Urban Planning through Remotely Sensed Data Using Digital Image Processing: A Case Study of Bareilly Region

Prerna[1], Jitendra Nath Shrivastva[2], Hari Kumar Singh[3]

[1]M.Tech Student of Computer Science and Engineering, Invertis University Bareilly, Uttar Pradesh, India
[2]Associate Professor, Deptt. of Computer Science and Engg., Invertis University Bareilly, Uttar Pradesh, India
[3]Department of Electronics Engineering, Institute of Engineering and Technology,
M.J.P Rohilkhand University, Bareilly, (U.P), India

Abstract: This research paper helps in urbanization of Bareilly, Uttar Pradesh, India region by utilizing remotely sensed data. We have used the Satellite remote sensing to improve the quality of multi-spatial and multi-temporal remote sensing data. This data plays an important role in acquiring information about particular area. It reduces our precious time and cost. Satellite remote sensed is a powerful tool for mapping and monitoring the ecological changes in the urban core and in the peripheral land-use planning. It will reduce unplanned urban sprawl and the associated loss of natural surrounding & biodiversity.

Keyword: **Digital Image Processing, Satellite Remote Sensed, ANN, etc.**

1. INTRODUCTION

The present often springs from the lessons of the past – a fact that forms the imagery around us as we live in the India of today. Our cities hold traces of our incredible history – a past that delved deep into several issues and brought out solutions relevant to this day. Our tradition in urban planning has been noteworthy. In this paper to collate the data of different area of satellite image processing like National Remote Sensing Agency (Space Department, Government of India); Temporal and Spatial Features of the Objects, Integrating Spectral and these collected Satellite Data Image to analyze. We have already mentioned for the land cover classification, how the use of land changes according to time and also performed the temporal analysis to analyze the impact of climate over the surface.

1. Acquiring the satellite images of various administrative regions of Bareilly.

2. Extracting pixel wise data through different images through MATLAB programming.

3. Combining the result and applying these results on satellite map of Bareilly.

4. Plan a model for sub-urbanized area of Bareilly and future references.

2. REMOTE SENSING

Remote Sensing technology is a new type of technology which extracts the information of object or phenomenon without physical contact with the object.

Remote Sensing work on a two types of sensors first one active and another passive sensor In Active collection emits energy in order to scan objects and areas. Sensor detects those images which is to be used in urban planning and measures the radiation that is backscattered or reflected from the target. The example of active remote sensing are RADAR and LiDAR where the time delay between emission and return is measured, establishing the location, speed and direction of an object. In Passive sensors detect natural radiation which is emitted or reflected by the object or surrounding areas. In passive sensors, reflected sunlight is most common source to measure the radiation. Film photography, infrared, charge-coupled devices, and radiometers are the examples of passive remote sensor.

Collect the data on inaccessible and dangerous areas very easily by the using of remote sensing. Military collects data during the Cold War to make use of stand-off collection of data about dangerous border areas.   Remote sensing applications include monitoring deforestation and ocean depths and depth sounding of coastal. Remote sensing is useful for also replacing costly and slow data collection on the ground and ensure it not disturbed areas and object in the processing. In earth science lots of area where we use the remote sensing like agricultural fields, natural resource management such as land usage and conservation, ground-based and stand-off collection on border areas.

Remote Sensing is basically divide into three main parts the target, data acquisition, and data analysis. Targets-object or in an area; Data Acquisition- through certain instruments; Data Analysis- again by some devices. This definition is helpful for human eyes, ultrasound and x-rays which is used in medical sciences, probing for atmospheric particles by laser, sonar sounding of the sea floor, etc. in the case of large scale it useful for the earth, the moon, and other planets.

3. INDIAN REMOTE SENSING (IRS) PROGRAM:

Remote sensing is an important part of the Indian Space Program and the Department of Space (DOS), Government of India and other bodies. In other word we can say that Indian Remote Sensing Satellites (IRS) record the series of Earth Observation Satellites, built, launched and maintained. We get the remote sensing services in India by the use of IRS series.

