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A Land Use Land Cover classification System Using Remote Sensing data

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Abstract

Geospatial Technology has developed at a significant pace over the past two decades and will play a key role in the development of the nations in the 21st century. In a developing nation like India where many people reside in the rural area and very few live in urban areas, we require a very structural planning and procedure such that the developmental activities and infrastructure facilities are available for both urban and rural areas. The rapid expansions of urban areas are due to rise in population, economic growth and migration from rural to urban areas. Therefore serious problem associated with rapid development such as additional infrastructure, informal settlements, pollution and scarcity of natural resources has to be studied carefully using Geospatial Technology. GIS and RS data along with collateral data which help in analyze the growth pattern and nature of urban sprawl. In urban expansion, open land is converted into residential area, industrial area, transport facility. The accuracy of change-detection system of urban area is important for understanding the relationships and interactions between human and natural phenomenon. In this paper, we investigate the major techniques, among that post-classification comparison and PCA are mostly used in change detection System.

Keywords: GIS, RS, PCA, CVA, LULC.

1. Introduction:

Application of Remote Sensing technology have been identified and used as an important tool to monitor land use and surface changes. Satellite Remote sensing collects multi-spectral, multi-resolution, multi-temporal data providing and monitoring the process of urban land cover changes [1].Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times [2]. In change detection application, it is necessary to use multi-temporal datasets to analyze the temporal effects of the object or phenomena [3]. Currently, with increased computer capability and data availability, Remote Sensing [RS] and geographic information systems [GIS] have become effective tools for detecting objects and phenomena change [4]. Remote sensing is a process of acquisition of data or information of objects or targets, which is located on earth's surface. For this, sensors are used which are placed on the satellite [5].

Remote sensing and geographic system technology is more useful in management functions and decision support system which are also useful in the planning process of urbanisation. RS and GIS application can support a variety range of planning, analysis and decision support systems operations that can make extraordinary effect to the development and growth of urban area. Instead of finding optimal solutions for urban problems, bold approaches must be developed [6]. Temporal and special reservations allow scientists to monitor and detect changes over a broad scale and help planners to obtain or maintain information on various phenomena such as shifting agriculture patterns, industrialization, urban expansion, land use land cover changes [7] [8].

Geographic information system is useful tool for measuring the change between two or more time periods. It has the ability to incorporate multi sources of data into a change detection platform, for example the use of multiple layers, classified images, maps, toposheets provide a greater ability to extract useful information about the change over a particular area. Moreover, GIS can measure trends in these changes by modelling the available data and using statistical and analytical functions. The benefit of GIS is the provision of different outputs in different formats, for example the facility of maps or tables allow users to select appropriate output for extracting the desired information [6] [8] [4]. Many studies have attempted to use RS and GIS technology for LULC detection.

The article presents many land use land cover change detection techniques used for study. It also focuses on urban expansion of a city with different methodology used in different study. Table 1 shows some examples of applications that are investigated using change detection techniques [4].

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Table 1: Applications with commonly used Techniques

Sr. No.	Applications	Most commonly used techniques.
1.	Land use/land cover change	Image differencing, image rationing, NDVI, CVA, PCA, chi-square, post-Classification, hybrid change detection, ANN, decision tree, GIS.
2.	Urban change	Image differencing, post-classification, Hybrid change detection, PCA, GIS, Chi-square, image fusion.
3.	Environmental change	NDVI, ANN, CVA, Post-classification, Image differencing.
4.	Vegetation change	NDVI, CVA, image differencing, post Classification.
5.	Landscape change	Post classification, GIS.
6.	Deforestation	Post classification, NDVI, image Differencing, PCA.
7.	Wetland change	Post-classification, GIS.

2. Land Use and Land Cover Techniques

A modern nation, as a modern business, must have adequate information on many complex interrelated aspects of its activities in order to make decisions. Land use is only one such aspect, but knowledge about land use and land cover has become increasingly important as the Nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels [8] [9] [10].

One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time [9] [10].

Following are the techniques for LULC.

