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Land Use and Cover (LUC) Change Detection Using Image Processing Techniques

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- **ABSTRACT:** At present situation, in India urbanization is at low level compared to other countries in the world. Most urban local bodies in India are characterized by shortfalls in housing and water supply, urban encroachments in fringe area, pollution, poverty , inadequate sewerage, traffic congestion, and social unrest making urban governance a difficult task as lack technology knowledge and use. The high rate of urban population growth is a cause of concern among India urban and town planners for efficient urban planning. An attempt is being made to improve the performance ability of municipalities/urban local bodies, so that they would be able to perform their duties efficiently in the planning and development of urban areas. At present, there is an urgent need to adopt latest modern technology of remote sensing and GIS mapping which includes both aerial a satellite based systems, allow us to collect lot of physical data, with land cover images rather easily, with speed and on repetitive basis, and together with GIS helps us to analyze the data spatially, offering possibilities of generating various options (modeling), thereby optimizing the whole planning process of urban area land use and cover detection. These information systems also offer interpretation of physical (spatial) data with other social-economic data, and so provide an important linkage in the total town planning process and making it more effective and meaningful. Satellite high resolution images provide past and current status of the land cover which is significant for productive environmental management. Image processing techniques are used to detect the Land use and cover. Image Enhancement techniques are applied to preprocessed data in order to effectively display the image for visual interpretation or for clear pixel value change detection. It includes techniques to effectively distinguish and detect surface features means land used and covered in urban area for visual interpretation.

Index Terms— Histogram Hyperbolization, Edge Detection analysis, Change detection (CD), Image Enhancement, Image segmentation, Remote sensing, Object recognition.

I. INTRODUCTION

Over past few years, Earth Remote Sensing (RS) data acquisition has increased significantly. The large number of satellite images are generated from variety of sources which is provided online as data sources in India also. With modern sensor technology, different sensor systems are also on rise for different colour value image capture. Remote sensing is the process of gathering data about the earth's surface from aerial or from space. This process is performed by sensing and recording reflected or emitted energy and then process, analyze and apply that information for urban planning.

Process of remote sensing contains the illumination of energy source which passes through the atmosphere and interacts with the target; the electromagnetic energy scattered or emitted from the target is collected then recorded by the satellite sensors is then transmitted in electronic form and then to a receiver and processing station where the raw sensor data is processed into an high resolution image.

To extract and record the information from raw data about the illuminated target., the

processed image is interpreted electronically or visually or digitally as Remote sensing systems which measure reflected energy are called passive sensors, which can be used only to detect energy in the presence of natural affecting energy. This can take place only during the time of sunny day without cloudy environment on the earth.
Remote Sensing, image processing, enhancement techniques are most effective in monitoring manmade features on the surface of earth. Manmade features are dynamic and constantly changing over time and space. Here, proposing a system which takes a raw imagery as an input and output imagery provides enhanced characteristics/features available on processed with accuracy. Imagery of different time period is used to detect the change on urban land area which is unauthorized or illegal and affects the natural environment which causes natural disaster like flood and draught situations that occurred recently in last two years in India.

II. REVIEW OF LITERATURE

In research paper of Boundary Delineation of Agricultural Fields in Multi-temporal Satellite Imagery Field, farm boundary detection and marking is proposed using Raster to vector analysis by calculating per-band, per-pixels on STD images. Gis analysis on satellite images is performed by GRASS function, and the vector lines of field boundaries are then checked for accuracy on Hand-delineated vector line work using max-likelihood and GIS analysis [1].

Research paper [2] presents the study that illustrates the spatio-temporal dynamics of land use/cover (LUC) in Zakho district, Kurdistan Region-Iraq. Proposed approach predicts LUC of the study area for year 2050. It uses Landsat satellite images of two different time periods, i.e., Landsat Thematic Mapper (TM) of 1989 and Landsat Operational Land Imager (OLI) of 2014 were acquired and the changes in Zakho over a period of 25 years were quantified. Maximum Likelihood Algorithm is used to classify the satellite image [2].

In research paper, Unsupervised Deep Change Vector Analysis for Multiple-Change Detection in VHR Images proposed CNN-based unsupervised technique for detecting changes in multi-temporal VHR optical images is proposed. Deep features extracted from a pre-trained multilayer CNN in a novel CD architecture. The proposed DCVA exploits these properties of deep features and processes those features through a layer wise feature selection mechanism that ensures that only change-relevant features are retained [3].

