Automatic Detection of Buildings from Aerial Images Using Color Invariant Features and Canny Edge Detection

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Abstract— **Automatic detection of damaged buildings from aerial and satellite images is an important problem for rescue planners and military personnel. A method for detecting the buildings from high resolution color aerial images is proposed in this paper. The aim is to extract the buildings from high resolution color aerial images using color invariance property and canny edge detection technique. The buildings on the aerial images are 2-dimentional structures which are mostly made up of regions having borders being straight line which depicts edges in the images. The color information in the aerial image using a specific color index is extracted. The green area is separated by vegetation green from color aerial image. Then the primary colored roofs such as blue and red is segmented with the help of the primary color bands, such as red, green and blue bands. Once red, blue roof tops are segmented and separated from the imagery. Using canny edge detection method, the other colored roof tops are also segmented. Our proposed method is able to detect 85-90% buildings from color aerial images**

Keywords⎯ **Aerial Images, Building Detection, Canny Edge Detection, Color Based Segmentation, Color Index**

I. INTRODUCTION

Building detection from high resolution digital images has been a major research issue for more   than two decades. Manual detection of buildings from images requires an unacceptable amount of effort both in terms of time and cost.

The studies on automatic building detection aim to reduce the time taken for building detection and produce reliable results. The purpose of automatic building detection methods is to minimize the human intervention in the detection process and produce accurate results as in the manual detection method. Building detection study can be used in many applications such as military simulations, training and city planning, identification of illegal or unauthorized buildings etc.

In the current research this difficulty is solved by utilizing the color information gathered from the aerial imagery with the help of color invariance property and canny edge detection technique.

Many researchers developing building detection algorithms. T.Guo and Y.Yasuoka (2002) used snake-based approach to extract 2D building outlines from high resolution IKONOS satellite images and height data captured by air borne laser scanning system [6]. Some of the proposed methodologies include the use of additional information, such as Hough transform [7], multispectral and hyper spectral images [8].Beril Sırmacek and Cem U¨ nsalan used invariant color features for extracting red roof from color aerial images and extract the shadow information using grayscale histogram [2]. T. Kim and J.P. Muller. (1999) Used single aerial image for automatic building detection by utilizing a graph-based approach [3]. McKeown *et al.* detected shadows in aerial images by thresholding [1]. Matsuoka *et al.* also used shadows to model buildings. [5]. A. Huertas and R. Nevatia (1998) benefited from shadows as the supplementary data source which is used to verify the buildings in automatic building detection methods. [10], [9]

II. METHOLODGY

The building detection approach used in this paper is a model based method, the purpose of which is detecting rectilinear buildings. The buildings on the aerial images are 2D structures which are mostly made up of regions having borders being straight line. And these straight lines are the combinations of pixels in an image. The color information in the aerial image using a specific color index is extracted. Then the primary colored roofs such as blue and red is segmented with the help of the primary color bands, such as red, green and blue bands. Once red and blue roof tops are segmented and separated from the imagery, using canny edge detection method other colored roof tops are also segmented
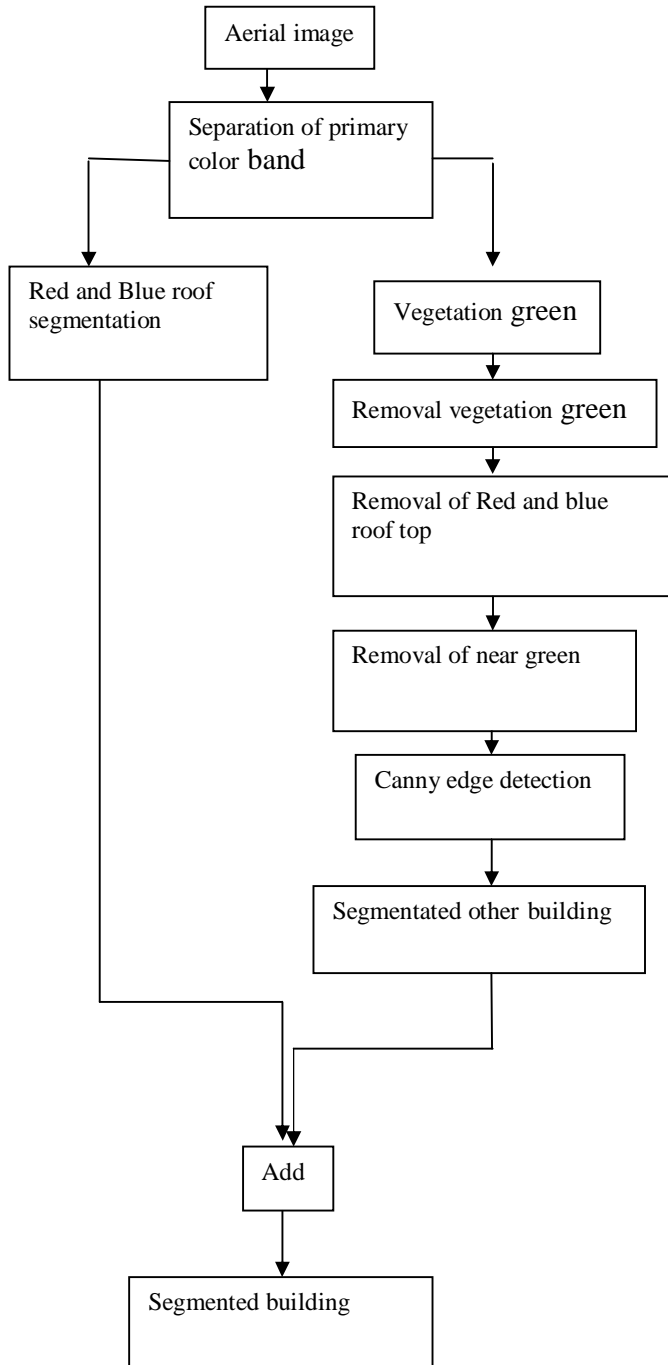
A. Flow chart

Aerial image

Separation of primary color band

Red and Blue roof segmentation

Vegetation green

Removal vegetation green

Removal of Red and blue roof top

Removal of near green

Canny edge detection

Segmentated other building

Add

Segmented building

Fig.1.Flow chart

B. Data Acquisition

A portion of a color aerial imagery of pixel to ground resolution of 10cm/pixel is shown in Fig.2. This imagery is provided by the Saroma-cho Local Government, Japan. This RGB imagery is of 1/2500 of scale ratio is analysed in the current research work.