2.1 Image Differencing

Image differencing is an image processing technique used to determine changes between images. The difference between two images is calculated by finding the difference between each pixel in each image, and generating an image based on the result. For this, the two images must first be aligned so that corresponding points co inside, and their photometric values must be made compatible, either by careful calibration, or by post-processing. The complexity of pre-processing needed before differencing varies with the type of image [11].

Image differencing, also referred as image data, it is a simple technique for implementing and interpreting change detection. It divides the image pixels into two results: change or no change. This process is obtained by subtracting a pixel's digital number on the image for one date from the corresponding pixel's digital number on the image for second date. The general process for detecting the change in two dates in image differencing is extracting the change of the image of date 2 from the image of date 1. However, the image differencing technique cannot provide sufficient information about the change itself. Atmospheric and other non-surface radiance characteristics can affect the result of image differencing [12].

Image differencing is widely utilised for change detection in geographical environment [13].

2.2 Image ratioing

Image rationing is extracting information between two registered images from different dates with one or more bands in an image or rationed, band by band. The data is compared on a pixel by pixel basis. In image rationing, the unchanged pixel takes the same number for both dates with a grey level. The changed pixel takes a different value and is displayed at a lighter or darker level [4].

One can compute

$$Rx^{k}ij = x^{k}ij(t1) \;/\; x^{k}ij(t2) \qquad \ldots (1)$$

Where, $x^{k}ij(t2)$ is the pixel value of bank k for pixel x at row i and column j at time t2. If intensity of reflected energy is nearly the same in each image than $Rx^{k}ij=1$, this indicates no change. In areas of change the ratio value would be significantly greater than 1 or less than 1 depending upon the nature of changes between two dates [14].

2.3 Change Vector Analysis (CVA)

Spectral change vector Analysis is based on multi-temporal images. Change Vector Analysis can represent both the direction and magnitude of a change. The magnitude of change is determined by constructing a vector in the multispectral feature space. The one end of the vector is specified by multispectral digital numbers (DN's) for the first date and other end by the DN values for same pixel on second date [15]. The magnitude of vector was calculated from the Euclidean Distance between the differences in positions of the same pixel from different data takes within the space generated by axes. Greenness and Brightness, as follows [16].

$$R=\sqrt{(yb-ya)^2 + (zb-xa)^2} \qquad \ldots\ldots(2)$$

Where, R = Euclidean Distance

Ya = DN values of Greeness from date2

yb = DN values of Greeness from date1

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xa = DN values of Brightness from date1

xb = Dn values of Brightness from date2

The decision that a change has occurred is made if the magnitude of the computed spectral change vector exceeds a specified threshold direction. The direction of vector contains information about the type of change. This method was applied to forest change detection in northern Idaho and South Carolina. For study of Acre state in Brazilian Amazon the CVA technique was used to detect and satisfy different types of changes in terms of biomass gain and loss. Spectral change vector analysis can avoid not only the classification and time-consuming effort and accumulated error in the type of unreasonable defect in post-classification comparison method, but also can use more or even all of the bands to detect changes in pixels and changes in pixel type information [17].

2.4 Image Fusion

Image fusion is a technology that merges two or more images from the same area in different sensors and wavelengths. In image fusion, the first step is to prepare the input images for fusion process. This includes registration and re-sampling of the input images. Registration is to align corresponding pixels in the input images. This is usually done by geo-referencing the images to a map projection such as UTM (Universal Transverse Mercator). If the images are from different sensors, and even if they are geo-referenced by the image vendors, a registration process is still necessary to ensure that pixels in the input images exactly represent the same location on the ground [18]. It shows that proposed wavelet transform approach improves the spatial resolution of a multi-spectral image it also preserve much portion of the spectral component of the image [19].

Details of cartographic features and interpretability can be realized using multi-sensor image fusion techniques. Enhanced multi sensor data products will prove useful to scientists seeking to maximize the amount of information that can be extracted from satellite image data.

Image Fusion having five methods for merging the images. Intensity-Hue-Saturation (HIS), Principal Component Analysis (PCA), High pass filters (HPF), Brovery and wavelet technique. The fused image outputs were evaluated based on three characteristics i.e. statically, graphically and by comparing classification accuracy. Image fusion provides the way to integrate disparate and complementary data to enhance the information apparent in the images as well as to increase the reliability of interpretation [20]. Out of all five algorithms wavelet PCA fusion image has high integrated frequency information and has a high certainty in extraction of construction in the study area and it is also found that the unsupervised classification of the comparison of original image and supervised classification to extract infrastructural information.

