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An Algorithm to Depreciate the Energy Utilization using Bio-Inspired method in Wireless Sensor Network

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Abstract
Wireless Sensor Network is an autonomoustechnology emanating in current scenario at a fast pace. This technology faces a number of defiance's and energy management is one of them, which has a huge impact on the network lifetime. To sustain energy the different types of routing protocols have been flourished. The classical routing protocols are no more compatible to perform in complicated environments. Hence, in the field of routing the intelligent algorithms based on nature systems is a turning point in Wireless Sensor Network. These nature based algorithms are quite efficient to handle the challenges of the WSN as they are capable to achieve local and global best optimization solutions for the complex environments. So, the main attention of this paper is to develop a routing algorithm based on some swarm intelligent technique to enhance the performance of Wireless Sensor Network.

Keywords
WSN, Routing, Bio-inspired algorithms, MPRSO, LEACH

I. Introduction

Wireless sensor networks (WSN) consist of a group of nodes working in a co-ordination to accomplish the desired task. These nodes are efficient enough to manipulate the physical parameters (temperature, pressure, humidity etc.) into another form. Sensor nodes are skilled to carry the functioning of sensing, aggregating and transmitting the information. WSN are widely associated with numerous applications such as military and medical applications, in defence systems, crisis management etc. [1]. WSN suffers from the various issues like node deployment, reliability, energy consumption, fault tolerance etc. [2]. These networks are having limited energy, restricted storage and transmission capabilities so it is essential to balance these factors in order to have a proficient Wireless Sensor Network. Energy regulation is a main task for these networks as it further improves the network lifetime.

To make a network adequate and productive number of routing algorithms has been evolved. As the classical routing techniques lead to complexity, so researchers are exploring swarm intelligence techniques [3]. These SI (Swarm Intelligence) algorithms are broadly in use for the distinct applications. The United States military forces are inspecting swarm intelligent algorithms for governing unmanned vehicles [4]. For interferometry and self-gathering the European Space Agency (ESA) is formulating an idea for the orbital swarm. NASA is building up a thought to adapt the swarm techniques in planetary mapping. The researchers are in the urge to use these swarm methods against the deadly diseases like cancer or to detect the tumors. The various techniques of the swarm intelligence are there and some important of them are described in the paper.

Consequently section II talks about the essential Bio-inspired algorithms. The related work on different parameter of WSN is examined in section III. The closed issue is planned in section IV and the thought to moderate the characterized issue has been proposed in section V took after by conclusion in section VI.

II. Bio-Inspired Algorithms

A. Ant colony optimization

The Ant Colony algorithm relies on the behavior of ants finding food in an area. This algorithm is used for obtaining optimal paths in the network [5]. At the beginning the ants move randomly in a search area. When they found food, the ants moves back to the colony, leaving "markers" which can also be named as pheromones. These markers show the path that has food. When other ants come across these pheromone marks they tend to follow that path with some probability. The ants start following each other and form a chain one after another and populate the path with their own marks while bringing food back. This path gets stronger and stronger with the increase in the number of ants following the same path. After some time the pheromone starts depleting, hence on the longer path the solution may get evaporated from some areas which is not in the case of shortest path so shorter paths are more likely to be chosen. This similar approach is used to find near optimal solutions to the travelling salesman problem [6].

B. Artificial Bee Colony Optimization

The Artificial Bee Colony Optimization algorithm is an algorithm having its roots in the artificial intelligence algorithm. This algorithm is galvanized by the intelligent foraging action of honey bees. The algorithm comprised of three bee groups and food sources. The location of a food source indicates a feasible solution to the optimization issue and the quality is denoted by the nectar amount of a food source either we can declare it as a fitness of the affiliated solution. The three kinds of bees are there and these are named as scouts, onlookers and the employed bees [7]. The Scout is a bee which executes a random search. The employed bee is the bee which is moving towards the source of food, explored by it earlier. The onlooker bee waits on dance area. There is a bee which is known as unemployed bee and it is composed of both onlooker bee and scout bee. The advantages of employing this technique are it has to control few parameters i.e. size of population , restricted and maximum cycle numbers and it is easy to use this algorithm with other algorithms.

C. Genetic Algorithm

The Genetic algorithm is based on the concept of the Darwin principles of biological evolution, reproduction and the survival of the fittest. The population comprised of a group of strings named as chromosomes, the chromosome represents distinct points in the search space. The real numbers or the binary numbers are used to represent the chromosome. The morality of each chromosome is evaluated on the basis of objective function or the fitness function.

