Bacterial Foraging Algorithm for Oil Spilling in Marine

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ABSTRACT

The world has become more and more dependent upon oil based products, derived from petroleum. Large volume of oil is stored and transported through water transport. Sometimes in transport, oils are spilled onto level or in water. Spillage of oil can seriously affect the marine environment as a result of physical challenges and toxic effects. When an oil spill occurs the damage may be limited and extend over a small area or be extensive and encompass a large area. In all of these situations, it is important for scientists, citizens and government officials to know what to expect and what action need to be taken when spills occur.

Bacterial Foraging Optimization Algorithm is considered for solving the problem of oil spillage in marine. The proposed work focuses on remotely locating the spill areas in marine with the use of automatic robotic swarms termed as Aquaboats. These aquaboats are supposed to enter the sea or ocean and tend to move randomly over the area to locate the spill. And once the spill got in contact with the boundary of aquaboats, it stops and corresponding results are tabulated

Keywords

Marine, Aquaboats, Bacterial Foraging Optimization, Oil Spilling

1. INTRODUCTION

Since it is described that, problem solution which is inspired by the collective behavior of swarms is defined as swarm intelligence [1]. Thus, such an intelligent and autonomous systems are required that are able to solve complex tasks with self-organizing nodes that are not having central control (means distributed approach).

Swarms are broadly categorized into:

1. Ants
2. Honey bees
3. Termites
4. Particle
5. Bacteria

Since there are number of problems that are required to be solved by the approximation methods despite of calculations. These approximated results are very much near to the actual results. But these results help that very problem to be under knowledge and control.There are so many such fields in which approximations are to be made example: robotics, networking etc. Similarly, this paper describes you the problem in marine application and its possible solution by using Bacterial Foraging Optimization Algorithm (BFO).

2. BACKGROUND

Swarm intelligence is the wider means for solving problems that having their behaviour same as that of social animal societies like, ants, bees, birds, bacteria.

These are valuable source for designing intelligent systems comprising many agents.

3. PROBLEM DOMAIN

Oil pollution arising either from machine accidents or from routine ship operations is one of the major problems that threaten the equilibrium of the marine environment. They cause both economical and ecological damage.

Some efforts that are made so as to cleanup this pollution, costs billions of dollars. Thus it is supposed to have implementation of this work that could be beneficial in terms of monetory and timely aspects.
It's difficult task to go into the sea/ ocean and locate the actual area where the spillage has occurred. It will help to remotely locate the area first by sitting at one shore of the sea. And after getting location, one can easily undergo the cleaning process.

As 71% of the earth surface is covered with water. And water is the most essential element for life. Keeping in mind the importance of water, if it is to be noticed for now days. Then definitely one comes to the point of pollution. There are so many causes by which the water is being polluted. Some of them are throwing wastes into water bodies, contact of water bodies with industrial outlets, residue after burning, and several other direct or indirect reasons. One of the major causes is export of oil which is being carried out from under the water bodies. Though it is a means of earning, but probably is responsible for the water pollution. Due to several accidents, or at source site during pouring of oil, or at destination during receiving of oil, there might be some leakages that may occur. The present work focuses on the same oil spills that are very common over the water surface. Since it is very well known that oil is lighter than water, thus oil floats over the surface of water. There are several means and tools to extract out the oil from the water surface. The area of concern is moving into the water without knowing where oil is actually locating is useless. In fact it will consume lot of time. It could be well termed as wastage of time to enter into water without having prior knowledge of the target location.

3.1 Bacterial Foraging Optimization

Bacterial Foraging Optimization algorithm is a kind of evolutionary computation algorithm. It is based on the foraging behavior of Escherichia Coli (E. coli) bacteria that resides in human intestine. This method is used for locating, handling and ingesting the food in the intestine. During its foraging phase, it can exhibit two different states: tumbling or swimming. The modification in the orientation of the bacterium is due to the fact of tumbling action possessed by the bacterium. And the swimming action is responsible for the movement of the bacterium in the current direction. After a certain number of complete swims, the best half of the population undergoes the reproduction and eliminating the rest of the population. In order to escape local optima, an elimination- dispersion event is carried out where some bacteria are liquidated at random with a very small probability and the new replacements are initialized at random locations of the search space.[1]

Parameters of BFO:-

P: Dimension of the search space,

S: Total number of bacteria in a population,

Nc: The number of chemotactic steps,

Ns: The swimming length,

Nre: The number of reproduction steps,

Ned: The number of elimination-dispersal events,

Ped: Elimination-dispersal probability,

C(i):The size of the step taken in the random direction specified by the tumble.