2.5 Post-Classification

It is currently the most popular method of urban change detection. In Post Classification Comparison, each date rectified imagery is independently classified to fit a common land type schema (equal number and type of land cover classes). The resulting land cover maps are then overlaid and compared on a pixel-by-pixel basis. The result is a map of land cover change. This per pixel comparison can also be summarized in a 'from-to' change matrix shows every possible land cover change under the original classification schema and shows the areas of each change class. Post classification comparison includes two scheme supervised classification and unsupervised classification algorithms. Supervised classification is a process when the analysts select a number of areas for an image and then identifies the type of each phenomenon on the computer screen. Supervised classification usually requires training data and prior knowledge of the objects that are selected for classification. Unsupervised classification is a process by which the computer partitions the data without prior knowledge and then applies thematic labels. Unsupervised classification usually requires training data and prior knowledge of the objects that are elected for classification [4].

3. Change Detection Accuracy Assessment

Accuracy assessment was critical for a map generated from any remote sensing data. Error matrix is in the most common way to present the accuracy of the classification result [21]. Overall accuracy, user's and producer's accuracies and kappa statistics were then derived from error matrices. The kappa statistic incorporates the off diagonal elements of the error matrices and represents agreement obtained after removing the proportion of agreement that could be expected to occur by change [22]. A considerable number of pixels are taken from classified image and compared with a reference map of higher authority to evaluate correctness of classification process. The kappa coefficient ranges from 0 to 1, values higher than 0.7 are considered acceptable, while those equal to or lower than 0.4 identify a very low correlation between classified image and the ground truth [23].

4. Evaluation of change Detection Techniques

An analysis of the literature reviewed indicates that different methods of change detection produce different maps of cover change. Some change detection techniques, such as image differencing, image rationing and PCA, do not provide sufficient change trend information. These techniques only provide change or no change results, therefore, the trend and direction of the change is difficult to determine [24]. Post classification comparison provides more details about the objects. Some techniques are affected by reducing such errors to produce high-quality thematic change detection maps. Post-classification comparison always contains omission and commission errors and needs the selection of a confusion matrix and its measures to minimize these errors [25].

Refer Table 2 : Evaluation of change Detection Techniques.(see at last)

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Table2 : Evaluation of change Detection Techniques.

Sr No	Techniques	Providing Change Direction	Selecting Threshold	Selecting Training	Providing Change Matrix	Data used
1.	Image Differencing	×	√	×	×	Satellite Imagery
2.	Image ratioing	×	√	×	×	Satellite Imagery
3.	Change Vector Analysis (CVA)	√	√	×	×	Satellite Imagery
4.	Principal Component Analysis(PCA)	×	√	×	×	Satellite Imagery
5.	Post Classification Comparison	√	×	√	√	Satellite Imagery
6.	Hybrid Change Detection	×	√	√	√	Satellite Imagery
7.	Image Fusion	×	√	×	×	Satellite Imagery
8.	GIS	√	×	×	√	Satellite Imagery

5. Conclusion By analyzing the related literature, it is observed that the selection of appropriate technique for detecting change in an object on earth's surface depends on a number of elements, including the characteristics of study area, the spatial resolution of sensor, atmospheric effects, the sun angle etc. The accuracy of change detection also depends upon the resolution of spatial and spectral images. Furthermore, the majority of digital change detection techniques depend upon the accuracy of geometric registration of two images.

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References

[1] Mapping and Evaluation of urban sprawl using an integrated approach of Remote sensing and GIS techniques (2012).

[2] A. Singh, Review Article Digital Change detection Techniques using Remotely Sensed Data, International journal of RS vol. 10 No. 6, 1989, pp 989-1003.

[3] D. Lu. Et. Al, Change detection techniques, International journal of remote sensing, volume 25, no. 12, 2004, PP 2365-2401.

[4] Abdullah F. Al Qurashi and Lalitkumar, A review, investigation the use of remote sensing and GIS techniques to detect LULC change, Advances in RS, 2013, 2, 193-204.

