An Efficient Routing Algorithm for Lifetime Enhancement in Wireless Sensor Network using Artificial Bee Colony Algorithm

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Abstract— ***As technology emerges over the decades, WSN has come to the limelight for its unattained potential and significance. A natural disaster scenario is highly convoluted and vibrant. Communications systems are most likely to be damaged in disaster scenarios. Our main objective is to provide technological solutions for managing disaster using wireless sensor networks (WSN) via disaster detection and alert for the immediate rescue operation for significant improvement of disaster management. Artificial Bee Colony (ABC) Algorithm is used for maintaining connectivity even in disaster conditions. We also analyze the WSN protocol based on metrics such as Energy efficiency, throughput, end to end delay, network lifetime. NS2 simulator is proposed for simulation.***

Keywords— *Disaster Prediction, Wireless Sensor Networks, Disaster Management, Artificial Bee Colony algorithm, Optimization, Throughput, End to End Delay, Network Lifetime, NS2 Simulator etc.*

I. INTRODUCTION

The natural disasters usually occur abruptly and suddenly, resulting in loss of life as well as harsh damage to property and the surrounding environment. Therefore, it is important to execute effective emergency plans to tackle natural disasters. Rescue team should take action rapidly in order to reduce further risk and losses in disaster response scenarios. Cataclysmic natural disasters such as earthquake, flood, hurricane, typhoon, tsunami, landslide, etc the world are experienced in recent years. Emergency communication modules in large-scale disaster struck areas is deployed by using wireless ad-hoc networks which requires no centralized networks.

In most real-time exploitation solutions, they demand self-organizing capabilities to keep track of the vibrant domain. The main benefits of such a configuration is the spatial multiplicity they provide, enabling applications such as target detection & tracking as it moves throughout the sensor field; for a wide variety of applications such as surveillance, precision agriculture, smart homes, automation, vehicular traffic management, habitat monitoring, disaster detection, smart grids, etc [1]. Bio-inspired ethics have found their way into Wireless Sensor Network R & D due to the pleasing analogies between biological systems and large network. The dynamics of many biological systems and the laws governing them are based on a surprisingly small number of simple rules, yielding concerted & effective mechanisms for resource management, task allocation, and synchronization with no any central controlling element.

Swarm Intelligence systems are typically made up of a population of self-organized individuals interacting locally with one another and with their surroundings. Although there is normally no centralized control structure dictating how each individual should behave, local interactions between all individuals often lead to the emergence of global behaviour [20]. Artificial Bee Colony Algorithms give simple solutions to WSN Deployment problems is one such. Characteristic of Biological system:

- Adaptive to the changing environmental circumstances.
- Capable to resolve difficult actions even if the task is not clearly defined.
- Able to learn, adapt and take an action when needed.
- Able to self organize in completely distributed manner.

Many natural systems of the most creatures in the world are very rich topics for the scientific researchers and developers. However, a simple individual behaviour can collaborate to create a system able to solve a real complex problem and perform very sophisticated tasks. In real scenario there are many patterns of such systems like ant colonies, bird flocking, fish shoaling, animal herding, bacterial growth, bee colonies, swarm intelligence and human neuron system.

Connectivity issue in disaster conditions can also be observed as topology problem. In Topology problems objective is to find optimal topology to optimize several parameters. The use of NS-2 to evaluate the fitness function is very interesting since it allows the designer to model the communication layers and the signal propagation models. The implemented topology control was able to calculate the suitable node's coverage area to minimize the energy consumption and enhance network lifetime. The network simulator NS-2 is useful to model the communication layers of ad hoc network [19].
This paper is organized as follows. The proposed approach to solve the connectivity problem is in Part II. In Part III, the paper describes the implementation of the Artificial Bee Colony algorithm. The simulation results are presented in Part IV. Finally, conclusion and future aspects are in Part V.

