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Identification of Roads from RS Images

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ABSTRACT

As a significant role for traffic management, city planning, road monitoring, GPS navigation and map updating, the technology of road extraction from a remote sensing (RS) image has been a hot research topic in recent years. In the project, after analysing different road features and road models, the road extraction methods were classified into the classification-based methods, knowledge-based methods, mathematical morphology, active contour model, and dynamic programming. Firstly, the road features, road model, existing difficulties and interference factors for road extraction were analysed. Secondly, the principle of road extraction, the advantages and disadvantages of various methods and research achievements were briefly highlighted. Then, the comparisons of the different road extraction algorithms were performed, including road features, test samples and shortcomings. Finally, the research results in recent years were summarized emphatically. It is obvious that only using one kind of road features is hard to get an excellent extraction effect.

Keywords : Remote Sensing Image, GPS navigation, Traffic management, City Planning, Road Extraction Methods.

I. INTRODUCTION

Road detections in video or image sequences is an important service. This service should be able to track the Road of interest accurately, i.e. there should not be any false detection. There are many reasons of false detection; one of the reasons is the noise of the Road. i.e. the noise of the Road is mistaken as the Road itself as the Road and its Road has similar shape. Thus it is necessary to successfully detect these Roads and eliminate them before tracking.

Computer vision cannot differentiate between object and Roads by itself therefore Road Detection is introduced as a preprocessing stage after image acquisition .The problems addressed in this paper are related to Roads as they mainly lead to false detection. Dynamic Road Detection is implemented with respect to image frames.[1]

Reliably extracting information from aerial imagery is a difficult problem with many practical applications. One specific case of this problem is the task of automatically detecting roads. This task is a difficult vision problem because of occlusions, shadows, and a wide variety of non-road objects. Despite 30 years of work on automatic road detection, no automatic or semi-automatic road detection system is currently on the market and no published method has been shown to work reliably on large datasets of urban imagery. We propose detecting roads using a active contour model.

We demonstrate that predictive performance can be substantially improved by initializing the feature detectors using recently developed unsupervised learning methods as well as by taking advantage of the local spatial coherence of the output labels. We show that our method works reliably on urban color datasets to evaluate current approaches [1].

The difficulties of road extraction from RS images lie in that the image characteristics of road features can be affected by the sensor type, spectral and spatial resolution, weather, light variation, and ground characteristic, etc. In practice, a road network is too complex to be modeled using a general structural model. Hence, the analysis of road features and road models is very important [1].

Road Features: In general, here the image enhancement has to be done so as to extract useful information from a RS image. A road in a RS image appears as elongated geometric features with slowly changed gray values. As described by Vosselman and Knecht (1995) [6], the road features in an image are summarized from four different aspects. Based on their description, the road features in an image can be concluded as follows:

- **Geometric features:** A road has a stripe feature its width does not suddenly vary much and its length is not as short as its width. The ratio between length and width is very large. The road junctions usually can be presented as the signs of "T", "Y", or "þ". Geometric features have the direct relationships with the road shapes.
- **Photometric features**: Photometric features are also known as radiation features. It means there are two obvious road edge lines, and the edge gradient is larger. Meanwhile, the gray values or colors of roads are relatively consistent and change slowly, but they are very different from those of the neighboring non-road areas such as trees and buildings, etc. Photometric features are close to the road gray levels or colors.
- **Topological features:** Generally, road consists of intersections and here the road network is not suddenly interrupted. Topological features and functional features are relatively simple but hard to apply in real applications.
- **Functional features:** A road has specific functions in the real world. In order to realize those functions, it must have some constraint conditions.
- **Texture features:** Textures in an image have the regional characteristics, which are a kind of visual features to reflect the homogeneity phenomenon in the image. It has nothing to do with the color and intensity information. The essence of texture features is to find the spatial distribution of pixel gray levels in the neighborhood. In practice, many road extraction methods use multiple road features rather than only one feature. However, due to the influence of illumination, shadow and occlusion, a road in an image does not have all features mentioned above, which makes it difficult to extract road from a RS image.

II. METHODS AND MATERIAL

A. Methodology

An Digital image processing is a broad subject and often involves procedures which can be mathematically complex, but central idea behind digital image processing is quite simple. The ultimate aim of image processing is to use data contained in the image to enable the system to understand, recognize and interpret the processed information available from the image pattern. Image enhancement techniques improve the quality of an image as perceived by human.

The basic definition of image processing refers to processing of digital image, i.e removing the noise and any kind of irregularities present in an image using the digital computer. The noise or irregularity may creep into the image either during its formation or during transformation etc. For mathematical analysis, an image may be defined as a two-dimensional function $f(x,y)$ where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the intensity values of f are all finite, discrete quantities, we call the image a digital image. It is very important that a digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are called picture elements, image elements, and pixels. Pixel is the most widely used term to denote the elements of a digital image.

