Extraction Of Road Using Morphological Enhancement

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Abstract: In today's world of growing population, the need for urban planning is very high. In the scientific literature, multiple studies address the application of road extraction methodologies to a particular cartographic dataset. However, it is difficult for any study to perform a more reliable comparison among road extraction methodologies when their results come from different cartographic datasets. In this paper, a robust and efficient method for extraction of roads from a given set of database is explained. Roads play a vital role and important role in urban planning and thus, its extraction can be of great help. The other applications of road extraction are: identification of isolated buildings that need to be detected and updating of GIS database according to the requirements of the human expertise. In this method, roads are extracted solely based on their color. The steps in the algorithm are easy to follow and implement. It is also less time consuming and an automatic method.

Key words: Thresholding, Median filtering, Morphological operations.

1. INTRODUCTION

Road extraction plays one of the major roles in many applications regarding the betterment of present human lives. Thus, the need for road extraction using a robust and efficient method is also high. Currently, there are many ways to extract roads manually and automatically. Some of the methods are explained. The main disadvantage of the different given methods is the difficulty to provide the best parameters for a particular given image. Road extraction explained in this paper depends only on the color of the road. The advantage of this method is that road images from any type of satellite can be used provided it has more than 0.5m resolution. Here, the images considered are multispectral images. Multispectral images are those images that consist of three or more spectral bands. Any type of roads can be extracted based on their color.

The algorithm is implemented using MATLAB. The remaining part of the paper is organized as follows. The Literature Survey is given in section II. The proposed steps and extraction algorithms are explained in section III. Experimental results for the algorithm implemented are given in section IV. Finally the conclusion for the algorithm implemented is given in section V.

2. LITERATURE SURVEY

This section reviews some references from previous projects, journals, articles and books. All these information were collection from different sources such as internet, products, manuals etc. The information gathered in this chapter is related to background study of this project.

HU Hua, LIU Ying., (2008), improved the traditional algorithm and presented a new method which uses a multi-weighted terms to judge the road edges s, makes full use of the physical characteristics of the road, and makes the context of road edge pixels as a judgment, in order to recognize the edge segments of the road. Bridge-link mode accord to the characteristics of the road: two parallel lines and certain width. To connect the two marginalized segment of the corresponding pixels in order to achieve road extraction .Experimental results demonstrate the algorithm can eliminate noise, effectively improve the accuracy and velocity of the road extraction.

Jose Hormese and Dr C.Saravanan (2016), proposed automated road extraction method. In this method, a Vectorization Approach for the automatic method of road extraction is being used where the image is segmented to identify the road network regions followed by a decision making and continuity procedure to correctly detect the roads and the Vectorization step to identify the line segments or curved segments which represents the road. This method may be employed for obtaining information for feeding large-scale Geographic Information System. In the automatic method of road extraction the extracted roads are converted into road vectors in order to use these vector road maps in GIS. A semi-

automated scheme is used for scenarios where fully automated system fails. A combination of both methods can be devised for a full-fledged real business scenario

Wang Zhendong (2018), suggests a new road extraction method from high resolution satellite image based on Delaunay algorithms was proposed in this paper. Firstly, the images should be pretreated by edge detection and binarization, etc. Secondly, the Delaunay triangulations were constructed according to the Delaunay triangulation algorithm, which could represent the image information. Each triangle in Delaunay triangulation was defined as the basic processing unit, namely triangle-unit. Thirdly, combined with the road features, the four feature parameters were put forward after analyzing and summarizing the characters of triangle-units. Then, the triangle-units belonging to road section were extracted depending on the feature parameters. Finally, road edges and road centerlines were automatically extracted by road triangle-units.

Zelang et al., (2013), Proposed a road extraction approach which is based on shape features and multivariate adaptive regression splines (MARS). The measurement of optimally oriented flux (OOF) helps to eliminate the undesired spurs for the selection of end points from a classified image and further these end points are connected accurately to formulate the road network using a geodesic method.

Singh and Garg,(2013) The controlling parameters have utilized in the fuzziness of the FCM approach, which help to estimate the segmented road results and thereafter Stentiford thinning algorithm (STA) is used to estimate the road network from classified results. Such improvements facilitate FCM method manipulation and lead to segmentation that is more robust.

M.Revathi And M.Sharmila(2013), they proposed a method where there are two approaches for road extraction based on Level Set and Mean Shift methods are proposed. The image is preprocessed to improve the tolerance by reducing the noise (the buildings, parking lots, vegetation regions and other open spaces) and roads are first extracted as elongated regions, non-linear noise segments are removed using a median filter (based on the fact that road networks constitute large number of small linear structures). Then road extraction is performed using Level Set and Mean Shift method. Finally the accuracy for the road extracted images is evaluated based on quality measures. The 1 m resolution IKONOS data has been used for the experiment.

