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Rectangular features extraction from aerial image of urban area

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Abstract: We purpose a model based approach to extraction of rectangular features of aerial image of urban area. We focus on reconstruction strategy that is restricted to constant rectangle which is defined by its interior's property of having constant or uniform intensity pixel. Examples of such rectangles appearing in input imagery are building's roofs, car parks and field boundaries. Extractions of geometrical objects are easier due to availability of many well known geometrical techniques. The model proposed in this paper makes use of the basic image processing techniques. Noise removal and image sharpening techniques are used to boost the input image. Then, the edges are extracted from the image using the Canny edge detection technique. The edges obtained are composed of discrete points. These discrete points are vectorized in order to produce straight line segments. This is performed with the use of the Hough transform and the perceptual grouping techniques. The straight line segments become the basic structures of the buildings. The straight line segments are grouped to apply segment pair matching technique. Finally, rectangles are constructed by using harries corner detection technique. In addition to rectangle construction, the rectangle size and the parameters used in the Hough transform and the perceptual grouping stages also affect the success of the proposed method. Due to the explicit representation of well defined processing states in terms of model based rectangle descriptions at all levels of modeling and data aggregation, our approach reveals a great potential for reliable rectangle extraction for building extraction

Keywords: Rectangle extraction; Building extraction; Canny edge detection; Harris corner detection; Noise removal techniques; Morphological filter; Smoothening

I. INTRODUCTION

Due to the fact that more than about 50% of the world population lives in urban or suburban environments the automation of manmade objects extraction such as buildings, cars, car parks, etc. is an issue of great importance and shows an increasing need for various applications including geo-information systems, town planning or environmental related investigations.

Automatic detection and description of cultural features, such as buildings, from aerial images is becoming increasingly important for a number of applications. Aerial images contain on the one hand a certain amount of information not relevant for the given task of building extraction like vegetations, cars and building details. On the other hand, there is a loss of relevant information due to occlusions, low contrast or disadvantageous perspective [1]. To compensate for these properties of image data as well as for being able to handle the complexity of building types and building structures, a promising concept of automated building extraction from aerial images must incorporate a sufficiently complete model of the objects of interest and their relations within the whole process of image interpretation and object reconstruction [2]. Hypotheses for rectangular roof components are generated by grouping lines in the images hierarchically; the hypotheses are verified by searching for presence of predicted walls and shadows. The hypothesis generation process combines the tasks of hierarchical grouping with matching at successive stages. [3]

For extraction of rectangle a problem occurs when the interior of a constant rectangle has the ambiguity of intensity pixels. The target constant rectangles cannot be precisely defined in an aerial image. Some features may be occluded by its surroundings. These cause problems to the extraction. For example four flat roofs could not be detected as four constant rectangles because the intensity of consecutive features is deceived by inconstant lighting. This development of the existing system aims to filter out unnecessary noise until there are only significant features to be dealt with. Therefore, many steps employed in this approach are to achieve noise reduction wherein many geometrical techniques are applied.

II. METHODOLOGY

The methodology for rectangular features extraction from aerial image of urban area involves three steps as below:

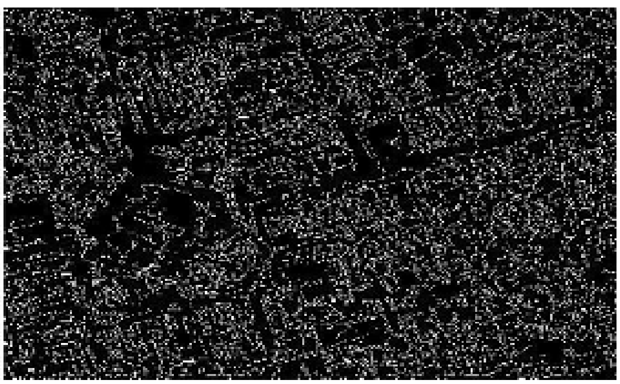
a. Noise reduction
   i. Edge detection.
   ii. Complement image.
   iii. Morphological Open operator.

iv. Morphological Erosion.

b. Rectangle construction
   i. Region filtering
   ii. Harris Corner Points Detection
   iii. Rectangle Construction

c. Rectangle Validation

Figure.1: (a) Original topographic image



(b) Canny edge image

A. Noise reduction:

i. Edge Detection:

Canny finds edges by looking for local maxima of the gradient of f(x, y). The gradient is calculated using the derivative of a Gaussian filter. The method uses two thresholds to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. Therefore, this method is more likely to detect true weak edges.

The implemented Canny edge detector presented the best performance both visually and quantitatively based on the measures such as mean square distance, error edge map and signal to noise ratio. Using the implemented Canny edge detector as an enhancement tool for remote sensing images, the result was robust and achieved a very high enhancement level [4].

For topographic image edge detection an image of Nanded city in Maharashtra, India is considered (image source: www.googlemap.com).

ii. Complement Image:

This process is to transform an edge image into regions as well as reduce unnecessary noise such as spurs to provide a clean region image [5]. Applying binary invert operator to the binary edge image gives a region image in binary with 1's where a region found a 0's elsewhere is given. In the complement of a binary image, black becomes white and white becomes black. This operation facilitates further morphological filtering and smoothing operations which are carried out in next phases for fine edge detection.