II. PROPOSED APPROACH

Due to the complexity of the problem and the number of parameters to be considered, an Artificial Bee Colony algorithm combined with the network simulator NS-2 is proposed for managing a disaster. Artificial Bee Colony (ABC) algorithm is subset of swarm intelligence algorithm. It is widely used by researcher and academics in order to replicate both wired and wireless networks. NS-2 is used for evaluating fitness function. Bonn motion is liberally available mobility generator. A flowchart of artificial bee colony (ABC) system has been proposed an algorithm as seen below in Fig. 2. This paper proposes a new optimization algorithm that uses the honey bee behavior in food forging as the functions to be used by the processing engine. In the following subsections present these two scenarios:

- The Behaviour of Scout Scenario
- The Behaviour of Forger Scenario

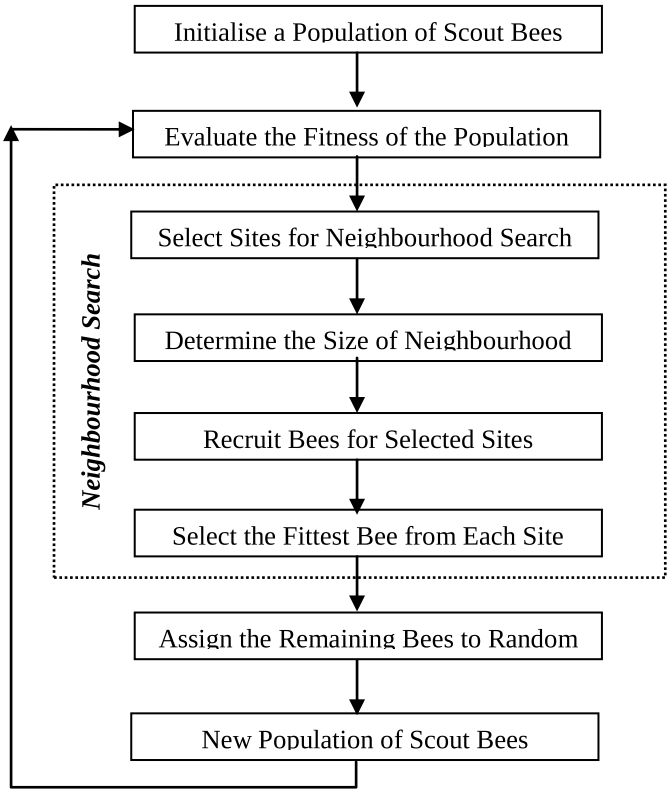

Fig -1: Flow Chart of ABC Algorithm.

III. ARTIFICIAL BEE COLONY (ABC) ALGORITHM IMPLEMENTATION

There is a trend in the scientific community to model and solve complex optimization problems by employing natural metaphors. This is done mainly due to inefficiency of traditional optimization algorithms in solving larger scale combinatorial and/or highly non-linear problems. A given problem is modeled in such a way that a conventional algorithm like simplex algorithm can manage it. This generally requires making several assumptions which might not be easy to authenticate in many situations. In order to overcome these limitations more flexible and adaptable general purpose algorithms are needed. Based on this motivation many nature inspired algorithms were developed in the literature like genetic algorithms, simulated annealing and taboo search. This algorithms can provide far better solutions in comparison to conventional algorithms. Ant colony optimization, firefly optimization, particle swarm optimization, swap nets etc. are some of the well known algorithms that mimic insect behavior in problem modeling and solution. Some of the essential merits of bio-inspired approaches are:

- Flexibility
- Scalability

- Performance
- Flexibility in decision making
- Enhancement scope and novelty

Artificial Bee Colony (ABC) is a relatively very new member of swarm intelligence. Artificial Bee Colony (ABC) tries to mold natural behavior of real honey bees in food foraging. Honey bees use several mechanisms like waggle dance to optimally locate food sources and to search new ones. It has been found that Artificial Bee Colony (ABC) is a exceptional kind of optimization technique having characterization of Swarm Intelligence which is highly suitable for finding the adaptive routing for such type of networks. Artificial Bee Colony (ABC) is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. ABC is used because they are more strong, consistent, and scalable than other conventional routing algorithms.

