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A Real Time Change Detection Algorithm: Pixel Based to Object Based

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ABSTRACT

The importance of correct information about earth surface is increasing day by day. This information is used in local, regional and global resources monitoring, land-cover and land-use change monitoring, and environmental studies. There are opportunities of information of land at varying resolution by the data provided by the remote sensing satellites. There are large number of techniques are available and so many new techniques are emerging for change detection studies. This paper discusses major pixel based techniques and then object-based techniques. Comparison has been done between all techniques. Importance to integrate Image Differencing with Image Mining has been highlighted as Image Data Volume has been increasing and there are several challenges in the current methodologies for the change detection. So there is a need to integrate pixel based method to object based image mining method.

KEYWORDS Image Differencing, Image Mining, Integration of Image Differencing and Image Mining, Remote sensing, Change detection, Pixel-based, Object-based.

I. INTRODUCTION

Change Detection of land is useful in deforestation, damage assessment, disasters monitoring, urban expansion, planning, and land management discriminate between natural seismicity and anthropogenic events such as mining blasts. "Change Detection is the process of identifying differences in the state of object or phenomenon by observing it at different times", defined by Singh[1].

Multi Temporal Datasets are used in Change Detection Framework to analyze temporal effects of phenomena and to measure the changes.

Currently ongoing research agenda is to develop change detection methods in remote sensing. spatial, spectral, thematic and temporal constraints, radiometric resolution, atmospheric conditions, and soil moisture conditions affects the change detection from Remote Sensing Data. Depends on the requirements various methods have been developed. However, the selection of the most suitable method or algorithm for change detection is not easy in practice Researchers have made enormous efforts in developing various change detection methodologies including both the traditional pixel-based and more recently, the object-based [1]

One of the most challenging issues in land change detection is the development of land change detection method which can efficiently finds the land change of different objects present in it[2]. The limitation with only using two images is that similar land cover types can appear significantly different at various times of the year, Land change had been identified in past decades through direct image subtraction method [2], which is not efficient. Due to the difficulty of that like method, researchers were motivated to develop the enhanced change detection method.

We studied several papers related to pixel-based techniques and object-based techniques and provide comparative analysis. The paper is organized as follows: Section II is dedicated for the literature review. Section III gives a comparison of various techniques which is followed by Conclusion in Section IV.

II. LITERATURE REVIEW

There are various pixel-based and object-based methods are available for change detection. Pixel-Based Methods includes Background Subtraction, Frame Differencing, Temporal Differencing, Image Differencing and many others. Image Mining is the tool for change detection as a Object-Based Method.

Background Subtraction

Background subtraction is most basic and popular method for motion segmentation. In this method moving region is detected by differencing the current and reference background frame in pixel by pixel manner. Here presented a two-frame differencing scheme where the pixels that satisfy the following equation are marked as foreground.

$|I(x, y) - B(x, y)| > \text{Threshold}$; Here I(x, y) is the current frame pixel and B(x, y) is background image pixel. The pixels where the difference is above a threshold are classified as foreground.

Temporal Frame Differencing

The approach of temporal differencing makes use of pixel-wise difference between two or three consecutive frames in an image sequence to extract moving regions.

Image Differencing

In this technique, images of the same area, obtained from times t1 and t2, are subtracted pixel wise. Mathematically, the difference image is $Id(x, y) = I1(x, y) - I2(x, y)$, where I1 and I2 are the images obtained from t1 and t2, (x, y) are the coordinates of the pixels. The resulting image, Id , represents the intensity difference of I1 from I2.

Rosin and Ioannidis investigated the performance of several automated thresholding algorithms using a large set of difference images calculated from an automatically created ground truth database. They give results based on several measures for a complete evaluation. In this study, we benefit from three different threshold selection methods.

These are **percentile thresholding, Otsu's method** and **Kapur's algorithm**[6].

NCC (Normalized Cross Correlation)[4]

Manoj S. Nagmode et.al presented object detection step to have reliable, robust and fast visual surveillance system. The algorithm used gives better performance in terms of Detection Rate (DR) and processing time per frame.

