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Road Extraction in a very high resolution image based on Hough transformation and LBP operator

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Abstract:

This paper presents a novel algorithm of road detection in an image with very high spatial resolution based on Local binary patterns and Hough transformation. The very high resolution also allows a real representation of roads on a map, but also causes a significant increase in noise. This article proposes a road detection method using only the digital image as a source of information. It can detect and determine both the orientation of the road by exploiting some of their intrinsic properties by using the Hough transformation. This transformation dedicated to the extraction of the lines; for his power to extract linear structure. This approach generally provides good results in spite of some disadvantage. In particular, only the linear parts of the roads will be extracted, and in case of non-linearity method fails to extract these parts of roads. That is the reason why we will add texture presented by the LBP operators that enhance detection by removing the false detections found by Hough detector. The LBP method, introduced by Ojala is defined as a measure of invariant texture, derived from a texture in a local neighborhood.

The proposed approach has been tested on different images. The provided results demonstrate the effectiveness of the proposed method.

Keywords:
Road detection, Local Binary patterns, Hough transformation, Contour

Introduction:

The analysis of remote sensing images for the detection / extraction of road networks is a very important field of investigation and hold attention for twenty years.

The major problem is the complex structure of the images, which contain many different objects, such as roads, houses, trees, etc. with differences in shape, tone, the texture and the diversity of road widths.

A large number of publications about road extraction appeared and various approaches for road extraction have been proposed: Bacher and Mayer (2005), proposed an automatic road extraction technique from satellite images of rural and suburban areas, Lacoste et al. (2005) propose an approach which models the target line network by an object process, Grote and Heipke (2008), proposed a region-based approach on high resolution aerial images working from small local regions to roads as groups of road parts. Das et al. (2011), proposed a multi-stage automated system for extracting road networks from high-resolution satellite images which produces impressive results, Mnih and Hinton (2010)proposed the detection of roads which looks at a much larger context than was used in previous attempts at learning the task, Zheng et al. (1998) detected roads from satellite images by using filtering and edge detection processes and Ruisheng Wang and Yun Zhang, (2003) extracted roads from Quickbird images using classification techniques.

This paper presents a novel algorithm of road detection in an image with very high spatial resolution.

This algorithm based on the application of the Hough transformation method to detect the lines existed in the image, the result obtained gave straight lines which are not significant, does not correspond to a road.

The algorithm requires the addition of another supplement that's why we added another method LBP is to give meaning to the lines found.

The proposed approach:

Our approach begins by pretreatment, canny edge detection to reduce the number of edge points and connecting them.

Well sure, by applying the Hough transform. The results expected by the Hough transformation are less suitable [3] because some roads and especially the small roads will not be extracted. This is why, we added another operator to remedy this inconvenience. Here we will use a texture operator; is LBP.

The role of the LBP operator in this approach is the resolution of the false detection of the Hough transform, to achieve better results to complete detection roads whatever their shape.

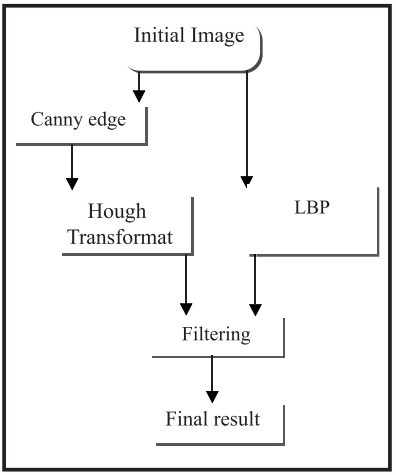


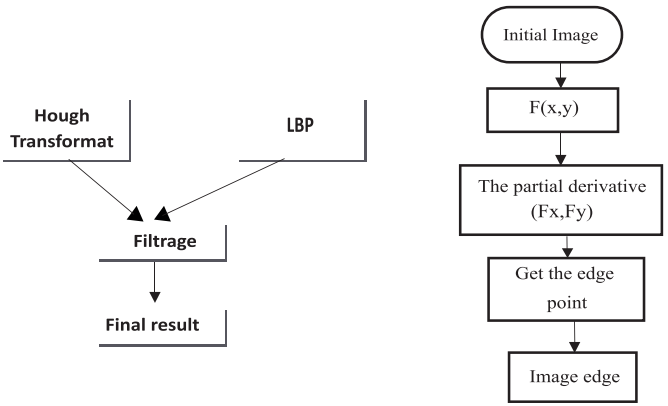
FIG. 1- Overall scheme of the method

1.Pretreatment (Canny)

Canny's edge detection algorithm [1] is well known as the optimal edge detection method, it works on three main principles: low error rate, well localization of edge points and one response to a single edge.

We used Canny in this part for delineate objects in the image, it will detect the contours from the derivates method based on the gradient.

The specific description of the Canny algorithm is shown in next figure:



This part helped us to calculate the following right for each contour point.

2. Hough Transformation

Hough Transformation (Hough, 1962) is the most popular method used to detect the straight line in digital images.

The idea of the Hough transform is that every edge position in the image votes for the descriptions of the curves where that edge position may belong to. The description of the curve with the most votes is most likely to be present in the image.

The line equation in Hough transform is given by:

$$\rho = x \cos \varphi + y \sin \varphi$$

3.Local Binary Patterns (LBP)

Local Binary Patterns is a technique is to index the local pattern in the neighborhood of a pixel P to image I [Porebski 2009 Pietikäinen 2011] [5][6].

