

REMOTE SENSING IMAGE CLASSIFICATION AND CHANGE DETECTION

¹Judith Varshini J Cr, ²Mrs Piramu M,
Post Graduate Student, ²Associate Professor,
¹Computer Science And Engineering
¹P.S.R.Engineering , Sivakasi, India

Abstract : Global Monitoring with a high resolution can provide detail information for change detection. The widely used method for high resolution image detection depends on textural/structural features. However these spatial features always generate a high dimensional data gap because they are related to a series of parameters. Machine learning methods are commonly employed but their performances are subject to the quality and quantity of training samples so much effort should be made to collect the high quality samples. To address these problems automatic change detection method is proposed for high resolution image. First the image is clustered into group of regions by using FRFCM algorithm then the change detection scheme is applied with LANSAT8 spectral bands. The change detection model is carried out automatically without using training samples the multi-index representation refers to the enhanced vegetation index, water index, building index. Experiments are conduct on the multi temporal LANSAT8 images over southern Tamilnadu by the proposed method. Finally the detection has been shown to identify the changed region.

IndexTerms - Fast and Robust Fuzzy Clustering Algorithm (FRFCM), textural/structural features.

I. INTRODUCTION

Detection of urban expansion, urban planning, deforestation and urban landscape monitoring[1] with rapid development of earth observation techniques. It become convenient to obtain remotely sensed image over a certain area at different times, In recent years change detection using high spatial resolution remote sensing images receives increasing interest so detailed ground change information is now available. In recent years a large number of remote sensing images can be acquired from hundreds of earth observation platforms in order to timely process the big remote sensing data and rapidly transfer the data into information and knowledge it is necessary to develop automatic techniques for image change detection

. LIST OF ABBREVIATION

S.NO	ABBREVIATION	EXPANSION
1	FRFCM	Fast and robust fuzzy clustering method.
2	DIP	Digital image processing.
3	EVI	Enhanced vegetation index
4	SVM	Support vector machine.
5	NDBI	Normalized differential build-up index.
6	RGB	Red Green Blue.
7	LSWI	Land surface water index
8	NDWI	Normalized differential water index.

1.1. Digital image processing

Digital image processing (DIP) deals with manipulation of digital images through a digital computer. It is a subfield of signals and systems but focus particularly on images. Digital Image Processing focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output.

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technology. It forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps:

- 
- Importing the image via image acquisition tools
 - Analyzing and manipulating the image
 - Output in which result can be altered image or report that is based on image analysis.



A sensor array is used for the acquisition of the image. So when the sunlight falls upon the object, then the amount of light reflected by that object is sensed by the sensors, and a continuous voltage signal is generated by the amount of sensed data. In order to create a digital image, we need to convert this data into a digital form. This involves sampling and quantization. The result of sampling and quantization result is a two dimensional array or matrix of numbers which are nothing but a digital image.

