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A Survey of Current trends in road extraction from Satellite images

T.Ganesh Kumar*, D.Murugan and Manish T.I

Department of Computer Science & Engineering, Manonmaniam Sundaranar University, Tirunelveli, India.

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ABSTRACT

Road Network detection is important role of earth observation. It is detected from various satellite images like multispectral images, pan-sharpened images, SAR images and Aerial images. These are differentiated from various resolutions. In this survey most of the road networks detected from areal images, world view and quick bird images. Because very high-resolution images and Very less types of multispectral images has been used for road network detection. All researchers are focused on very high resolution satellite images for road network detection.

Introduction

Remote sensing is the art and science of making measurements of information extraction from the earth using sensors on airplanes or satellites. Remote sensing has come to be associated more specifically with the gauging of interactions between earth surface materials and electromagnetic energy.

Humans have evolved very precise visual skills can differentiate colors and process a large amount of visual information very quickly. An image is a single picture which representing a scene, or a microphotograph of an electronic component, or the result of medical imaging. Image processing involves altering the nature of an image like improve its charming information for human interpretation, either machine perception.

Energy Source

Sensors can be divided into two broad groups such as passive and active sensors. Passive sensors are depending on existing sources of energy, and active ones provide their own source of energy. The majority of remote sensing is based on passive sensors like the sun is the major energy source.

Wavelength

Most remote sensing devices make use of electromagnetic energy [1]. The electromagnetic spectrum is very broad and not all wavelengths are equally effective for remote sensing purposes. The atmosphere absorption and/or scattering of the very shortest wavelengths and the glass lenses of many sensors also cause considerable assimilation of shorter wavelengths such as the ultraviolet (UV). The green, red and near-infrared (IR) wavelengths all provide good opportunities for gauging earth surface interactions without significant interference by the atmosphere. In addition, these regions provide important clues to the nature of many earth surface materials like water, mineral ore, Chlorophyll. It is a very strong absorber of red visible wavelengths. The thermal regions have confirmed to be very useful for monitoring of the spatial distribution of heat from industrial activity, a broad set of applications ranging from fire monitoring to animal distribution studies to soil moisture conditions.

The next area of major active radar imaging is the environmental remote sensing is in the microwave region. The texture of earth surface materials causes significant interactions with several of the microwave wavelength regions. This can be used as a supplement to retrieving information from earth surface usable at night and in regions of persistent cloud cover.

Remote sensing system

Suborbital Sensors [1]

- Color infrared film, Panchromatic film ,Color film, Digital frame cameras
- Airborne Visible Infrared Imaging Spectrometer (AVIRIS)
- Airborne Terrestrial Application Sensor (ATLAS)
- Intermap Star-3i X-band radar

Satellite Sensors

- Multispectral Scanner (MSS), Thematic Mappers ,
- Enhanced TM (ETM+) - Multispectral-Panchromatic
- GOES Series (East and West), European Remote Sensing Satellite (ERS-1 and 2)
- Canadian RADARSAT, Shuttle Imaging Radar (SIR-C)
- Sea-Viewing Wide Field of View Sensor (SeaWiFS)
- Multiangle Imaging Spectro Radiometer (MISR)
- Moderate Resolution Imaging Spectrometer (MODIS)
- Space Imaging IKONOS-Multispectral-Panchromatic
- Digital Globe QuickBird- Multispectral-Panchromatic

Hyperspectral Remote Sensing

AVIRIS and MODIS are capable of capturing *hyperspectral* data. These systems cover a similar wavelength range to multispectral systems, but in much narrower bands. This dramatically increases the number of bands (and thus precision) available for image classification (typically tens and even hundreds of very narrow bands). Moreover, hyperspectral signature libraries have been created in lab conditions and contain hundreds of signatures for different types of land covers, including many minerals and other earth materials in [1].

Aerial Photography

Aerial photography is the oldest method of remote sensing. Cameras mounted in light aircraft flying between 200 and 15,000 m capture a large quantity of detailed information. Aerial photos provide visual inventory of a portion of the earth's surface. It can be used to create detailed maps. Aerial photographs commonly are taken by commercial aerial photography and operate specifically modified aircraft equipped with large format (23cm x 23 cm) mapping quality cameras.

Tele:
E-mail addresses: tganeshphd@yahoo.com

Aerial photos can also be taken using small format cameras (35 mm and 70 mm), hand-held or mounted in unmodified light aircraft. Camera and platform configurations can be grouped in terms of oblique and vertical. Oblique aerial photography is taken at an angle to the ground. The resulting images give a view as if the observer is looking out an airplane window.

These images are easier to interpret than vertical photographs, but it is difficult to locate and measure features on them for mapping purposes. Vertical aerial photography is taken with the camera pointed straight down. The resulting images depict ground features in plan form and are easily compared with maps. Vertical aerial photos are always highly desirable, but are particularly useful for resource surveys in areas where no maps are available. Aerial photos depict features such as field patterns and vegetation which are often omitted on maps. Comparison of old and new aerial photos can also capture changes within an area over time. Vertical aerial photos contain subtle displacements due to relief, tip and tilt of the aircraft and lens distortion. Vertical images may be taken with overlap, typically about 60 percent along the flight line and at least 20 percent between lines. Overlapping images can be viewed with a stereoscope to create a three-dimensional view, called a stereo model in [1].

Accessibility Index

Road for attractive factors in transportation accessibility, many variables such as travel cost, travel time, job opportunity, and the number of facilities or population can be applied. Among them, some parts are associated with visually recognizable features revealed on remotely sensed imagery, and accessibility indices can be utilized to road network or bypass design problem, and public transit planning [7].

Data Selection

Satellite data selection is very important role in satellite data processing. Because We like what kind of result extracted from what kind of satellite data.

