North Asian International Research Journal of Sciences, Engineering & I.T.

ISSN: 2454-7514 Vol. 3, Issue-7 July-2017

IRJIF. I.F. : 3.821

CLASSIFICATION OF REMOTE SENSED IMAGES USING ARTIFICIAL BEE COLONY ALGORITHM

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ABSTRACT

Remote Sensing has been globally used for acquaintance of earth's surface and their categories. Classification of remote sensed data is one of the widely used fields of remote sensing and it is a method for acquiring spatial information from satellite data. We have attempted here to explain the bands classification problem by satellite image classification using one of the most recent and most talented swarm based techniques and it is known as Artificial Bee Colony optimization (ABC) technique. In this paper, we have proposed an implementation of ABC optimisation technique for satellite image classification using their band feature. ABC optimisation technique is used for globally optimal classification of satellite images according to their feature set. The results produced by ABC optimisation algorithm are compared with the results obtained by several existing optimisation techniques like BBO, PSO, CS, hybrid Rough/BBO, hybrid Fuzzy/BBO, Hybrid FPAB/BBO, Hybrid ACO/SOFM, Hybrid ACO/BBO and Fuzzy classifier to show the effectiveness of our proposed implementation. The proposed work utilizes the conventional swarm intelligence technique for classification of remote sensed images according to feature of several bands. After applying the proposed algorithms to the proposed image, the classified image is obtained with different classes and results has shown the value of Kappa Coefficient for ABC algorithm is near about 0.941, which shows that the observed classification is better as compared to Kappa Coefficient of some other existing algorithms. The whole result scenario has been implemented and presented in data acquisition toolbox under the MATLAB 2010a environment.

Key words: ***Classification, Remote sensing, Artificial Bee Colony, Kappa Coefficient, Satellite Imaging.***

INTRODUCTION

ABC is presented by Dervis Karaboga under the encouragement of collective behaviour of honey bees with improved performance in function optimization problem compared with Genetic Algorithm (GA), particle swarm optimization (PSO), and Differential-Evolution (DE). ABC is the meta-heuristic Swarm intelligence is subjected by

search optimization procedure which impersonate as the representation of natural biological development as well as social activities of the specific species. The activity of such category of species is directed through advancement, learning, in addition to adaptation. In these methods fitness factor chooses all kinds of these features. The selection of the chromosome is biased towards the fittest of the specific species. Ultimately, the fit chromosome is carefully chosen the minute the optimization criterion is met. In our proposed algorithm, we have proposed utilization of ABC method. In this manner, the proposed algorithm could probably offers more enhanced as well as proficient key intended for the complex problems. In this paper Artificial Bee Colony optimization (ABC) technique is used for the classification of remote sensed data. The Artificial Bee Colony optimization (ABC) is inspired from the obligate bees. Artificial Bee Colony optimization is high-quality for optimising then it is good and proven that ABC algorithm can significantly improve classification rate by improving their feature sets.

A Satellite image classification is a significant method used in remote sensing for the automated analysis and pattern recognition of satellite data, which facilitate the automated understanding of a large amount of information [1, 2, 3, and 4]. These days, there exist many types of classification algorithms, such as parallelepiped and minimum distance classifiers, but it is still essential to get better their performance in terms of correctness rate. Alternatively, over the last few years, cellular automata have been utilized in remote sensing to implement procedure related to simulation. While there is little preceding research of cellular automata related to satellite image classification, they offer much reward that can improve the results of classical categorization algorithms.

In this work, we are applying Swarm intelligence based on ABC method to execute the satellite picture classification. ABC is the meta-heuristic Swarm intelligence is search optimization procedure which impersonate as the representation of natural biological development as well as social activities of the specific species [5, 6, 7]. The activities of such category of species are directed through advancement, learning, in addition to adaptation. In these methods, fitness factor chooses all kinds of these features. The outcomes generated through the proposed algorithm are contrasted with the outcome attained by means of other swarm intelligence to demonstrate the proofs of our proposed algorithm. The test of method is accomplished by categorizing a multi-spectral, high resolution satellite picture of Indian region.