1.2. Fundamental steps in image processing

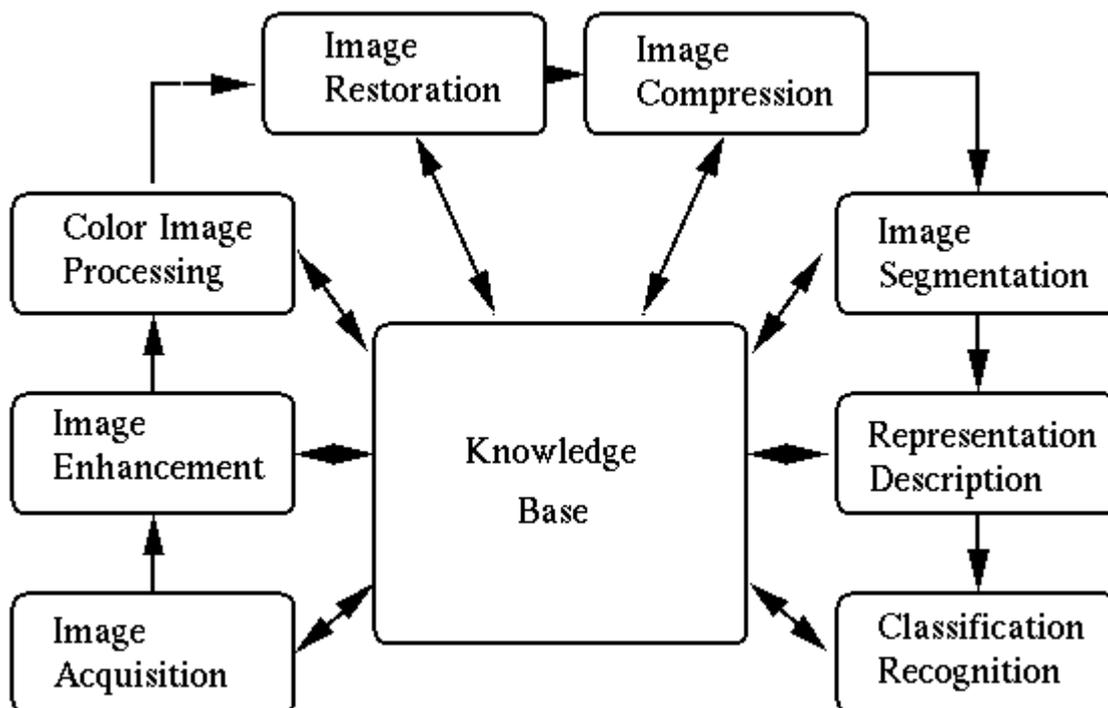


Figure: 1.1: Fundamental Step in image processing

Image Processing is the process of analysis and manipulation of digitalized image, especially in order to improve its quality. The above image depicts the fundamental steps in image processing that are used in remote sensing image classification and change detection.

1.3. Categories of image processing

The most common image processing functions can be placed into the following seven categories:

1. Preprocessing
2. Image Enhancement
3. Image Transformation
4. Image Classification
5. Image Analysis
6. Image Restoration
7. Image Compression

1.3.1. Application of image processing

The digital image processing has experienced continuous and significant expansion in recent years. The usefulness of this technology is apparent in many different disciplines covering medicine through remote sensing. The advances and wide availability of image processing hardware has further enhanced the usefulness of image processing.

- Medical applications
- Restorations and Enhancements
- Digital cinema
- Image transmission and coding
- Color processing
- Remote sensing
- Robot vision
- Hybrid techniques
- Facsimile
- Pattern recognition
- Registration techniques
- Multidimensional image processing
- Image processing architectures and workstations
- Video processing
- Programmable DSPs for video coding
- High-resolution display
- High-quality color representation
- Super-high-definition image processing
- Impact of standardization on image processing.

1.3.2. Remote sensing

The information about the particular land area is defined through Remote Sensing. It is done by rapid monitoring of the land area. The classification of an image is based on the Temporal Correlation by Change detection methods. Every object has its own Spectral Characteristics. Remote Sensing images are based on Spectral band as they are represented in RGB channels they are,

1. **True color:** It uses only the RGB channels which are being mapped to respective colors. In this usually Plain color Photographs are used.
2. **Green red infrared:** It is used for representing the Vegetation areas.
3. **Blue:** It is used for representing the Water Depth.

1.3.3. Types of remote sensing images

Remote Sensing is classified into 3 types based on the band as Multispectral, Super spectral, Hyper spectral .

1.3.3.1. Multispectral

Multispectral [5] images provide a combination of various bands and combinethem into a single system. Wavelengths are being separated through filters. It is mainly used for extracting the information which is not visible to the human eye. It uses only small number of bands as from (3-15) bands.

1.3.2.2. HYPER SPECTRAL

Hyper spectral images process and collects the information through Electromagnetic spectrum. They use more than 100 bands and are represented in three-dimensional format. In this the target pixel is represented in hyper spectral images. It measures Contiguous Spectral band which is being opponent to Multispectral images.

1.3.2.3. SUPER SPECTRAL

Super spectral images use more than 30 bands. It is used for acquiring images in various wavelength

CHAPTER 3

SYSTEM DESIGN

A novel multi index automatic change detection method is for the high-resolution image. First the image is clustered into group of regions by using Fast and Robust Fuzzy C-means Clustering (FRFCM) algorithm. Then the change detection scheme is applied with LANSAT 8 spectral bands. The change detection model is carried out automatically without using training samples since the information indexes can directly indicate the primitive urban classes. The multi-index representation refers to the enhanced vegetation index, the water index, and the recently developed

morphological building index. Experiments were conducted on the multi temporal LANSAT 8 [6]images over southern Tamilnadu by the proposed method. Finally the change detection map has been shown to identify the changed regions.

3.1. Spectral Signature

Spectral signatures are used for the classification of an image for land-use and land-cover mappings. The reflected spectra from different materials are defined as Spectral signatures. They are used to determine the materials in the surface. Spectral signatures are recorded using the Spectroradiometer which are extracted from airborne or space borne data on the ground. These classes are usually a group of pixels with specific spectral characteristics. Raw images with their digital numbers are being given and they are converted into surface reflectance with respective to the image classification. With their respective spectral classes it represents the materials present in the ground which are similar to the time of image acquisition. Land-cover usually covers the certain portion of ground, whereas the Land-use gives the mapping of socio-economic use. It is very difficult to obtain the Land-cover area based on their spectral characteristics.

The values of the spectral signatures are stored in the Spectral library. There are various indices for calculating the Land-cover vegetation, water, soil, and building with their respective indices.