3.1 INDIAN REMOTE SENSING SATELLITES:

Bhaskhar and Bhaskara-2 satellites are successfully launched in 1979 and 1981 respectively. After successfully launched these satellites, India work and develop the indigenous Indian Remote Sensing (IRS) satellite program, which helps in national economy specially in the areas of water resources, marine fisheries, forestry, ecology, geology, agriculture, water sheds, and coastal management.

To see the need of work in this field India established the National Natural Resources Management System (NNRMS) for which the Department of Space (DOS), providing operational remote sensing data services. Receive data from IRS satellite and disseminated the overall world.

New applications of high-resolution satellites in the areas of urban sprawl, infrastructure planning and other large scale applications for mapping have been initiated.

Presently 12 operational satellites are dedicated for civilian use. These all 12 operational satellite are providing data in a variety of spatial, spectral and temporal resolutions and it is placed in form of sun-synchronous orbit. In 17 marches, 2013 Indian Remote Sensing Program completed its 25 years of successful operations. [4]

IRS-1A and 1B: These two satellites were the first generation and operational remote sensing satellites.

IRS-1C and IRS-1D: These two satellites are the second generation and operational remote sensing satellite with improved sensor and coverage characteristics.
The satellites are on these three sensors board:
* A PAN
* A LISS-III
* A Wide Field Sensor (WiFS) sensor

IRS-P3:

The main objectives of IRS-P6 is to provide continued remote sensing data services on an operational basis for integrated land and water resources management at micro level with enhanced multi-spectral and spatial coverage with stereo imaging capability.

4. NEURO FUZZY SYSTEMS:

Neural networks are black boxes to the user because it can learn from data, but cannot be interpreted. Fuzzy Systems also consists interpretable linguistic rules, but they cannot also learn from data. It usually uses the neuro-fuzzy system which display the following properties:

A neuro- fuzzy system is trained by
- Learning algorithm which is derived from neural network theory.
- A neuro-fuzzy system can be viewed as a 3-layer feed forward neural network. The first one layer represents input variables, the middle (hidden) one layer represents fuzzy rules, and it is hidden layer and the third one layer represents output variables. Fuzzy sets are encoded as (fuzzy) connection weights.
- A neuro- fuzzy system also creates the system out of training data from scratch.
- The learning procedure of a neuro-fuzzy system takes the semantic properties of the underlying fuzzy system into account.
- A neuro-fuzzy system approximates an N-dimensional (unknown) function that is partially defined by the training data.
- The Neuro-Fuzzy system is able to deal with multiple parameter input and multiple class output problems.

4.1 Analysis of the Multi Spectral Image Using ANN

STEP 1

Assembling the Training Data

We have received the image of the Bareilly Ramganga region as shown in the figure 4.2 and by using the Data Cursor tool in the MATLAB we have obtained the R-G-B components of the pixels which best represent the different features of the image like the River & Water Bodies, the Concrete Structures, the Roads and the Vegetation.
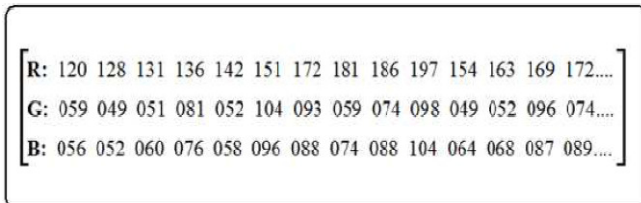

Fig 4.2 Multi Spectral Image of Bareilly City

Table 4.1 Few of Pixels representing different Features

Features	R	G	B
River & Water Bodies	120	059	056
	128	049	052
	131	051	060
	136	081	076
	142	052	058
	151	104	096
	172	093	088
Concrete Structures	181	059	074
	186	074	088
	197	098	104
	154	049	064
	163	052	068
Roads	169	096	087
	172	074	089
	178	062	073
	224	086	101
	229	119	130
Vegetation	230	096	105
	234	082	095
	240	104	114

