once used 100-ft long **metal tapes** that are graduated in hundredths of a feet. Distances along slopes are measured in short horizontal segments. Skilled surveyors can achieve accuracies of up to one part in 10,000 (1 centimetre error for every 100 meters distance). Sources of error include flaws in the tape itself, such as kinks; variations in tape length due to extremes in temperature; and human errors such as inconsistent pull, allowing the tape to stray from the horizontal plane, and incorrect readings.

2.2 Current Methodes of Land Measurement

Using levelling instrument

A levelling instrument is positioned midway between a point at which the ground elevation is known (point A) and a point whose elevation is to be measured (B). The height of the instrument above the datum elevation is HI. The surveyor first reads a back sight measurement (BS) off of a levelling rod held by his trusty assistant over the benchmark at A. The height of the instrument can be calculated as the sum of the known elevation at the benchmark (ZA) and the back sight height (BS). The assistant then moves the rod to point B. The surveyor rotates the telescope 180°, and then reads a foresight (FS) off the rod at B. The elevation at B (ZB) can then be calculated as the difference between the height of the instrument (HI) and the foresight height (FS).

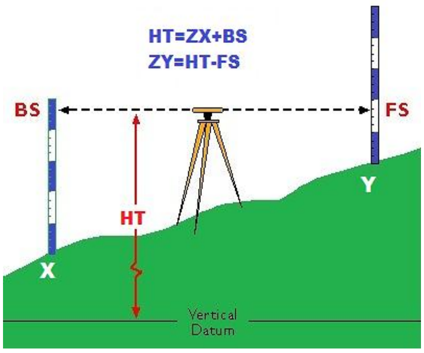


Fig.1 Differential levelling

HT- height of the instrument elevation.
ZX- elevation at X
ZY- elevation at Y
FS- foresight height
BS- backsight height

Why region growing is used in this project?

1.Region growing methods can correctly separate the regions that have the same properties we define.

2.Region growing methods can provide the original images which have clear edges with good segmentation results

3.The concept is simple. We only need a small number of seed points to represent the property we want, and then grow the region

4.We can determine the seed points and the criteria we want to make

5.We can choose the multiple criteria at the same time

6.It performs well with respect to noise.

Why not neural network is used?

1. Poor Transparency: Neural networks operate as "black boxes".

2. Trial-and-error design: The selection of the hidden nodes and training parameters is heuristic.

3. Data hungry: Estimating the network weights requires large amounts of data, and this can be very computer intensive.

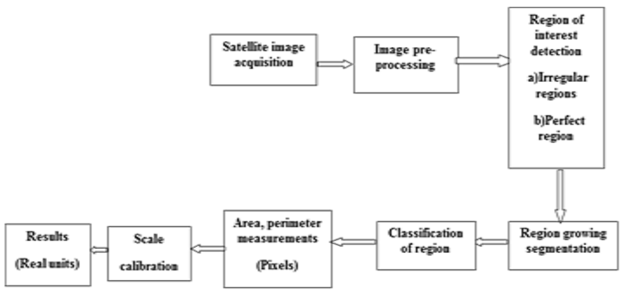
4. Over-fitting: If too many weights are used without regularisation, Neural network become useless in terms of generalisation to new data.

5. There is no explicit set of rules to select the most suitable Neural network algorithm.

6. Neural networks are totally dependent on the quality and amount of data available.

7. Neural network techniques are still rapidly evolving and they are not yet robust.

3. Methodology



3.1 Image pre-processing

Impulse noise is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel. Two common types

of impulse noise are the salt-and-pepper noise and the random-valued noise. For images corrupted by salt-and-pepper noise (respectively, random-valued noise), the noisy pixels can take only the maximum and the minimum values (respectively, any random value) in the dynamic range. There are many works on the restoration of images corrupted by impulse noise. The median filter was once the most popular nonlinear filter for removing impulse noise because of its good denoising power and computational efficiency. However, when the noise level is over 50%, some details and edges of the original image are smeared by the filter [Qiyao Yu and David A. Clausi, Senior Member, IEEE (December 2008)].

It consists of taking at 256*256 image and adding noise to it and converting a noise image into a matrix and then dividing an entire matrix into 3×3 siding window. Then the pixel values 0's and 255's in the image i.e. the pixel values responsible for the salt and pepper noise are removed from the image. Then the median value of the remaining pixels is taken. This median value is used to replace the noisy pixel. This filter is called trimmed median filter because the pixel values 0's and 255's are removed from the selected window.