3.2. VEGETATIVE INDICES

Normalized Differentiate Vegetation Index (NDVI),[4] is used for representing the respective biomass of the land area. It is a standard vegetative index. In this the Chlorophyll absorption is represented by the Red band and the vegetation of high reflectance is represented by Near Infrared as NIR band (Eq:1.1) by combining these both the particular NDVI is classified.

$$\text{NDVI} = (\text{NIR-RED}) \div (\text{NIR+RED}) \quad (1.1)$$

3.3. Soil indices

Soil Adjusted Vegetation Index [5](SAVI), is used for representing the background of soil conditions. It is a hybrid between NDVI and PVI (Perpendicular Vegetation Index) (Eq:1.2). Here, L is represented as soil brightness. If the area is with high vegetation it is taken as L=0; and if it is

with low or no vegetation the $L=1$. They uses NIR as band 5 and RED as band 4 by combining these two bands they provide the SAVI value.

$$\text{SAVI} = [(\text{NIR}-\text{RED}) \div (\text{NIR} +\text{RED})] \times 2 \quad (1.2)$$

3.4. Water indices

Normalized Differential Water Index [6](NDWI), is used for representing the water bodies. It uses two bands as band 3 as Green and band 5 as NIR for presenting the water areas. For the extraction of water bodies, multi band threshold methods are widely used. They extract the water bodies based on their respective band.

NDWI is used for improving the accuracy for extracting the water bodies; this is done by suppressing the non water body information. The Modified Normalized Differential Water Index (MNDWI) method was implemented to improve the water body results in urban areas. (Eq:1.3)MNDWI is also used for extracting water body results in mountainous areas which provide the accurate results. NDWI improves the water body signals by considering the reflectance of the wavelength and therefore by removing a portion of noise from the different wavelength. If the wavelength has been increased then the water region is found with low reflectance.

$$\text{NDWI} = (\text{GREEN}-\text{NIR}) \div (\text{GREEN}+\text{NIR}) \quad (1.3)$$

3.5. Building indices

Normalized Differential Buildup Index (NDBI), is used for describing the building areas. (Eq:1.4) They use two bands as MIR and NIR bands for representing the building areas.

$$\text{NDBI} = (\text{MIR}-\text{NIR}) \div (\text{MIR}+\text{NIR}) \quad (1.4)$$