3.2 Flowchart

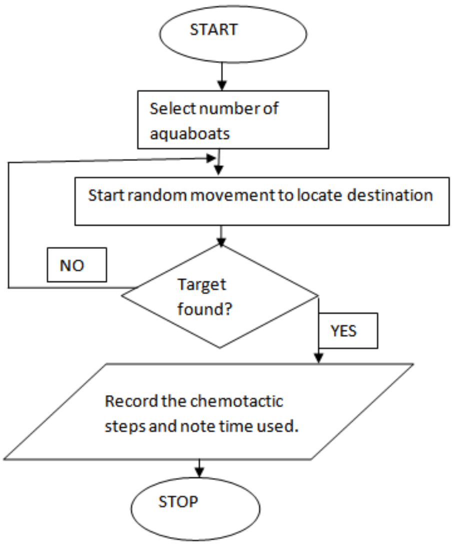

Fig: 1 Flowchart

The above flowchart is showing a user-interface screen in which, the user first have to select number of acquaboats. After selection, the boats tend to move in a random direction as they are influenced by the bacterial behavior. They tend to locate the destination (that is oil leakage). Once they found the target, they will stop and corresponding time taken and steps used by that aquaboat agent are displayed over the screen. Otherwise they tend to continue with the same randomness.

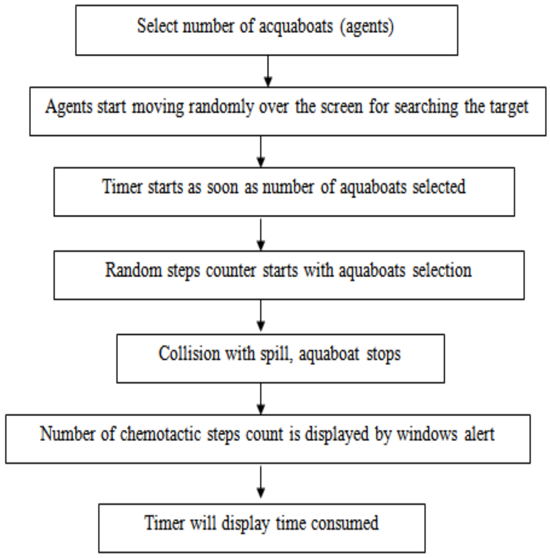

Fig: 2 Diagramatic Representation

4. EXPERIMENTS AND ANALYSIS OF RESULTS

Taking all constraints into account, the outcomes were reasonably good. The research clearly demonstrated the development process of acquaboats and their implementation in bacterial swarms to accomplish the task of search operation. The Aquaboats were capable of moving randomly and all the aim and objectives mentioned were achieved. Several experiments were conducted to demonstrate the capabilities of Acquaboats to locate the target object by avoiding the obstacles in their path. When the acquaboats were implemented in swarm to optimize the group size, it was found that two Acquaboats were appropriate and resulted in minimal time to locate the target object.

Several experiments were conducted in order to find the chemotactic steps required completing the operation. First of all several experiments were conducted with the help of only one acquaboat and then results are tabulated in the table, an average value is taken for the convenience. The outcomes of those respective operations are tabulated as below:-

Table 1. Steps Count for one agent

Experimen t no.	No. of Acquaboats	Chemotactic steps used
1	1	1
2	1	10
3	1	10
4	1	11

Average no of chemotactic steps used by one acquaboat = 8

Table 2. Steps Count for two agents

Experiment no.	No. of Acquaboats	Chemotactic steps used
1	2	6,10
2	2	6,22
3	2	4,14
4	2	6,28

Average no of chemotactic steps used by two acquaboats = 5.5, 18.5

Table 3. Steps Count for three agents

Experiment no.	No. of Acquaboats	Chemotactic steps used
1	3	6,24,36
2	3	15,23,45
3	3	21,23,29
4	3	21,27,41

