Int. J. Adv. Res. Sci. Technol. Volume 2, Issue1, 2013, pp 59-62.

IJARST

International Journal of Advanced Research in Science and Technology

journal homepage: www.ijarst.com

ISSN 2319 – 1783 (Print)

ISSN 2320 – 1126 (Online)

Automatic Road Detection of Satellite Images- a Survey

Supreet Kaur*, Seema Baghla

Dept. of Computer Science, Yadavindra College of Engineering, Talwandi Sabo, Bathinda (Pb.), INDIA.

****Corresponding Author's Email: supreet_kaur0222@yahoo.com***

ARTICLEINFO

Article history:

Received 02 Aug. 2013

Accepted 12 Aug. 2013

Available online 19 Aug. 2013

Keywords:

Road images,

Edge detection,

Road detection,

Satellite remote sensing

ABSTRACT

Road networks play an important role in a number of geospatial applications, such as cartographic, infrastructure planning and traffic routing software. Automatic and semi-automatic road network extraction techniques have significantly increased the extraction rate of road networks. The road detection performance is a critically affected by the noise or low frequency images. Road edge detection plays an significant role to detect the direction of the road and the specific location of obstacles, size and speed of obstacles in the road. In this paper, several road detection techniques are theoretically analyzed, and are used for road detection. By comparing some well known techniques it is found that there exist many gaps in the techniques proposed so far. This paper ends up with suitable future direction to enhance the road detection method.

Introduction

Today satellite remote sensing systems [1]-[7] provide large volumes of data that are invaluable in monitoring Earth resources and the effects of human activities. Road feature extraction from remotely sensed images has been a long term topic of research and because of its complexity is still a challenging topic[6]. The ability of the next generation sensors to provide fine spatial resolution data has motivated the urgency for automated road extraction research.

Accurate and up-to-date road network information is essential for urban planning, automated road navigation, and emergency response applications [3]. Automated methods have the potential to improve the speed and utility for road mapping and are therefore highly desirable. Roads are only extracted in the regions around database roads. Road extraction is difficult in the presence of context objects such as buildings or trees close to the road, disrupting the appearance of the road or occluding it.

Many approaches for road extraction have been developed. However, only few approaches work in urban scenes which complicates the task of automatic road extraction [1]. The comparison of the two methods i.e. normalized cuts method and mean shift method is done in this literature. A normalized cut is a graph based method taking both local and global characteristic of the image [3]. The combination of the local and global aspects ignores noise, small surface changes and weak edges and producing extraction with most segments covering only a road area [8]. In this approach, only the boundaries are considered. The advantage of this method is that hard constraints are not needed to gain information about roads. This makes this method more conductive for automatic road extraction.

Mean shift method is a clustering technique used to classify data into different categories and does not require information about specific object and extracts road information exactly by object oriented method. In this method, data is segmented and these segments are analyzed to detect road – like and non- road segments.

Literature Survey

A literature review goes beyond the search for information and includes the identification and articulation of relationships between the literature and

our field of research. While the form of the literature review may vary with different types of studies, the basic purposes remain constant:

M. Rajeswari et al. [1] has evaluated the speed of growth of an urban area road is one of the fast information updating element during urban development. Road information extraction based on high resolution satellite images play an important role because roads affect city land usage. In this paper, two approaches for road network extraction for an urban are proposed. Most research in road extraction begins with an original image. It is difficult and computationally expensive to extract roads due to presences of other road-like features with straight edges.

J. Senthilnath et al. [2] has evaluated the the study of Urban population is growing so fast in India that planning officials are racing to keep up with urban development .Use of geographic information like satellite imagery helps urban planners manage the ever-changing urban environment accurately and efficiently. Roads are one of the most important features to be extracted from Satellite imagery for urban planning. Manual extraction of roads is operator dependent and time-consuming task. Hence Automatic extraction of roads from high resolution satellite images has grown in importance in the last decade. An approach for automatic road extraction from high resolution based on Level set, Normalized Cuts and Mean Shift algorithms is developed. Initially the image is preprocessed to improve the tolerance by reducing the noises (buildings etc.,) then roads are extracted based on the three methods.

M. Butenuth et al. [3] introduce a paper in which they study road extraction of high resolution aerial images of suburban scenes based on segmentation using the Normalized Cuts algorithm. The aim of our project is the extraction of roads for the assessment of a road database, however, this paper is restricted to road extraction. The segmentation as our basic step is designed to yield a good division between road areas and the surroundings. We use the Normalized Cuts algorithm, which is a graph-based approach that divides the image on the basis of pixel similarities. The definition of these similarities can incorporate several features, which is necessary for the segmentation in complex surroundings such as built-up areas. The features used for segmentation comprise colour, hue, edges and road color derived with prior information about the position of the centerline from the database.

M.Rajeswari et al. [4] introduce a paper in which they study Automatic road network extraction based on high resolution satellite image for urban planning holds great potential for significant reduction of database development/updating cost and turnaround time. Satellite remote sensing has been recognized worldwide as an effective technology for the monitoring and mapping the urban development. Two approaches for road network extraction for an urban region have been proposed. When an image is considered in original form it is difficult and computationally expensive to extract roads due to presence of other road-like features with straight edges. Hence roads are first extracted as elongated regions by removing bright regions (that mostly represent the buildings, parking lots and other open spaces), non-linear noise segments are removed median filtering (based upon the fact that road networks constitute large number of small linear structures).