3.6. System Architecture

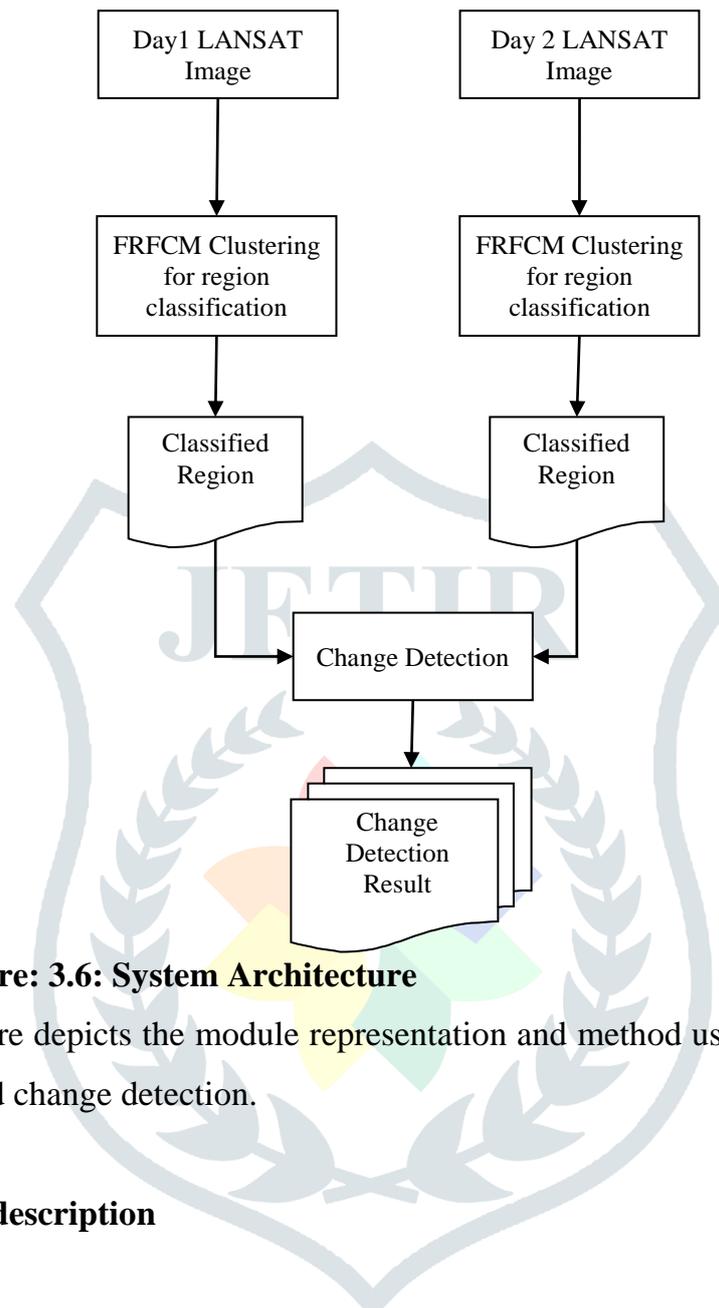


Figure: 3.6: System Architecture

The system architecture depicts the module representation and method used in the remote sensing image classification and change detection.

3.6.1. Data set description

3.6.1.1. Buildings: The buildings in the middle of the block were removed[6], leading to a significant reduction of building components in both block- and cell-based histograms.

3.6.1.2. Vegetation: where the vegetation was removed for the purpose of construction. The multitemporal changes are clearly reflected in the cell-based histograms. Where a significant reduction of vegetation components can be observed.

3.6.1.3. Water: The changes of water in the urban areas can be related to both natural and artificial changes.). Results for the south Tamilnadu, the proposed multi index change detection can provide two products.

3.6.1.4. Binary result: Each block is identified as changed or unchanged, which is the commonly used change detection strategy for high-resolution images.

3.6.2. Fuzzy clustering

Fuzzy clustering is a form of clustering in which each data point can belong to more than one cluster. Clustering or cluster analysis involves assigning data points to clusters such that items in the same cluster are as similar as possible, while items belonging to different clusters are as dissimilar as possible. Clusters are identified via similarity measures. These similarity measures include distance, connectivity, and intensity. Different similarity measures may be chosen based on the data or the application.

3.6.3. Fast and robust fuzzy clustering method

Fuzzy clustering algorithms generally treat data points with feature components under equal importance. However, there are various datasets with irrelevant features involved in clustering process that may cause bad performance for fuzzy clustering algorithms. That is, different feature components should take different importance. In this paper, we present a novel method for improving fuzzy clustering algorithms that can automatically compute individual feature weight, and simultaneously reduce these irrelevant feature components. In fuzzy clustering, the fuzzy c-means (FCM) algorithm is the best known. We first consider the FCM objective function with feature-weighted entropy, and construct a learning schema for parameters, and then reduce these irrelevant feature components. We call it a feature-reduction FCM (FRFCM). During FRFCM processes, a new procedure for eliminating irrelevant feature(s) with small weight(s) is created for feature reduction. The computational complexity of FRFCM is also analyzed. Some numerical and real datasets are used to compare FRFCM with various feature-weighted FCM methods in the literature. Experimental results and comparisons actually demonstrate these good aspects of FRFCM with its effectiveness and usefulness in practice.

3.6.4. Automatic change detection

Automatic Change Detection[2] combined both the pixel-level method and the object-level method. Both pixel-based change features and object-based ones are extracted to improve the discriminability between the changed class and the unchanged class.

- 1) The complicated urban scenes can be automatically and effectively represented by a set of low-dimensional information indexes.
- 2) The local histograms of these indexes are able to describe the frequency and spatial arrangement of the urban primitives.

Consequently, the multitemporal multi index representations can be used to detect the structural change of the urban scenes. The proposed change detection method is described by the following steps.

Step 1—Calculation of Information Indexes: Information on buildings, vegetation, and water is obtained at the pixel level based on the MBI, the EVI, and the NDWI, respectively; and the corresponding post processing is then used to suppress the noise in the initial result, i.e., removing bright soil from buildings and shadow from water bodies.

Step 2—Automatic Change Detection: The image is first divided into a series of blocks with the size of $N \times N$ (pixels) for each one, which is viewed as the basic unit for the change detection. which is a commonly used approach for change detection from high-resolution images. The decision for whether changes take place in this block is made according to the degree of similarity between the multitemporal multi index histograms in the area. In this paper, two approaches, block based and cell based, are used to describe the multi index distribution and measure the similarity.

3.6.5. Decision Tree

Decision tree also uses supervised learning algorithm and is used for classification. Decision tree is applicable in both cases that are continuous and categorical output and input variables. In the DT algorithm the significant differentiator in input variables is used to split the samples of dataset into homogeneous sets.

