Shortest Path Finding in Country using Hybrid approach of BBO and BCO

Monica Sood
Assistant Professor, Lovely Professional University, Phagwara , Punjab, INDIA

Mandeep Kaur
M.Tech Student Lovely Professional University, Phagwara , Punjab, INDIA

ABSTRACT
In this paper a hybrid approach of BBO and BCO technique is used to find the shortest path from source to the target point. The input data is a red band satellite image. In this image there are no prior paths and we don't have any prior information about the area. So path planning is a key factor to find out the optimized path which includes terrain mapping, obstacle detection and avoidance, and goal seeking in cross-country using a hybrid approach of BBO and BCO techniques of Swarm Intelligence. In this hybrid approach Biogeography Based Optimization (BBO) is used for path extraction and obstacle detection from the red satellite image, morphological operation is used for smooth image and Bee Colony Optimization (BCO) algorithm is used for obstacle avoidance and shortest safe path from source to the target.

Keywords: satellite image, Path planning, terrain mapping, obstacle detection and avoidance, and Swarm Intelligence.

1. INTRODUCTION
The broader area of research is swarm intelligence under which BBO and BCO has been chosen for a hybrid approach algorithm. In swarm intelligence the social insects can obtain information about environment and interact with the remote insects or environment indirectly, by nectar. All these features characterize Swarm Intelligence. We can find these features in nature such as ant colonies, bird flocking, animal herding, fish schooling etc. Various problems are encountered using this approach like how to find the shortest and obstacle free smoother path. Thus for further firstly, detailed study of BBO and BCO techniques of swarm intelligence to make a hybrid approach of BBO and BCO. This hybrid approach of Biogeography Based Optimization (BBO) and Bee Colony Optimization (BCO) describes autonomous navigation for outdoor vehicles which includes terrain mapping, obstacle detection and avoidance, and goal seeking in cross-country using Swarm Intelligence. In this research paths and obstacles extracted from red satellite image and smooth path planning can be implemented for various kinds of purposes, e.g. military, transportation, robot navigation, etc.

1.1 Biogeography based Optimization
The science of biogeography was sown by naturalists like Alfred Wallace and Charles Darwin. Till 1967, biogeography was mainly a descriptive study. This

Technique is feasible to predict the number of species in a habitat (a habitat is an ecological area that is inhabited by a particular plant or animal species and which is geographically isolated from other habitats). Each habitat is classified by habitat suitability index (HSI). The value of HSI depends upon many features of habitat like rainfall, temperature, diversity of vegetation, land area, safety and security. Each of these features that characterize habitability is known as suitability index variables (SIV). SIVs are the independent variables while HSI are the dependent variables immigration rate λ and emigration rate μ. The immigration and emigration rate depends upon the number of species in the habitats. The values of emigration and immigration rates are given as:

$$\lambda = I\,(1 - k / n)$$
$$\mu = E / n$$

Where I is the maximum possible immigration rate; E is the maximum possible emigration rate; k is the k^{th} number of species and n is the total number of species.

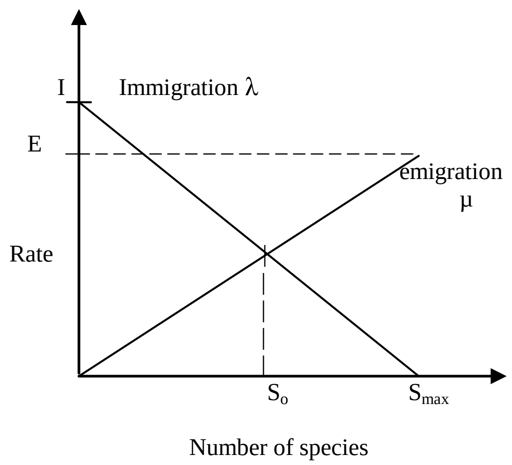

Figure.1 Biogeography based Optimization

Figure. 1 shown that when low HSI then λ is high and μ is low then on that island there are less number of species because large number of species migrate to other island. When there is low λ and high μ then the island have large number of species and high HIS.