In this, work has taken multi-spectral images of different regions resembling to barren, water, vegetation, rocky, and urban, that are specifically being classified for further requirement for image analysis. And, also take data set of specified region multi-spectral images. Initially, upload a multi-spectral image. Then, apply ABC optimization

technique on the multi-spectral image which is utilized for feature selection as well as feature extraction for each image. In ABC Optimization, first select the features and then classify it according to which place/group they belong. Once the feature is extracted then apply genetic algorithm to reduce the feature which are similar or the features which are undesirable in the images. Once feature reduction and optimization process of features selected is done then we classify it according to its feature obtain from optimization process utilizing genetic algorithm. Then, as an output, we will get a classified image and a graph is obtained [8, 9].

Classification is a method in which we take out valuable data from remote-sensing information. It is one of the important subject matters in remote-sensing studies. For instance, classification is recurrently carried out on the way to acquire land use/cover facts. Local, regional, and global environmental changes are closely related to land use/cover and its changes over time. Remote sensing imagery has been an important source of acquiring land use/cover information. Numerous methods for remote-sensing classification have been developed in the last three decades, but none of them has been achieved good accuracy. So, the proposed work is enhanced using Artificial Bee Colony Optimization Method in which kappa coefficient value has also been modified [10, 11].

The Aims and objectives of this work are summarized as follows;

a) To propose novel method for image classification for acquiring better results in remote sensing field.
b) To validate the proposed model using kappa coefficient metrics.

The Kappa Coefficient can be defined as the discrete multivariate technique that is used to interpret the results of error matrix. The Kappa statistic incorporates both the off diagonal observations of the rows and columns and the diagonal observations to give a more robust statement of accuracy assessment than overall accuracy measures. The Kappa Coefficient can be calculated by applying the following formula to the error matrix:

$$\hat{k} = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}(x_{i+}..x_{+i})}{N^2 - \sum_{i=1}^{r}(x_{i+}..x_{+i})}$$

Where,

r = no. of rows in the error matrix (r=5 in our case)
x_{ii} = the no. of observations in row i and column i (on the major diagonal)
x_{i+} = total of observations in row i (shown as marginal total to right of the matrix)
x_{+i}= total of observations in column i (shown as marginal total at bottom of the matrix)

N= total no. of observations included in matrix (*N*=572 in our case)

The Kappa Coefficient of the proposed work is 0.917.

METHODOLOGY

Artificial Bee Colony optimization (ABC)

For the classification of remote sensed data or satellite image, the main part is feature optimisation because of without appropriate feature set, we cannot classify accurately, so we use Artificial Bee Colony optimization technique of optimisation of feature set. ABC optimization algorithm is most popular optimisation technique that improves the classification rate as well as the efficiency of the proposed work. With the help of satellite image, various features of our nature can be identified. The general features on which scientists generally works are water, barren, urban and vegetation areas. Example of this type of image is being shown in figure 1. Indeed, other features are being recognized but these are commonly available in any kind of land areas. Thus, land covers all these common category of topographies. In this proposal, we tried to focus on extracting the natural terrain features like urban, vegetation, rocky, barren and water from satellite image using membrane computing. Though water has been already extracted through membrane computing [4] but these papers classified the image into other different terrain features also and show how membrane computing classifies the homogeneous, heterogeneous and sparse regions of the specified areas. The methodology steps of proposed work are given below:

Step 1: Firstly, we extract the feature set from the uploaded input data set of a remote sensed data.

Step 2: Initialised the swarm n in the implementation for the feature carrying purpose.

Step 3: ABC optimisation technique is an iterative searching optimisation algorithm, so, we set the I_t iteration to optimisation purpose.

Step 4: We find the best solution according to the all generated population from the feature set of input data set of a multi- spectral, multi resolution and multi sensor image data/images of the datasets according to the objective function of ABC optimisation algorithm. and multi sensor image data/images of the datasets according to the their bands which involve several bands.

Step 5: At last, we find the best solution of ABC searching algorithm from the input dataset according to their bands of water pixels, vegetation pixels, urban pixels, rocky pixels and barren pixels

Step 7: Store all data in different cell of optimised feature set according to the best solution for ABC optimisation algorithm.