Each bee at the low-level component works through a swarm at the global level of component to form a system. Thus, the system global behaviour is determined from it is individual's local behaviour where the different interactions and coordination among individuals lead to an organized teamwork system. This system is characterized by the interacting collective behaviour through labour division, distributed simultaneous task performance, specialized individuals, and self-organization.

The formation of a tuned collective knowledge is lead by exchanging of information among bees. A colony of honey bees consists of a queen, many drones (males) and thousands of workers (non- reproductive females). The queen's job is to lay offspring and to start new colonies. The one and only one function of the drones is to mate with the queen and during the fall they are ejected from the colony. The worker bees build honeycomb, and they lead to clean the colony, feed the queen and drones, guard the colony, and collect food.

As nectar is the bees' energy source, scout bees and forager bees are two kinds of worker bees which are responsible for food. A bee does many things in its life history, and does not become a scout/work bee until late in its life [3]. While scout bees carry out the searching process, forager bees control the management process. However, searching and utilization processes must be carried out together by the colony's explorers and colony's exploiters. As the increase in the number of scouts encourages the searching process, the increase of foragers encourages the utilization and management process.

Studying the foraging behaviour leads to optimal foraging theory that directs activities towards achieving goals [4]. This hypothesis states that organisms forage in such a way as to maximize their intake energy per unit time [4]. In other words, the swarm of bees behaves to find and capture the food that containing the most energy while expending the possible smallest amount of time in real variables. There are two forms of scenarios readily available for any bee in forging process which is either scout or forager.

Movement of the Scouts

- The movement of the scout bees follows equation.

$$\theta_{ij} = \theta_{j\min} + r \cdot \left(\theta_{j\max} - \theta_{j\min}\right)$$

  - r : A random number and $r \in [0,1]$

Movement of the Onlookers

- Probability of Selecting a nectar source:

$$P_i = \frac{F(\theta_i)}{\sum_{k=1}^{S} F(\theta_k)}$$

P_i : Probability of selecting the i^{th} employed bee
S : Number of employed bees
θ_i : Position of the i^{th} employed bee
$F(\theta_i)$: Fitness value

Movement of the Forgers

- Calculation of the new position:

$$x_{ij}(t+1) = \theta_{ij}(t) + \phi\left(\theta_{ij}(t) - \theta_{kj}(t)\right)$$

x_i : Position of the onlooker bee

t : Iteration number

θ_k : Randomly chosen employed bee.

j : Dimension of the solution

$\phi(\bullet)$: A series of random variable in the range [-1,1]

IV. SIMULATION SETUP AND RESULTS

The experiments for the evaluation of the proposed scheme have been carried out using the network simulator *ns-2.* For this we have used Dynamic Source Routing (DSR) routing protocol and consider various number of nodes like 20,40,60,80,100. The scenarios developed to carry out the using these parameters (i) Throughput Vs. Number of Sensors (ii) End Delay Vs. Number of Sensors (iii) Energy Consumption Vs. Number of Sensors. From all these result we are able to analyzed effectiveness of proposed method. Finally compare the performances of DSR/ABCDSR/EABCDSR. Network Scenario will be as follows:

Parameters	Values
Number of Sensor Nodes	220
Traffic Patterns	CBR
Network Size	2000 X 2000
Mobility Speed	1 m/s
Simulation Time	40/50/60/70/80 s
Transmission Packet Rate Time	10 m/s
Pause Time	1.0s
Routing Protocol	DSR/ABCDSR/EABCDSR
MAC Protocol	802.11
Transmission Protocol	UDP
Number of Flows	10