1.2 Bee Colony Optimization
The ABC algorithm is proposed by Karaboga in 2005 but analyzed in 2007. The ABC algorithm is the behaviors of the real bees on finding food source nectar, and sharing the information of food sources to the other bees in the nest. This algorithm was inspired by the method adopted of a swarm of honey bees to locate food sources. There are two different honey bee groups that share knowledge in order to successfully locate such sources. A) Employed bees that are currently exploiting a food source. B) Unemployed bees that

are continually looking for a food source. Unemployed bees are further divided into scout bees (search around the nest) and onlooker bees (wait at the nest) and establish communication with the employed bees. A number of employed bees are equal to the number of the food sources and move by using the following equation:

$$vij = xij + \phi ij \times (xij - xkj)$$

Where j is a randomly selected number in [1, D] and D is the number of dimensions, ϕij is a random number uniformly distributed in the range [-1, 1], and k is the index of a randomly chosen solution. Both vi and xi are then compared against each other and the employed bee exploits the better food source. Onlooker bees next choose a random food source according to the probability given as.

$$Pi = fiti / \Sigma fitj$$

Where $fiti$ is the fitness of the ith food source.

$$P_{ij} = \frac{[\rho_{ij,\ n}]^{\alpha}.[1/d_{ij}]^{\beta}}{\Sigma_{j\varepsilon A} [\rho_{ij,\ n}]^{\alpha}.[1/d_{ij}]^{\beta}}$$ update the best food source

Here ρ_{ij} is the amount of nectar at j location and d_{ij} is the distance from i to j and the Σ show the summation of nectar and distance for all the points from i to j [3].

2. REMOTE SENSING IMAGE CLASSIFICATION FOR INPUT

The multi-spectral data are used to perform the classification of images, the spectral pattern present within the data for each pixel is used as the numerical basis for categorize spectral pattern refers to the set of radiance measurements obtained in the various wavelength bands for each pixel. Subcategories of multispectral remote sensing include hyper spectral, in which hundreds of bands are collected and analyzed, and ultra spectral remote sensing where many hundreds of bands are used. Red band satellite image of remote sensing is the input to this hybrid approach of BBO and BCO for shortest path finding. Using various sensors, we remotely collect data that may be analyzed to obtain information about the objects. Satellite remote sensing images are representation of earth surfaces as seen from space. The input to this approach is red band satellite image.

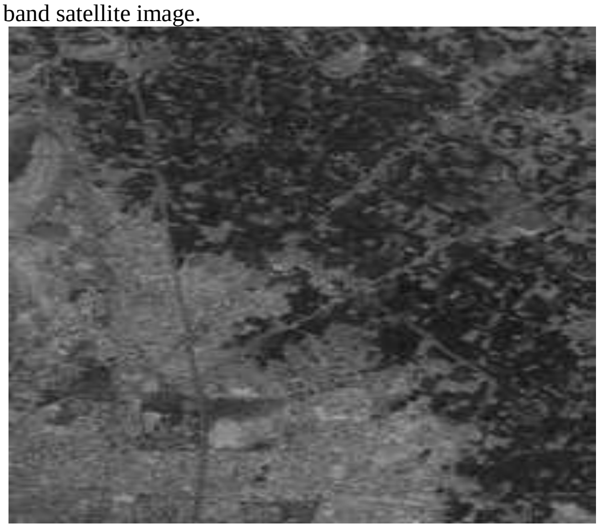

Figure2. Red band satellite image (input image)

3. PROPOSED WORK

The proposed algorithm is implemented with Matlab [10]. The algorithm is based on combined approach of BBO and BCO applied on Red band satellite image.

3.1 The solution process by BBO

There are 4 numbers of islands every island having the HSI value by calculating the mean of two pixel value of every island and check the SIVs conditions. The SIVs belongs to which island means that island have high HIS (rainfall, temperature, diversity of vegetation, land area, safety and security). So, divide the histogram in 4 islands region I take two-two pixel value of initialize islands to calculate the HIS value of every islands for immigration and emigration. Region II calculates the HSI of whole image by mean, and the region III checks the SIVs conditions to select the most suitable value of Island (high HIS). The paths and obstacles extracted after applying BBO is shown in figure 3.

Figure3. Paths and obstacles extracted after applying Biogeography based optimization (BBO)

3.2 Morphological Operations

Morphological operations mean identifying objects or boundaries within an image. Morphology is a technique of image processing based on shapes [5]. In this research obtained paths and obstacles are refined using morphological operations to minimize the detection of shadows, trees and inconvenient areas. After applying the morphological operation it provides a smooth image. Figure 4 shows the refined image after morphological operations.