Image enhancement is a process involving changing the pixels' intensity of the input image, so that the output image should subjectively looks better. The purpose of image enhancement is to improve the interpretability or perception of information contained in the image for human viewers, or to provide a "better" input for other automated image processing systems. There are many image enhancement methods have been proposed. A very popular technique for image enhancement is histogram equalization (HE). This technique is commonly employed for image enhancement because of its simplicity and comparatively better performance on almost all types of images. The operation of HE is performed by remapping the gray levels of the image based on the probability distribution of the input gray levels. It flattens and stretches the dynamic range of the image's histogram and resulting in overall contrast enhancement [Manpreet Kaur, Jasdeep Kaur, Jappreet Kaur (2011)].

3.2 Region based segmentation

In this system region growing segmentation technique is used. Region is nothing but the group of pixel with similar properties. It is important concept in image segmentation because region may corresponds to objects in a scene. Consequently for correct segmentation we need to partition an image into regions that correspond to objects or parts of an object. The main goal of segmentation is to partition an image into regions. The region based segmentation is partitioning of an image into similar or homogenous areas of connected pixels through the application of similarity criteria among candidate sets of pixels. Each of the pixels in a region is similar with respect to some characteristics or computed property such as colour, intensity, texture.

In this system we present a region growing technique for colour image segmentation. Region growing is a simple region-based image segmentation method. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points. Conventional image segmentation techniques using region growing requires initial seeds selection, which increases computational cost & execution time. To overcome this problem, a single seeded region growing technique for is proposed, which starts from the centre pixel of the image as the initial seed. It grows region according to the grow formula and selects the next seed from connected pixel of the region. Region Growing is an approach to image segmentation in which neighbouring pixels are examined and added to a region class if no edges are detected. This process is iterated for each boundary pixel in the region.

Region Growing offers several advantages over conventional segmentation techniques. Unlike gradient and Laplacian methods, the borders of regions found by region growing are perfectly thin (since we only add pixels to the exterior of our region) and connected. The algorithm is also very stable with respect to noise.

This approach to segmentation examines neighbouring pixels of initial seed points and determines whether the pixel neighbours should be added to the region. The process is iterated on, in the same manner as general data clustering algorithms. A general discussion of the region growing algorithm is described below. Means that the segmentation must be complete that is, every pixel must be in a region. Deals with the properties that must be satisfied by the pixels in a segmented region, the main goal of segmentation is to partition an image into regions. Some segmentation methods such as thresholding achieve this goal by looking for the boundaries between regions based on discontinuities in gray scale or colour properties. Region-based segmentation is a technique for determining the region directly. The basic formulation is:

[Raymond H. Chan, Chung-Wa Ho,(OCTOBER 2005)]

a)$\cup_n^{i=1}$ R=R. Means that the segmentation must be complete; that is, every pixel must be in a region.

b)Ri is a connected region, i = 1, 2, …, n. Requires that points in a region must be connected in some predefined sense.

c)Ri ∩ Rj = Ø for all i = 1, 2, …, n. Indicates that the regions must be disjoint.

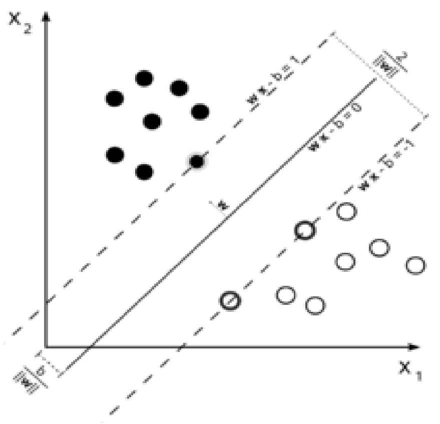
d)P(Ri) = TRUE for i = 1, 2, …, n. Deals with the properties that must be satisfied by the pixels in a segmented region. For example P(Ri) = TRUE if all pixels in Ri have the same grayscale.

e)P(Ri ∪ Rj) = FALSE for any adjacent region Ri and Rj. Indicates that region Ri and Rj are different in the sense of predicate P P(Ri) Is a logical predicate defined over the points in set Ri and Ø is the null set.

3.3 Types of SVM

1. Linear SVM
2. Nonlinear SVM

Here we are using non-linear SVM.