Feature extraction from multispectral images

Many algorithms have been proposed to extract road networks from satellite imagery. Most of these algorithms [3, 4, 5], however, were developed to extract road networks from panchromatic low resolution satellite imagery (10 meters to 20 meters per pixel) such as SPOT satellite imagery. As more and high resolution satellite images such as IKONOS images are 1m per pixel. IKONOS satellite sensors provide 4-meter resolution multispectral data in the blue, green, red, and near infrared bands, and 1-meter resolution panchromatic data, which is the highest resolution available in commercial satellite imagery today[6]. The four-band color is then viewed as a vector in color space, which is first normalized, and then multiplied by the intensity given in the panchromatic image. We can extract road from NDVI images due to red and green bands. Road segments are iteratively identified by examining contextual length-width features extracted from the multispectral imagery conjunction with a vegetation index in [15].

Spaceborne sar images

The input images are ERS-1 SAR and SIR-C/X-SAR images. Since the speckles appearing in SAR images can degrade the performance of road detection, we first need to reduce them. For this procedure, a sigma filter developed by Lee [8] because it suppresses speckles with the least amount of blurred edges and fine details, and it is computationally efficient. Road extraction is strongly dependent on the spatial resolution and the relative orientation between road axesand the satellite sensors [10]. The detection of discontinuities in multitemporal SAR data is usually performed separately in the spatial domain, image by image [10] an information extraction step, which consists in computing several attributes that are sensitive to stable spatial features to temporal changes, or to any mixture of speckle distribution in local 3-D neighbourhoods. An information fusion is allows the end-user to classify each pixel spatial location. The sought-after classes correspond to temporal changes (TCs), spatial features (SFs) in [11].

Initial terms

Road extraction methods are categorized into automatic and semiautomatic methods. Statistical models are used to represent characteristics of the road features. Particle filters (PFs) are used for nonlinear filtering [12]. A semiautomatic feature binarization and fusion algorithm followed by a skeletonization algorithm, and a routine, which approximates skeletons with linear segment chains. The procedure maintains the information about junctions along the retrieved segment to preserve the extraction of intersecting roads. This allows the extraction of fewer and longer road segments in areas, such as urban ones, where a large number of junctions are expected and thus reconstructs the intersecting roads in a junction in [13]. Linear feature extraction from SAR data is challenging, particularly from VHR SAR data. It is an efficient line extractor already applied in automatic approaches for both optical and SAR data. The line extraction is followed by a smoothening and splitting step the linear features are evaluated based on their attributes using Bayesian probability theory.

Technical methods

Each remote sensing images having different types of algorithms. Road extraction on both images was performed using two fuzzy extractors proposed in [14]. The procedure requires a first classification step for a rough characterization of the scene in street or nonstreet pixels, followed by their clustering in consistent street segments. A user-guided method based on the region competition algorithm to extract roads in [16]. This algorithm recovers the road centreline and also road sides. A path optimizer method requires user attention at the beginning, seed point stage and at the end. Snakes and dynamic programming are the most successful path-optimizer methods. Region growing makes the first steps faster and region competition delivers more accurate results. Most of the research work used PCA and SVM methods.

A linear feature extraction methodology mainly focused in rural areas. Extractor II is a more sophisticated procedure developed for urban areas and is more successful particularly in terms of completeness. In order to get the best combination of both, we applied a rapid mapping filter for discriminating rural and urban scenes. In the end, the results from the two extractors are fused at the feature level in [13].Some of the parameters used in the Extended Kalman Filtering (EKF) module and the Particle Filter (PF) module are different from each other since the tasks of these two modules are quite different. The EKF module should properly find and estimate the coordinates of the road median, while the PF module is only utilized in critical situations, i.e., when the EKF module stops due to road obstacles or road junctions in [12]. A method for dynamic clustering of the road profiles in order to maintain tracking when the road profile undergoes some variations due to changes in the road width and intensity.

Snake model is one of the road extraction techniques and it gives the more accuracy result. This dynamic manipulation of node distribution is based on an analysis of the energy terms of the snake solution. By narrowing the energy range of the accepted points we increase the snake resolution, and hence the accuracy of the sub-snake. The obvious trade-off is that by narrowing the acceptable energy range we increase the number of iterations and correspondingly the solution runtime.

Recently, a theory for high dimensional signals called multiscale geometric analysis (MGA) has been introduced in [25]. Several MGA tools like ridgelets, curvelets and contourlets were proposedin [26][27].

Result analysis

A linear extraction method, Radius-Rotating Intersection detection method and classification algorithm used for grid structured roads from LIDAR data. It is separate the entire road from non-roads and the problem to extract the road network from this noisy classification result in [22]. Region growing method is very suitable for SPOT and IKONOS satellite images and this images covered small areas due to high resolution images [23].

Conclusion & advandages

The literature has numerous works for road extraction but very less contribution is found in dealing with rural areas. In this survey consist of filtering and threshold based processing is performed. Most of the road areas detected from high resolution satellite (less than 1 meter resolution) images. But various countries are having different types of roads. For example if we want take color based roads it may different from various countries. Some countries are having on black and white color roads. Very less classification techniques are used for road detection in satellite images.

Aerial image is always an import problem in Photogrammetry, meanwhile has involved more attention for working class in the fields of Remote-Sensing Surveying and Mapping, Pattern Recognition, Computer Vision and Artificial Intelligence, etc. It occupies a critical position in Image Matching, Topographic Map updating, Object Detection and Recognition, Urban Planning and Traffic Dispersion, etc. Recently, many scholars at home and abroad are both taking of this issue; they have taken great effort and put forward many relatively mature algorithms in [24].

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