Figure.2 An inverted edge image

iii. Morphological Open operator:

Morphology relates to structure or form of objects. Morphological filtering simplified segmented images by smoothing out object outlines using filling small holes, eliminating small projections. Primary operations are dilation and erosion. These operations use a structuring element which determines exactly how object will be dilated or eroded. Dilation process expanding image objects by changing pixels with value of "0" to "1". On the other hand the erosion process shrinking binary objects by changing pixels with a value of "1" to "0". There is also a combination of dilation and erosion called opening and closing. Opening is erosion followed by dilation. Closing is a dilation followed by erosion.

Morphological edge detection algorithm selects appropriate structuring element of the processed image makes use of the basic theory of morphology including erosion, dilation, opening and closing operation and synthesization operations of them get clear image edge. The effect of erosion and dilation operations is better for image edge by performing the difference between processed image and original image, but they are worse for noise filtering. As opposed to erosion and dilation, opening and closing operations are better for filtering [6].

Then, in order to remove spike noise regions, opening operator [7] using a 3 x 3 square structuring element is applied to the region image for three times. The result is shown in the figure below.

Figure.3: An edge image obtained by operating three times morphological open operator.

iv. Morphological Erosion:

The morphological erosion operator is applied for localisation of edges [7] on Fig.3 image that shrinks region pixels in size which make clear image as sown below.

Figure.:4 A Eroded region image.

B. Rectangle Construction:

i. Region Filtering:

After completion of first step very much noise is removed but still region filtering is required before start rectangle construction step to remove the number of candidates. For this purpose size filter is used. In this model two threshold values are used lower and higher. If the size of region is smaller than lower threshold or greater than higher threshold, the region is considered as noise. This can be save computational time.

ii. Harris corner points detection:

Remaining region after region filtering are considered for corner detection. Harris corner detection method is used which is more suitable than the minimum Eigen value method. Harris corner detection method detects the corner points of region as shown in fig. 5. Detected corner points are used in next phase i.e. rectangle construction.

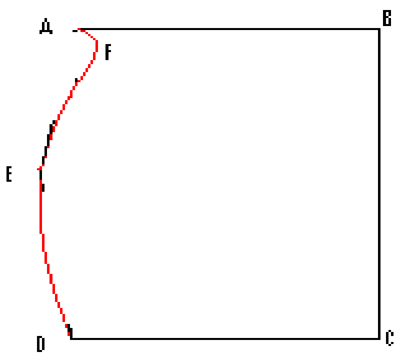


Figure. 5: corner point detection

iii. Rectangle construction:

In rectangle construction phase straight line segments are constructed which are parallel lines. Suppose the process of corner finding comes to the segment between point A and point D as shown in fig.6.

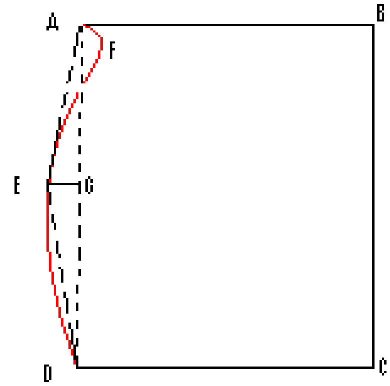


Figure.6: straight line segment finding.

If in between top left corner A and bottom left corner D, E corner is find out by corner finding method; distance of EG is compared with threshold and the line segment is considered as AD or AE and ED. In this way rectangle is constructed and test process is applied on every region as explained in next phase.

Rectangle Validation

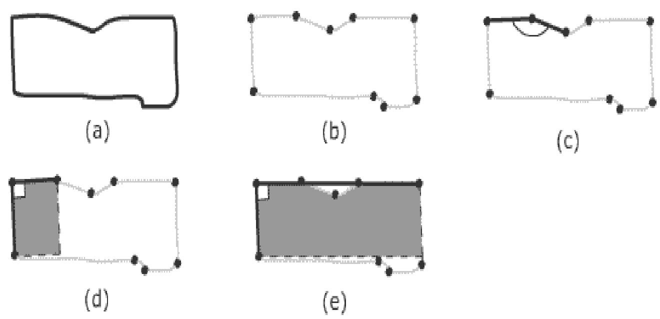


Figure. 7: Rectangle Validation Process

Fig.7(b) shows detected corner point of region shown in fig.7(a). In this phase any three point are selected and then the angle is compared is it 90 or not. In fig.7(c) the angle does not provide right angle hence these point are discarded for further process. Though the selection in fir.7(d) provides right angle; it provides larger outbox area. The reselection of point procedure is continued until the selection gives acceptable rectangle as shown in fig.7(e). After classification of region as a rectangle the next area is validated by applying the same process.

III. CONCLUSION

The proposed model is designed to extract rectangle not for the building, any this rectangular shape with a constant interior is extracted. There is no artificial intelligence mechanism is used to extract expected rectangle. The model has done reasonably well in constant rectangle extraction.

IV. REFERENCES

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