Thus we obtained R-G-B values of almost 100 pixels and these values may be molded to form a 3X100 matrix as displayed in figure 4.3.
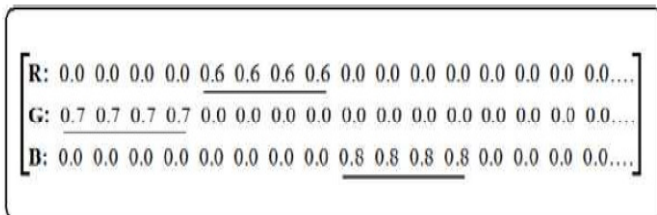

$$\begin{bmatrix} R: & 120 & 128 & 131 & 136 & 142 & 151 & 172 & 181 & 186 & 197 & 154 & 163 & 169 & 172.... \\ G: & 059 & 049 & 051 & 081 & 052 & 104 & 093 & 059 & 074 & 098 & 049 & 052 & 096 & 074.... \\ B: & 056 & 052 & 060 & 076 & 058 & 096 & 088 & 074 & 088 & 104 & 064 & 068 & 087 & 089.... \end{bmatrix}$$

Fig 4.3 the Matrix of Input Pixels

STEP 2

Create the Network Object

Now we define the network and specify its features like number of neurons, range of the values of the input neurons, number of layers etc. and specify the input and target matrices. In target matrix, there is a particular color for the particular feature to generate the FCC.

$$\begin{bmatrix} R: & 0.0 & 0.0 & 0.0 & 0.0 & \underline{0.6 \ 0.6 \ 0.6 \ 0.6} & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0.... \\ G: & 0.7 \ 0.7 \ 0.7 \ 0.7 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0.... \\ B: & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & \underline{0.8 \ 0.8 \ 0.8 \ 0.8} & 0.0 & 0.0 & 0.0 & 0.0.... \end{bmatrix}$$

4.4 the Matrix of Target FCC

After this we start the training of the network by assigning the weight automatically. Since, the input and output are already defined. Hence the step 2 makes it to meet the requirement of the mapping relationship between the input and the target.

STEP 3

Simulate the Network Response for Entire Image

Our obtained function represents the relation between the input and the target. Now we can generate a resulting matrix corresponding to the final FCC of the given image. But, before this we simulate the image with the help of given network of neurons. we have converted the 3-dimensional matrix of dimensions '512 X 512 X 3' corresponding to the multi spectral image into a 3-dimensional matrix of dimensions '3 X 512X512' i.e. '3 X 262144'. Now this converted form of the multi spectral image applied to neural network for the simulation. After the simulation, what we obtain the result in a 2-dimensional matrix of the same dimensions '3 X 26212144', which is again to be converted into the 3- dimensional matrix of dimensions which represents the FCC corresponding to the given multi spectral image.
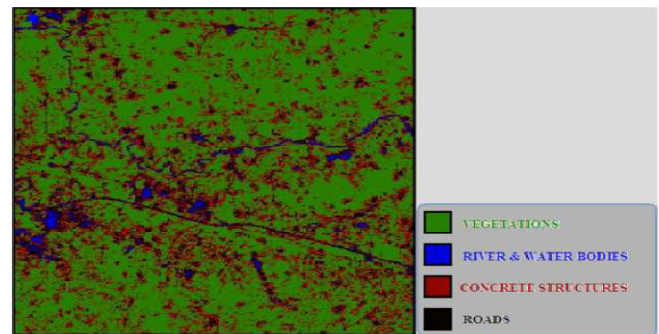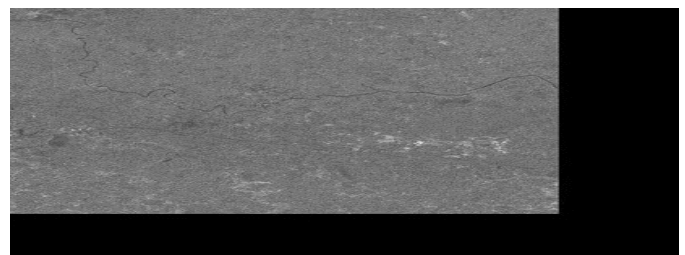

Fig 4.5 FCC Image of the Multi Spectral Image

4.2 Analysis of the Multi Spectral Image Using DWT

STEP 1

In the very first step we received the multispectral image and converted it into the grayscale image (figure 4.6) to apply the DWT algorithm on this image.

