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Engineering

A STUDY ON VARIOUS OBJECT DETECTION METHODS IN SATELLITE IMAGERY

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ABSTRACT Image Processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. Satellites are man-made objects launched into space to take images useful for umpteen applications. Object detection is a computer technology related to image processing that deals with detecting instances of semantic objects of a certain class (such as humans, buildings, cars etc.) in digital images and videos. This paper is to review various object detection techniques in satellite images and its scope.

KEYWORDS : Object detection, satellite, edge detectors, filters, image processing

I. INTRODUCTION

An image is a two-dimensional representation of objects in a real scene. Remote sensing images are representations of parts of the earth surface as seen from space. The images may be analog or digital. Aerial photographs are examples of analog images whereas satellite images acquired using electronic sensors are examples of digital images. A digital image consists of a two dimensional array of individual picture elements called pixels which are arranged in rows and columns. Each pixel represents an area of earth's surface that has an intensity value and a location address in the image. Resolution of an image is the smallest distance between two adjacent objects that the sensor can identify. The four types of resolutions defined for the remote sensing systems are

1) Spatial Resolution - It is the pixel size of an image representing the size of surface area.
2) Spectral Resolution - Gives the wavelength interval size and number of intervals that the sensor is measuring.
3) Temporal Resolution - The amount of time that passes between imagery collection periods for a surface location.
4) Radiometric Resolution - The ability of sensor to record many levels of brightness to the effective bit depth of the sensor.

Object detection in remote sensing images is to determine if a given aerial or a satellite image contains one or more objects belonging to the class of interest and locate its position of each predicted object in the image. Detecting and enumerating objects of interest over large areas is one of the primary aspects of satellite imagery analytics. An edge in an image is an abrupt change in intensity of pixels or discontinuity in image brightness or contrast. The important features are corners, lines and curves. One dimensional edge profiles are shown in the following Fig. 1.

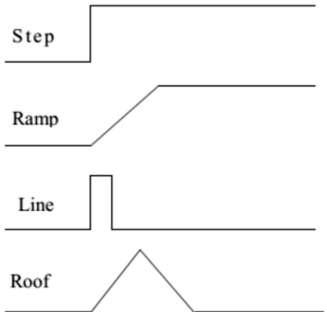

Fig 1. One Dimensional edge profiles

The four steps of edge detection are

1) Smoothing - Suppresses as much noise as possible, without destroying the true edges
2) Enhancement - Edge sharpening is done by applying a filter to enhance the quality of edges
3) Detection - Determines which pixels to discard as noise and which to retain, called Thresholding
4) Localization - Determines the exact location of an edge by edge thinning and linking

There are many ways to perform edge detection, but the majority may be grouped in two categories: Gradient based Edge Detection, Laplace based Edge Detection

II. LITERATURE SURVEY

Teymur Azayev [1] in his thesis looks at a way of automating the detection of ships to track maritime traffic in a desired port or region. He proposes a machine learning approach using deep neural networks and explores the development, implementation and evaluation of such a pipeline, as well as methods and dataset used to train the neural network classifier. He also takes a look at a graphical approach to computation using TensorFlow which offers easy massive parallelization and deployment to cloud. The final result is an algorithm which is capable of receiving images from various providers at various resolutions and outputs a binary pixel wise mask over all detected ships.

N. Sai Kumar, B. Sukanya, B. Mohan and G.Prathibha [2] present an efficient method of extraction of roads from a given set of database. The extraction of roads plays an important role in urban planning. The other applications of road extractions are identification of isolated buildings that need to be detected and updating of GIS database according to the requirements of the human expertise. Edge detection techniques such as Canny, Sobel, and Prewitt were applied to the image. Morphological operations were applied to the resultant image which consisted of noise due to the edge detection operators. The noise present in the resultant image was reduced by applying Median filtering. The proposed method extracted roads with in less time compared to the earlier methods.

Adam Van Etten's [3] paper discusses a simpler approach using pre-filters and sliding windows paired with histogram of oriented gradient (HOG) based classifiers. In this post he showed how to combine Canny edge detector pre-filters with HOG feature descriptors, random forest classifiers, and sliding windows to perform object detection on satellite imagery. For boats of length [140, 100, 83, 66, 38, 22, 14, 10] meters, the entire classification pipeline took less than 30 seconds for the test image, translating to ~15 minutes for a full 8x8 kilometer DigitalGlobe image on a single CPU. This run-time could be greatly reduced by looking only for longer ships. For example, only searching for boats of length greater than 20m takes only ~3 minutes for a full DigitalGlobe image, a marked decrease from 15 minutes.

Chaitanya Malladi [4] says that objects in a satellite image can be identified using Machine Learning Techniques with Supervised and Unsupervised algorithms. Based on the literature survey, support vector machines and k-means were selected for supervised and unsupervised learning respectively. An experiment was performed to implement these algorithms with a dataset consisting of objects from satellite images. The results of the experiment were evaluated

using confusion matrix analysis and silhouette score analysis. The analysis of confusion matrix and silhouette score suggested that the support vector machine classification performed well unlike k-means which produced a weak cluster. The support vector machine was found to have an accuracy of 99.3%. On the other hand, the k-means clustering generated a silhouette score of 0.3237. From the results of the research, it can be concluded that the support vector machine was found to be more applicable for object recognition on satellite images in comparison to k-means clustering.

Arkadiusz Nowaczynski [5] and his team applied a modified U-net, an artificial neural network in Deep Learning for Satellite Imagery via image segmentation to detect 10 different types of objects such as buildings, miscellaneous man made structures, roads, tracks, trees, crops, waterway, standing water, large and small vehicles. Their fully convolutional model combined lower and higher level feature maps to enable precise location. They normalized images to have a zero mean and unit variance and left preprocessed images unchanged, used sliding window approach to eliminate weaker predictions on image patch boundaries and morphology dilation/erosion for post processing.

Gong Cheng and Junwei Han [6] surveyed 270 publications of object detection methods based on template matching, knowledge, object based image analysis (OBIA) and machine learning. They proposed two research directions namely deep learning-based feature representation and weakly supervised learning - based geospatial object detection.

Raman Maini and Dr. Himanshu Aggarwal [7] compared various image edge detection techniques like Canny, LoG (Laplace of Gaussian), Robert, Prewitt, Sobel and found that Canny's edge detection algorithm performed better but was computationally expensive.

III. CONCLUSION

Object detection has always been a fundamental but challenging issue in the field of aerial and satellite image analysis. In this paper, the main terminology of object detection has been addressed. The various edge detection techniques proposed for object detection for satellite imagery such as roads, ships, buildings etc. have been reviewed.

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