Average no of chemotactic steps used by three acquaboats = 15.7, 24.2, 37.7

Further several experiments in order to get the timings taken by the same chemotactic steps to complete are tabulated in the following table as given below:-

Table 4. **Time Consumption by different number of agents**

Experiment no	No. of Aquaboats	Time used(secs)
1	1	57
2	2	49
3	3	61

The above tabulated results show that the time is varying with the use of number of acquaboats. Since the area in which these acquaboats are sent of locating the oil spillage is restricted. The above results are very much satisfactory. This is due to the fact that the time taken by the aquaboats is in terms of seconds.

The results of the time required for the respective number of aquaboats is shown in the form of column chart as shown below:-

Table 5. Comparison Matrices of ACO versus BFO

Algorithm used	Number of Agents used	Time required to complete the operation
ACO	1	2.64 min
ACO	2	1.54 min
ACO	3	2.21 min
BFO	1	57 sec
BFO	2	49 sec
BFO	3	61 sec

4.1 Graphical Representation

The following is the given the graphical representation of the experimental results of the implemented algorithm. The x-axis is representing the number of acquaboats being taken at a time and that of the corresponding column gives you the time taken by the same in order to complete the following operation.

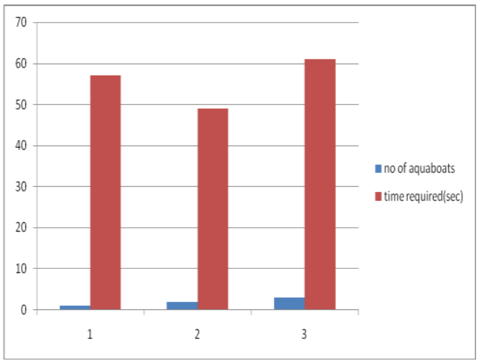

Figure 1. Graph representing the outcomes of the implementation with BFO

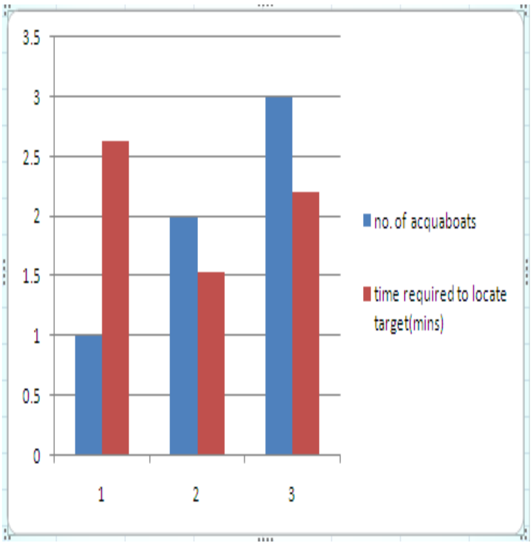

Figure 2. Graph representing the outcomes with ACO

After the study of graph we come across that with the use of BFO algorithm concept, we are now with better results. The ACO was consuming time in terms of minutes while in BFO we are consuming with seconds only.

5. CONCLUSION

The conclusion deduced from the above experimental results explains that when one agent is sent for the operation to be performed. It takes time. And in comparison to the same if two agents are sent for the same operation, they will take little less time. This is due to the fact that with the increase in number of agents, the work is almost reduced and is distributed among several agents thus the time used is reduced. And when the number of agents is still increased in number then there is problem of complexity within the same specified area. Since the complexity factor increases, thus the time required for the same operation will also be increased to some extent. And if taking the experimental results of the same when it was implements with the help of ACO (Ant Colony Optimization Algorithm), it is being noticed that BFO algorithm implementation is showing better results.

6. FUTURE SCOPE

Since every work requires amendment with due course of time, thus taking into account the lacking points of this work that could be made even better in future may include elimination of problem of inertia, that is when an aquaboat stops at one position it takes a second or two to stop from its motion state. And one more future term work lies in making a remembering unit that could hold the values of the aquaboats that to which locations they have already searched, they may not leave for those in upcoming trails.

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