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Energy Efficient Bioinspired Whale Optimization Algorithm for Wsn

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I ABSTRACT

In recent years, Wireless Sensor Network has become a wide area of research and has been recognized as extensive and general approach for emerging applications like real-time traffic monitoring, ecosystem and battlefield surveillance. Transmission of data in WSN causes energy depletion in the sensor nodes. In this paper the energy efficient method of sending data to the neighbouring node is done by the proposed Whale Optimization Algorithm (WOA). The efficiency of WOA is compared with the standard routing protocols and with Particle Swarm Optimization. The nearest neighbour is identified using the fitness function and the WOA considers the energy, throughput, lifetime and stability.

II INTRODUCTION

Wireless Sensor Networks are the set of sensor nodes for observing the physical parameter information. As Wireless Sensor Network is an emerging technology it is used in different places like environmental, surveillance and biosphere observation. The sensor nodes are known as motes. These nodes are capable of sensing the information and transmitting the information to the other nodes in the network.The sensor nodes consumes power to sense,communicate and to process data. The power is stored in either batteries or capacitors. These batteries are both rechargeable and non-rechargeable. They are deployed in remote areas so the changing of the batteries is not possible all time. So in order to increase the battery lifetime the nodes should use less energy for transmission and gathering the information. In this paper, Whale Optimization Algorithm isused to transmit the information from the source to the sink by identifying the nearest neighbour node which will use less energy for transmission.

IIILITERATURE SURVEY

CONTEMPORARY ROUTING ALGORITHM

Flat Routing

Hassan echoukairi(2015),focused on Search parameter by considering each sensor nodes collaborate together to perform the sensing task. It is used in high delay constraints

HierarchicalRouting

MallanagoudaPatil (2012),riveted on transmission of data occur through neighbour node. So, that it reduces energy consumption, balance traffic load and improves scalability.

Location Based routing

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MallanagoudaPatil (2012),riveted on transmission of data occur through neighbour node. So, that it reduces energy consumption, balance traffic load and improves scalability.

Data Aggregation Algorithm(LEACH,TAG,Diffusion)

Madden (2002), developed a tiny aggregation service for ad-hoc sensor networks to identify pattern and trends in the data that would not be immediately visible and help in comply with regulatory requirements.

QoSBased R outing

R. Guerin(1998), revived on quality of service based on routing protocols in order to reach the destination quickly, it uses Bellman-Ford algorithm to allows fine control over the route and resources at the cost of additional state and set up time.

METAHEURISTIC ALGORITHM

Particle Swarm Optimization Algorithm

Kuila,P(2014), proffer a method which is involved by search of food and birds. It consumes less energy and provide fast convergence while searching optimal solution.

Grey Wolf Optimization Algorithm

AmruthaLipare (2019), It revived on energy efficient load balancing approach for saving network energy and it avoids energy hole problem in WSN by balancing the load on gateways**.**

Moth Flame Optimization Algorithm

Mittal, N.(2019), Propound on reducing the energy consumption, it organizing the nodes into groups. In Multi-hop communication it is achieved by providing optimal link cost for load balancing of distant neighbouring node .

Chicken Swarm Optimization Algorithm

Libua Zhu (2017), It reduces energy consumption and network life time of neighbouring nodes by avoiding the die of partial node and balances the load on the network**.**

Cuckoo Search Algorithm :

GandomiA.H.(2013), it is used for solving structural and continuos optimization problem, It fuses the data in wsn

Energy Consumption Optimization with Bat Algorithm[ECO-BAT protocol]:

Mohammed Kaddi(2021), In WSN it provide longer network lifetime effectively by reducing the energy consumption of the network.

Improved social spider optimization algorithm(SSA)

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.Aboul Ella Hassanien (2018), developed a rough sets for solving minimum number of attribute reduction problem, it performs ten times faster than the original SSO algorithm.