C2VA method [4] i.e. Compressed change vector analysis which is spectrum-based and jointly analyze spectral-special change information (change vector feature) according to the morphological analysis. This method is used to detect the change in images.

The method introduced in [6] is based on the sequential spectral change vector analysis, which exploits an iterative hierarchical scheme that at each iteration discovers and identifies a subset of changes, which is designed to be sensitive to the small spectral variations that can be identified in HS images but usually are not detectable in multispectral images [6].

A novel hierarchical CD approach is proposed [7], to address the change detection in multiple HS remote sensing images, which is aimed at identifying all the possible change classes present between the considered images.

Concept in [8] models the problem under non-Bayesian quickest detection framework, and proposes a detection procedure based on the CUSUM statistic. It shows that this proposed detection procedure is asymptotically optimal.
In present, there are many concepts introduced, implemented, used for the land use and cover detection using satellite images. Websites like Bhuwan.gov.in in India and other from all over the countries are providing satellite data free of

cost to study and develop new concepts that will be use full to save environment.

III. PROBLEM STATEMENT

Remote Sensing techniques are effective in monitoring manmade features on the surface of earth. Manmade features are dynamic and constantly changing over time and space. We propose a system which takes raw imagery as an input and output imagery provides enhanced characteristics/features available on processed with accuracy.

IV. SYSTEM ARCHITECTURE

Digital image processing mainly includes three main steps as importing raw imagery, secondly, it is used for analyses and manipulating of information, and third, the result or output. take raw imagery as an input and output imagery provides enhanced characteristics/features available on processed with accuracy.

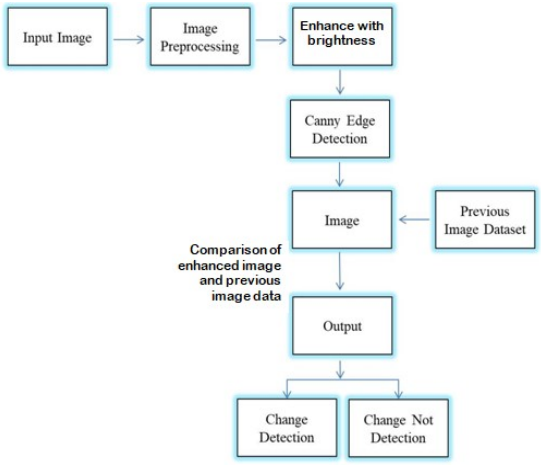


Figure 1. System Architecture

Figure 1 shows the system architecture that includes image enhancement for the satellite images captured with some natural disturbances or darkness in image, which affects the clearness of image to compare it with previous date images of land (urban area).

Comparison detects the changes in enhanced image and marks it with vector lines to show the changed objects on land.