Classification based on ABC optimisation algorithm

The process of proposed methodology has been shown below and the original and test images for proposed work has been also shown below.

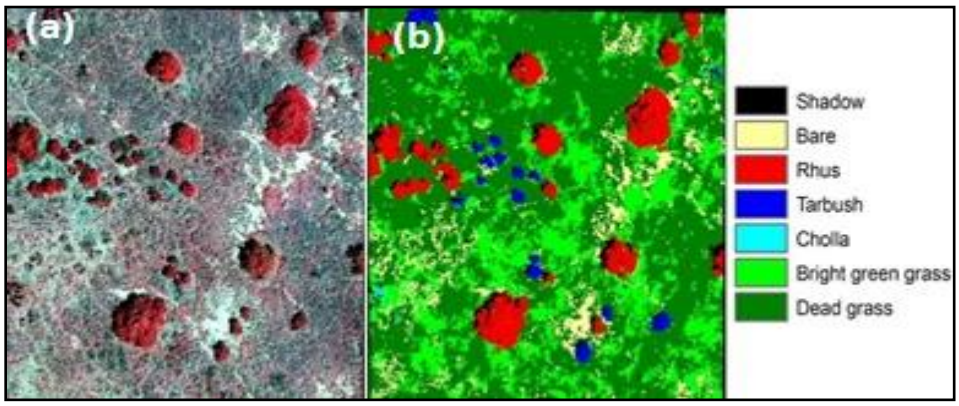

Figure 2.(a) Original Satellite Image and (b) Classified image

Proposed algorithm

Assumptions

- Initialised Swarm
- Iterative loop = Total number of iteration
- First loop = Total number of feature set rows
- Second loop = Total number of feature set columns
- Classify = Dataset according to bands feature set

Input: Training feature dataset and Remote Sensed Images

Output: Classified image according to the bands

In proposed work using ABC optimisation algorithm we follow some important steps to classify the satellite image according to their bands. The steps of proposed work are given below:

Step 1: Load Input Remote Sensed Image (I) and find the total number of rows and columns of satellite image pixels. After that extract the band of remote sensed image for the next phase

```
for i = rows of I
      for j = columns of I
            band(i) = I(i,j)
            save bands
       end
end
```

Step 2: Initialised the swarm and set the iteration for the ABC optimisation algorithm

```
    Swarm = N
    Iteration = 100
for Itr = rows of I
          for i = rows of I
                for j = columns of I
                      band(Itr) = band(i,j)
                      ABC_Data(Itr) = PSO(i,j,N)
                      ABC_Data(Itr) = FFA(i,j,N)
                 end
          end
end
save optimised_data
```

Step 4: Train data using optimised data according to bands

Step 5: Finding best and appropriate solution using the training for the classification image

Step 6: Classify water pixels, vegetation pixels, urban pixels, rocky pixels and barren pixels according to the trained data.

Step 7: Calculate the parameters of the proposed work like Kappa Coefficient.

Above algorithm describes the process of remote sensed image classification using ABC optimization methods and the flow diagram of proposed work is given as:

