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Survey of Some New Road Extraction Methods

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----------**ABSTRACT**----------

This paper surveys the state of the art on new automatic road network extraction from remotely sensed imagery methods. It presents an extensive bibliography of recent references describing these methods. These new methods are classified according to a general classification (segmentation, vectorization , neural networks and genetic algorithms) and by the application of these techniques and combination with other methods such as directional mathematical morphology based on the size of the form, the use of texture, morphology and spectral information with neural networks and also the progressive texture analysis (TPA) method Ribbon Snake and Ziplock snake , the segmentation and classification by the "Support Vector Machines " (SVM) and Fuzzy C - Mean (FCM) (compared to MRF) and finally the method of Boosting (Adaboosting) . The aim of this classification is to provide a significant contribution to research in this topic.

KEYWORDS: *Automatic road extraction, remote sensing, high resolution image.*

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I. INTRODUCTION

The extraction of roads has been the subject of numerous studies over the past twenty years, image processing in general, and remote sensing in a particular way. It is still an active research topic mainly with the advent of very high resolution satellite images (VHRS) and aerial images that provide a more accurate location of the road as part of the surface and allow a particular recognition pathways detected (highway, street, road). This extraction accuracy is also beneficial for various applications such as in the urban area (mapping, tracing the way ...) and in the military (road safety). Most work of extraction of road network,, appeared before the increase in resolution, concern only the extraction of line networks. Indeed, a linear network of one to three pixels wide on low resolution images appears as an area-network with high resolution. This variability appearance has caused variability in the proposed, among the classical methods used: mathematical morphology, neural networks [1], dynamic programming [2] [3], active contours [4] [5], Markov chains [6] and more recently, directional morphology using the size of the surface [7] and texture analysis of the shape to extract [8].This document is a state of the art new automatic extraction of road networks from remote sensing images VHRS methods. Certainly, there are many ways to classify these methods [9] but the goal of this paper is to classify these methods into two broad categories:

1) Overall Classification: detection and definition of the road network is made from the original image. As segmentation, vectorization, networks neurons..etc
2) Classification as applied techniques: some techniques use the image pre-processing before extracting the road network and other techniques using new parameters such as texture, morphology, spectral information of roads to extract them.

II. METHODS OF EXTRACTION UNDER A GENERAL CLASSIFICATION

These methods tend to achieve the detection and definition of the road network from the original image. Segmentation techniques are used and vectorization. Various research has been done on the extraction starting with Eidenbenz and al. (2000) [10] Bonnefon and al. (2002) [11]. Amini and al. (2002) [12] who applied the technique of segmentation algorithms and morphology followed by a process of extracting skeleton based on the wavelet transform by Benedetto and Frazier (1994) [13] and Chui (1997) [14].

Long before other researchers as Leymarie and al. (1996) [15] reported on a detection based on the analysis of texture. In this document, the detection based on the analysis of the texture is a low level of visual processes, whereas recovery is a geometric mean level visual process wherein the background knowledge on roads are used.

General method of segmentation: The general image segmentation methods have many applications these techniques can be used for extraction of road in order to obtain a binary image where the road network is shown. Therefore, many researchers have opted to include these techniques in their extraction methods road. Cheng and al. (2001) [16] have several references on the main segmentation techniques supervised or unsupervised. Comaniciu and Meer (2001) [17] propose a general method for the recovery of significant features of the image based on the algorithm of the average offset and analysis of density gradients. Wyatt Bajaj (2002) [18] used the image segmentation using the active contour models and the connection zones. Mukherjee (2002) [19] applied the method of Markov chain (Markov Random Field MRF) to improve an initial segmentation based on growth in the regions. Another version of the MRF treatment was developed by Kim and Zabih (2002) [20]. On the other hand, Chen and Lu (2002) [21] develop a fuzzy clustering algorithm iteratively generating clusters of colors using a fuzzy membership function uniquely defined and an objective function for optimization concentration. The unsupervised clustering segmentation can also be found in Hermes and al (2002) [22], Yang and al (2002) [23].