Correlation is mainly used for measuring similarity between two images. It is useful in feature recognition and registration. Normalized cross correlation is given by equation (1).

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right)\left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}}$$

In this, $\bar{A}$ and $\bar{B}$ indicates average pixel value in image A and B respectively. 'r' is normalized

Image Mining[11]

Image Mining is an extended branch of data mining that is concerned with the process of knowledge discovery concerning images. Image Mining deals with the extraction of image patterns from a large collection of images. In Image Mining, the goal is the discovery of image patterns that are significant in a given collection of images.

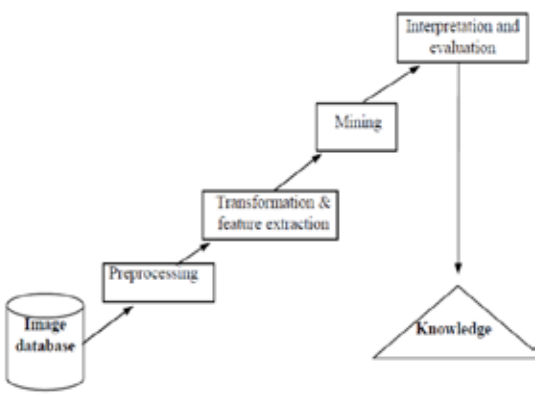

Fig 1: Image mining process

Section III Comparison Various Pixel Based Change Detection Methods

METHOD NAME	DESCRIPTION	ADVANTAGES	DISADVANTAGES	EXAMPLE
Background substraction	This method extract foreground by subtracting background so it is called background substraction. In this method first background estimated. Then background is subtracted from new incoming frame so that we can get foreground. If threshold is greater or equal to subtraction value then and then we get foreground otherwise not. # |I(x, y) – B(x, y)| > Threshold	Extremely easy to implement and use! I All pretty fast.	I Corresponding background models are not constant, they change over time. Used only when background is static	There is incoming frame with boat and water consider water as background subtraction apply on both frame if result is greater than or equal to threshold then foreground as a boat we can detect otherwise not.
Frame differencing	In this method 2 consecutive frames pixel wise absolute difference is calculated. When I'th time K'th frame.. When I+1 time K+1'th frame.. Subtract k+1 from K (absolute diff)	Adaptive to dynamic environment	does a poor job of extracting the entire relevant feature pixels. Generate holes because of air motion solve it 3 frame difference is used.	To detect motion from video.
Temporal differencing	Here pixel wise difference between 2 or 3 consecutive frames estimated.			
image differencing	image of same place or same area is captured at different time then pixel wise difference will calculated. Id=I1(x, y) – B2(x, y)	simple and straight forward . Easy to interpret result.	images must be registered. Selecting suitable boundary. selecting suitable threshold.	forest, defoliation, land cover change and iregulated monitoring of crops.
Normalized cross correlation	Here similarity between 2 images estimated. Using normalized equation 2 consecutive frame partition into 4 quad. 4 times NCC applied we get 4 values if there min values then motion is present otherwise not..	Give better performance in terms of detection rate & processing power.	computation hard.	To detect object in reliable robust & fast Visual surveillance system

Figure 2: Comparison Various Pixel Based Change Detection Methods [3]

IV. CONCLUSION

This paper compares several pixel-based and object-based change detection techniques that can be applied to the large image data provided by the satellite. This data can be analyzed in different applications.

By studying various methods of change detection we found that traditional algorithms of Pixel-Based methods like Background Subtraction, Temporal Differencing, Image Differencing and Object-Based Image Mining method is not enough. In these traditional methods there are some limitations and complexity found like Difficult learning curve, No complete matrices of change information, Optimal threshold selection etc. So there is a need of Integration between Pixel-Based and Object-Based Techniques. In further studies we found that such type of integration can be done between Image Differencing and Image Mining. As in Image Differencing Technique we take images consideration at two different time to detect the change and using image mining we can detect the object. So we proposed to research about integration of Image Differencing and Image Mining Methods for the change detection.

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