Review of Techniques Used For Change Detection in Remotely Sensed Images

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Abstract: The propensity towards up to date information about the earth's surface is ever increasing. The information generated through the satellites is used in wide range of applications such as land monitoring, whether forecasting, resource monitoring and environment monitoring. Legion of techniques are developed to detect change by utilizing the applications of remote sense data and new techniques through research are still emerging. This paper begins by first of all discussing slandered pixel based techniques and statistics based techniques for change detection. This is preceded by describing object oriented techniques. Data mining approaches for change detection is comprehensively described. The relative merits and demerits of each technique is described to determine optimal methodology to be used in future research.

Keywords: Remote Sensing; Pixel based; satellites; Object oriented; data mining.

1. Introduction

The remote sensing application, changes are inevitable as surface component alter with varying rate. Land cover and land use vary information is critical because of its practical uses in critically vast applications, including deforestation, assessment of damage, monitoring of disaster, land expansion and land management. Change detection is defined as identifying differences in the state of an object or phenomena by observing it at different times[1]. Change detection framework utilizes multi time varying datasets to analyze time dependent event and determine changes which are required in current system[2]. The remote sensing data becomes major source for change detection studies because of its accuracy in determining stabilized point in given time series[3]. Digital format which suits for computation, synoptic view and vast selection of space dependent and spectral resolution is great application supported by remote sensing application. [2]The general objectives of change detection in remote sensing includes determine location over wide area along with distinct changes and then determining amount of changes in particular location. Also accuracy of result is analyzed produced through change detection using remote sensing. The change detection methods researched within remote sensing is ongoing agenda. The principal behind utilizing remote sensing data in change detection is to detect other factors which are causing changes so that those factors could be separable from remote sensing with change detection. Paper is organized as: Section II describes general considerations used in change detection. Section III describes pixel oriented methods for change detection, section IV describes object oriented methods for change detection, section V describes data mining approach whereas section VI provides comparison of relative merit and demerit of various approaches and last section provides conclusion and future scope.

2. General consideration in change detection

Change detection has legion of assumptions and general facts associated with it. Most general factors involves

- Feature Extraction: it is expressed in terms of ratio or difference.
- List of functions for Decision making: it is used to form decision regarding change in current environment or not.

These are general assumptions but may not be always followed. The change detection is divided into following categories.
- Pre-processing
- Selection
- Checking Accuracy or assessing Accuracy of prediction

Pre-processing is the process by which radiometric, atmospheric and image registration process is tackled. Data from same sensor is required to handle such parameters. There are legion of factors which distort the collected data. These factors include sunlight, noise from the medium of transmission, phonological difference; angle deviation etc. corrections are required to tackle such issues. Corrective measures are applied by the use of error correction metrics such as root mean square error, absolute error and relative error. The amount of discrepancy is predicted through the corrective measure metrics[4].

Legion of techniques after corrective metrics application are utilized for change detection in remote sensing areas. These methods include pixel, object and Data mining based approaches for change detection. These methods are discussed in proceeding sections.

3. Pixel driven approach for change detection

Pixel is picture element and is basic unit of image analysis. Pixel is a atomic analytical technique in which spatial characteristics are not considered. Most commonly statistical methods are used to evaluate individual pixel. Different pixel based approach for change detection are described in this section. The relative merits and demerits are described in tabular structure as follows

Table 1: Summary of Pixel based approach for change detection

Category	Approach	Merits	Demerits
Comparison of pixels [5]	Image differencing	It is simple in nature	Complete metrics of change detection is absent
		Interpretation is easy	Optimal threshold is difficult to fetch
			Information fetched is malicious which means same information may have different meanings
			It is binary in nature which means data which is fetched either give change detection or no change detection. All other information is discarded.
			No complete metric to detect change
	Image rationing[7]	Information calibration is handled better	Subtle changes are poorly detected
			Less accurate
			Noise prone
	Regression Analysis technique [8]	It reduces errors arising lightning or illumination	It is binary in nature
Transformation based approach	Index Differencing [9]	It reduces errors arising due to topological effect and lightning	Prone to coherence noise
			Binary in nature
	Vector Change Analysis[10]	It can process any number of spectral bands	
		Change detection is determined with detailed information	
		Spectral manifestation if not known then this method is useful	
	Principal Component Analysis technique [11]	Handles redundancy efficiently	Difficult to label information fetched for change detection
		Information from derived components is used	Change types are difficult to differentiate
	Tesselled cap transformation [12]	Platform independence	Metrics is absent or below power
		Stable spectral components is produced	Difficult to label information
	Analysis of texture (Texture analysis) [13]	Statistical information is present hence information is better classified	Window size is critical for this process.
		Higher textured value is analyzed	Success rate is low
		Spatial transformation is analyzed easily	
Classification based Approach	Technique of post classification [14]	Environmental effects are analysed effectively	Accurate and complete dataset is