Guilherme Pina Cardim, Erivaldo Antônio da Silva and Mauricio Araújo Dias (2018), proposed a statistical evaluation and analysis of road extraction methodologies using a common image dataset, to achieve this goal a dataset containing remote sensing images of three different types of roads i.e., highways, city roads and rural paths, a group of images from the ISPRS (International Society for Photogrammetry and Remote Sensing) dataset. Furthermore, three road extraction methodologies were selected from the literature, in accordance with their availability, to be processed and evaluated using well-known statistical metrics. The achieved results are encouraging and indicate that the proposed statistical evaluation and analysis can allow researchers to evaluate and compare road extraction methodologies using this common dataset extracting similar characteristics to obtain a more reliable comparison among them.

Sghaier and Lepage (2016), they performed a multiscale decomposition using the beamlet transformation that allows the identification of the most appropriate scale for each road segment calculation, and the segments position and direction. Summarizing, the beamlet transformation consists of successive divisions of the image by four in a recursive way until it obtains blocks of 2 × 2 pixels. The former division of the image leads to the the requisite of processing images or sub images with a size equal to a number power of two.

3. PROPOSED WORK

In this Algorithm, first step is the creation of database. The database should contain satellite road images whose road intensity values are within a particular range. By considering different intensity ranges, any type of roads can be extracted.

The basic steps involved in the algorithm are described in Figure(1). The basic steps involved are

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1. The given input image is converted to grayscale image and then the

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grayscale image is adjusted to the threshold values of the road.

2. The obtained image is then converted to binary image with threshold value taken from graythresh() i.e., Otsu's method.
3. Then the image is filtered using a median filter to remove noises and it still contains unwanted objects and those are removed using morphological operations.
4. The edges of the extracted road are determined and finally the extracted road is overlaid onto the original image.

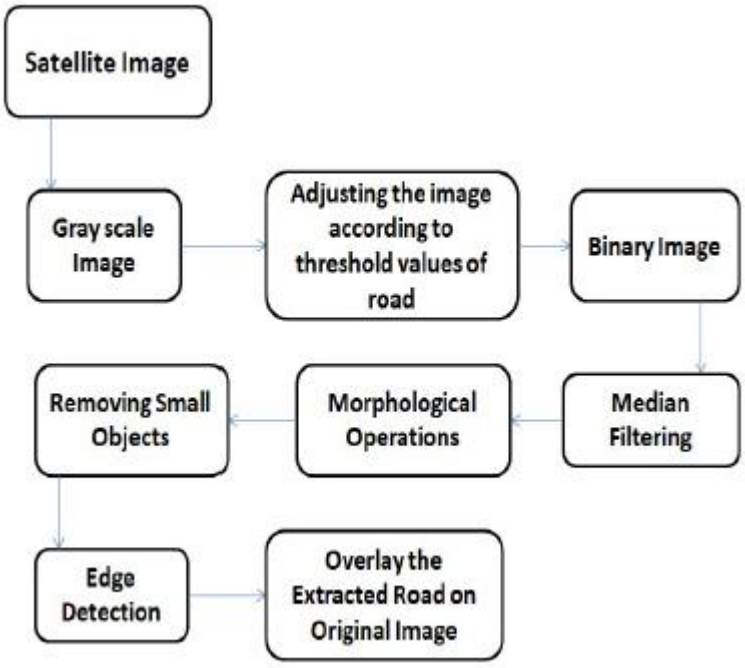

Figure (1)

The various steps in the extraction algorithm are explained below

At first the image is converted into grayscale image and then it is adjusted from threshold range 0.5 to 0.9 as most of the roads contain this range to remove unwanted stuff. Figure 4(a) shows the image obtained after adjusting. Then the image is converted to binary image using 'graythresh' i.e., Otsu's method which automatically sets the threshold value for the conversion. Figure 4(b) shows the image obtained after converting to binary. In Otsu's method we exhaustively search for the threshold that minimizes the intra-class variance (the variance within the class), defined as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = \omega_0(t)\sigma_0^2(t) + \omega_1(t)\sigma_1^2(t)$$

Where w0 and w1 are the probabilities of the two classes separated by a threshold t, and sigma not and sigma one are the standard deviations of these two classes.

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = \omega_0(\mu_0 - \mu_T)^2 + \omega_1(\mu_1 - \mu_T)^2$$
$$= \omega_0(t)\omega_1(t)[\mu_0(t) - \mu_1(t)]^2$$

The class probabilities and class means can be computed iteratively. This idea yields an effective algorithm.

