

PBBO: A NEW HYBRID ALGORITHM FOR SATELLITE IMAGE CLASSIFICATION

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ABSTRACT

From last two decades many optimization techniques have been evolved. PSO and BBO are the two techniques that have been widely used in Swarm Optimization. PSO is better than many genetic algorithms. PSO has applications in various areas like Optimization, Neural Networks training, Fuzzy controls and etc. BBO is based on science of biogeography. BBO has some features common to PSO and Genetic algorithms but it has some important features that make it more reliable than others. In this paper, we have proposed new algorithm that combines the features of PSO and BBO. It will help in providing more reliability in optimization world.

Keywords: PSO, BBO, GA, optimization, biogeography.

1. INTRODUCTION

PSO algorithm was originally developed by Dr. Eberhart and Dr. Kennedy. It was based on stochastic optimization technique. PSO is first populated with random solutions and then search for optimum solution by repetitions. In this method, the behavior of bird is simulated. It is supposed that there are number of birds that are searching food in a location and there is only single piece of pray is present is there. There are only few birds that know where the pray is. Then the best solution for remaining birds is that follow the birds which is nearby to pray. In PSO, bird is known as particle. We use a fitness function in which different values are given to particles which is then optimized. The particles have particular positions and velocities in starting and then afterwards go on changing in search of pray. After every repetition, every particle updates its two values. First one is the value that it has gained and other one is the best value by optimization that is achieved so far. These are stated as pbest and gbest respectively. The two equations are used by particle to update its velocity and position is

$$\text{Vel}[] = \text{Vel}[] + C1 + C2 \quad (1)$$

where

$$C1 = \text{const1} * \text{rand}() * (\text{pbest}[] - \text{present}[])$$

$$C2 = \text{const2} * \text{rand}() * (\text{gbest}[] - \text{present}[])$$

and

$$\text{present}[] = \text{present}[] + \text{Vel}[] \quad (2)$$

Here Vel [] is the velocity of particle and Present [] is current result of particle. const 1 and const 2 are learning factors. Here both are takes as 1.

Pseudo Code for PSO is

```

For each particle
    Initialize the particle
End
Do
    For each particle
        Find out the fitness value of each particle
        If current value of pbest is good against value in
        history then
            Set current value as pbest
    End
    Select the gbest as the best fitness value of all the
    particles.
    For each particle
        Find out the particle velocity for equation 1.
        Increment the position of particle by using
        equation 2.
    End
    Repeat while maximum iterations or the criteria of
    minimum error are not attained.
    
```

On each position velocity of particle is equated to a maximum velocity as Vmax. If the sum of accelerations try to exceed the velocity from the input value which is given by the researcher then the velocity is limited to Vmax.

BBO (Biogeography Based Optimization) was introduced by simon and is used for global optimization. Here species immigrate or emigrate between islands in search of more friendly habitats. Each result is known as habitat and each has habitat suitability index (HSI) which

is a vector. Each individual is represented with some initial random value and good HSI values are retained. Both high and low HSI values share their features. The migration and mutation operators are used for generating the new habitat from the all the solution in the problem. BBO migration is helpful to change present solution and modify existing island.

The probability X_i is proportional to the immigration rate Y_i and the source of probability is proportional to the emigration rate U_j .

Procedure for Habitat migration is

Start

For $i = 1$ to N

Select X_i with probability based on Y_i

if $\text{rand}(0, 1) < Y_i$ then

for $j = 1$ to N

Select X_j with probability based on U_j

if $\text{rand}(0, 1) < U_j$ then

Randomly select an index vector σ from X_i

Replace a random vector in X_i with σ

end if

end for

end if

end for

End

While mutation is based on probability that modifies the index vectors randomly this depends on the priority of probability of existence. Here we ignore the very high HSI and very low HSI and take the medium HSI.

Procedure for mutation is

Begin

for $i = 1$ to N

calculate the probability P_i

select vector $X_i(j)$ dependent on P_i

if $\text{rand}(0,1) < m_i$ then

replace $X_i(j)$ with randomly generated vector

end if

end for

End

The mutation rate is defined as:

$$m = m_{\max} \left(\frac{1 - P_s}{P_{\max}} \right) \quad (3)$$

Here m_{\max} is user defined and here it is 2.

Diversity of population is increased by this mutation process.

2. PROPOSED ALGORITHM

The proposed enhanced model will use the basics of BBO and PSO.

For each particle

Initialize particle

For each particle

Calculate fitness value

If the fitness value is better than the best fitness value (pbest) in history.

set current value as the new pbest

End

Choose the particle with the best fitness value of all the particles as the gbest

For each particle

Calculate particle velocity according to Eq. 2

Update particle position according to Eq. 1

End

Continue while maximum iterations or minimum error criteria is not attained

Consider each feature as one habitat.

