Indonesian Journal of Electrical Engineering and Computer Science
Vol. 3, No. 3, September 2016, pp. 579 ~ 585
DOI: 10.11591/ijeecs.v3.i2.pp579-585

Building Segmentation of Satellite Image Based on Area and Perimeter using Region Growing

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Abstract

A building can be known by look shape, color, and texture. The building can be detected by using many methods and can be count population density in the area. Region growing is one simple segmentation method because only use seed point. Before segmentation, the image through pre-processing step include sharpening, binarization by the Otsu's method. Sharpening for clarifying image and otsu method changed image valued 0 and 1. Next step is post-processing include segmentation using region growing and opening-closing operation. The last process is detection building where a building of detection will be signed. In this research, we present region growing for building segmentation by using both area and perimeter as an important variable in the region growing.The value of area more than 10 and perimeter is more than 50 are produced most of the building.

Keywords*: building, region growing, area, perimeter*

1. Introduction

Photogrammetry and remote sensing techniques create geospatial data for big areas with suitable accuracy. Automatic detection of physical objects such as bonds, buildings, and road in satellite images is advantageous in many significant purposes as well as formation and upkeep of accurate geographical databases, evaluation of an extent of destruction after natural disasters as floods or earthquakes and military operations [1]. Building detection is interest topics in remote sensing. Many methods used in building detection based on segmentation, because segmentation has many properties such as shape, color, and texture to label them as a building or non-building objects. Buildings are built by non-vegetation roof resources and are well – known from greatly cluttered background, mainly, by their rectangular shapes and related shadows [2]. Building segmentation is an early process of detection, which building have many functions for future research.

Much previous research to detect building in computer vision, remote sensing and photogrammetry. In paper [3] discuss automatic building detection based on purposive fastICA (PFICA) algorithm using monocular high-resolution Google Earth images. Caglar S, et al., [4] propose a self-supervised decision fusion framework for building detection. The combination between hough transform and region growing is used for urban road extraction [5]. Besides that, a combination of approximate triangulation and region growing for efficient segmentation and smoothing of range images [6]. Implementation of area and perimeter are used in the detection of watermelon seeds exterior quality based on machine vision [7]. Chunyang Mu, et al., [8] using object segmentation and piecewise fitting on lane detection.

In this research, present about region growing for building segmentation by using both parameters is area and perimeter. Satellite image get from Google Earth images of Google corporation with scale 50.0 meters. The first step is preprocessing consist of sharpening and Otsu's method. Sharpening used to enhancement image of original image and Otsu's method used to be change image to black and white. The second step is region growing and opening-closing, a function of region growing for image segmentation and simple segmentation method, then opening-closing for fixing the structure of an image.he last process is detection which finds image of a building and not building using perimeter and area then the image of building signed by red color.

Received April 2, 2016; Revised July 25, 2016; Accepted August 10, 2016

2. Region Growing

Image segmentation plays an important task in image analysisandconsidering as one of the difficult and challenging problems in image processing technology [9]. Region growing is a modest region-based image segmentation techniques. It is also categorized as a pixel-based figure segmentation technique since it includes an assortment of initial seed points. The method of segmentation is inspecting neighbor pixels of initial "seed points" and decides whether the pixel neighborhood should be enhanced to the area [10]. The concept of region growing segmentation is to use the image like data structure. Other common region growing method to series image segmentation create usage of local surface curvature [11].

3. Research Method

Process consist of three step pre-processing, post-processing, and detection. There is a flowchart of the research.