Given some training data D, a set of *n* points of the form $D = \{(x_i, y_i) \mid x_i \in R^p, y_i \in \{-1,1\}\}_{i=1}^{n}$
where the y_i is either 1 or −1, indicating the class to which the point x_i belongs. Each x_i is a *p*-dimensional real vector. We want to find the maximum-margin hyperplane that divides the points having $y_{i=1}$ from those having $y_i = -1$.
$w.x - b = 0$
where · denotes the dot product and w the (not necessarily normalized) normal vector to the hyperplane. The parameter $\frac{b}{||w||}$ determines the offset of the hyperplane from the origin along the normal vector w.
If the training data are linearly separable, we can select two hyperplanes in a way that they separate the data and there are no points between them, and then try to maximize their distance. The region bounded by them is called "the margin". These hyperplanes can be described by the equations
$w.x - b = 1$
and
$w.x - b = -1$
By using geometry, we find the distance between these two hyperplanes is $\frac{2}{||w||}$, so we want to minimize ||w||.
As we also have to prevent data points from falling into the margin, we add the following constraint: for each i either
$w \cdot x_i - b \geq 1$ *for* x_i of the first class
or
$w \cdot x_i - b \leq -1$ *for* x_i of the second.
This can be rewritten as:
$y_i(w \cdot x_i - b) \geq 1$, *for all* $1 \leq i \leq n$.

We can put this together to get the optimization problem:
Minimize ||w|| subject to (for any $i=1,\ldots,n$)

$y_i (w \cdot x_i - b) \geq 1$

The optimization problem presented in the preceding section is difficult to solve because it depends on ||**w**||, the norm of **w**, which involves a square root. Fortunately it is possible to alter the equation by substituting ||w|| with $\frac{1}{2}||w||^2$ (the factor of 1/2 being used for mathematical convenience) without changing the solution (the minimum of the original and the modified equation have the same **w** and b). This is a quadratic programming optimization problem. More clearly:

$\arg\min_{(w,b)} \frac{1}{2} ||w||^2$ subject to (for any $i=1,\ldots,n$)

$y_i(w.x_i - b) \geq 1$

By introducing Lagrange multipliers, the previous constrained problem can be expressed as

$\arg\min_{w,b} \max_{\alpha \geq 0} \{ \frac{1}{2} ||w||^2 - \sum_{i=1}^{n} \alpha_i [y_i(w.x_i - b) - 1] \}$

that is we look for a saddle point. In doing so all the points which can be separated as $y_i(w \cdot x_i - b) - 1 > 0$ do not matter since we must set the corresponding α_i to zero.
This problem can now be solved by standard quadratic programming techniques and programs. The "stationary" Karush–Kuhn–Tucker condition implies that the solution can be expressed as a linear combination of the training vectors

$w = \sum_{i=1}^{n} \alpha_i y_i x_i$

Only a few α_i will be greater than zero. The corresponding x_i are exactly the *support vectors*, which lie on the margin and satisfy $y_i(w \cdot x_i - b) = 1$. From this one can derive that the support vectors also satisfy

$w.x_i - b = 1/y_i = y_i \Leftrightarrow b = w \cdot x_i - y_i$

Writing the classification rule in its unconstrained dual form reveals that the *maximum-margin hyperplane* and therefore the classification task is only a function of the *support vectors*, the subset of the training data that lie on the margin.

Using the fact that $||w||^2 = w.w$ and substituting $w = \sum_{i=1}^{n} \alpha_i y_i x_i$, one can show that the dual of the SVM reduces to the following optimization problem:
Maximize (in α_i)

$\tilde{L}(\alpha) = \sum_{i=1}^{n} \alpha_i - \frac{1}{2} \sum_{i,j} \alpha_i \alpha_j y_i y_j x_i^T x_j = \sum_{i=1}^{n} \alpha_i - \frac{1}{2} \sum_{i,j} \alpha_i \alpha_j y_i y_j k(x_i, x_j)$

subject to (for any i=1,…,n)

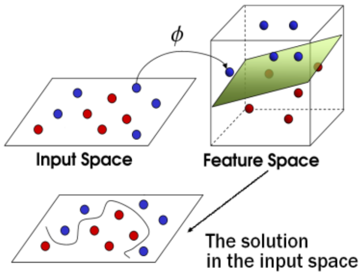
$\alpha_i \geq 0$,

and to the constraint from the minimization in *b*

$\sum_{i=1}^{n} \alpha_i y_i = 0$

Here the kernel is defined by $k(x_i\, x_j) = x_i \,.\, x_j$.
w can be computed thanks to the α terms:

$w = \sum_i \alpha_i y_i \mathrm{x}_i$



Working in high dimensional space is computationally expensive. If we look again at the optimization problem.