For each particle

Total no. of habitat = universal + feature habitat

Define HSI, S_{\max} , S_{\min} , immigration rate and emigration rate.

Find HSI for each other feature habitat.

Z) Select species from universal habitat and migrate it to one of the other habitat and recalculate HSI.

If recalculated HSI is within threshold then absorb the species to that habitat else.

Check for the other habitats and recalculate the HSI.

If all species in universal habitat are checked then stop else go to step Z.

Here habitat is group of pixels around corners where pixel with best value is located. The particle velocity is related to intensity of pixel while the position of particle with position of image pixel. Sobel edge detector is used as it is the smallest average filter that is used to detect edge values.



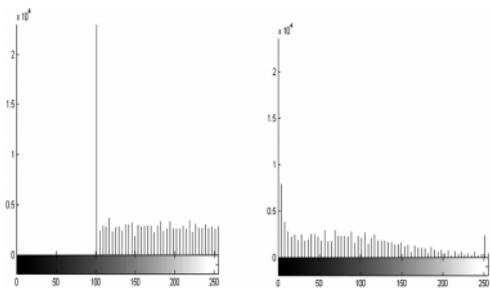


Figure 1: Global Histogram Equalization, Upper Left: Unequalized Image, Upper Right: Same Image After Histogram Equalization, Lower Left: Unequalized Histogram, Lower Right: Equalized Global Histogram of a City.

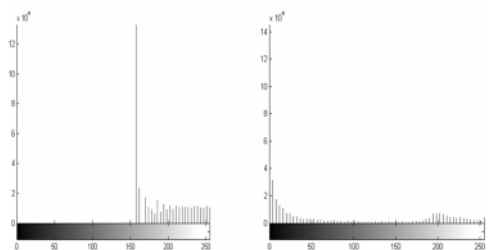
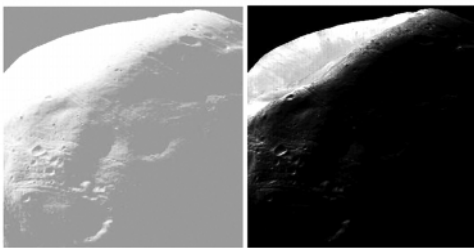


Figure 2: Global Histogram Equalization, Upper Left: Unequalized Image, Upper Right: Same Image After Histogram Equalization, Lower Left: Unequalized Histogram, Lower Right: Equalized Global Histogram of Moon.

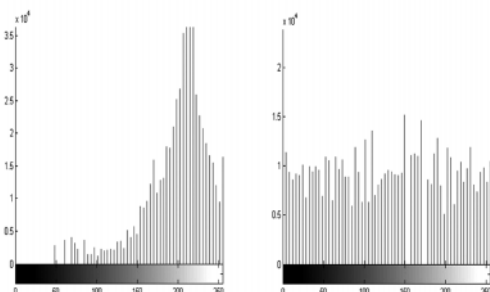


Figure 3: Global Histogram Equalization, Upper Left: Unequalized image, Upper Right: Same Image After Histogram Equalization, Lower Left: Unequalized Histogram, Lower Right: Equalized Global Histogram of Moon.

$$F(Z) = \log(\log(E(I(Z)))) * \frac{edges(I(Z))}{M * N} * H(I(Z)) \quad (4)$$

Here $F(Z)$ is the fitness function. And H is the entropy of the function [4]. Here M and N are the size of image.

3. PBBO PARAMETERS

The performance of the algorithms is governed by three parameters

- computing the objective function in terms of the fitness value.
- The computational time per run of each algorithm.
- The efficiency in terms of the number of edges which gives an indication of the performance of the proposed algorithm.

The results are given in Table 1. Here good, better and best ranges are taken as 60-70 %, 70-80% and 80-90% and above respectively.

Table 1
Shows the Fitness Value of the Image

Image/Fitness Value	PSO	BBO	PBBO
Figure 1	good	better	best
Figure 2	good	good	best

Table 2
The Number of Edges as Detected with Sobel Mask

Image/Fitness Value	PSO	BBO	PBBO
Figure 1	49%	58%	69%
Figure 2	52%	60%	71%
Figure 3	50%	57%	68%

4. RESULTS AND CONCLUSION

In this paper, a new approach to automatic satellite image enhancement using PBBO is implemented by using a suitable fitness function and the number of edges in image.

PBBO gives better results in very less time which is compared with PSO and BBO, the basic methods. BBO gives much better results than PSO. In the future we will try to modify the algorithm so that better results can be derived.

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