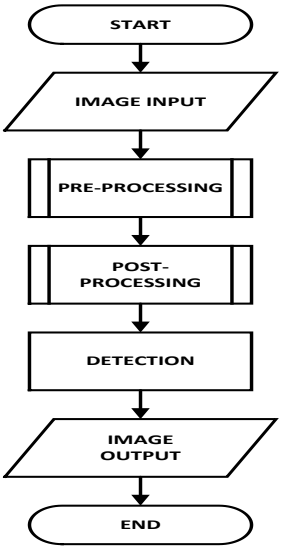

Figure 1. Flowchart of Research Method

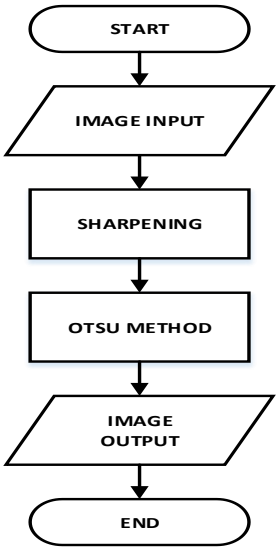

Figure 2. Flowchart of Preprocessing

3.1.Pre-Processing

Pre-processing consist of sharpening image and binarization with Otsu's method. follow this flowchart of pre-processing (Figure 2).

3.1.1. Sharpening

Pre-processing is imperative, and even indispensable, because the accuracy of subsequent operations (e.g., image classification, enhancement, segmentation, and parameter estimation) is widely affected by the quality of the filtered image [12]. Sharpening of an image is using unsharp masking so that enhancement image for next process. The other methods is filtering process based on an adaptive window observation [13], which a piece pixel about P in the adaptive window, those pixels are showed as a noise or not, pixel that would be filtered is named P.

3.1.2. Otsu Method

Otsu's thresholding technique is one of largest thresholding technique in image segmentation that has simple purpose, effective and easy of implementation. Otsu technique decides optimal threshold by maximizing the between class variance and minimizing the class variances of the data in an categorized classes [14]. Otsu's method is calculating threshold (*T*) automatically based on input image. The approach used Otsu's method isused discriminant analysis for determining a variable can be differ of group two or more group appear naturally.

The discriminant analysis will maximum a variable so that divided both object and background. For example, threshold will be searched denoted by *k*. Value of *k* between 1 until *L*, by *L* = 255, following probability for pixel *i*:

$$P_i = \frac{n_i}{N} \quad (1)$$

Denoted,

P_i : probability for pixel *i*
n_i : total pixel by gray level *i*
N : total pixel on image

Zero and first cumulative moment and mean value showed in this formulas:

$$\omega(k) = \sum_{i=1}^{k} P_i \quad (2)$$

Denoted,

ω(k) : zero cumulative moment
k : threshold between 1 until 255
P_i : probability for pixel *i*

For the first cumulative moment can be calculated using formula in this below:

$$\mu(k) = \sum_{i=1}^{k} i.P_i \quad (3)$$

Dentoted,

μ(k) : first cumulative momen
k : threshold between 1 until 255
i : threshold between 1 until *k*
P_i : probability for pixel *i*

Mean value can be calculated using formula:

$$\mu_T = \sum_{i=1}^{L} i.P_i \quad (4)$$

Denoted,

μ_T : mean value
L : 255
i : threshold between 1 until 255
P_i : probability for pixel *i*

Threshold k can be defined by maximum equation:

$$\sigma_B^2(k^*) = max_{1 \le k \le L} \sigma_B^2(k) \quad (5)$$

Denoted,

σ_B : variansi
k : threshold between 1 until 255

The last process is calculated of variance showed as this formula:

$$\sigma_B^2 = \frac{[\mu_T \omega(k) - \mu(k)]^2}{\omega(k)[1-\omega(k)]} \quad (6)$$

Denoted,

σ_B : variance
ω(k) : zero cumulative moment
μ(k) : first cumulative moment
μ_T : mean value

3.2. Post-Processing

In post-processing consist of region growing and opening-closing. Follow this is flowchart from post-processing step:

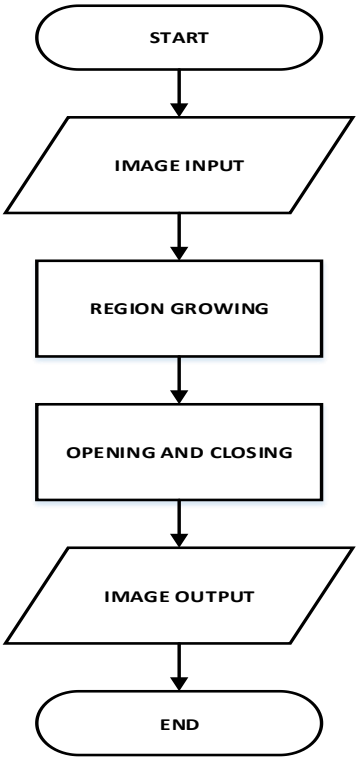

Figure 3. Flowchart of Post-Processing

3.2.1. Region Growing

Region growing is one popular segmentation in digital image processing. Region growing is a approach method for image segmentation by begin from some pixel that representation image area of different and developed so that can be create more area at the image.In this research, region growing not begin from seeds instead of initial of region get from binary segmentation.

3.2.2. Opening and Closing

Morphology have two bases operator, dilation and erosion usually used for component extraction desire in the image. Based on two operator, can be inherited two operators that use for enhancement subinterval component boundary have been extracting, both opening and closing. Operators of morphology is:

Dilasi : $I \oplus E = \{z \mid (\hat{E}_z) \cap I \neq \emptyset\}$
Erosi : $I \ominus E = \{z \mid (E)_z \subseteq I\}$
Opening : $I \circ E = (I \ominus E) \oplus E$
Closing : $I \bullet E = (I \oplus E) \ominus E$

Where I is component of image and E is structuring element.

3.3. Detection

Detection in this research using area and perimeter. Area and perimeter are ones important variable in region growing especially in detection process. Area is the amount of surface in the 2D shape covers. Perimeter is the total distance around the outside of a 2D shape.

4. Result and Analysis

Result from this research show in the Figure 4:

Figure 4. Result of research (a) original image, (b) sharpening image, (c) otsu image, (d) region growing image, (e) opening and closing image, (f) detection image

Referring to the result, original image appears blurry for processing in the next step so that need for enhancement by using sharpening where the original image will be clarified. Furthermore, the sharpening image will be changed into biner image by using otsu method so the image have value 0 and 1 (255). Next step is region growing which used for noise remove in the image and get image without noise. Both Opening and closing are used for combining small size pixel so that will ease for detection process. Detection is using area and perimeter variable where building of detection will be signed in red line as showed figure in above. Analysis of the research showed by Table 1.

Table 1. Analysis of Parameter and Area

Area	Parameter	Amount of Building
>10	>50	10
>20	>100	6
>30	>150	4
>40	>200	4
>50	>250	4

The amount building of detected at value of area more than 10 and parameter more than 50 is 10 building, value of area more than 20 and parameter more than 100 is 6 building, and value of area more than 30, 40, 50 and parameter more than 150, 200, 250 have a same result is 4 building. For the result using precision and recall as show in Table 2:

Table 2. Accuracy Computation

		System	
		TRUE	*FALSE*
prediction	*TRUE*	*TP*	*FN*
	FALSE	*FP*	*TN*

Value of *TP, FN, FP,* and *TN* show at the Table 3.

Table 3. Value of Each TP, FN, FP, and TN

		System	
		TRUE	*FALSE*
prediction	*TRUE*	*7*	*0*
	FALSE	*3*	*0*

From the Table 3 can be counted precision and recall as follow:

Precision = *TP / (TP + FP)* = 7 / (7 + 3) = 7 / 10 = 0.7 x 100% = 70 %
Recall = *TP / (TP + FN)* = 7 / (7 + 0) = 7 / 7 = 1 x 100% = 100%
Accuracy = *(TP + TN) / (TP + TN + FP + FN)*
= (7 + 0) / (7 + 0 + 3 + 0) = 7 /10 = 0.7 x 100% = 70%

Segmentation of buildings in urban areas, especially dense urban areas, by using remotely sensed images is highly desirable can get error 50% between image and original building, accuracy with proposed ENVI EX algorithm only adding 12% and 24% from previous research [15].

5. Conclusion

Building segmentation using region growing still have disadvantages where in the detection not really building so that must be fixed for next research. Area and perimeter are used affect to detection result in this research using area more than 10 and perimeter more than 50. Moreover, the result only perimeter that affect in the building segmentation. In the future, can be added other method after segmentation for recognition building, which use for counting population density in the area.

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