[5] Emilio Chuvieco and Alfredo Huete, Fundamentals of satellite remote sensing, RC Press Tailor and Franacis Group 2010.

[6] Ajay D. Nagne and Dr. Bharti W. Gawali, Transportation network analysis by using remote sensing and GIS A review, International Journal of Engineering Research and Application [IJERA], vol.3, issue 3, May –June 2013, PP 070-076.

[7] J. Rogan and D.M. Chen, Remote Sensing Technology for mapping and monitoring land cover and land use change, Progress in planning, vol. 61, no.4, 2004, PP 301-325.

[8] Ajay D. Nagne, Amol D. Vibhute, Bharti W. Gawali and Suresh S. Mehrotra, Spatial Analysis of Transportation Network for Town Planning of Aurangabad City by using Geographic Information System, International Journal of Scientific & Engineering Research, Volume 4, Issue 7, July 2013.

[9] James R Anderson, Ernest E. Hardy, john T, Roach and Richard E. Witmer, A Land Use & land Cover Classification System for use with Remote Sensor Data.

[10] Amol D. Vibhute and Dr. Bharti W. Gawali, Analysis and Modelling of Agricultural Land use using Remote Sensing and Geographic Information System: a Review, International Journal of Engineering Research and Applications (IJERA) Vol. 3, Issue 3, May-Jun 2013, pp.081-091.

[11] http:/Wikipedia.org/wiki/image-differencing.

[12] P. A. Rogerson, Change detection thresholds for remotely sensed images, Journal of Geographical systems boi: 10.1007/s101090100076.

[13] H. XU, X. Wang & G. XIAO used image differencing methods for study of fuquing city, China.

[14] Ashbinu Singh, Review article digital change detection techniques using remotely sensed data, International journal of remote sensing.

[15] Abdullah Almutairi and Timonthy A. Warner, change Detection Accuracy and Image properties: A Study Using Simulated Data, Remote Sensing,2010,1508-1529.

[16] Rodrigo Borrego Lorena, Joao Reberto das Santos, Yosio Edemir Shimabukuro, Irving Foster Brown and Herrmann Johann Heinrich kux, A change vector Analysis technique to monitor LULC in SW Brazilian Amazon: Acrestate.

[17] Song Xiaolu and Chen Bo, Change Detection using change vector Analysis from Landsat TM Images in Wuhan, Procedia Environmental sciences 11,238-244.

[18] Yan Luo, RengLiu and Yu Feng Zhu, Fusion of Remote Sensing Image Base on the PCA + Atrous wavelet transform, The international Archives of the photogrammetry, Remote Sensing and spatial Information Science Vol XXXVII.

[19] Manfred Ehlers in multi-sensors image Fusion techniques in Remote Sensing.

[20] Jyoti Sarup and Akinchan singhai, Image fusion techniques for accurate classification of Remote Sensing data, International Journal of Geomatics and Geosciences Vol.2, No2,2011.

[21] Fan F., Weng Q. And Wang Y., Land Use Land Cover change in Guangzhou, China from 1998 to 2003, based on Landsat TM/ETM +imagery sensor 2007, 7, 1323-1342.

[22] Yuan F., Sawaya K.E., Koeffelholz B.C., and Bauer M.E., land cover classification and change analysis of twin cities(Minnesota) metropolitan areas by multi-temporal Landsat remote Sensing, Remote sensing of Environment 2005,98,317-328.

[23] Jambally Mohammad, Land Use and Land cover Change assessment using Remote Sensing and GIS: Dohuk city, Kurdistan, Iraq (1998-2011), International Journal of Geomatics and Geo sciences Vol3, No 3, 2013.

[24] Amol D. Vibhute, Ajay D. Nagne, Bharti W. Gawali and Suresh S. Mehrotra, Comparative Analysis of Different Supervised Classification Techniques for Spatial Land

[25] Use/Land Cover Pattern Mapping Using RS and GIS, International Journal of Scientific & Engineering Research, Volume 4, Issue 7, July 2013.

[26] P. I. Rosin and T. Ellis, Image Difference Threshold Strategies and Shadow Detection, Proceedings of the 6th British machine vision conference, citeseer 1995.