3.6.7. k-nearest neighbour

The KNN is also the classifier of the category of supervised learning algorithm. In supervised learning the targets are known to us but the pathway to target is not known. To comprehend machine learning nearest neighbour forms is the perfect example. There are many clusters of labelled samples. The nature of items of the same identified clusters or groups are of homogeneous nature. Now if an unlabelled item needs to be labelled less than one of the labelled groups. Now to classify it K-nearest neighbours is easy and best algorithm that have record of all available classes can perfectly put the new item into the

class on the basis of largest number of vote for k neighbours. In this way KNN is one of the alternate to classify an unlabelled item into identified class.

3.6.8. Change type

Types of changes are noted in most of the automatic change detection methods only indicate whether changes take place in the block but cannot provide specific information related to the types of changes. In this paper, however, based on the information indexes, it is possible to further provide the change information corresponding to each block ,by investigating which information index is subject to significant changes in terms of both frequency and spatial arrangement in the block. This can be viewed as a by-product of the proposed change detection method.

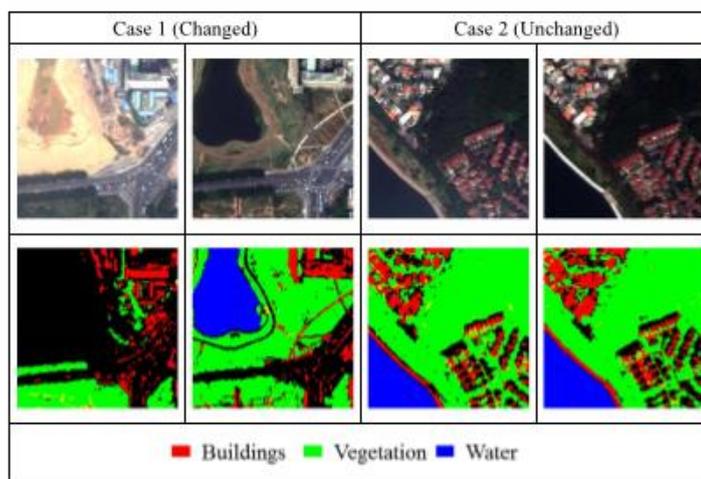


Figure: 3.6.8. Urban scene description

The image describes the classification of landforms as vegetative, Building, water and soil forms. And it also shows the variation between Changed and unchanged landforms.

CHAPTER 4

IMPLEMENTATION DETAILS AND RESULT

4.1. Hardware requirements

- Processor : Pentium IV 2.4 GHz.
- Hard Disk : 40 GB.
- RAM : 512 Mb.

4.2. Software requirements

- Operating system : Windows XP/7.
- Development Tool : Matlab2016

4.3. Implementation result

4.3.1. Input design

The input design depicts the input screen by using this the input is given in the form of image from LANSAT8 satellite.

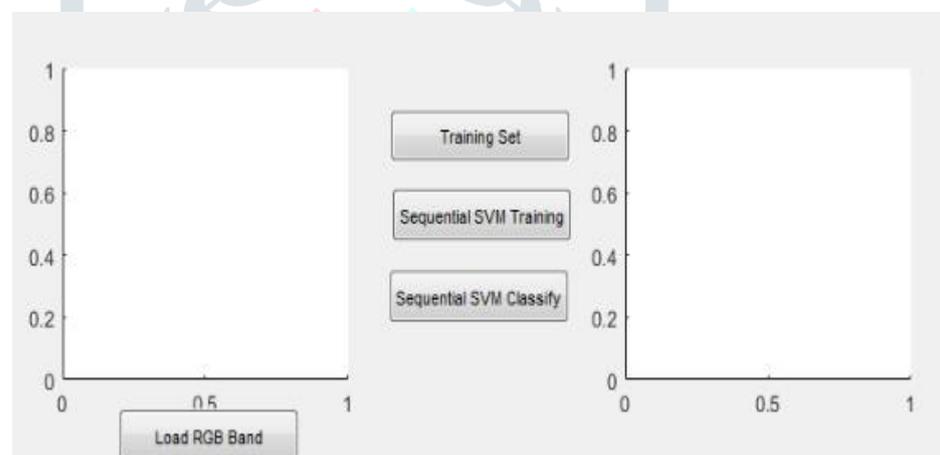


Figure: 4.3.1: GUI for display output

4.3.2. Signature generation

Raw images with their digital numbers are being given and they are converted into surface reflectance with respective to the image classification.