Fig 4.6(a) Grayscale Image of the Multi Spectral Image

After getting the grayscale image, we applied the averaging and differencing algorithm of the discrete wavelet transform on the multi spectral image and analyzed the averaged component of this multispectral image.
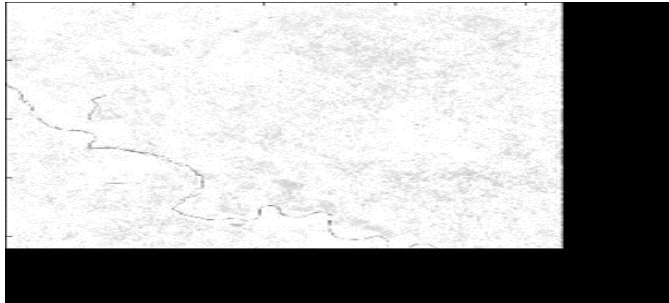
Fig 4.6(b) Averaged Component of the Input Image

This Averaged component of the image is considered as the original image and the DWT algorithm is again applied on this averaged component. Among the resulting components the averaged component is again analyzed. This process of calculating DWT is repeated four to five times and each averaged component is analyzed for the presence of the pixels representing the corresponding features.

STEP 3

We have obtained the fifth averaged component of the multi spectral image. Now the inverse process is to be undergone. In the process of calculating inverse DWT, the four resulting components of the input image are considered to be the input of the inverse filter.

After this we have applied the four components averaged, vertical, horizontal and diagonal. Here we get the earlier averaged component of the image. After repeating this inverse filtering process what we get is the original multi spectral image.

STEP 4

Now, we have finalized our study by analyzing all the averaged components and tried to check out the features of the multispectral image. The obtained results of the DWT analysis are given below.

4.3 Analysis of the Multi Spectral Image Using (DCT)

STEP 1

We receive the multispectral image and convert it into the grayscale image like figure 4.7 to apply the DWT algorithm on this image.
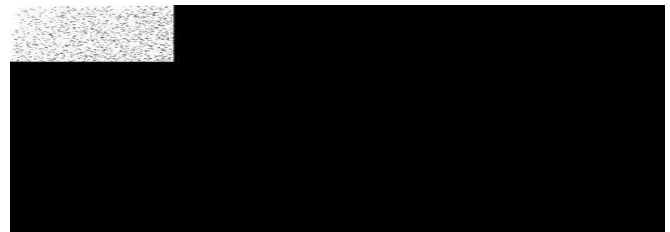
STEP 2

After getting the grayscale image in first step, we apply the DCT algorithm to get the DCT coefficients of the multi spectral image.
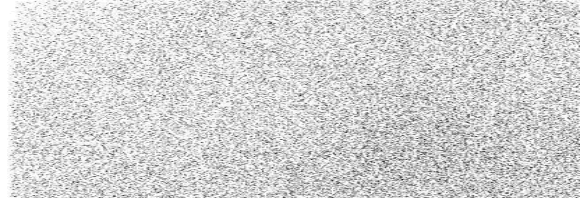
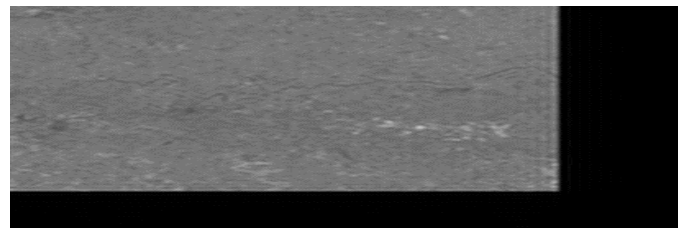**Fig 4.7 The DCT Coefficients of the Multi Spectral Image**

STEP 3

After obtaining the DCT coefficient matrix, we went for scaling these coefficients, and obtained a smaller matrix as shown hereunder.

