Matlab Based Road Detection from Satellite Images using Image Processing

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Abstract- Roads are the most important part of transportation system. This importance led to many tries to extract road from satellite images and image mining. In this paper, we tried to extract roads in a dense urban area by using of image mining methods. Due to spectral similarity of urban objects in dense areas, there is no assurance to detect the urban objects properly based on spectral information. Therefore in current work, it is aimed to take advantage of two data sets including lidar data and aerial images. The proposed method increased accuracy and pace of road detection and also led to promote the overall accuracy till 95 percent.

Keywords- Image mining, Lidar data, Object base, Road detection

I. INTRODUCTION

Nowadays, lots of data are stored as images. Satellite images are examples of these types of data. Recognition of patterns, independencies of features and detection of objects are role of image mining [1]. Image mining is a technique to explore the direct knowledge of image. It is needed to identify road networks to update the large-scale maps and GPS tools of intelligent emergency vehicles. For extraction of urban information, satellite images are used by many researchers [2]. Information extraction from satellite images usually was done by manual or semi-automatic methods which are expensive and time consuming. To overcome these limitations, automatic methods of image mining are required. On the other hand, the development of image analyzing technology together with advantages of computer processing led to development of automatic methods to extract image objects. Various methods and algorithms for road detection were used by different researchers [3]. Taking risk of road detection in complex urban areas which includes many objects is the main motivation of this research. There are many cities through the developing countries without systematic urban development; therefore designing of a system for information extraction seems to be necessary. In this paper four feature classes are considered: Water, road, building and vegetation.

II. OBJECTIVES

In today's world of growing population, the need for urban planning is very high. 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.

III. PROBLEM STATEMENT

The drawback is that manual intervention is needed initially to perform the computation. Approximations have to be provided by the operator. If the points are not given the Interpolation Routine can generate points out of track. With high quality images object identification and feature extraction can be done effectively. It helps in better decisionmakings for Urban Planning, Traffic Management and Vehicle Navigation. The Disadvantage is that the output is purely dependent on the Resolution of the images, Input road characteristics and variations.

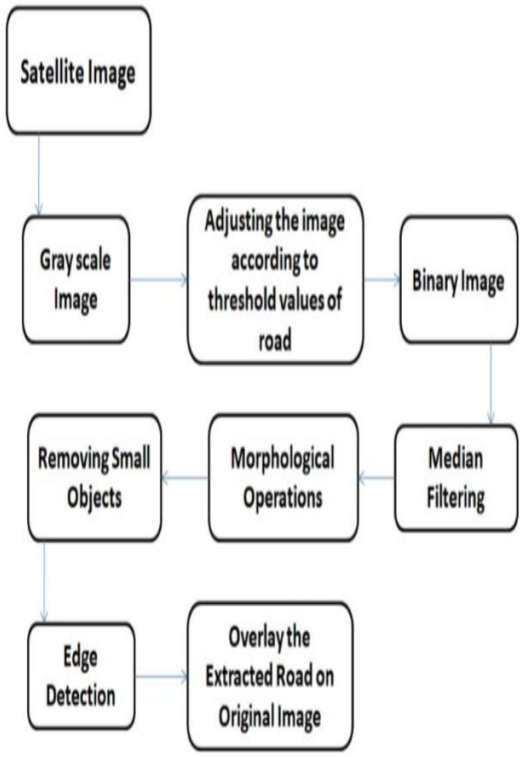
IV. RELATED WORKS

Many researchers studied road detection on satellite images. Cheng et al. extract road by presenting a road junction extraction method with two stages. First, global detection is performed to find the central positions of the road junction candidates by using morphological operators. Second, the shape of a road junction is identified based on a valley-finding algorithm. The proposed method is validated by airborne synthetic aperture radar (SAR) images of 1 m resolution [4]. Unsalan et al. proposed a novel system, which has three main modules: Probabilistic road center detection Road shape extraction Graph-theory-based road network formation. These modules may be used sequentially or interchangeably depending on the application at hand. To show the strengths and weaknesses of the proposed system, the authors tested it on several very high resolution satellite image sets [5]. Clode et al, offered a new method for roads in Sydney, Australia, by using lidar data. This method relies on the region growing area and objective classification of the road. The new method has corrected some of the problems that were faced with the previous classification [6]. There is no possibility to compare the obtained result by other works because the inputs of algorithm and methods are different.