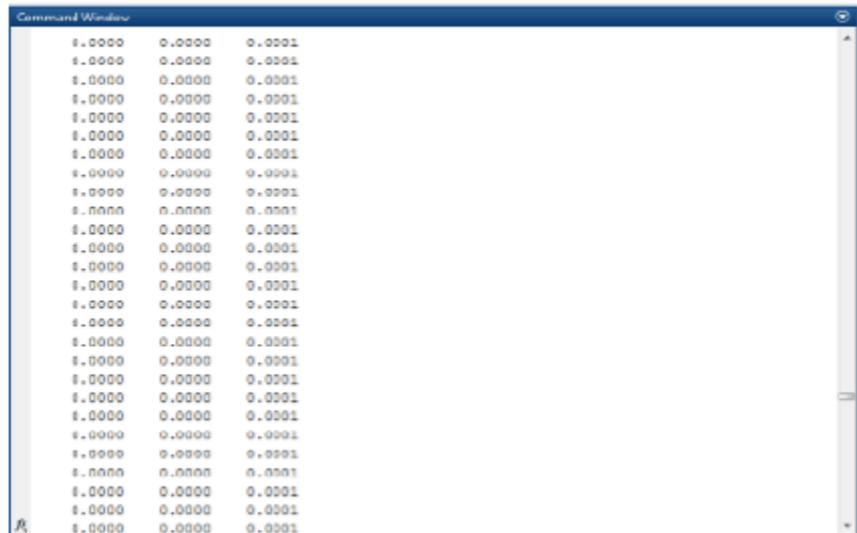


Figure: 4.3.2. Signature generation

4.3.3. Obtained LANSAT image

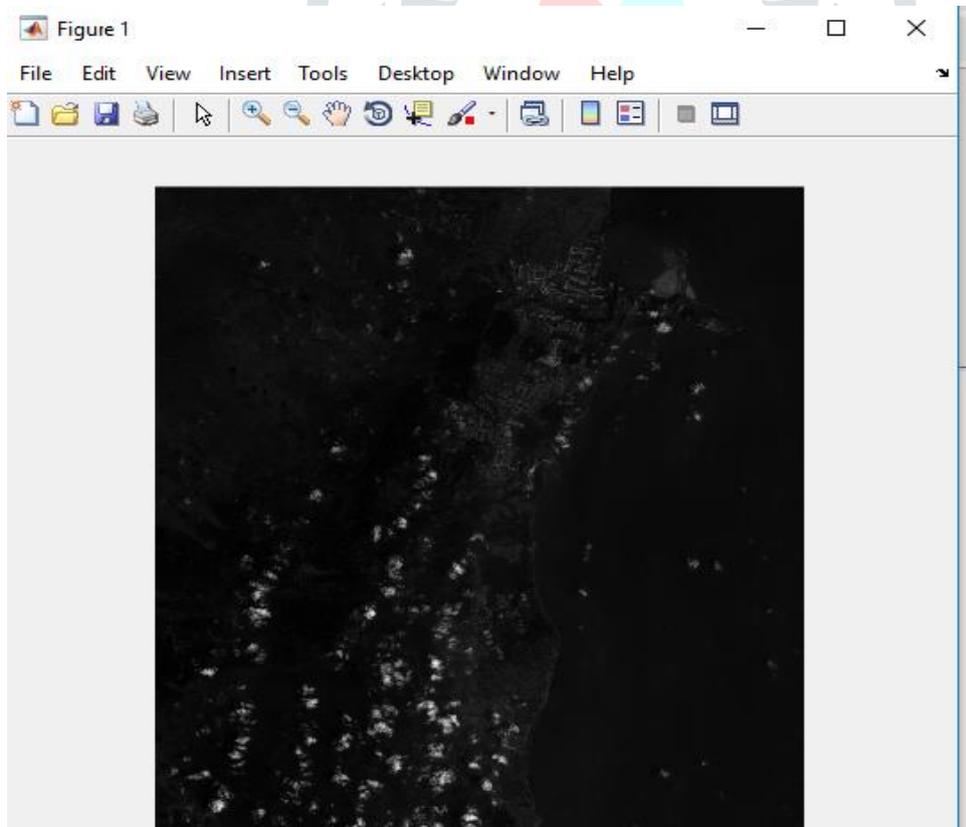


Figure: 4.3.3: Obtained LANSAT image

The above represented image is an obtained image directly from LANSAT8 by using the image the process of classification of landforms are takes place.

4.3.4. Classified LANSAT image

Obtained images are classified into three types of indices they are vegetative indices, water indices, building indices, soil indices and the changes in the images are detected by made a comparison on three different days and finally the change detection result in image on two different days are obtained.