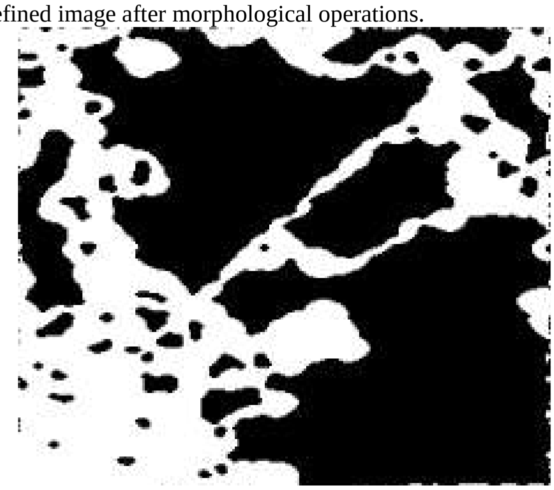

Figure4. Smooth image after morphological operations

3.3 Shortest and Safest Path Finding Using BCO

There are the employed bees that are currently exploiting a target. Second, there are unemployed bees that are continually looking for a target. Unemployed bees are divided into scout bees that search around the nest and onlookers that wait at the nest and establish communication with the employed bees. The swarm is divided into employed bees, scouts and onlookers. Now the shortest path is obtained. On the whole, we have the safest and shortest path and the resultant image is shown in results.

3.4 Problem descriptions

Definition 1: islands i (i=1,2,3,4) denotes islands in the image.
Definition 2: collect the two pixel value for each island.
Definition 3: calculate the HSI of two pixel value for immigration rate λ and emigration rate μ.
Definition 4: calculate the HSI of whole image is the average of whole image.
Definition 5: check the SIVs condition for each island using BBO. The SIVs belongs to which island then that island has high HSI.
Definition 6: Spray ne percentage of the populations into the solution space randomly, and then calculate their fitness values.
Definition 7: Move the Onlookers: Calculate the probability of selecting a food source by the equation.

$$Pi = fiti/\Sigma fitj$$

$$P_{ij} = \frac{[\rho_{ij,n}]^{\alpha}.[1/d_{ij}]^{\beta}}{\Sigma_{j\varepsilon A}[\rho_{ij,n}]^{\alpha}.[1/d_{ij}]^{\beta}}$$ update the best food source

The movement of the onlookers follows the equation.

$$xij(t+1) = \theta ij + \phi(\theta ij(t) - \theta kj(t))$$

where xi denotes the position of the ith onlooker bee, t denotes the iteration number, θk is the randomly chosen employed bee, j represents the dimension of the solution and $\phi(\cdot)$ produces a series of random variable in the range $[-1,1]$.
Definition 8: Move the Scouts: If the fitness values of the employed bees do not be improved by a continuous predetermined number of iterations.
Definition 9: Update the Best Food Source Found So Far: Memorize the best fitness value and the position, which are found by the bees. If the termination condition is satisfied, terminate the program and output the results.

4. SIMULATION RESEARCH

The flowchart of the proposed algorithm is shown in figure 5.

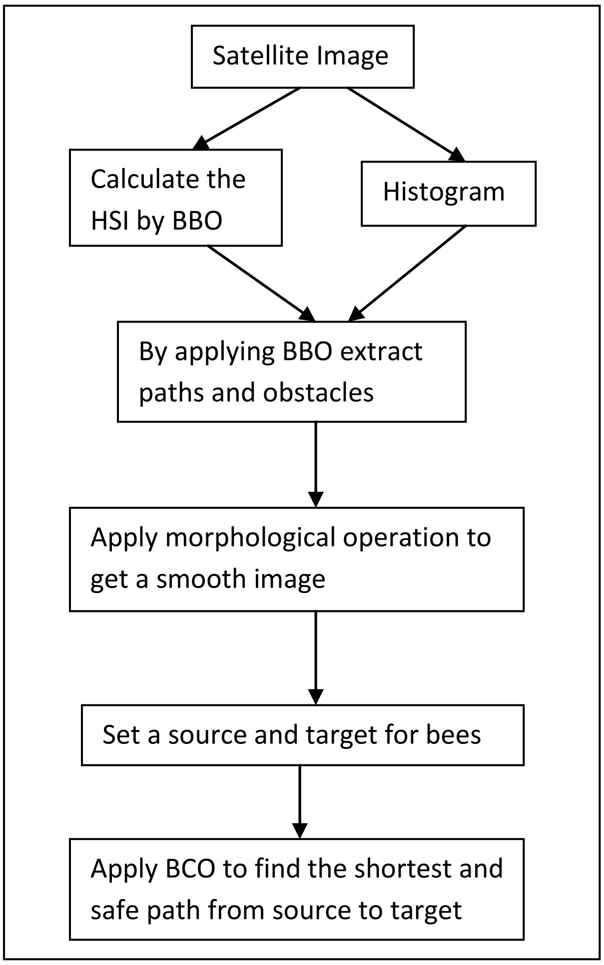

Figure5. Flowchart

The pseudo-code of the proposed algorithm is given in figure 6.