Fig 4.8 Compressed Matrix of the DCT Coefficients

STEP 4

If we desire to get the original image back from the coefficients, the inverse DCT algorithm will be employed. Here if all the coefficients of the image are used then we get original grayscale image. But if we use the smaller coefficients matrix then we get a compressed grayscale image of the original image which is given herein figure below.
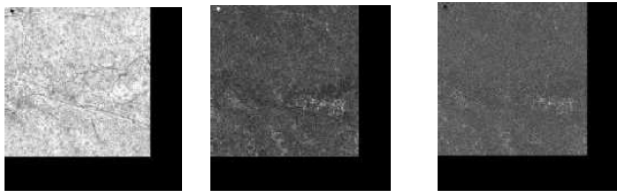

Fig 4.9 Compressed Image Obtained from the Smaller Coefficient Matrix

The analysis of this compressed image shows that the pixels representing the vegetation in the multi spectral image are not as clear, but the pixels representing the water bodies and the concrete structure are quite revealing.

4.4 Analysis of the Multi Spectral Image Using NDVI

STEP 1

(a) NIR Band (b) Red Band (c) Green Band

Fig 4.10 Images of the Different Bands

We have received the color image that has the RGB components, in the given images R represents the near infrared band, G represents the red band, and B is for the green band.

STEP 2

After getting the images of the different bands, our aim is to find out the NDVI values of the given image
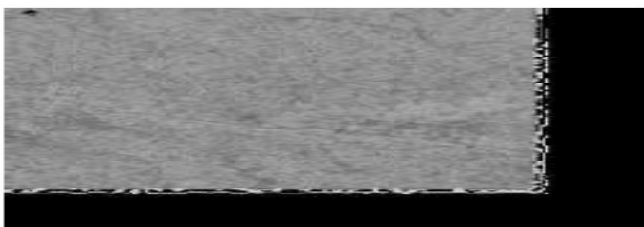
NDVI = (NIR – RED) / (NIR + RED) (4.1)

By using the MATLAB we have obtained the NDVI values of each pixel.

STEP 3

The values of NDVI are in the range of -1 to +1. For making the image we have converted this range to 0 to 200; as

NDVI image value = (NDVI value +1)*100; (6.2)

Fig 4.11 NDVI image

STEP 4

After getting the NDVI image, our job was to get the classified images of the region, in order to get these images we performed the ground survey at various places of the city and taken the proper longitude and latitude values of the survey region from Google earth, and with the help of these images we identified the survey locations into the multi spectral images. We have found the specific range of the NDVI for each object through the ground survey.

1. For the vegetation, we found the NDVI vales are in between 0 & 1, but most of the concentration of the vegetation is in the range of the 0.5 to 1:
    (ndvi (m,n) < 1) & (ndvi (m,n) >= 0.5)

2. For the concrete structures, we found the NDVI vales are in the range of between 0 & 0.5:
    (ndvi(m,n) < 0.5) & (ndvi(m,n) >= 0.0) & (red(m,n) > 80) & (nir(m,n) < 160)

3. For the roads, we found the NDVI vales are in the range of between 1 & 0:
    (ndvi(m,n) < 0.5) & (ndvi(m,n) >= 0.0) & ((nir(m,n) > 115) & (nir(m,n) < 125)) & (red(m,n) < 85)