Category	Approach	Merits	Demerits
			required for prediction
		Metric to detect complete change is present	Accuracy of individual image determine accuracy of entire process
	Direct Comparison [15]	One classification is used for multiple situations	It is difficult to label information
		Environmental changes does not affect accuracy of this system	Change metrics are absent or below power
Geographical information system	GIS integration support[8]	Image interpretation and analysis has additional support of GIS	Quality of data fetched is low
			Accuracy is low since data source are different along with distinct formats
		against the similar object based from other image	
		Implementation is fairly easy	From-to changes is not handled
		Similar properties reduces complexity in calculation	Multi temporal images is not handled effectively
Classification based approach[19]	Segments created separately are compared	Objects available in images can participate in such approach	Difference in size can cause the problem
		Topological measure can easily be detected	Locational changes leads to error in change detection
		Classification based changes can be detected using this approach	Accuracy of segmentation is critical in this approach
			Accuracy of classification determine accuracy of change detection
Time dependent change detection	Bi-temporal images	All images are arranged over a single segment	Accuracy is at stake when distinct images under varying shadow conditions are fetched
		Same geometric properties are possessed by multiple images	New objects are fetched
		It extract spectral, geometrical and derived images of change detection	

The classification based approach is most cited and most commonly used for change detection. GIS based approach is used to support decisions regarding change detection based on remote sensing. Most of the techniques fetch binary information indicating change vs. no change approach. Next section describes object oriented approach for change detection.

4. Object oriented approach for change detection

Object oriented approach provides higher levels of security while fetching of information. Multi spectral images and higher computational capabilities challenge pixel driven approaches. Remote sensing using this approach is capable of determining damage occurring through earthquakes [16]. It is determined that pixel is not a geographical object. Hence pixel based approach is not recommended for GIS systems [17]. This section provides summary of object oriented techniques used to detect changes.

Table 2: Comparison of object oriented approaches for change detection

Category	Approach	Merits	Demerits
Direct Approach based on comparison [18]	Object fetched from image and compare	Simple in nature	Segmentation Dependent

Object based approach is commonly utilized in geographical object based image analysis. Object based approach helps fetch

more richer information in terms of texture, shape and spatial resolution[21].

5. Data mining approach for change detection

Repository of datasets relating to remote sensing is available which can be used to detect changes. Images available through the datasets are at very high resolution. This causes criticality of data mining approach to promote data based approach for change detection in remote sensing. Data rich and information poor is promoted through this approach[22]. Data mining approach is used in this section and described in comparative manner as follows

Table 3: summary of data mining approach of change detection

Category	Approach	Merits	Demerits
Data mining of remote sensing images [23]	Remote sensing through data mining	Allow to search through large number of images represented as datasets	Integration of data mining approach with image analysis is difficult.
		Spatial and temporal based images are easily tackled	Learning graphs generated through this approach is difficult to understand
		Knowledge and relationship is extracted easily	
		Clustering of information provides graphical means of analysis	

Remote sensing can be greatly improved by the use of data mining approach. Clustering of information can be generated using K-Means[24], C means[25], and fuzzy approaches [26] of neural network. Hybrid approaches are generally preferred in the area of change detection in remote sensing images. Since optimal features can be extracted using the hybrid approach.

6. Conclusion

This paper describes legion of techniques which are already researched and are used in change detection in remotely sensed images. Bi temporal and multi temporal image are main focused image through change detection techniques. This paper provides details analysis of all the techniques along with merits and demerits of each. Mostly environment change detection is area of focus through remote sensing. With the increased high

end images datasets data mining approach has shown their potential towards remote sensing applications also.

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