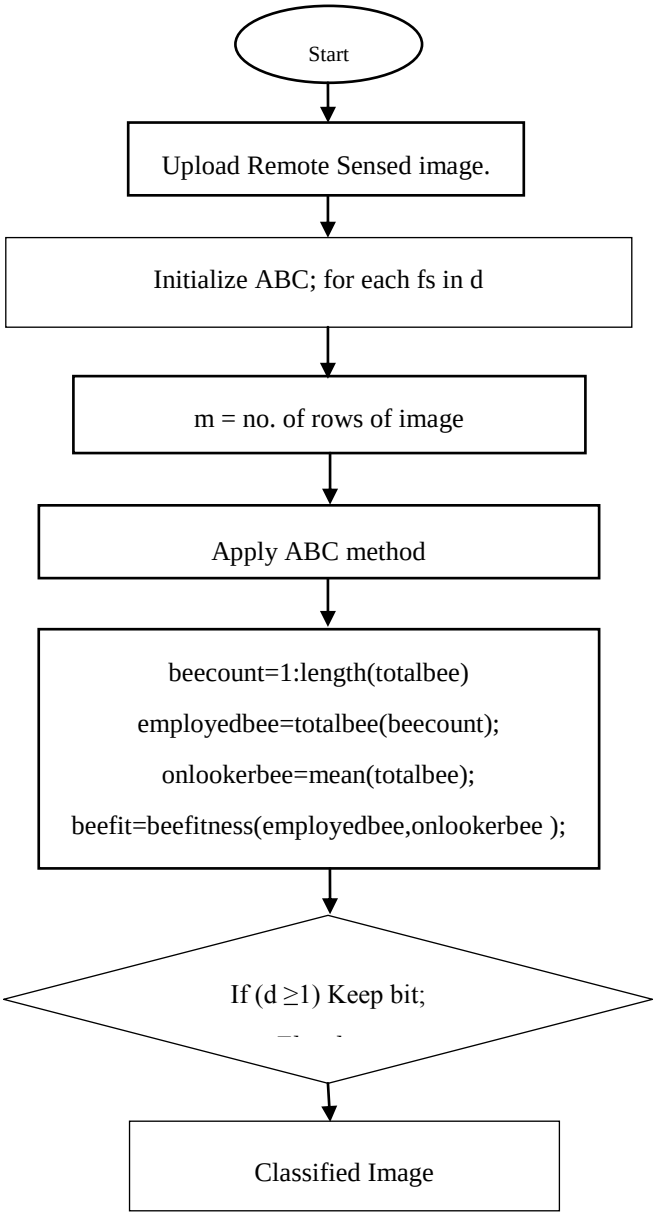

Fig.2: Flowchart of proposed algorithm

RESULT AND DISCUSSIONS

Database

We have taken a multi-sensor, multispectraland multi-resolution picture of a specific region in INDIA. The area is selected because it carries some good land cover features like Vegetation, Water, Urban, Barren and Rocky areas. The size of picture used is 548*474 pixels.

Metrices

The Kappa Coefficient can be calculated by applying the following formula to the error matrix:

$$\hat{k} = \frac{N \sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} . . x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} . . x_{+i})}$$

Where,

r = no. of rows in the error matrix (r=5 in our case)

x_{ii} = the no. of observations in row i and column i (on the major diagonal)

x_{i+} = total of observations in row i (shown as marginal total to right of the matrix)

x_{+i}= total of observations in column i (shown as marginal total at bottom of the matrix)

N= total no. of observations included in matrix (N=562 in our case)

The Kappa Coefficient of the proposed work is0.917.

Analysis

Table 1. Error Matrix Obtained After Implementing Proposed Work using the ABC optimisation.

Feature	Water	Vegetation	Urban	Rocky	Barren	Total
Water	73	0	0	0	0	73
Vegetation	0	161	1	0	0	162
Urban	1	0	147	0	10	157
Rocky	0	0	0	101	2	103
Barren	0	0	12	0	55	67
Total	74	161	160	101	67	562

For validation process following number of pixels is taken into consideration in ABC optimisation algorithm:

- Water Pixels - 73
- Vegetation Pixels - 161

- Urban Pixels - 147
- Rocky Pixels - 101
- Barren Pixels - 74

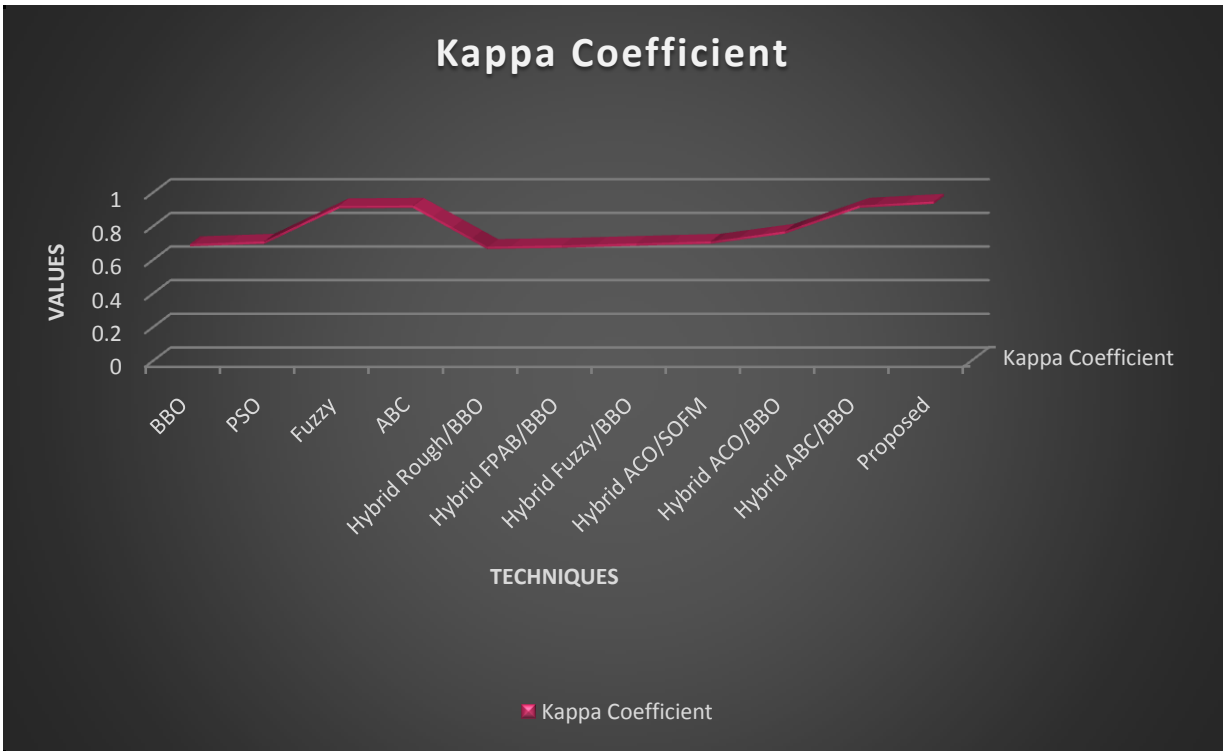

Figure 4: Comparison of result obtained from various past work using kappa coefficient with proposed Work

The value of Kappa Coefficient for ABC algorithm is 0.941, which shows that the observed classification is better as compared to Kappa Coefficient of some other algorithms as shown in above figure. The Kappa coefficient of Fuzzy set (Banerjee et al., 2012), BBO (Panchal et al., 2009) (Goel L. et al., 2011), PSO (Panchal et al., 2009), ABC (Banerjee et al., 2012), CS (Bhardwaj et al., 2012), hybrid Rough/BBO (Goel S. et al., 2011), hybrid Fuzzy/BBO (Goel S. et al., 2011), Hybrid FPAB/BBO (Johal et al., 2010), Hybrid ACO/SOFM (Goel S. et al., 2011), Hybrid ACO/BBO (Goel S. et al., 2011) Hybrid ABC/BBO (Arora et al., 2012) and Hybrid of CS/ACO as well as CS/PSO (Harish Kundra et.al, 2013) are 0.9137, 0.68812, 0.7033, 0.917, 0.9465, 0.6715, 0.6912, 0.6793, 0.7075, 0.7636 and 0.917respectively.

CONCLUSION

In this research work we proposed the ABC optimisation algorithm to achieve the more accuracy for the remote sensed image classification. Despite being an age old problem, remote sensed image classification remains an active field of inter-disciplinary research till date. No distinct algorithm is acknowledged that will be able to assemble different groups of all real world kind datasets competently as well as without error. To judge the quality of an image classification from images taken from satellite, we need some specially designed statistical-mathematical algorithm. In this work, we have presented method using ABC Optimization to classify multispectral satellite picture. Correspondingly a relative study of the analogous swarm dependent procedure is discovered. In the proposed work, the method having Kappa coefficient value is 0.917 which shows good performance value as compared to other swarm based individual optimization algorithms given by the figure 1. In proposed work, we compare the obtained results with some previous existing methods like BBO, PSO, CS, hybrid Rough/BBO, hybrid Fuzzy/BBO, Hybrid FPAB/BBO, Hybrid ACO/SOFM, Hybrid ACO/BBO and Fuzzy classifier after that we observe the better classification rate in case of proposed work.

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