

Analyses of Nature Inspired Intelligence in the domain of Path Planning and searching in Cross Country with consideration of various constrained parameters

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Abstract—the Firefly and Cuckoo search algorithm are the best known algorithms for solving meta-heuristics optimization problems. It is necessary to develop hybrid algorithms derived from Firefly and Cuckoo search algorithms, for finding cross country optimized path as to detect the probability of terrorists in the country defense system. By moving from source to destination (terrorists), the best optimized path is chosen. To track the movement of terrorists and their location (region), the Firefly algorithm can be used which has the behavior to get inspired very quickly from the flashing behavior of fireflies. Through this property we have chosen the best region among various regions based on its light. Then after it, the optimized path is find out from that region using Cuckoo search which has the behavior of laying its own eggs in the nests of other host birds. This research paper discuss about the working of firefly and cuckoo search algorithm and their advantages and disadvantages. Later, we analyze the performance of firefly algorithm and cuckoo search on the basis of various factors such as light, communication and behavior.

Keywords—Satellite-image, Test-data (images), Morphological analysis, Cuckoo search, Firefly algorithm, BAT algorithm.

I. INTRODUCTION

Optimization methods are mainly concerned with large scale of applications like scientific and engineering fields. By the evolution of evolutionary algorithms, cost factor has reduced dramatically. In this research paper, the initial step is the best location is selected across different locations according to best features present in the environment and then the best optimized path is finding out in the same region avoiding all obstacles on the way like trees, rivers, oceans, forests etc. This approach focused on finding Cross country path with the Hybridization of two most popular swarm intelligence algorithm's i.e. (firefly and Cuckoo). These two algorithms will help us finding the Cross country optimized path considering real world Impediments, which are often ignored in the process of making Robotic navigation system. As with the Capacity of firefly algorithm to detect Territories and attract towards interesting satellite image (with maximum information gain) out of Real time test data adding with the power of Cuckoo algorithm to use such Informational pixels in finding insight patterns of territories to find best area and locate best Cross country path which leads to the improvement in Robotic navigation for External vehicles. This would lead to better territory plotting, Impediment detection and escaping from unknown hurdles.

These algorithm are defined in using Path planning, Self-localization. Swarm intelligence (SI) is the discipline which has the collective behavior, and it is decentralized approach [1]. It is mainly concerned with the design of intelligent multi-agent systems. It inherits the collective behavior of social insects such as ants, bees, and bats, cuckoos, fireflies etc. Colonies of these insects govern their social behavior for a long time till up to the end of their life. Even the single members of the colonies are non-sophisticated individuals, but still they are able to achieve complex tasks with the cooperation and their behavior with each other. Their coordinated colony behavior rises from relatively simple actions or interactions. This helps in their daily to daily communication between the colonies individual members. They communicate with each other through their swarm behavior and find the best results to achieve the goal.

II. CONCEPTUAL DEFINITION AND DETAILS

A. *Satellite Image*

Information obtained from different satellites and sensors in the form of an image, which carries insights about undiscovered Territories. The digital data obtained from sensor carried in satellite, includes data which includes both in the visible and non-visible portions of the electromagnetic spectrum in image [2]. These spectrums hold insight to lay paths in the territories which provides details to discover paths for Map building and map interpretation.

B. *Feature Extraction*

Feature extraction is the property which has the tendency to extract the category of pixels in image and convert it into the land cover classes [3]. The data called multi spectral data are used to perform both the feature of extraction and spectral pattern. The spectral pattern extracts this data for each pixel. These pixels are counted on numerical basis for feature extraction. Therefore a different features type represents different forms of digital numbers on the basis of their inherent spectral reflectance and emittance properties. Features can be extracted in two ways from a multispectral data.

C. *Supervised Feature Extraction:*

In supervised feature extraction, the image expert called analyst verifies the pixel categorization process. In this, he verifies with the help of computing algorithm, numerical descriptors of various land cover types. The pixels in each data set are then compared to each category in interpretation key and it is labeled finally with the category of “looks most like”. The other strategies can be adopted that can be employed for comparison between unknown pixels, training set pixels.