V. PROPOSED METHODOLOGY

The first step in this method is the creation of a 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 : the given input image is converted to grayscale image and then the grayscale image

is adjusted to the threshold values of the road. The obtained image is then converted to binary image with threshold value taken from graythresh() i.e., Otsu's method. 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, edges of the extracted road is determined and finally the extracted road is overlaid onto the original image



B. Road Extraction Algorithm

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 2(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 2(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.

$$\omega_0(t) = \sum_{i=0}^{t-1} p(i)$$

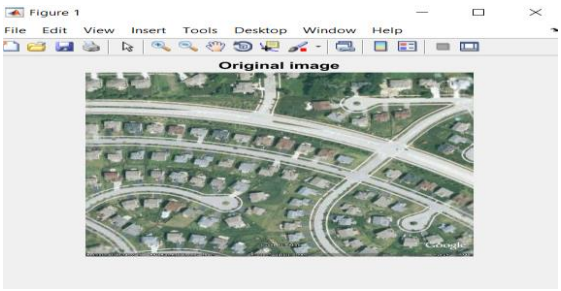
$$\omega_1(t) = \sum_{i=t}^{L-1} p(i)$$

Otsu shows that minimizing the intra-class variance is the same as maximizing inter-class variance.

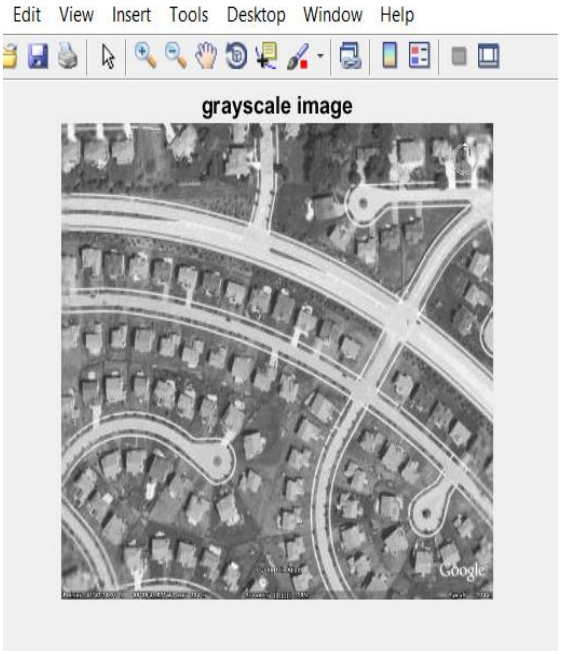
$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = \omega_0(\mu_0 - \mu_T)^2 + \omega_1(\mu_1 - \mu_T)^2$$
$$= \omega_0(t)\omega_1(t)[\mu_0(t) - \mu_1(t)]^2$$