Table No -1: Network Scenario

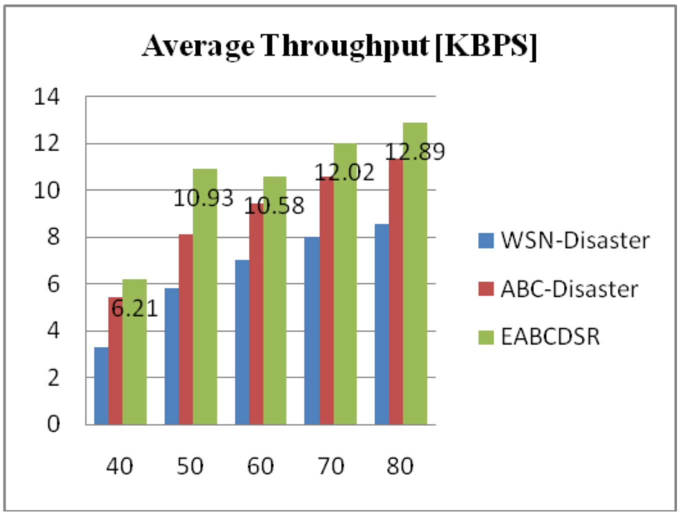

Fig -2: Average Throughput

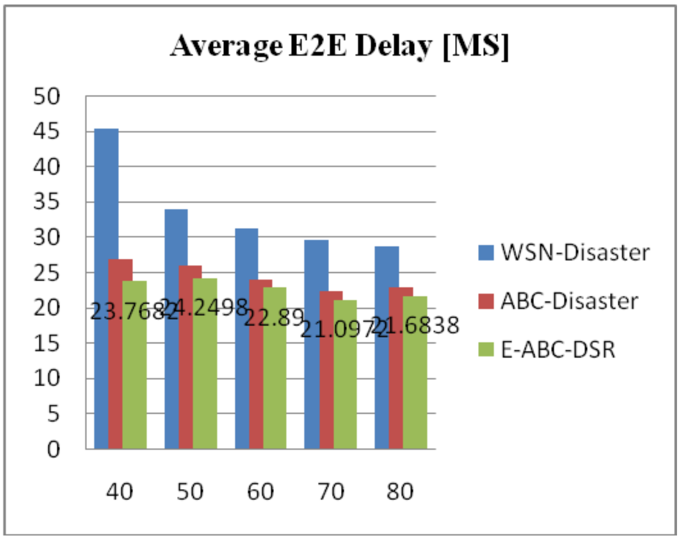

Fig -3: Average E2E Delay

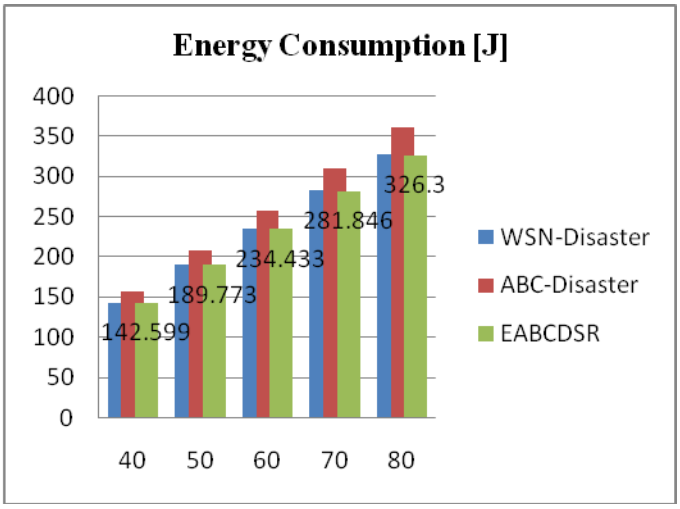

Fig -4: Total Energy Consumption

V. CONCLUSION

In this paper we have conducted a NS2 based simulation study to investigate the performance of proposed method by using DSR protocol. In wireless sensor networks where nodes operate on limited battery energy efficient utilization of the energy is very important. Network lifetime is highly related to the route selection is one of the main distinctiveness of these networks. We proposed an Artificial Bee Colony algorithm with some modifications. After implementation of this approach we got result of various parameters performance of wireless sensor network are stringently enhanced. We need to reanalyze some of these techniques to present more efficiency to network changes and external factors which could affect our approach such as node mobility, obstacles and other issues while implementing these techniques.

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