Fig.2.Color aerial imagery of Saroma-cho, Japan [Image Courtesy: Saroma-cho Local Government, Japan]

III. BUILDING DETECTION.

A. Identify and Remove Vegetation Green.

Vegetation candidate pixels are identified by Otsu thresholding[12],[4], and a first-order color invariant then, given region, identified via the color segmentation algorithm, contains vegetation candidate pixels, then that entire region is labelled as a vegetation region.

The green area of color aerial image is separated by vegetation green. First of all maximize this green area by using this equation (1). After maximization of green color, Applied ostu thresholding method to segment out green vegetation and removed this vegetation using masking method [4].

$$\varphi_G = \frac{G}{R+G+B} \tag{1}$$

B. Detecting Red and Blue Rooftop

Color invariants help extracting color properties of objects without being affected by imaging conditions. Gevers and Smeulders [13] proposed several color invariants. We extract the color information in the aerial image using a specific color index based on a previous study [14] [4].

Calculate the thresholding value from equation (2) and (3) and separate out red and blue roofs by ostu's thresholding technique [12], [4] from color aerial image. Fig.3 and Fig. 4 shows the segmentation of red and blue roof tops

$$\varphi_R = \frac{4}{\pi}\tan^{-1}\left(\frac{R-G}{R+G}\right) \tag{2}$$

$$\varphi_B = \frac{4}{\pi} \tan^{-1}\left(\frac{B-G}{B+G}\right) \quad (3)$$

Where R stands for red band, B stands for the Blue band and G stands for the green band.

C. Addition of Red and Blue roof
After segmentation of Red and Blue roof, perform addition of blue and red roof [4].

D.Removal of Red and Blue roofs
The next stage of algorithm is to removal of red and blue roof from fig.2.

E. Segmentation and Removal of Near Green
For near green segmentation, calculate the thresholding value from equation (4) and segment near green region by ostu's thresholding technique and after remove near green area using masking method [4].

$$\varphi_{NG} = \frac{4}{\pi} \tan^{-1}\left(\frac{G-B}{G+B}\right) \quad (4)$$

F. .Edge Detection
Edge detection stage extracts the edges from the image. Among the several known edge detection algorithms (Sobel, Canny, LoG, Roberts).
Canny Edge Detection [11] algorithm is used in this paper to detect the edges..The Canny algorithm provides several advantages over the other edge detection techniques. The Canny edge detector is known to produce good results since it merges the broken lines.
Next, the edge detection algorithm is applied, (after the removal of near green area) to the color aerial image to produce edge pixels [4].

G. Road Separations
After edge detection, remove the roads and find other segmented building and add the segment red and blue roof top buildings. The result is shown in figure 4

IV .RESULTS

Fig.3 and Fig. 4 shows the segmentation of red and blue roof tops and Fig.5 shows the final output of segmented building.
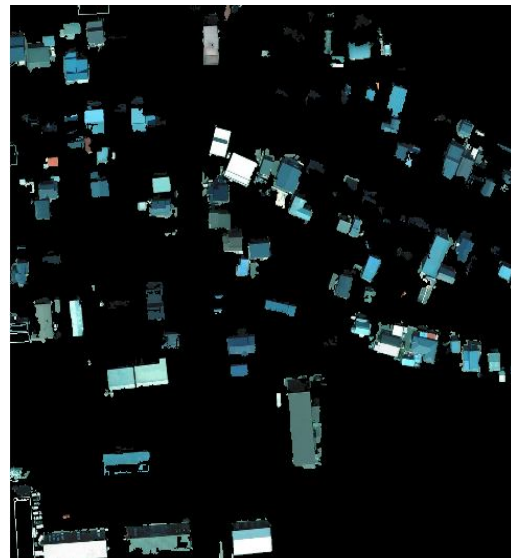

Fig.3. Red Roof Segmented

Fig.4.Blue Roof Segmented

Fig.5. final output of segmented building

V. CONCLUSION

This paper proposed an automatic method for detecting Building structures from high Resolution color aerial images. This approach is based on color invariant features and canny edge detection technique. Overall performance of the algorithm is actually determined by the poorest stage. First stage in the algorithm is the aerial image, the quality of the image is important since color based segmentation, and edge detection stages take this image as an input. Therefore, these stages performance depends on the image quality. Edge detection stage plays a key role in the algorithm. The parameters (low threshold, high threshold, and sigma) determine the success rate of this stage. The building detection rate can be improved or degraded by adjusting these parameters, such as by lowering the threshold value more buildings can be detected in the image but a lower threshold also catches more noise in the scene which will result in false

positives and an increased runtime of the algorithm. Another important stage in the algorithm is the line merging and removing stage. The threshold parameters to merge lines and remove lines can be adjusted to perform better for one image, but these values may not perform well for another image. In other words, it is difficult to find theoretically optimal solutions satisfying for all the images.

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