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VEHICLE DETECTION FROM REMOTE SENSING IMAGES

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ABSTRACT

Image object detection is an important application of remote sensing technology. Road vehicle detection using very high-resolution remote sensing images has a unique advantage of covering a large area such as jaddah and alriad at the same time over all ground-based detectors. But the detection of small vehicle-object in remote sensing imagery is still a challenging task. Several parameters of gray values and sizes are examined to classify the objects in the image. The vehicles and their associated shadows can be discriminated by removing big objects such as roads. Our test shows a promising result of detecting the vehicle. We present an object-based detection approach with IMAGINE Objective for the detected vehicles in the study area. (jeddah city , alriad city)

IMAGINE Objective employs feature models working on objects produced by image segmentation and various other pixel-based algorithms can be processed by geometric and textural parameters after being vectorised. This process is used and optimised for the extraction of the vehicles from high resolution images. Preliminary object detection tests using a semi automated post-classification approach show reliable results. For this research, the applied methods prove to be useful to detect vehicles on the road of example images even without producing a complete extraction of all vehicles. The approach will be extended to the whole images area.

INTRODUCTION

With the availability of sub-metric resolution remotely sensed imagery, the automatic detection, characterization and monitoring of traffic vehicles using (airborne or satellite image) with its unique wide-area coverage and synoptic view has become an emerging field of research (Hinz et al.,2006 ; Gerhardinger et al.,2005 and Jin &Davis ,2007). Currently, more reliable vehicle detection can only be achieved from the very high-resolution remote sensing images. Existing approaches for vehicle detection can be categorized based on the underlying type of vehicle modeling (Sharma et al.,2006; Schlosser et al.,2003; Stilla et al.,2004; Hinz et al.,2005). There are two basic kinds of vehicle models that have been used: ⁽¹⁾ an appearance-based implicit model by clustering appropriate pixel groups into potential

vehicles. The implicit model typically consists of intensity or texture features surrounding each pixel. Detection is performed by checking feature vectors surrounding image pixels. ⁽²⁾ an explicit model. An explicit model usually describes a vehicle as a box or wire-frame representation. Matching the model top-down to the image, or grouping extracted image features bottom-up to create structures similar to the model is performed on the image. We present an object-based detection approach with Imagine Objective (Erdas,2010)for detect vehicles in the project area. Imagine Objective employs feature models which work on objects produced by image segmentation and various other pixel-based algorithms can be processed by geometric and textural parameters after being vectorised. This process is used and optimized for the extraction of the vehicles from high resolution images.

Data and Methodology

Data

The Available data of the study area of roads are two Aerial photo(Panchromatic image , res. 60 cm and Pan Aerial photo res. 15.24cm) and satellite image (Worldview2 images, 4bands (2Red; 3Green,5 Blue, and Infrared of 2m resolution) (Fig. 1).

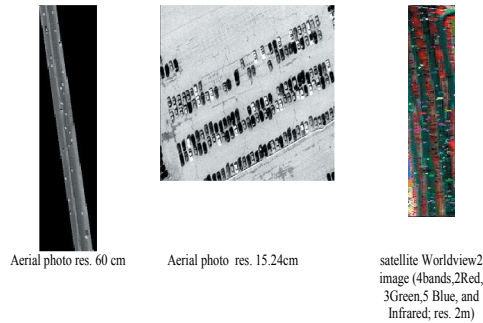


Fig.1: Original Images

Methods

Image processing was conducted in ERDAS Imagine10, using the Imagine Objective tool (Erdas,2010) which enables automated feature extraction. An object based classification was used to identify vehicles in the Aerial photo and satellite image. Object based classification is defined as assigning classes to image objects which are the result of segmentation of an image into discrete non-overlapping units based on specific criteria. The object based classification consisted of five processes: probability matrix computation, image segmentation, raster to vector conversion, vector processing, and vector cleanup. The probability matrix computation is a supervised procedure being trained using the location of known vehicle. The probability matrix computation assigns a probability of being a vehicle or not to each pixel. The probability of being a vehicle or not is determined based on the similarity of spectral values of the given pixel to the spectral values of the pixels of known vehicle identified during the training process. Segmentation of an image is

the process of partitioning a digital image into multiple regions to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. The segmentation based on spectral values and spatial characteristics created objects that are useful in classifying land cover in regions. The segmentation process was performed on the original Aerial photo and 4 band satellite images; however, the pixel probability layer was also used to calculate the probability zonal mean for each generated segment. The segmentation approach used combined splitting and merging of the input image with the use of edge detection to identify segments with similar characteristics. Threshold and Clump approach use to get all possible vehicle pixels to generate vehicle raster objects.