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Input Image

Gray scale Image

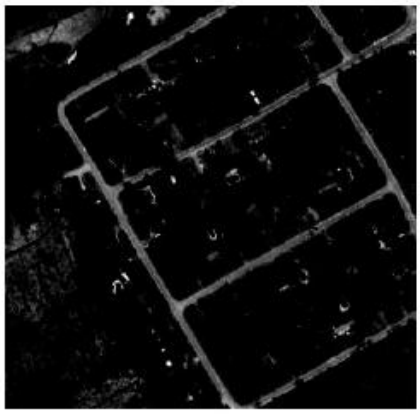

Figure 3(a)

Gray Image after Thresholding

Figure 3(b)

Binary image after thresholding

On the binary image median filtering is done to remove the noise that affects the satellite image. When considering different types of filters, median filter is the most apt one to reduce noise in satellite image. Figure 4(c) shows the image after median filtering.

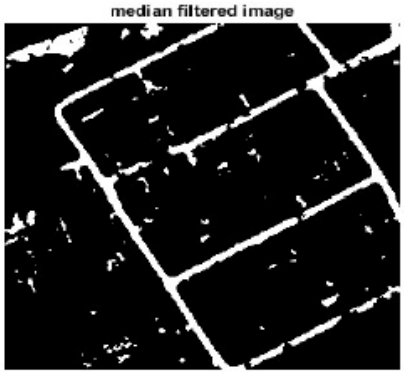

Fig 3(c) Median filtered image

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From the median filtered image small objects are removed which are unnecessary and whose pixels are less than 60 using 'bwareaopen'. This helps in removing buildings and small parking slots. The image is given in Figure 4(d).

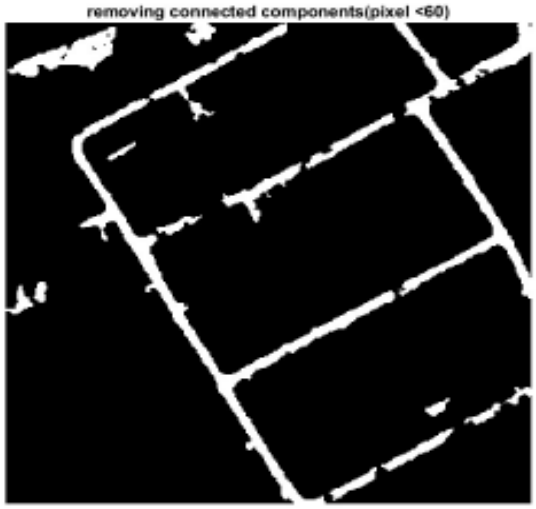

Fig 3(d) Removing connected components

The image still contains many unwanted pixels. One of easiest way to eliminate unwanted objects from an image is by applying morphological operations. Morphological operations are those operations used to remove undesired pixels based on the foreground and the background of an image. Since the operations are done on the binary image, the MATLAB function used is 'bwmorph' [7]. The image obtained after applying morphological operations is given in Figure 4(e).

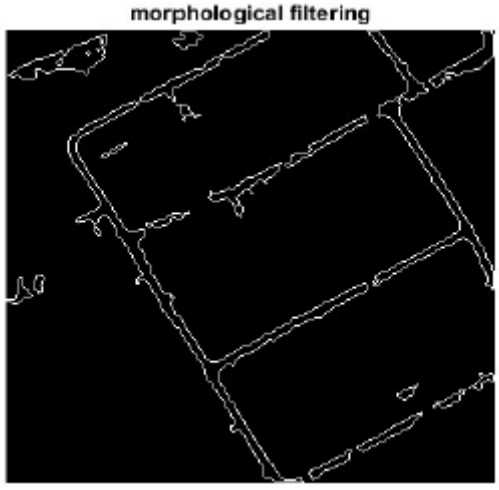

Fig 3(e) Morphological Filtering

After applying the morphological operations we get the clean roads but it is very important to obtain the edges of these roads for clear identification of the roads. Gradient filter is used for the edge detection and the type of operator used for the detection is 'sobel'. Sobel operator is used because the edges are extracted with greater accuracy. The edges of the roads are shown in Figure 4(f).