Watershed Algorithm

Watershed is a transformation defined on a Gray Scale image. The Watershed Transform is a unique technique for segmenting digital images that uses a type of region growing method based on an image gradient. The Watershed Transform effectively combines elements from both the discontinuity and similarity based methods. This computes the Foreground Markers. These are connected blobs of pixels within each of the objects in the image.

A marker is a connected component belonging to an image. The markers include the internal markers, associated with objects of interest, and the external markers, associated with the background. The marker selection typically consists of two steps: pre-processing and definition of a set of criteria that markers must satisfy. The pre-processing scheme is to filter an image with a smoothing filter. This step can minimize the effect of small spatial detail, in other words, this step is to reduce the large number of potential minima (irrelevant detail), which is the reason of over-segmentation.

Algorithm for Marker-Controlled Segmentation

1. Read the Color Image and convert it into Grayscale.
2. Use the gradient Magnitude as the Segmentation method.
3. Mark the Foreground Objects.
4. Compute the Background Markers.
5. Compute the Watershed Transform of the Segmentation Function.
6. Visualize the Results.

Most of the existing algorithms start with extraction of potential watershed line pixels using a local 3 x 3 operation, which are then connected into geomorphologic networks in subsequent steps. Due to the local character of the first step, these approaches are often inaccurate. A watershed transformation was also introduced in the context of mathematical morphology - computationally demanding and therefore time consuming. Two basic approaches to watershed image segmentation.

- The first one starts with finding a *downstream* path from each pixel of the image to a local minimum of image surface altitude. A catchment basin is then defined as the set of pixels for which their respective downstream paths all end up in the same altitude minimum. While the downstream paths are easy to determine for continuous altitude surfaces by calculating the local gradients, no rules exist to define the downstream paths uniquely for digital surfaces.
- The second approach is essentially dual to the first one; instead of identifying the downstream paths, the catchment basins fill from the bottom. Imagine that there is a hole in each local minimum, and that the topographic surface is immersed in water - water starts filling all catchment basins, minima of which are under the water level. If two catchment basins would merge as a result of further immersion, a dam is built all the way to the highest surface altitude and the dam represents the watershed line.

An efficient algorithm is based on *sorting* the pixels in increasing order of their gray values, followed by a *flooding* step consisting of a fast breadth-first scanning of all pixels in the order of their gray-levels. During the sorting step, a brightness histogram is computed. Simultaneously, a list of pointers to pixels of gray-level h is created and associated with each histogram gray-level to enable direct access to all pixels of any gray-level. Information about the image pixel sorting is used extensively in the flooding step.

Suppose the flooding has been completed up to a level (gray-level, altitude) k. Then every pixel having gray-level less than or equal to k has already been assigned a unique catchment basin label. Next, pixels having gray-level k+1 must be processed; all such pixels can be found in the list that was prepared in the sorting step - consequently, all these pixels can be accessed directly. A pixel having gray-level k+1 may belong to a catchment basin labeled l ("el") if at least one of its neighbors already carries this label. Pixels that represent potential catchment basin members are put in a first-in first-out queue and wait for further processing.

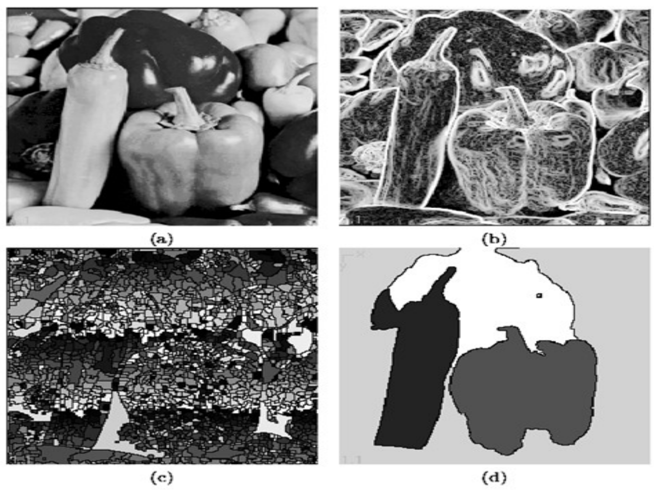


Figure a. Original **b.**gradient image **c.** raw watershed segmentation **d.** watershed segmentation using region markers to control over segmentation

Watershed segmentation

Raw watershed segmentation produces a severely over segmented image with hundreds or thousands of catchment basins. To overcome this problem, region markers and other approaches have been suggested to generate good segmentation.