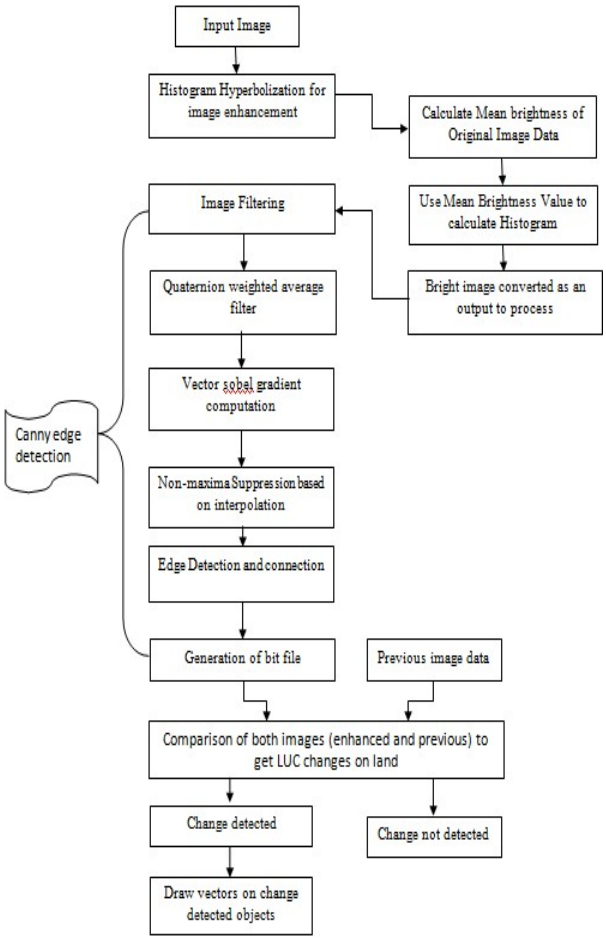


Figure 2. System Flow chart

V. MATHEMATICAL MODEL

Let S be the whole system
S= {I, P, O}
Where,
I is input to the system,
P is processes in the system,
O is output of the system,
I = {I0, I1}
I0 = First image for comparison
I1 = Second image for comparison

P = {P0, P1, P2, P3, P4}
P0 = Image Preprocessing
P1 = Histogram Hyperbolization
P2 = Deep feature extraction
P3 = Canny edge detection
P4 = Deep feature selection and comparison
O = O0 {Change}

VI. ALGORITHM

Steps for change detection:-

1. Histogram Hyperbolization

Concept of contrast is the difference between the light and dark areas. Basic concept is that the function perceived the brightness level of the pixels in an image. It transforms the brightness value of the pixels, which is based on the histogram of the image to be processed and nature of human perception towards brightness. So the visibility between two pixels with minimum difference can be detected and then using ML algorithm, pixels clustered in different classes of objects.

2. Maximum likelihood classification algorithm

In image processing, maximum likelihood classification concept is used to cluster the same valued or nearest valued pixels in the respective object class. So that we can create different object wise classes and marked it as a feature for future use. Using ML concept, we can classify maximum objects in an image to mark vectors for objects that may be changed in new Landsat satellite images.

$L_k = P(k/\mathbf{X}) = P(k)*P(X/k) / \Sigma P(i)*P(\mathbf{X}/i)$

L_k is the probability of a pixel belongs to class k, where P(k) : prior probability of class k P(X/k):-conditional probability to observe X from class k, or probability density function.

3. Digital change detection algorithm

A. Canny edge detection:-

Traditional CED is used for grey-scale images only, but now the improved algorithm detects edges in color images, which we can use for satellite images which are having different RGB values of image pixels. Canny edge detection method can determine real edges from bright images finely as discontinuous parts determination is improved because of Histogram Hyperbolization. The algorithm is consist the following steps: quaternion weighted average filter, vector Sobel gradient computation, non-maxima suppression based on interpolation, edge detection and connection.

B.Change Detection Using Write KFunction Memory Insertion:-

It is analog method for qualitatively assessing the changes in a region and do not provide quantities information of the changes took place in a region.

C. Multi-Date Composite Image Change Detection:-

The multiple data sets or imagery are registered to a single database. Such composite data sets are used to extract information using unsupervised classification technique resulting into a class of change and no change.

D. Image Algebra Change Detection

It is possible to simply identify the amount of change between two images by band ratio or image difference, the same band in two images that have previously been rectified to a common base map.

VII. SYSTEM REQUIREMENTS

A. Software Requirement

The Software Requirements of the system are:

1. IDE : Net beans
2. Front End : Jsp
3. Back End: Servlet/Database (MySQL)

B. Hardware Requirement

The Hardware Requirements of the system are:

1. CPU Speed: 2.2 GHz minimum; Hyper-threading (HHT) or Multi-core recommended.

2. Platform: x86 or x64 with SSE2 extensions
3. Hard Disk: 1 TB
4. RAM: at least 8GB of RAM but preferably 16GB or higher.
5. Screen resolution: 1024x768 recommended minimum at normal size (96 dpi)
6. Display properties: 24-bit color depth
7. Video/Graphics adaptor: 24-bit capable graphics accelerate

C. Datasets:-

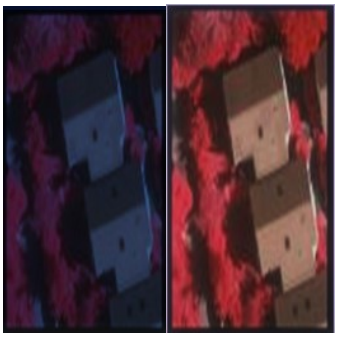
* Image database used in this study is taken from National Aeronautics and Space Administration (NASA) website www.nasa.gov.
* USGS Earth Explorer − Unlock the Power of Landsat and More https://earthexplorer.usgs.gov/
* National Institute for Space Research (INPE) http://www.dgi.inpe.br/CDSR/
* Bhuvan Indian Geo-Platform of ISRO https://bhuvan-app3.nrsc.gov.in

VIII. ADVANTAGES

- To detect changes from the images in an unsupervised manner, dividing the set of all pixels.
- Delineating change in such a scenario is not straightforward and can be subjective.
- If each pixel is considered individually, many pixels may have considerable radiometric dissimilarity between prechange and postchange images.