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At the start, the initial population is originated randomly. New populations are generated in consecutive generations by using the four elementary mechanisms, i.e. selection, crossover, repair and mutation operators [8]. The selection mechanism performs the function of selecting individuals for crossover and mutation mechanisms. Crossover mechanism carries the interchange of genetic characteristics between parents for the offspring and mutation assimilates new genetic attributes in the offspring. GA manages this population and updates it regularly to create a new generation. This procedure is re-occurred again and again until convergence or a large number of generations are accessed.

D. Particle Swarm Optimization

A Particle Swarm intelligence technique is described on the concept of the cooperative behavior of self - governing and decentralized mechanisms such as bird flocking and fish schooling [9]. They are composed of interacting agents systemized in compact societies named as swarms, which are capable of making decisions and handles the environmental threats efficiently. PSO is a population based search strategy in which particles known as individuals change their location with respect to time. In this process, particles moves around in a multidimensional search area. During this mechanism, each particle remembers its own experience, and the experience of a neighboring particle to adapt its position by considering the best position encountered in it. Both the local solution and the global solution methods are carried out in the algorithms like PSO. The main pros of this technique are to adjust few parameters and it accommodates the global search with higher proficiency.

III. Related Work

On the basis of various performance metrics of WSN, the researchers have following related work.

Jennifer Yick et al., [10] discussed the survey of the WSN including its types and different types of applications. A wireless sensor network has important applications such as remote environmental monitoring and target tracking. The design of a WSN depends significantly on the application, and it must consider factors such as the environment, the application's design objectives, cost, hardware, and system constraints. In this paper the author describes the problems into three different categories: (1) internal platform and underlying operating system, (2) communication protocol stack, and (3) network services, provisioning, and deployment. Hence author summarized and compared different proposed designs, algorithms, protocols, service and also highlighted possible improvements and research in each area.

Stefanos A. Nikolidakis et al., [11] proposedanenergy efficient routing protocol called Equalized Cluster Head Election Routing Protocol (ECHERP) in wireless sensor networks for energy conservation through balanced clustering. The wireless sensor networks have limited energy constraints of the individual sensor nodes. WSN focuses on the development of energy efficient routing protocols. The proposed protocol allows new nodes to be added to the system and automatically adjusts its behavior based on the dying nodes and the signal-to-noise interference. The ECHERP also adopts a multi-hop routing scheme to transfer fused data to the base station. The simulation result indicates that ECHERP outperforms several previously proposed protocols, namely LEACH, PEGASIS and BCDCP.

Runwei Zhang et al., [12] proposed a new scheme known as virtually moving the BSs. The Moving BSs addresses the energy-hole problem, as it increases the degree of freedom for evenly distributing the energy consumption in the WSN. The properly scheduled movements of BSs can greatly improve the energy efficiency of the WSN. The existing approaches exploiting BS mobility have a major drawback because they make BSs physically move and require BSs to have additional implements for mobility. The practical implementations of these approaches are complicated and costly. To overcome these drawbacks virtual moving BS algorithm is introduced, in which an excessive number of BSs are deployed and an active subset of BSs is adaptively re-selected.

Farzad Kiani et al., [13]proposed an intelligent routing protocol algorithm to reach energy efficiency. In proposed protocol a new clustering method is applied to the network and is established using a connected graph. The network performance is enhanced by using an intelligent algorithm. It manages the system overhead by means of CH selection. In the proposed method, all the sensor nodes can be CH node. They are chosen by a machine learning technique. This method saves energy in the whole network. The most important feature of the algorithm is routing mechanism and the paths detection. Another important feature of FTIEE was fault tolerance. From simulation results found that proposed protocol has improvement in different parameters such as network lifetime, packet delivery, packet delay, and network balance.

Nizar Hadi Abbas at al., [14] a novel idea has been developed for lengthening the lifespan of WSNs. The proposed algorithm is based on nature inspired algorithm such as particle swarm optimization (PSO) and ant colony optimization (ACO). PSO is altered based on inertial weight and the acceleration and then this extended version of PSO is put onto comparison with ACO. The results, determines that the MPSO is faster than ACO because the update of the parameters is faster in MPSO. The simulation results show that the presented approach for power minimization is faster than the previous works by 10 times and network lifetime may get raises by 8 times. Therefore, better efficiency is obtained by using this modified version throughout the whole network.