Vectorization : The vector definition of the road network represented in a binary image, to automatically get the digital and topological definition of the different components is very difficult. [9] However, some interesting references in relation to this subject can be found as Doucette and al (2001) [24] present an approach elongated region based on the extraction of 2D route analysis from high resolution images. Similarly, Mena (2002) [25] presents an almost automatic method to extract the skeleton and topology based on a binary image using the K-means clustering technique and a new method based on the construction of the Voronoi diagram and the Delaunay triangulation.

Neural networks method and genetic algorithms : These methods are much used in the optimization that is both technical as they are also used in the automatic extraction of roads. In first, and Bhattacharya Parui (1997) [26] have proposed the use of a multilayer neural network for detection of roads. The network entries are windows of size n * n centered on each pixels p of the image. The network calculates by itself discriminant values in the nodes of the single hidden layer from the n*n entries and classifies the pixel p from the hidden node in the output nodes. Mokhtarzade and Zoej (2007) [1] propose to use the multilayer neural networks to detect roads in the Ikonos and QuickBird images respectively and try to find an optimal network structure. They improve their results using the methods of unsupervised classification and genetic algorithms (2006) and a variety of texture parameters in (2007). [1] In 2008, Farnood and al. [27] Propose to use neural networks and image processing environment based on Computer Aided Design (CAD) for the extraction and automatic vectorization of roads from satellite images.

III. METHODS OF EXTRACTION BASED ON EXTRACTION TECHNIQUES APPLIED

Extraction methods can be classified according to the different extraction techniques applied.

Directional mathematical morphology method (based on the grain size of form) : Unlike the conventional method of mathematical morphology, this method is very flexible perfectly adapts to curved shapes. Unlike the conventional method of mathematical morphology, this method is very flexible perfectly adapted to curved shapes. In 2007, Talbot H and Appleton B [7] developed advanced directional morphological filters Path Openings and Path Closings with flexibility tailored to not strictly rectilinear forms, regardless of their direction. These filters are used by Valero and Chanussot (2009) [28] in order to extract information about the pixel structure. These morphological operators do not depend on the choice of the structuring element, they are flexible enough to adapt to the straight and slightly curved structures unlike conventional operators strongly which depend on the shape of the structuring element. The method is to build a chain of particle size by using two filters: Path Openings and Closings Path to build morphological profiles. For each pixel, the profile is the morphological feature vector on which the extraction of routes is based.

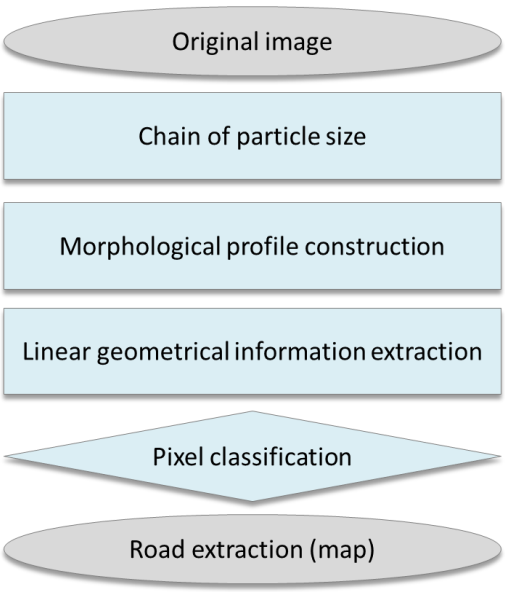

Fig1. Methodology of the extraction of roads with directional mathematical morphology .

These filters have the properties of openings: they remove structures appearing as small size and lighter than their immediate environment. [28]

Using the texture, morphology and spectral information with neuron networks : In order to improve the accuracy Ghasemloo Nima (2013) [8] proposes in his work to study neural networks to extract roads and tunnels from real images. The roads are extracted using spectral and morphology and the texture information. The method was applied to the SPOT satellite imagery from Tabriz Miyaneh (two cities in Iran). The results of this study indicate that it would be possible to promote the accuracy of the extraction of the route using the morphology and texture in the image classification using neural networks. Finally the location of the tunnel to extract is extracted by digital elevation information. The junctions of roads and mountains have a high potential to locate the tunnel. For this reason, in this study, the junctions of roads and mountains were also detected and used.