The parameters used for (Aerial photo, resolution. 15cm) image segmentation included: Euclidean distance (the compute settings function was used to determine the minimum value difference and the variation factor, 40 and 3.5 respectively), edge detection with an automatically generate threshold of 53, and a minimal edge length of three pixels.

The parameter used for (Aerial photo ,resolution. 60cm and satellite worldview2, 4band, res. 2m) images Threshold and Clump included: Probability threshold= 0.50 .The outputs images from segmentation of (Aerial photo) and Threshold and Clump (Aerial photo) image res 60 and satellite image (4 bands) res. 2m were then converted into a vector files, which was used for the vector object processing and cleanup procedures. Vector object processing consists of another supervised classification which utilizes geometry to refine the identification of vehicles. A variety of geometric cues are available for use in vector object processing, however after experimenting with the cue options we selected the following cues for use: area, a perimeter-area ratio, and shadow. The thresholds used for the cues were determined by training the classification with the area and perimeter-area

characteristics of the vehicle observed on the road. The area characteristic had a minimum value of 4 square meters and a maximum of 24 square meters. The shadow cue measures the association (determined based on adjacency) of the vector objects generated from the first three steps of the object based procedure to a shadow polygon created using a separate unsupervised classification. The vector cleanup process consisted of applying a probability filter to the vector file. The probability filter removed all object with less than 0.9 probability of being a vehicle, thereby ensuring that the final vector layer only included polygons that had a high certainty of being vehicle. An assessment of the accuracy of the object based classification was conducted comparing the location of vehicle polygons as identified in the final vector layer from the object based classification with the actual spatial location of individual vehicles as determined in the road (Fig. 2, 3, and 4).

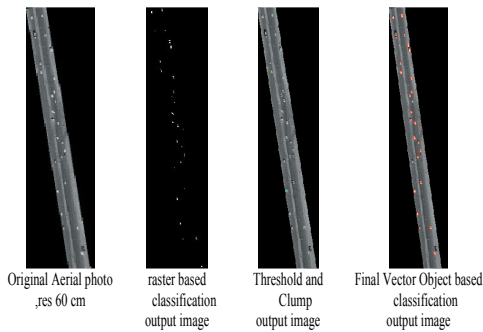


Fig. 2: Object based classification stages during vehicle detection from Aerial photo (res 60 cm)

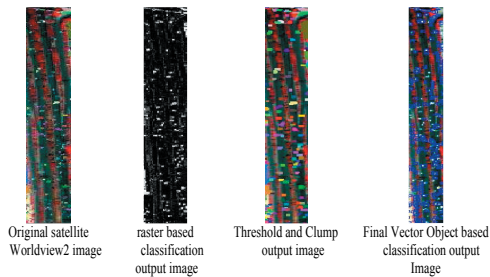


Fig. 3: Object based classification stages during Worldview2 satellite image (3band, res 2 m) And Vector Object based classification output Image

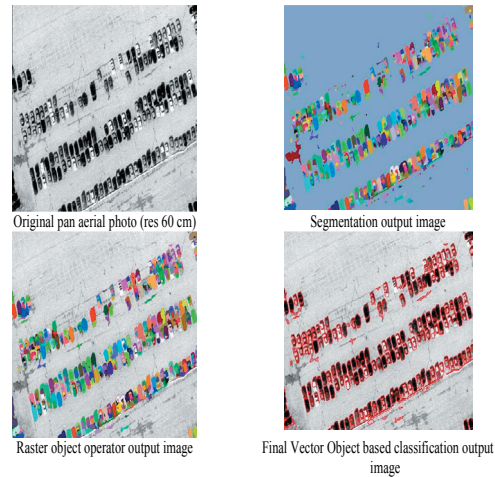


Fig. 4: Object based classification stages during vehicle detection from Aerial photo (res 15.24 cm)