IV. Problem Formulation

In Wireless Sensor Network transmission consumes more energy than processing. Since, the nodes have limited energy resource it is important to manage and facilitate the energy throughout the network. To carry out the data transmission we need an accurate route with nodes having sufficient amount of energy. To enhance the performance, nodes always maintain some connectivity with each other till the process finishes off. But at the time of delivering packets the nodes may get impaired, which causes an obstruction in sensor network. The node get useless due to factors like tightened energy resource, physical changes, failure in the software or mishandling etc. resulting into degrading the performance of the WSN.

V. Proposed Technique

For the solution to this drawback we proposed an idea to obtain the route with a maximum energy resource using the swarm intelligent technique to diminish the energy usage, resulting in extending the lifetime of the network.Firstly, we assumed sensing area of 100*100 dimensions and which is further divided into 3*3 rows and columns forming blocks of the sensing region. Each block contains equal amount of nodes and these nodes are immobile. The position of the source and destination are fixed in the block 1 and block 9 respectively and each node is provided with some initial

energy value. The exchange of information would be in between source and destination and it is compulsory that the route enters into each block and pick out a node from each block. At the beginning there is a generation of initial population, which provides the set of routes randomly between source to destination. The energy of each route is aggregated i.e. the energy of each node in each block is summed up and the fitness function is evaluated on the basis of highest energy value retrieved by any route. Hence, the initial solution is achieved. To have best route, iterations are performed with MRPSO technique which updates the parameters of the initial population. This would create new routes with updation and if updated route energy is greater than the previous energy value gained by the initial population, then saves the results otherwise turn to next iteration. Upgrading the initial population Position best (Pbest) solutions are obtained and all these solutions are further taken into account for achieving global best (gbest). The gbest is the route having maximum energy and is the final route for the transmission. Up to this the process of optimization is used to get the optimized route between source to destination further routing is carried out for the data transmission. All the initial energy parameters are assigned and iterations are carried out to transmit the data packets. The node would be declared dead when the energy of the node becomes equal to or less than zero and the iteration where the first node dies out is evaluated. The proposed technique minimizes the energy consumption and prolongs the lifetime. The network scenario is shown in fig. 1.

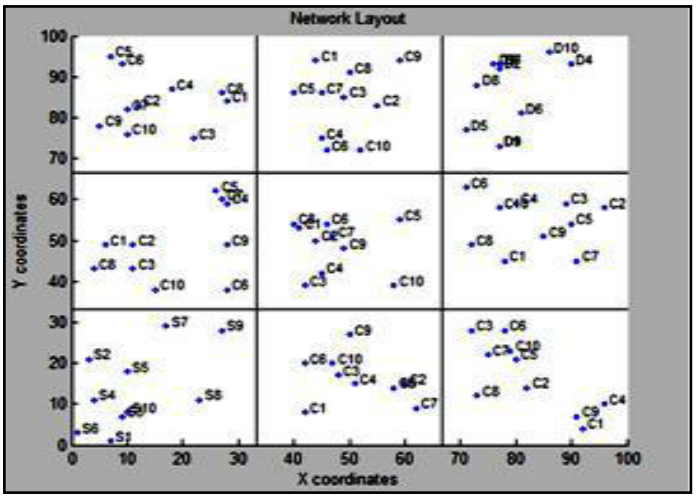

Fig.1 : Network Scenario.

A. Performance Evaluation

For this experiment we considered a sensing area of 100×100 m^2 and are further divided into 9 blocks such that the sensing region have 3 rows and 3 columns of equal size. Then an equal number of nodes are deployed in each block. Block 1 is assigned to source and block 9 is assigned to the destination. Further, the node S2 is assumed as a source node and the node D9 is assumed as a destination node. Size of initial population is set to 10. Energy consumption for transmitter and receiver are set to 50 nJ/bit. The energy consumption factor for the free space and multipath is set to 10 pJ/bit/m^2 and 0.0013 pJ/bit/m^4 respectively. The energy used to aggregate the data is set to 5nJ/bit/signal. Data packet size is set to 600bytes. All these parameters are summarized in the following Table 1.

Table.1. Simulation Parameters

Parameter	Value
Area	100*100m^2
Number of blocks	9
Number of nodes	90
Population Size	10
E_{TX}	50nJ/bit
E_{RX}	50nJ/bit
ε_{fs}	10pJ/bit/m^2
ε_{mp}	0.0013pJ/bit/m^4
Data packet size	600bytes
No. of rounds	300
Source block	1
Destination block	9

The fig. 2 shows the final optimized route from source to destination which is highlighted with green color selecting one node from each cell as it is mandatory to select a node from each cell. Selected node from each cell is a cluster head for that cell, which performs the function of data aggregation and data transmission in order to send the data packets to the destination. The nodes S2, C6, C4, C8, C10, C6, C4, C2, and D9 are selected for the route formation in order to have a data transmission from source to destination. The data transmission is carried out through this route which is obtained by the optimization process. The selected node from each cell acts as a cluster head, all other sensor nodes send data to the cluster head and cluster head combines the data and sends to next cluster head so that the data reaches up to destination. The Fig. 3 shows the comparison of the proposed technique with LEACH and ACR.