Texture progressive analysis (tpa): Gilles (2007) [29] studied the possibility of having a space of representation of the image best suited for detection. He suggests using the space of textures based on the methods of image decomposition and shows that the texture component provides better threadlike objects. The decomposition is then used as a pretreatment before the application of a detection algorithm (Gilles and Mayer, 2010) [30]. Senthilnath, Rajeshwari and Omkar (2008/2009) [31] proposed to use the texture analysis and segmentation algorithms standardized.The extraction of routes is based on two steps: extraction and pretreatment drive methods. The image is first treated to improve tolerance by reducing other objects in the background image, which generally represents the buildings, parking lots, vegetation zones…etc. The road segments are then extracted using progressive scanning of texture (TPA), which uses the technique of binary segmentation based on three levels of static evaluation of the texture, while the second method is the standard method of segmentation, also called standard cutting for the extraction of road based on a graph that generates the best scores of the road segments. The results of comparing the performance of both methods show that the standard method of segmentation is more efficient in extracting road segments in urban areas from satellite images with high resolution. The first method needs to be improved.

Ribbon snake and ziplock snake method : During application, the structure of the road is separated into visible roads or salient roads (with clear and well defined borders without disturbing presence of object shape. Fig2) and non-salient roads or non-visible roads (bordered poorly defined by the presence of trees along the road or vehicles passages...etc. Fig3).

Fig2: Image of a road well defined borders (Medea, Algeria 2014)

Fig 3: Image of a road not defined borders (noise: trees, cars… etc.) (Medea, Algeria 2014)

Özkaya M (2012) [32] proposes to extract both types of routes using the methods "Ribbon Snake" and "Ziplock Snake" which are derived from the traditional method models "Snake".
The results show that Ribbon Snake is used to extract the salient roads and Ziplock Snake is used to extract the non-salient roads.

Segmentation method and classification: support vector machine (svm) and fuzzy c-mean (fcm) (compare field of markov) : ZHU Da-ming, WEN Xiang, LING Chun-Li (2011) [33] proposed a MAP-MRF pull model (MRF map) using the Markov Random Field (MRF), the steps are the adoption training sampler, and get the factor model and then present simulated annealing to segment the image and extract the road. And on the other hand models Support Vector Machines (SVM) and Fuzzy C-Mean (FCM) have been proposed and built simultaneously for remote sensing image segmentation. First an unsupervised for remote sensing image using FCM clustering was then used SVM was adopted for classification and to extract the road. Finally the comparison of the proposed FCM-SVM model with MRF MRF shows that SVM-FCM is much more accurate than the MRF.

Classification adaboosting or method of boosting : Introduced by Yoav Freund and Robert Schapire (2002). "Adaboost" is a method based on an iterative selection of the weak classifier in accordance with a distribution of the training examples. Umut Çinar Ersin and Karaman (2012) [34] proposed a new approach for the automatic extraction based on spectral indices and properties of the structure. The learning algorithm Adaboost is used with extracted features to distinguish roads-highway areas on satellite images. The proposed algorithm is tested on the basis of image data and IKONOS GeoEye to check if the algorithm can be generalized. The empirical results show that the extraction method proposed route is promising and able to find the majority of the road network.

IV. CONCLUSION

This state of the art on the new automatic extraction of road network from remote sensing images VHRS methods shows the diversity of techniques developed over the last four years. There is no universal method that can be applied to any image successfully, the choice of a particular technique depends on several parameters such as the original color of the image, the nature of the objects up the image in addition to the road network (vehicles, trees, buildings ... etc.) and the type of the road itself (road or not protruding projection).
However, this article represents a fairly detailed summary that can be used for scientific research in the field of automatic extraction of road networks from remote sensing image VHRS.

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