Region growing post-processing: Region growing often results in under growing or overgrowing as a result of non-optimal parameter setting. A variety of post-processors has been developed. Some of them combine segmentation information obtained from region growing and edge-based segmentation. Simpler post-processors are based on general heuristics and decrease the number of small regions in the segmented image that cannot be merged with any adjacent region according to the originally applied homogeneity criteria.

Algorithm for removal of Small image regions

1. Search for the smallest image region Rmin.
2. Find the region R most similar to Rmin, according to the homogeneity criteria used, Merge R and Rmin.
3. Repeat steps 1 and 2 until all regions smaller than a preselected size are removed from the image.

This algorithm will execute much faster if all regions smaller than a preselected size are merged with their neighbors without having to order them by size.

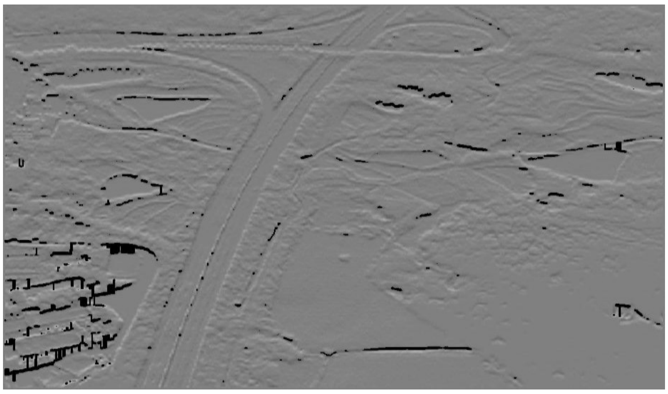
III. RESULTS

There are n number of distribution of the satellite image was used in the extraction of roads and identifying their features which result in their classification.. Remote sensing surveys provide a rapid means of data collection of satellite images and an appropriate classification scheme is required to perform the classification of road cover information from these images for various observations. When the images are available in Google earth surface or Google map they can be used in some of the applications. When the satellite image was taken as an input image we have to apply the object based image analysis for extracting some feature classes are trees, water, agriculture, shadows images. It was implemented in the java using net beans software for the image processing of a project.

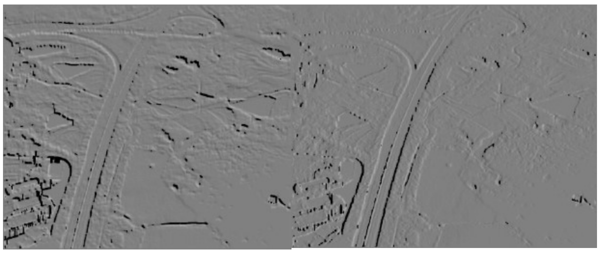
INPUT IMAGE CONTOUR IMAGE

Output Images at the phase of preprocessing by using median filter

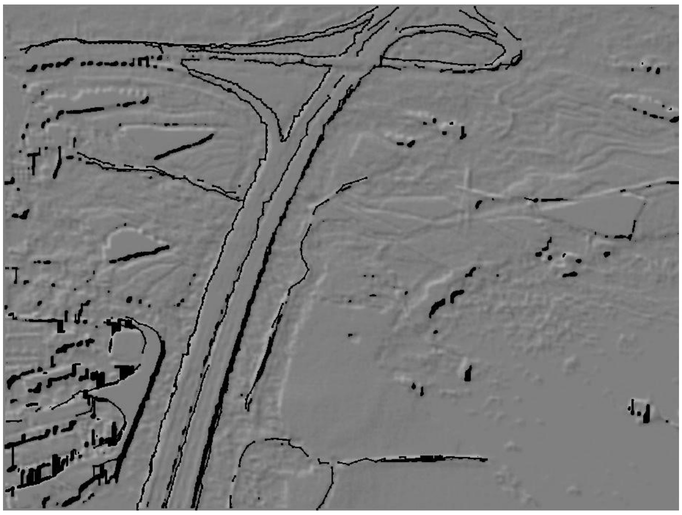
Output images at the phase of image enhancement by using Gaussian filter



Output image at the phase of segmentation by using water shed algorithm



Output images at the phase of feature detection by using Hough circle transformation



Final output image by using Active Contour detection

IV. CONCLUSION

Several algorithms provide a wide variety of approaches for enhancing or modifying images to provide a better view. It is not possible to say which technique is good because the image enhanced and feature that had detected by using such technique if it is looks good to user then it is good. The choice of such technique is depend on the requirements. Most of the previously developed road extraction methods could successfully recognize roads using different road features, which exhibit a homogeneous surface. However, in cases where surrounding objects like water, buildings, trees, grass and cars occlude the road or cast shadows, especially with influence of spatial structures such as overpass, the road extraction often fails, resulting in gaps and discontinuities in the detected road. Hence, how to extract road from RS images quickly and efficiently is of significance.

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