D. *Unsupervised Feature Extraction*

In unsupervised approach the image data called training data set is extracted and converted into spectral groups or clusters on the basis of their behavior or some property.

III. FIREFLY ALGORITHM

This algorithm is based on the flashing behavior of the fireflies. With the increase of light intensity, the brightness of the firefly also increases [4]. This will in turn leads to an increased attractiveness to which other fireflies will be attracted. Then these will subdivide and the each individual group will swarm around. Firefly algorithm uses the following three standard rules:

- Fireflies are unisex. This means that one firefly will be attracted to other fireflies irrespective of their sex.
- The attractiveness of firefly is directly proportional to its brightness. These both factors decrease as their distance increases. As conclusion for any two flashing fireflies, the less bright one will move towards the brighter one. But if there is no brighter one than any particular one firefly, it will move randomly.
- The brightness of a firefly is measured from the objective function.

IV. CUCKOO ALGORITHM

Cuckoo search is a meta heuristic optimization algorithm which is based on the breeding behavior of birds. It is concerned with the life of cuckoo, how it lays her own egg on some other host nest. Specific breeding and egg laying techniques are used in the modeling process. The cuckoo lays her eggs on other host nest according to best selected host nest in particular area. These eggs now will get mature, but if that host nest found that these eggs is not belonging to its own nest then she simply throughout the egg or abandon the nest. The matured cuckoo will fly out and reach to the best area for survival. Some rules for cuckoo optimization algorithm [5]

- Preparation of cuckoo habitats and assignments of eggs in between them with aiming on objective function.
- Cuckoo will randomly and lays its egg on some host nest.
- If host nest discovers the egg not it's own then it will remove or abandon the nest.
- Now the eggs get mature and chicks will grow up. She allows the eggs to hatch and chicks grow up.
- Chicks will inherit the habitat from her parents of travel to the goal point for its survival up.

V. BAT ALGORITHM

Bat is also an optimization approach introduced by Xin-She-Yang in 2010 [6]. This algorithm is based on the varying pulse rate and loudness of micro bat due to its echolocation behavior. The amazing thing about BAT is, that it can search for the prey in the darkness with loudness factor. The details of Bat Algorithm with its parameters, applications, operations, are written as below: Echolocation of Micro bats, Frequency and velocity, Loudness and pulse rate. Some rules for standard bat algorithm [6]

- All bats fly randomly in particular area for the search of prey. Echolocation is being done in between them to sense the distance between the prey and some obstacle.
- Bats fly with some velocity v_i , frequency f_{\min} and wavelength λ in the given region at some particular position x_i with varying loudness A_0 in search of prey. The variation depends upon the proximity of target as close as the bat is reached to its prey the loudness gets decreasing.

VI. RELATED WORK

In this research work [7], the author claimed the influence three kinds of meta-heuristic algorithm such as Evolution, Ecology and Swarm Intelligence algorithms. These three categories of bio inspired algorithm has the common purpose to provide optimal solution from the population. This paper mentioned the goal to emphasis on the nature based algorithms with heuristic technique. They shows that the hard and complex problem can be solve by the heuristic techniques and can provide the optimal solution. In this research paper [4], the author discussed about the nature inspired algorithms. He discussed the invention of new firefly algorithm for multimodal optimization. He compared the results with particle swarm optimization. He has analyzed his work through the various factors of comparison such as attractiveness, distance and movement. This research work [6], introduced the new approach by combining the original bat algorithm with differential evolution strategies. Bat algorithm is a very powerful technique for finding the optimization path based on the echolocation behavior of micro bat. Differential evolution techniques also optimize the population of agents' solution and generate a new agent group by combining existing ones. Later on it compared which one is best suited for the optimization problem. In this research paper [8], the author introduced a new approach by hybridizing particle swarm intelligence and bee colony optimization to find the optimized path to detect the probability of terrorists. Obstacles identification is being done and avoided using morphological operations.