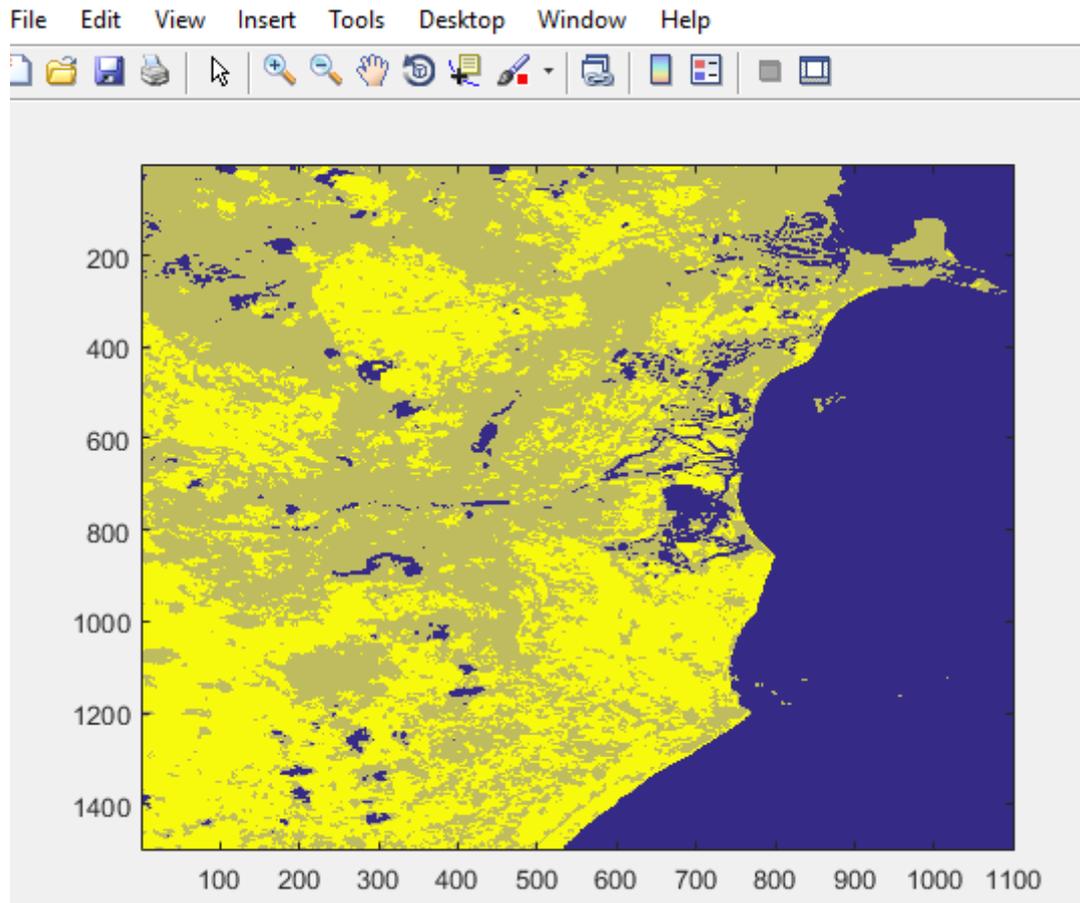


Figure: 4.3.4: classified image on day1

Image details:

Date: 24.10.2017

Region: south tamlinadu

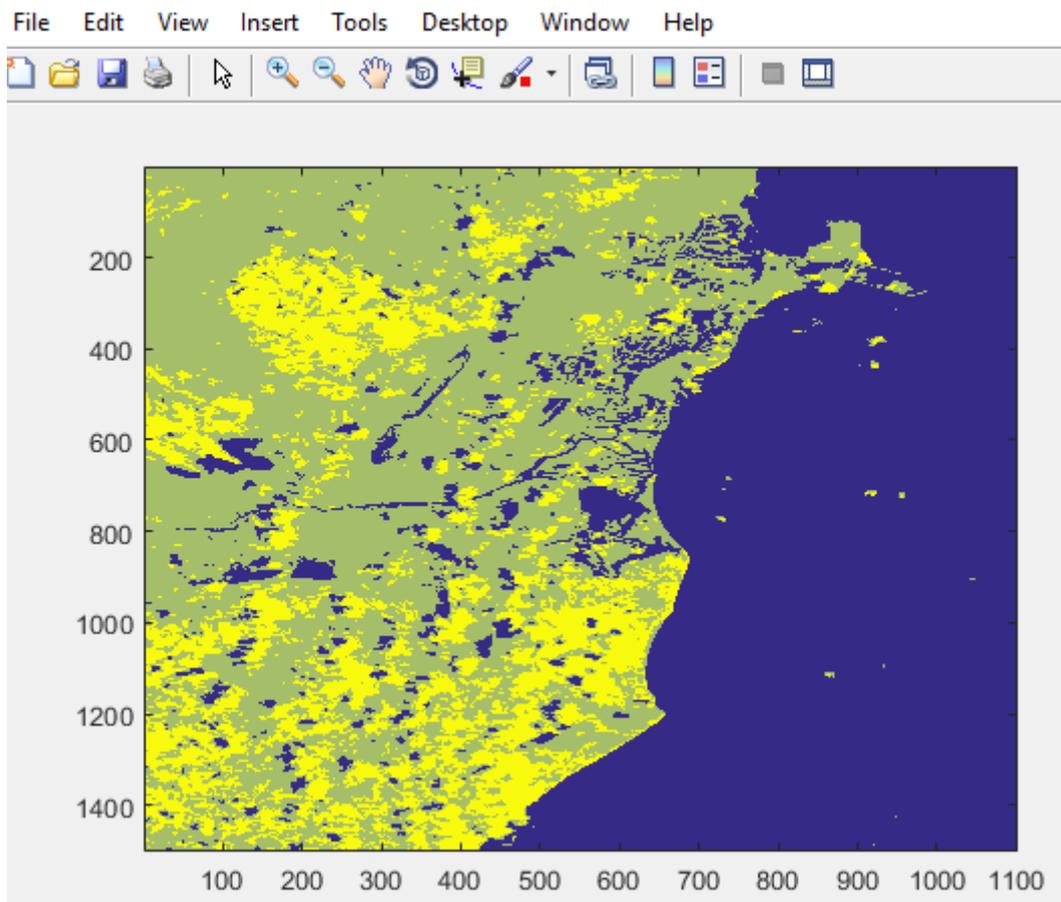


Figure: 4.3.5: Classified image on day2

Image details:

Date: 03.01.18

Method used for classification: frfcm

Region: south tamlinadu



4.3.6. Change detection result between day 1 and day 2

4.4. Result comparison

FRFCM is used for remote sensing classification and change detection method, the change detection method does not need samplings to classify a land forms by using the fuzzy clustering method the landforms are clustered as changed and unchanged and in this method its possible to compare the landforms status between different days.



CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1. Conclusion

An innovative change detection method based on the multi-index image representation has been proposed for high-resolution remote sensing imagery over urban scenes. The proposed method is capable of achieving satisfactory change detection accuracy (97%) with a set of low-dimensional Landsat data. Two specific strategies are implemented for the proposed method. The first one is a FRFCM clustering, where the spectral bands are grouped as the classified regions. Then the change detection based on the multi-index representation. This way, not only the frequencies but also the spatial arrangement of the information indexes in the block can be exploited. In experiments, it was found that the cell-based approach significantly outperformed the block based one for both binary and class-specific change detection. This phenomenon reveals that the order or arrangement of the primitives in a scene plays a key role for the scene-based image interpretation.

5.2. Future work

In future research, we plan to validate the proposed change detection method in more urban areas with high-resolution images and attempt to implement the method as an applicable tool for routine urban monitoring. In addition, the proposed multi index model is essentially an effective scene representation method, which has the potential for solving the semantic gap between the low-level features and the high-level semantics.

References

- [1].Tewkesbury, A.P., Comber, A.J., Tate, N.J., Lamb, A. and Fisher, P.F., 2015. A critical synthesis of remotely sensed optical image change detection techniques. *Remote Sensing of Environment*, 160, pp.1-14.
- [2].Gu, W., Lv, Z. and Hao, M., 2017. Change detection method for remote sensing images based on an improved Markov random field. *Multimedia Tools and Applications*, 76(17), pp.17719-17734.

- [3].Zhang, P., Gong, M., Su, L., Liu, J. and Li, Z., 2016. Change detection based on deep feature representation and mapping transformation for multi-spatial-resolution remote sensing images. *ISPRS Journal of Photogrammetry and Remote Sensing*, 116, pp.24-41.
- [4].Jan Verbesselt, Rob Hyndman, Achim Zeileis and Darius Culvenor, “Phenological change detection while accounting for abrupt and gradual trends in satellite image time series“ *Remote Sens. Environ.*, vol. 114, no. 12, pp. 2970–2980, 2010.
- [5].Cristina Gómez, Joanne C. White and Michael A. Wulder “Optical remotely sensed time series data for land cover classification “*ISPRS J. Photogramm. Remote Sens.*, vol. 116, pp. 55–72, Jun. 2016.
- [6].Xiangming Xiaoa,T, Stephen Bolesa, Jiyuan Liub, Dafang Zhuangb, Steve Frokinga, Changsheng Lia, William Salasc and Berrien Moore, “Mapping paddy rice agriculture in southern China using multi-temporal MODIS images “*Remote Sens. Environ.*, vol. 95, no. 4, pp. 480–492, 2005.
- [7].M. Xu, M. Pickering, A. J. Plaza, and X. Jia, “Thin cloud removal based on signal transmission principles and spectral mixture analysis,” *IEEE Trans. Geosci. Remote Sens.*, vol. 54, no. 3, pp. 1659–1669, Mar. 2016.
- [8].G. Mountrakis, J. Im, and C. Ogole, “Support vector machines in remote sensing: A review,” *ISPRS J. Photogramm. Remote Sensing*, vol. 66, no. 3, pp. 247–259, 2011.