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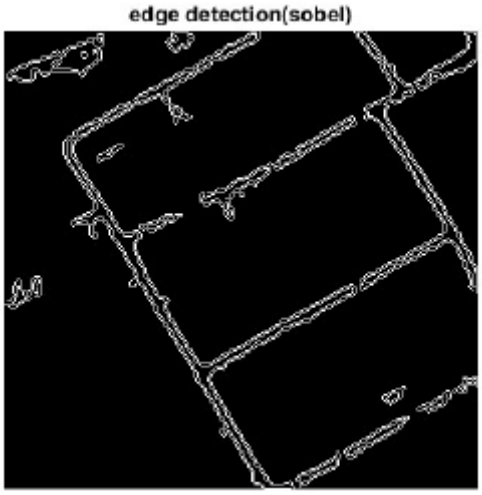

Fig 3(f) Sobel Edge detection

The final step is to overlay the extracted road onto the scalar image of the original image. Overlaying of the result helps to illustrate the accuracy of the road extraction. In the final image, the thin lines indicate the paths of roads in the image. The final image is given in Figure 4(g).

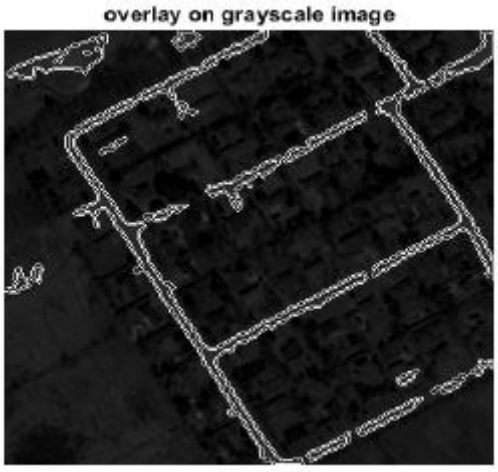

Fig 3(g) Final roads extracted

4. Experimental Results And Discussion

The database for road extraction can be created based on the color of the roads. MATLAB 7.10 software platform is used to perform the road extraction. From the Figure 4(g) it is clear that some of the objects other than roads are also detected. This is because those objects are also having the color within the particular range as that of roads. These objects could be small parts of barren land and parking lots. The output for a different input image is given below

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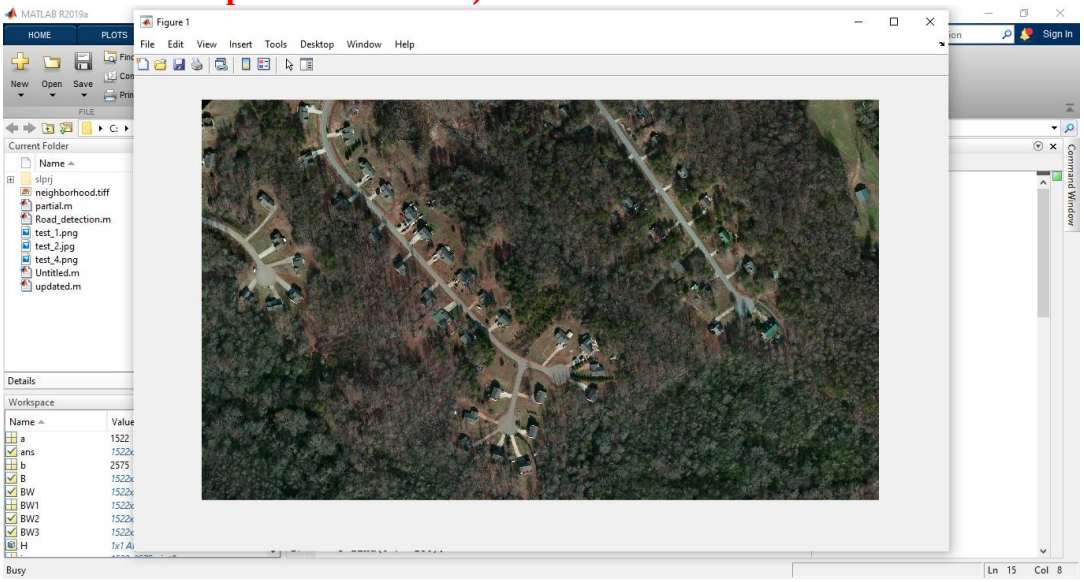

Input Image

Road extracted image

The above image is the road extracted image with the edges overlapped on the gray scale image.

5. CONCLUSION

The roads play a vital role in urban planning. The algorithm introduced is automatic one. It requires only very little interaction from the users. The algorithm was implemented to detect roadways from satellite images with resolution greater than 0.5m. The important and key parameter of this algorithm is the color of the roads in the database. Different types of roads can be extracted based on this algorithm. Since extraction is solely based on color, some of the barren lands and small areas of parking lots are also being extracted. This is because the locations also have the same pixel intensity values as that of roads. Different other techniques such as usage of Digital Elevation Models (DEM), active contours and artificial intelligence methods could be included to remove the unwanted objects that are being extracted. The algorithm implemented is fast, robust and easy to understand and implement.

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