Finally, conclusion from above review, the technique of finding best optimized path is taken with hybrid approach of firefly and cuckoo. The compared results with consideration of various constrained parameters called factors like weather and communication and behavior. It's finally applied in cross country path planning and finding. The combination of Firefly and Cuckoo search has been implemented in almost every area optimization like selecting optimal solution in semantic web service composition, multilevel image thresholding, optimizing turning operation.

VII. METHODOLOGY

Image selection is one of important factor in improving Robotic navigation, so an image would be chosen among repositories of images. This Best Image retrieval process would be carried out by Echo locating different pixel values. The firefly algorithm uses the Image parameter to compute interesting patterns and then different images are compared the final chosen image is then input to the Cuckoo search algorithm for the objective to extract best path keeping obstacle avoidance in the process. Morphological operations are done at the intermediate stage for the identification of objects or boundaries within an image. Paths are obtained and obstacles are refined are refined with morphological operations. This is required to minimize the detection of shadows, trees and inconvenient areas across the region which provides the smooth image.

The final results are compared with earlier proved hybridization of BAT and cuckoo for same application. And check which one is better under various factors. This research focuses to extract best or optimum image with the help of hybridization of proposed hybridization of Firefly Algorithm and Cuckoo Algorithm. Now for extraction optimum image with most decisive parameters to lay cross country path while avoiding obstacles and other light on the area, an image chosen from the repository would be on the basis of parameters initiated as of the Firefly algorithm, the Firefly expects lights and echolocation as decisive parameters to finalize the candidate for optimum path finding in the territory. We will map the parameter of image with the mention parameter which will get maximum light extracted from the location and the best image will be fetched.

A. Content Based Image Retrieval

The satellite images is one, which when analyzed gives useful information to the human users. While analyzing, there are still certain difficulties to gather the data in correct way. Certain images does not exhibit any information regarding path, so to facilitate the process few known parameters are Searched over selected image by using firefly capability to find the best location and communicate the other flies and quantify best out of repository.

B. Morphological operations

Morphology is used to process the image with respect to different shapes and topological differences, in the process each pixel is compared with its neighbors to decide semantic of information which helps us in constructing better pixel understanding as it related vague pixels to distinct paths by laying a well-connected path between neighbor pixels. Paths and obstacles were extracted and observed that there are some isolated white pixels that correspond to trees ,shadows etc. and paths are refined using morphological operations [9].

C. Computing threshold value

In the process we need boundaries or some ways to detect objects in the image , so we evaluate the threshold values, we create random agents which acts as an host Nest for Cuckoo search these nests are then scanned with their Corresponding areas are assigned to them from the image. Every Nest is then scanned from the image to choose a best host nest. Now the most suitable candidate nests will be used to find the optimum solution and optimal path.

D. Comparison of Factors

The three basic algorithms are based on their behavior like Bat is based on echolocation of other micro bats on the basis of loudness and wavelength. And if we compare with firefly, it has the behavior to attract to other fireflies on the basis of its light. The third algorithm cuckoo search is attracted towards the other host birds on the basis of laying its own eggs in their nests. But the other factors which affect their natural behavior will be considered like weather conditions, mode of communication and their producer and consumer behavior which affects the system. The other factors can be elaborated as:

- 1) *Weather:* Weather conditions is taken up as comparison factor between the combination of Firefly and cuckoo and Bat and Cuckoo as science proved that Weather conditions like summer, winter, moisture, humidity effects the BAT and firefly.
- 2) *Communication:* Firefly has the behavior to attract to other fireflies by the brightness of each other. The firefly with more brightness, the maximum communication will be done towards it. It is the flashing behavior of them. In all words the attractiveness term is defined which is directly proportional to its brightness. Attractiveness β of a firefly is determined by its brightness or light intensity I , which is turn, is proportional to the value of objective function i.e.

$$I(x) \propto f(x)$$

But if Bat uses echolocation for communication with each other and to sense the distance and they also 'know' the difference between food/prey and background barriers in some magical way. Bats fly randomly with velocity v_i at position x_i With a fixed frequency f_{min} , varying wavelength λ and loudness A_0 to search for prey. They can automatically adjust the wavelength (or frequency) of their emitted pulses and adjust the rate of pulse emission r in the range of $[0, 1]$, depending on the proximity of their target.