maximize $L_D(\alpha) = \sum_{i=1}^{n} \alpha_i - \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_i \alpha_j y_i y_j\, \phi(x_i^t)\phi(x_j)$
$s.\ t\ \alpha_i \geq 0\ \sum_{i=1}^{n} y_i\, \alpha_i = 0$

And the decision function:

$f(\phi(x)) = sign(w^t \phi(x) + b) = sign\,(\sum_{i=1}^{n} \alpha_i\, y_i\, \phi(x_i^t)\phi(x)+b)$

A *kernel function* is defined as a function that corresponds to a dot product of two feature vectors in some expanded feature space:

$K(x_i, x_j) \equiv \phi(x_{ij})^T \phi(x_j)$

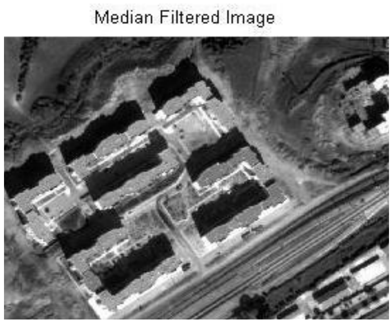
Now we only need to compute and we don't need to perform computations in high dimensional space explicitly. This is what is called the Kernel Trick.

4. Result

4.1. Image Pre-processing

1. Noise Removal

Here we are using median filter to remove salt and paper noise.

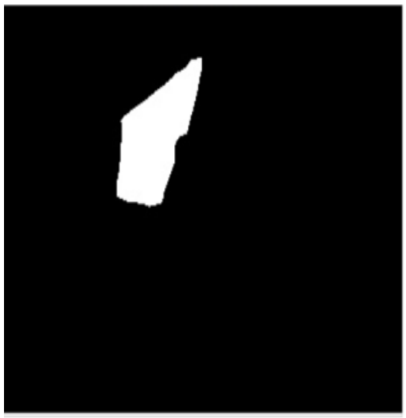


2. Histogram Equalisation

It flattens and stretches the dynamic range of the image's histogram and resulting in overall contrast enhancement.

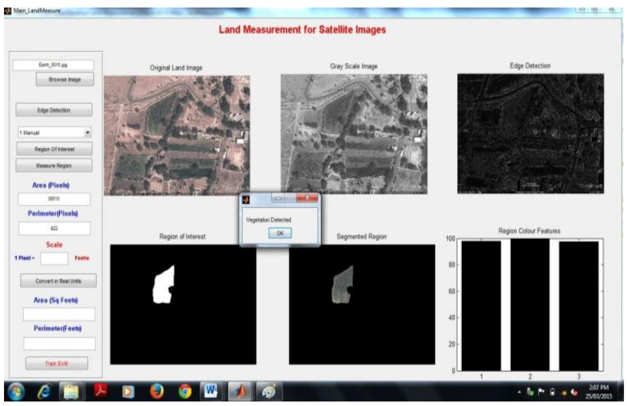
4.2. Region Growing Segmentation

Original Image   Gray Scale Image

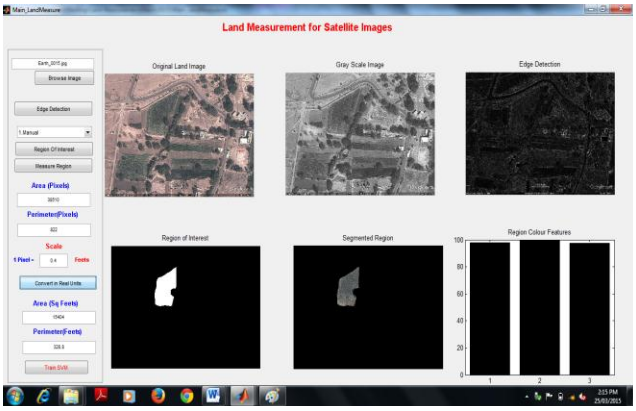


Region Growing

4.3 Classification of Region



4.4 Final measurement of land in GUI



Conclusions

Traditional way of land measurement requires human operators and this process is very complicated and time consuming. But in our project necessity of human operators is reduced. It can be used for perfect shapes like square, circle as well as irregular shaped land measurements. It gives accurate measurement of land. Here region growing segmentation is used whose algorithm implementation is faster as compared to to artifitial neural network algorithm. Hence time requirement is less. In this project, using SVM technique image is classified into various region like forest area, water and vacant land.

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