V.Parthasarathi et al.[5] has evaluated the study analysis of high resolution satellite images has been an important research topic for urban analysis. One of the important features of urban areas in urban analysis is the automatic road network extraction. Two approaches for road extraction based on Level Set and Mean Shift methods are proposed. From an original image it is difficult and computationally expensive to extract roads due to presences of other road-like features with straight edges. 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. Then road extraction is performed using Level Set and Mean Shift method.

T Rajani Mangala and S G Bhirud [6] has evaluated the study of road information extraction from high resolution satellite images plays an important role because roads affect urban and rural land cover and usage. It is difficult and computationally intensive and expensive to extract roads due to presence of their road like features with straight edges. In this paper we have used the level segment evolution and local binary fitting based model for the extraction of roads. This algorithm followed by morphological operations gives satisfactory results.

O.Sharma et al. [7] introduce a paper in which they study that areal features are of great importance in applications like shore line mapping, boundary delineation and change detection. This research work is an attempt to automate the process of extracting feature boundaries from satellite imagery. This process is intended to eventually replace manual digitization by computer assisted boundary detection and conversion to a vector layer in a Geographic Information System. There has been a good amount of work already done as far as boundary detection and skeletonization is concerned, but this research work is different from the previous ones in

the way that it uses the Delaunay graph and the Verona tessellation to extract boundary and skeletons that are guaranteed to be topologically equivalent to the segmented objects.

E. Karaman et al. [8] has evaluated the study to develop automatic road extraction algorithm in satellite images. As roads have different width and surface material characteristics in urban and rural areas, a modular approach for road extraction algorithm is desired. In this study, edge detection, segmentation, clustering and vegetation and land cover analyses are used. In order to combine the results of different methods, a score map based on segmentation analysis is constructed. Quantitative and visual results show that this method is successful in road extraction from satellite images.

F.Chun ling and R. Yuan yuan [9] introduce a paper in which road detection methods are becoming very important part of vision applications and play a significant role in Intelligent transportation system, which is the key technique of intelligent vehicle guidance. The road detection performance is an critically affected by the noise or low frequency images. Road edge detection plays an significant role to detect the direction of the road and the specific location of obstacles, size and speed of obstacles in the road. In this paper, several road detection techniques are theoretically analyzed, and are used for road detection. By comparing some well known techniques it is found that there exist many gaps in the techniques proposed so far. This paper ends up with suitable future direction to enhance the road detection method.

Gaps in literature:

By conducting the literature survey it has been found that most of persisting researches has neglected one of the following.

a) Noise
b) Restoration
c) Debluring

As we know that above parameters may decrease the performance of the road detection system. So, these parameters become the critical issue of road detection system.

How road detection works:

The past few years was marked by the development of researches that contribute to reach automatic road extraction which is perceived as a possible solution to prevent human errors in the quality evaluation process. There are various methods in the quality control which can replace the human operator. One of these methods includes Computer vision system. After hours of working the operator may lose concentration which in turn will affect the evaluation process. So a computer vision system proved to be more efficient at the level of precision and rapidity.

Here is the steps of proposed work have to be done for this research of road extraction.

Step 1: Pre-Processing

a) **Classification: -** dividing the image into two classes – roads and non-roads.

b) **Grouping: -** A nearest neighborhood grouping (NNG) operation is applied to the classified representation for smoothing the spectral response within the pixel's local neighborhood.

Step 2: Filtering:

The method of road extraction in certain locations poses challenge because the spectral reflectance of some of the old buildings resembles the road surface. Such buildings from the clutter and these non-road structures need to be removed. A morphological opening operation is applied which identifies road blocks.

Step 3: Segmentation

Segmentation is the process of partitioning the digital image into multiple segments.

Step 4: Road Extraction

There are two methods for the extraction of road using satellite images

a) Normalized Cut Method
b) Mean Shift Method

Step 5: Image Overlaying

In order to illustrate the accuracy, the extracted road region using is converted into binary image format. This binary image is overlaid on the original panchromatic image leads to display the road topology by avoiding the complex noise element. In the overlaid image the thin lines indicate the road topology.

Step 6: Performance analysis

The automatically extracted roads are compared with manually traced reference roads to perform accuracy

assessment. Since roads have linear features, it is possible to use all the data rather than just sample points to conduct the accuracy assessment.

Conclusion:

Recently, road detection methods are becoming very important part of vision applications and play a significant role in Intelligent transportation system, which is the key technique of intelligent vehicle guidance. The road detection performance is a critically affected by the noise or low frequency images.

Future work:

Automated road detection processes still yield some erroneous and incomplete results and costly human intervention is still required to evaluate results and correct errors. With the aim of improving the accuracy of road extraction systems, three objectives are defined in this research work: Firstly, the study seeks to develop a flexible semi-automated road extraction system, capable of extracting roads from satellite imagery. The second objective is to integrate a variety of algorithms within the road network extraction system. The benefits of using each of these algorithms within the proposed road extraction system, is illustrated. So in near future a fully automated system is proposed by incorporating a number of the algorithms investigated throughout the research work.

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