4. For the water, we found the NDVI vales are in the range of between -1 & 0:
    S(ndvi(m,n) < 0.0) & (ndvi(m,n) >= -1)

Vegetation   **(b) Structures**

(c) Roads   **(d) River &Water Bodies**
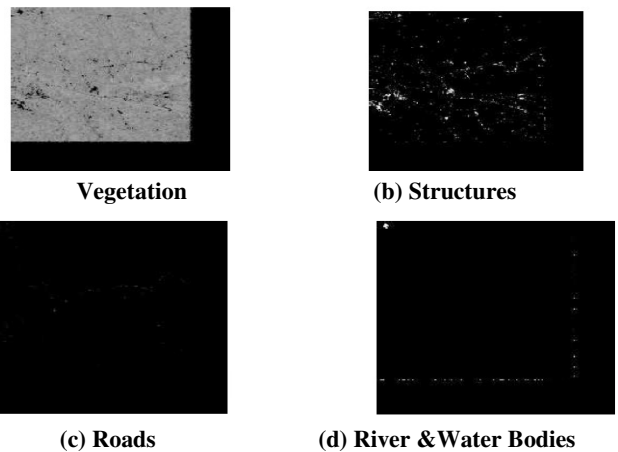
Fig 4.12 Images of the different components

STEP 4

Construction of the false color composite:
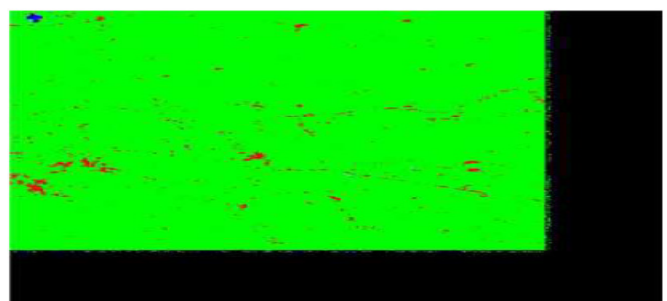
Fig 4.13 False Color Composite of Multi Spectral Image

5. SCOPE:

There is a lot of scope of this analysis. This analysis can be used for the purpose of monitoring the unauthorized development of the colonies, the agricultural planning, protection of the trees. This analysis can be useful in Water resource planning, infrastructures planning and in the so many other areas. In our country hyper spectral and very high resolution satellites will be available in coming years so these can provide us very useful data, now it is up to us how we process it and extract the useful information from this data.

6. CONCLUSION

Our results of the four are very promising. The ANN method has very good results for all features presented here in the multispectral image and almost all the pixels are trained in this case. The NDVI algorithm has better result in most of the cases than ANN. All these classification errors can be reduced by using the higher resolution devices and hyper spectral images from the satellites, such satellites may be launched by the Indian government in coming years.

REFERENCES

[1] Hari Kumar Singh, "Analysis of Remote Sensed Data Using Hybrid Intelligence System: A Case Study of Bhopal Region". 2013

[2] MathWorks. 1997c. Using MATLAB. Natick, MA: The MathWorks, Inc.

[3] Haykin, S. 1994. "Neural Networks: A Comprehensive Foundation". New York, NY: Macmillan College Publishing Company, Inc.

[4] Yang, C.-C., S.O. Prasher, R. Lacroix, S. Sreekanth, A. Madani and L. Masse. 1997a. "Artificial neural network model for subsurface-drained farmlands". Journal of Irrigation and Drainage Engineering 123: 285-292.

[5] MathWorks. 1997, "A. MATLAB Image Processing Toolbox User's Guide". The MathWorks, Inc.

[6] DEFRIES, HANSEN, M. and TOWNSHEND, J., 1995, "Global discrimination of land cover types from metrics derived from the AVHRR Pathfinder data. Remote Sensing of Environment", 54, 209-222.

[7] Kasabov, N.K. 1996. "Foundations of Neural Networks, Fuzzy Systems, and Knowledge", Engineering Cambridge, MA: The MIT Press.

[8] CHAVEZ, P. S., Jr. 1988, "An Improved Dark Object Subtraction Technique for Atmospheric Scattering Corrections of Multi Spectral data. Remote Sensing of Environment", 24, 459 – 479.

[9] Bareilly Population Census 2011, Bareilly, Uttar Pradesh literacy sex ratio and density. Census2011.co.in. Retrieved 17 June 2012.

[10] "Climate of Bareilly". India meteorological department. Retrieved 31 May 2014.

[11] "Bareilly – Bareilly is a small city of Uttar Pradesh". Infoofindia.com. Retrieved 9 January 2011.When Bareilly was in currency". The Times of India. 22 June 2003.