- 3) *Producers and consumers:* Firefly are the producers of light. They produced light as hundred percent but not heat. As compared to an incandescent bulb, it emits 10 percent of energy as light and the rest as heat, or a fluorescent bulb, which emits 90 percent of its energy as light. So firefly produces no heat, scientists mean the firefly lights as cold lights. BATS consume thousands of insects each hour which helps in keeping environment clean. They are fond of birds, lizards and rats. They can spot insects from far off places. It is concluded if there were no BATS then there would be insects everywhere and mice.

E. FLOWCHART

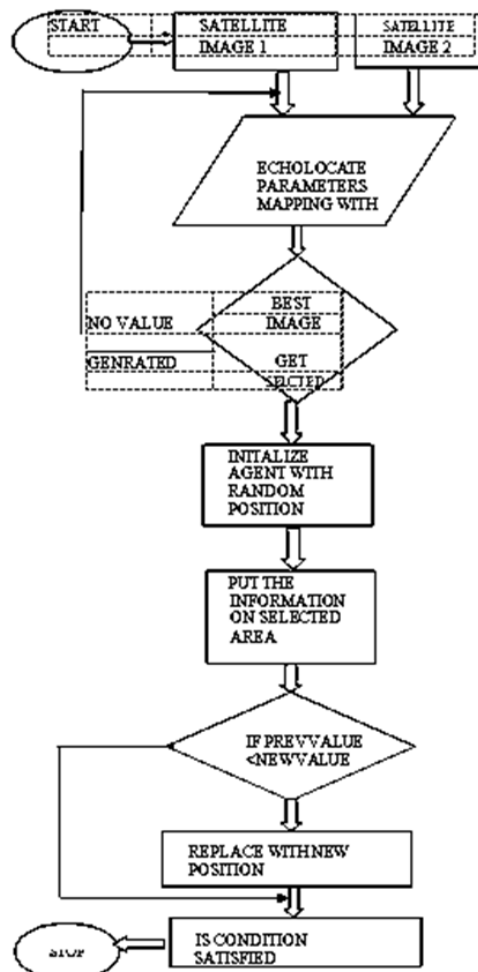


Figure1: Flowchart of proposed algorithm

F. Pseudo code of the algorithm

- Initialize an array with set of satellite images.
- For i in $1 \dots n$ loop.
- For each assign firefly echolocation light patterns to final best or interesting for Cross country path.
- Select a best solution among them and generate a image.
- Now selected image will be the input to cuckoo algorithm.
- Generate initial population of host nest $F(x)(1 \dots n)$
- While($t < \text{maxgeneration}$)
Stop.
- Get a cuckoo randomly allocated by levy flight.
- Choose host nest
- If $f_{\text{nest}} > \text{secnest}$ Then
Replace j by new solution
- Fraction worst nest will be abandon.
- Keep the best solution Rank the solution
- Finally dynamic changes in the map generated will be updated Self –Localization
End while End
- Finally comparison of results will be done with the hybridization of BAT and Firefly Algorithm.

VIII. CONCLUSION AND FUTURE SCOPE

The proposed hybridization algorithm will aim to search unknown territories in order to find best path while providing Robotic navigations to external vehicles. As the proposed algorithm is derived from the Firefly and cuckoo search algorithm and it extracts the best path. This best path is used for Retrieving best image from the pool of satellite images so this reduces the overhead of traversing noisy images and also makes process more efficient. Further such chosen Image is processed through Cuckoo search to compute threshold values which are then compared over neighboring pixels. This helps in Generating maps. These maps are then dynamically updated using Self- Localization method which gives result in optimized path in one region.

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