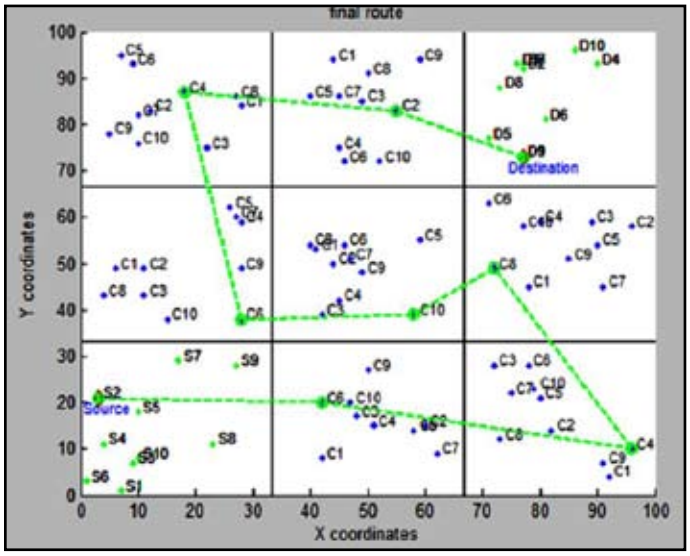

Fig.2. Final optimized Route

The numbers of alive nodes are calculated with respect to number of rounds. When the LEACH operates the first node dies at the round 60 and in the case of ACR the first node dies at the round 157 whose performance is better than the LEACH as in the case of ACR the cluster head are selected on the basis of enough residual energy besides this during data routing among the clusters the residual energy is put into the calculation of the pheromone strength and while choosing the next hop nodes with higher energy are selected on the basis of certain probability, whereas for his attempt when

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the proposed technique is executed the first node dies at the round 173 which means that in the case of proposed technique the nodes remain alive for the longer span thereby consuming minimum energy and hence, prolonging the lifetime of the whole wireless sensor network.

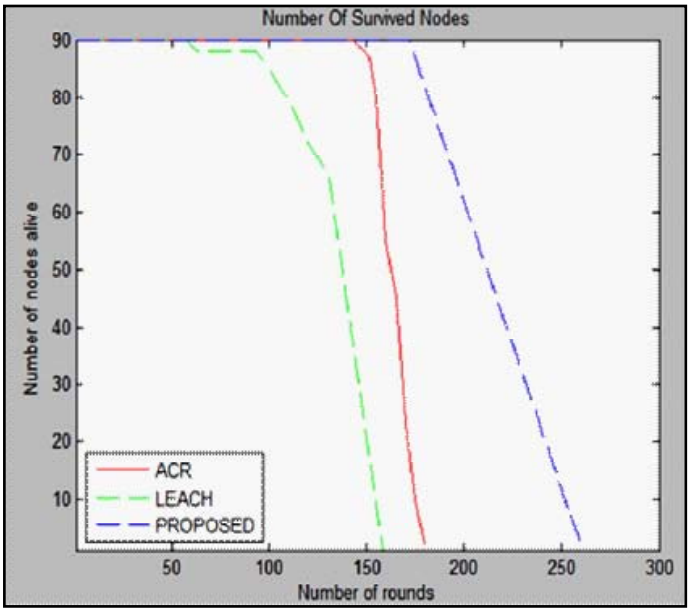

Fig.3. Comparison between ACR, LEACH and Proposed technique

VI. Conclusion

This paper initiates with a brief introduction about the Wireless Sensor Network and Swarm Intelligence techniques and its applications. It proposes an idea to achieve the proficient route using intelligent techniques for packet delivery in between source to destination and reducing the energy consumption to lengthen the network lifetime. Our proposed technique outperforms over Low Energy Adaptive Clustering Hierarchy (LEACH) and Ant Colony Routing (ACR) as the first node of these algorithm dies early than our technique. The first node dies out in proposed technique is at 173th round, whereas in the case of LEACH the first node dies out at 60th round and in ACR the first node dies out at 157th round, which means the existing technique consumes more energy as nodes dies before than the proposed technique. Hence, the proposed technique outperforms better in terms of energy efficiency and network lifetime.

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