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

VI. RESULT ANALYSIS



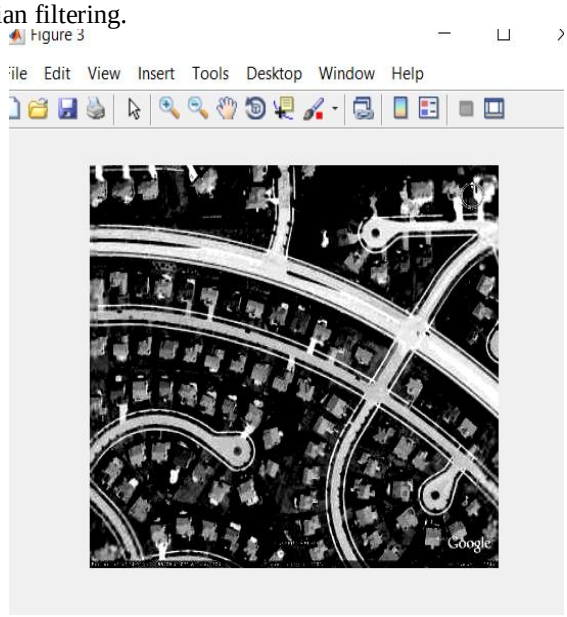
Original image



Grayscale Images

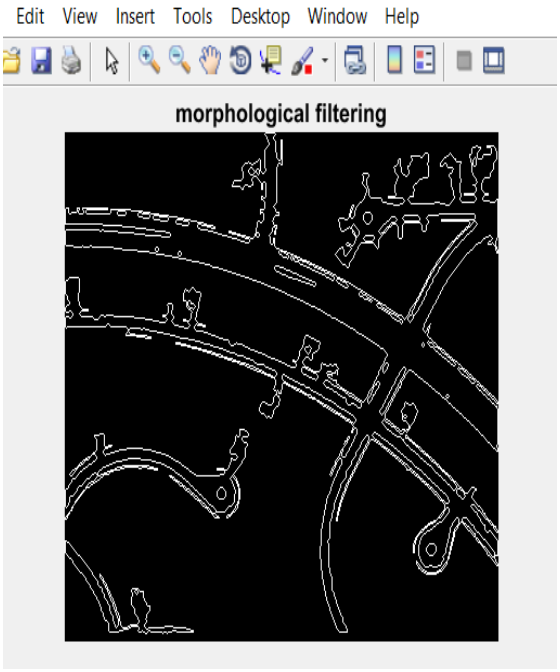
On the binary image median filtering is done to remove the noise that affects the satellite image. When considering different types of filters, median filter is the most apt one to

reduce noise in satellite image [6]. shows the image after median filtering.



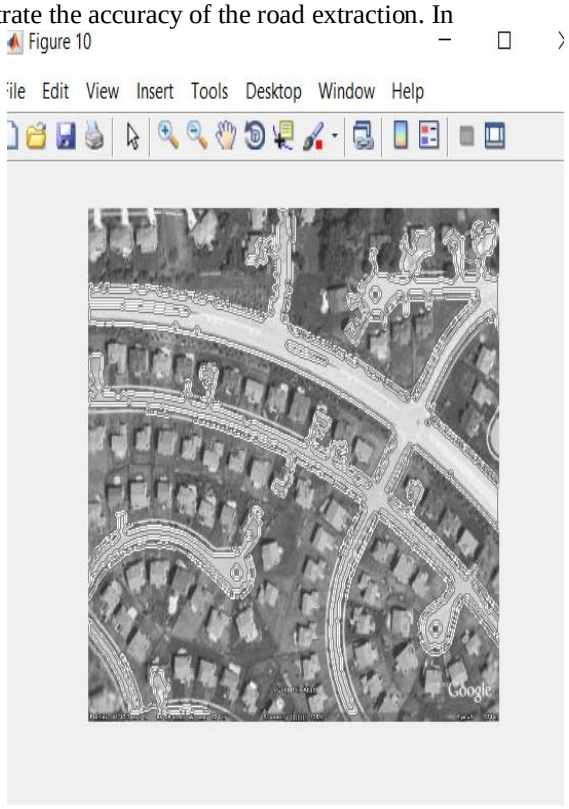
From the median filtered image small objects are removed which are unnecessary and whose pixels are less than 60 using 'bwareaopen'. This helps in removing buildings and small parking slots.

The image 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



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 2(f).

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.

VII. 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.

VIII. REFERENCES

[1]. J. Mena, "State of the art on automatic road extraction for GIS update: a novel classification," Pattern Recognition Letters, vol. 24, pp. 3037 3058, 2003.

[2]. I. Laptev, H. Mayer, T. Lindeberg, W. Eckstein, C. Steger, and A. Baumgartner, "Automatic extraction of roads from aerial images based on scale space and snakes," Machine Vision and Applications, vol. 12, pp. 23–31, 2000.

[3]. M. Rochery, I. Jermyn, and J. Zerubia, "Higher order active contours," International Journal of Computer Vision, vol. 69, pp. 27–42, Aug. 2006.

[4]. M. Barzohar and D. B. Cooper, "Automatic finding of main roads in aerial images by using geometric-stochastic models and estimation," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 18, pp. 707–721, July 1996.

[5]. M. Bicego, S. Dalfini, G. Vernazza, and V. Murino, "Automatic road extraction from aerial images by probabilistic contour tracking," in IEEE International Conference on Image Processing, ICIP'03, vol. 3, pp. 585–588, 2003.

[6]. Mr. Salem Saleh Al-amri, Dr. N.V. Kalyankar and Dr. Khamitkar S.D, "A Comparative Study of Removal Noise from Remote Sensing Image" IJCSI International Journal of Computer Science Issues, Vol. 7, Issue. 1, No. 1, January 2010.

[7]. D. Chaudhuri, N. K. Kushwaha, and A. Samal, "Semi-Automated Road Detection From High Resolution Satellite Images by Directional Morphological Enhancement and Segmentation Techniques" IEEE Journal Of Selected Topics In Applied Earth Observations And Remote Sensing, Vol. 5, No. 5, October 2012