The purpose of this technique is transforms an image into an array or image of integer labels describing small-scale appearance of the image, & advantage of this method is to generate a number of units of smaller textures.

The basic form of LBP, gray level value of each pixel is determined by its neighboring pixels located in a 3x3 block. According to Fig. 1, first the central pixel is compared with its adjacent pixels. Then, this binary pattern is multiplied by a weighted matrix with powers of two. Finally, the central pixel value is obtained by summation of these weighted elements. Since 3x3 neighborhood block may not accurately represent large scale structures, the basic LBP was extended to include all circular neighborhoods with any number of pixels.

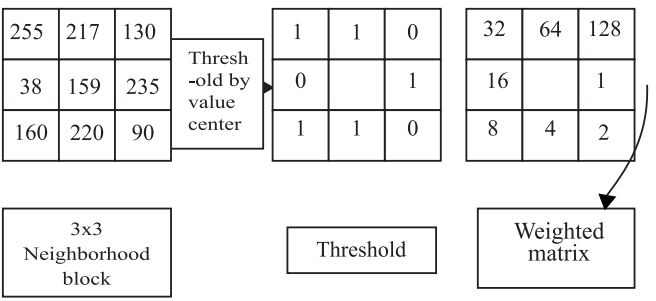


Fig: The basic operator LBP

4.combination of Hough transform and LBP

The results found by the two methods they are not yet significant.

We extract all lines existed in the image by Hough Transformation they are numerous and non significant, and in hand we found values of LBP in the image but the question which arises how to extract the road network based on these two method and how to detect the pixels between the road and other objects in the image ?

Then based on the hypothesis that assumes that the road is uniform.

If the road is uniform so the pixels that belong to the same road have LBP values more at least equal, and outside exactly from the edges of the road these values will be different.

According to this hypothesis we consider that the part where the road is uniform and the value of LBP more or less equal it is a road and other parties that have different values of LBP does not correspond to a road.

Finally we come to detect the pixels between the road and other objects in the image (roof of building…)

5.Filtering

We take two points any that belong to the road P(x,y) and Q(x,y), valp and valq are successively the values of LBP.

According the assumption that there are set concerning uniformity of road, valp and valq are equal valp = valq it is the same for all points on the road.

If the is one point that has the value of LBP different told that this point does not belong the road.

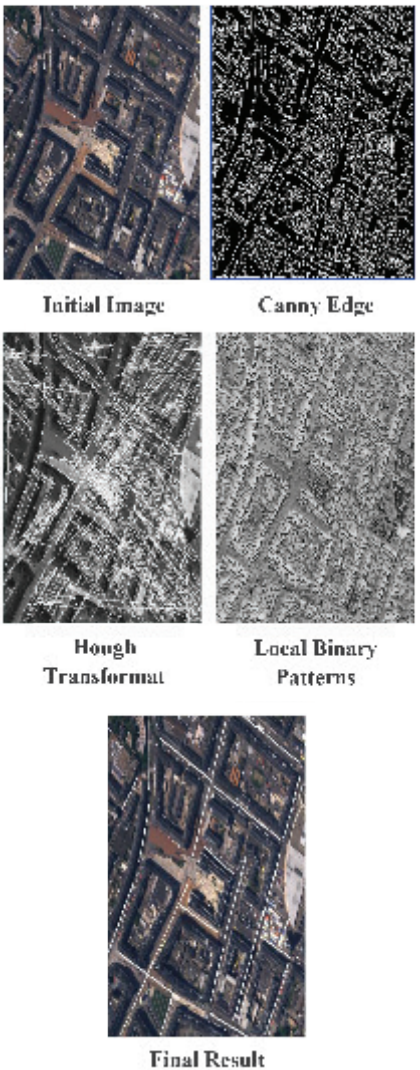
Finally we will filter the lines found by Hough Transformation, it will take just the straight lines that pass through areas found that the value of LBP more at least equal.

Here are some statistics on lines detected by the Hough transform and the filtered lines by applying the assumption of uniformly road.

Number of lines detected by HT	Number of lines filtred	Detection rate of the lines representing the road (%)	Detection rate of the lines in the image (%)
126	34	26	74

6.Results :

Fig. 13 shows the result after apply the Hough Transform to the image; the detected lines are remarked in yellow.



In this experiment, we use a computer Intel(R) Core(TM) 2 Duo CPU 2.09GHZ running under Windows XP is able to process approximately 30 cm. For software development, we use Opencv. The evaluation of each method is performed and measured by the quality and the accuracy of road extraction.

The proposed approach has been tested on several real images, an example of the results obtained from the road extraction process is proposed in Fig. I, in which one can notice that is able to correctly extract all the relevant roads in the image.

The results also show the efficiency of the method in the extraction of nonlinear roads.

The results obtained on the image show the good performance of the new operator based LBP.

Conclusion:

In this work, we developed the method to extract the road from image high resolution in the urban area, the results obtained with the method of Hough transform show that it is not enough to highlight any type of road but remains limited for linear structures.

The proposed model is particularly suited to the case of road network.

The application of this method has given satisfactory results exactly at adding texture LBP, which reinforced the result at the detection of non-straight roads, when the result of the approach is not limited to only extract the straight roads, but also to detect other types of roads.

Experimental results show that the LBP operator is more robust in the accurate detection of the road compared to the Hough transformation. It has better ability to extract the texture and better recognition accuracy of the lines.

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