RESULTS AND DISCUSSION

The object based classification results in a vector file containing polygons which are associated with one of two classes: class 1- vehicles, class 2-non vehicle. For the purpose of this study we are interested initializing object based classification to discriminate vehicles from the background. The object based classification improves upon a pixel based classification by incorporating shapes and spatial associations (e.g., association with shadow) of vehicles; additionally the resulting vector layer includes shape and size in the characterization of vehicles. The results from the object based classification were considered in terms of number of correctly identified vehicles, as determined by comparing the location of vehicles identified in the object based classification to the actual spatial locations of individual vehicles identified in the road. The results are compared with visual detection results (Table 1). There were 25 vehicles in Aerial photo (res 60cm), and 184 vehicles in Aerial photo (res 15.24cm), and 112 vehicles in Worldview image (4bands, res 2m) were extracted correctly by the process of vehicle detection. Only 3, 1, and 0 vehicles respectively were missed, and the noises which are not vehicles but extracted as vehicles were 0, 15, and 52, respectively

. The producer accuracy is 89%, 99%, and 100%, respectively and the user accuracy is 89%, 92% and 69%, respectively. In the images, 28, 169, and 112 vehicles, respectively were extracted correctly. Overall, almost all the vehicle could be extracted.

Table 1: Accuracy of vehicle detection

Image	Aerial photo (res 60 cm)	Aerial photo (res 15cm)	Worldview2 image (3bands , res 2m)
Vehicle in image	28	169	112
Extract result	25	184	162
Correctly extracted	25	168	112
Omission	3	1	0
Commission	0	15	52
Produser Accuracy	89	99	100
User accuracy	89	92	69

Not only light-color vehicles but also dark vehicles and some vehicles in shadow were extracted successfully. Because we extracted both vehicles and shadows, even the vehicle's gray value is similar to that of the road; the vehicle can be extracted by its associated shadow. There still have a few commission errors due to a Worldview2 image (4bands , res 2m), its shadow and some lines on the road. The environment condition around the target area influences the result of vehicle detection. Accuracy gets higher as an environment becomes simpler.

CONCLUSION

Object based classification of high resolution imagery provides the tools to detect vehicles in the road ,object-based detection approach with Imagine Objective for the detect vehicles in the test images. Preliminary object detection tests using a semi automated post-classification approach show reliable results. For this research, the applied methods prove to be useful to detect vehicles in the road of

example images even without producing a complete extraction of all vehicles in whole images. The approach will be extended to the whole images area.

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الكشف عن المركبات باستخدام تكنولوجيا الاستشعار عن بعد

عراقي خليفه و عيد الرحمن الزيدان

اكتشاف الكائن في الصورة هو تطبيق مهم لتكنولوجيا الاستشعار عن بعد. اكتشاف المركبات في الطريق باستخدام صور الاستشعار من بعد عالية الدقة لديه ميزة فريدة من نوعها لتغطية منطقة واسعة في الوقت نفسه على جميع أجهزة الكشف الأرضية. لكن الكشف عن كائن مركبة صغيرة في صور الاستشعار من بعد لا يزال مهمة صعبة. ويتم فحص العديد من المعاملات من القيم الرمادية والحجم لتصنيف الكائنات في الصورة. ويمكن تمييز هذه المركبات والظلال المرتبطة بها عن طريق إزالة الأجسام الكبيرة مثل الطرق. وعند الاختبار تبين لنا نتيجة واعدة للكشف عن المركبة. نقدم منهجية الكشف المعتمد على الكائنات مع برنامج IMAGINE Objective لاكتشاف المركبات في منطقة المشروع (مدينة الرياض و مدينة جدة). برنامج IMAGINE Objective يوظف نموذج الميزات التي تعمل لإنتاج الكائنات بواسطة تقسيم الصور وغيرها من مختلف الخوارزميات المعتمدة على الخلية والتي، بعد ذلك تتحول الى متجة، ويمكن معالجتها من قبل المعاملات الهندسية والتكوينية. هذه العملية استخدمت ومثلت لاستخراج المركبات من صور عالية الدقة. الاختبارات الأولية للكشف عن الكائن باستخدام طريقة نصف الآلية بعد التصنيف تظهر نتائج يمكن الاعتماد عليها. الأساليب التي تم تطبيقها لهذا البحث تثبت أنه من المفيد للكشف عن المركبات في الطريق من الصور على سبيل المثال حتى دون الاستخراج الكامل لجميع المركبات. الطريقة المتبعة سوف يتم توسيعها لتشمل نطاق منطقة صورة كاملة.