Apply Biogeography based Optimization (BBO) technique for path extraction and obstacles detection:

Step 1: Take the red band satellite image of remote sensing as input.
Step 2: Initialize islands like i1, i2, i3, i4, ….iN
Step 3: Collect the two pixels value for each island.
Step 4: For immigration and emigration calculate the HSI of two pixel value.
Step 5: calculate the HSI of whole image as average for whole image.
Step 6: check the SIVs conditions.

For each island

If SIVs belongs to i1.

Then HSI is high

Else check for next.

End

end

Step 7: Path extracted and obstacles detected using the BBO technique of swarm intelligence.
Step 8: Refine paths using morphological operations.

Apply Bee Colony Optimization (BCO) algorithm for obstacle avoidance and shortest path to the goal.

Step 9: Initialize: Spray ne percentage of the populations into the solution space randomly, and then calculate their fitness values, which are called the nectar amounts, where ne represents the ratio of employed bees to the total population.
Step 10: Move the Onlookers: Calculate the probability of selecting a food source and select a food source to move to by roulette wheel selection for every onlooker bees and then determine the nectar amounts of them.

$$P_{ij} = \frac{[\rho_{ij,n}]^{\alpha} . [1/d_{ij}]^{\beta}}{\Sigma_{j\varepsilon A} [\rho_{ij,n}]^{\alpha} . [1/d_{ij}]^{\beta}}$$ update the best food source

Step 11: Move the Scouts: If the fitness values of the employed bees do not be improved by a continuous predetermined number of iterations, which is called "*Limit*", those food sources are abandoned, and these employed bees become the scouts.
Step 12: Update the Best Food Source Found So Far: Memorize the best fitness value and the position, which are found by the bees.
Step 13: If the termination condition is satisfied, terminate the program and output the results; otherwise go back to Step10.

Figure6. Pseudo-code: Implementation of algorithm

5. RESULTS

Finally, BCO was implemented in which ants were initialized and they find the shortest path avoiding the obstacles from given source to destination according to the goal defined. Figure 7 shows the paths extracted and the shortest path from source to target from the satellite image using Swarm Intelligence.

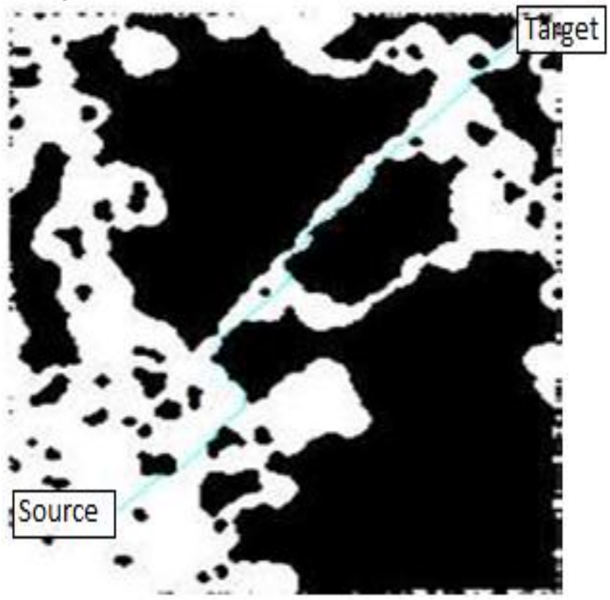

Figure7. Final safest and shortest path from source to target

6. CONCLUSION

In this paper a hybrid approach of BBO and BCO is used to find the shortest path from the source point to the target. Here, BBO technique is used for path extraction and obstacle detection on red satellite image. To make a path more smooth the morphological operations were implemented on the image after path extraction and obstacle detection to minimize the effects of shadows, trees and inconvenient areas. Then on the smooth image BCO technique is used for obstacle avoidance to find the shortest and safest path from source to the target. The simulation results show that it's a simple, quick and efficient algorithm.

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