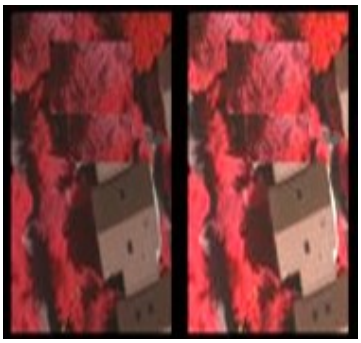
IX. RESULT AND DISCUSSION

Image (a) is selected from satellite images dataset, and is dark so that it needs enhancement by preprocessing like improving brightness of image, Result of Histogram Hyperbolization is in image (b) which is Original image.



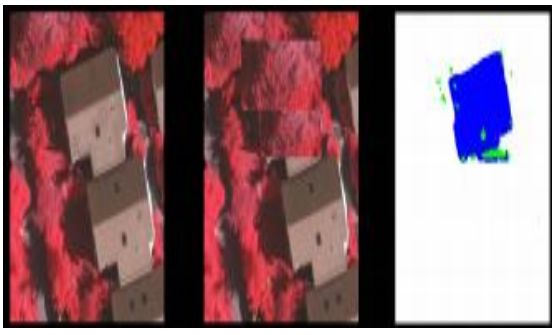
(a) **(b)**

Image(c) is also an image which is simulated and enhanced as shown in image (d) to detect the change between image (b) and (d). As using enhanced images change detection is giving very fine work, as shown in image (e).



(c) **(d)**

In image (e), the first image was used as the initial state; the middle image used as the changed state to simulate the appearance of a manmade object.



1 2 3

Fig (e): 1: Original image, 2: Simulated image, 3: Change detection output.

If we take the images in process vice-versa, then Fig. (f) Shows the same result as in Fig. (e).

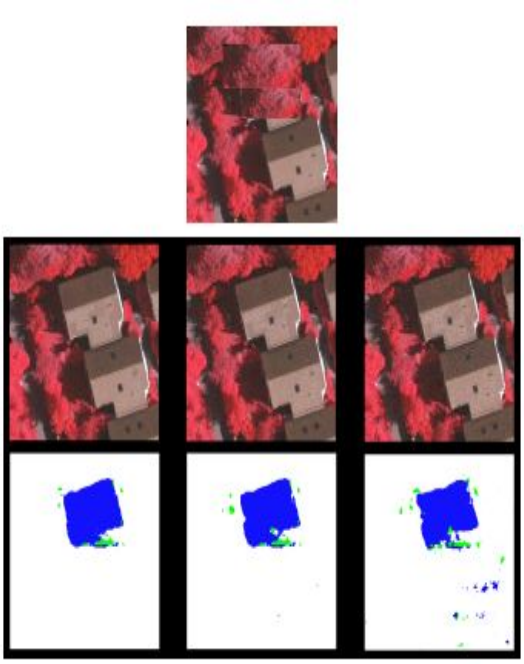


Fig (f): Top: Simulated initial state, Bottom: Simulated change. Bottom, Left: variance of 10, Middle: variance of 20, Right: variance of 40

X. CONCLUSION

Digital image processing of satellite data can be primarily grouped into three categories: Image Rectification and Restoration, Enhancement and Information extraction. Image rectification is the pre-processing of satellite data for geometric and radiometric connections. Enhancement is applied to image data in order to effectively display data for subsequent visual interpretation. Information extraction is based on digital classification and is used for generating digital thematic map.

Image enhancement using Histogram Hyperbolization and canny edge detection for color images gives fine results of change detection in satellite images. Image enhancement helps to cluster much closed pixel values in different classes. So that very blur or not-detectable boundaries of two objects or two spaces in image is detected very finely and vector line work can be done for very short objects present in an image.

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