IV EXISTING ALGORITHM

PARTICLE SWARM OPTIMIZATION[PSO]:

PSO is a metaheuristic and population-based state-space algorithm which is inspired by the social behavior of birds flocking. Each node in the network is called a splinter and the network is said to be a swarm. PSO is initialized with a group of random splinter and then searches for an optimal solution by updating generations. Splinter move through the solution space and are assay according to some fitness canon after each interval of time. In every repetition of the process, each splinter is updated by following two "*finest*" values. The first one is the perfect solution it has achieved so far. This value is called "*pfinest*". The second finest value can be tracked by the pso and the premier value can be obtained by any splinter in the population. This value is a global finest and called "*gfinest*". When a splinter takes part in the population as its topological neighbors, the second finest value is a local finest and is called "*lfinest*", Neighborhood bests allow parallel exploration of the search space and reduce the liability of PSO to falling into local minima, but slow down convergence speed. Splinter Swarm Optimization each splinter tries to modify its current position and velocity according to the distance between its present locus and pfinest and the distance between its present locus and gfinest.

ALGORITHM

- The group of nodes is randomly deployed and search for its destination node in a given area.
- Only one destination path can be provided at the time.
- All the node does not know where the destination is but each router node will know how far it will be in each iterate.
- Best searching strategy can be found by following the nearest sensor node to the source node.
- Node does not know the best position but, if any member of the node member can find the desirable path to go then remaining node will follow quickly.

MATHEMATICAL MODEL

$$v_j^m = wv_j^m + C_1 r_1\left(pfitness_j^m - x_j^m\right) + C_2 r_2\left(gfitness^m - x_j^m\right)$$

$$x_j^{m+1} = x_j^m + V_j^{m+1}$$

v_j^m represent the velocity of the j^{th} particle at the m^{th} iteration.

$C_1 C_2$represent positive constants.

$r_1 r_2$are two random variables with uniform distribution between 0 and 1.

w is the inertia weight.

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V PROPOSED ALGORITHM

Whale Optimization Algorithm

WOA is a bio inspired metaheuristic algorithm that was introduced by Mirjalili[15]. This algorithm was inspired from the hunting and the survival habits of the humpback whale. They hunt by creating the bubbles and encircles the prey. The Humpback whales hunting behaviour can be explained in three phases that are: searching, encircling and attacking the prey.

Encircling of Prey

During optimization, in WOA positions are updated by encircling the current best solution similar to the process of encircling behaviour of whales. This process can be mathematically modelled as the following equations:

$$\vec{E} = \left|\vec{D} \cdot y*(t) - D(t)\right| (1)$$

$$\vec{y}(u+1) = \vec{y}^{*}(u) - \vec{B} (2)$$

Where *u*represent the current iteration,

D and *B* is the coefficient vectors and

y represent the position vector.

The best solution position vector of the best solution that is obtained so far is represented as *y** . If a better solution is obtained in a iteration then the value of *y** is updated.

Eq. 3 is used to calculate the coefficient vectors *AB.*

$$\vec{B} = 2\vec{b} \cdot \vec{r} - \vec{b} (3)$$ The coefficient vector *D* is given by Eq. 4:

$$\vec{D} = 2 \cdot \vec{r} (4)$$

In the iteration the vector b linearly decreases from 2 to 0 .

r represents a random vector which varies between [0, 1].

Attacking of Prey (Exploitation Phase)

The bubble net hunting can be done in two different approaches and only one can be used at the time . They are spiral updating position approach and shrinking encircling position approach. Let q be the random variable that varies between[0,1]. *B* is also a random value between [-b,b] where b is linearly decreased during each iterations. Exploitation is to examine a constrained region of the search space in order to enhance a good solution '*S*'. This process is then carried out to refine the search in the nearby region of the solution 'S'. The value of *B* is between [-1, 1] and so when |*B*| < 1, the exploitation process is started and all the search agents merge to get the best solution. For updating Eq. 5. is used.

$$\vec{y}(u+1) = \begin{cases} \vec{y}*(u) - \vec{B} \cdot \vec{E} if \boldsymbol{q} < 0.5 \\ \vec{E}' \cdot f^{bl} \cos(2\pi l) + \vec{y}*(u) if \boldsymbol{q} \geq 0.5 \end{cases} \textbf{(5)}$$

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Searching of Prey (Exploration Phase)

It is a global search where the search agents are moved for searching the better solutions .The value of $|B|$ is set to >1 that makes the search agent to go far away in the search space. In exploitation phase the search agent is compared to best solution whereas here it is compared with a randomly selected search agent. The mechanism can be modelled by Eq. 6 and Eq. 7.

$$\vec{E} = \left|\vec{D} \cdot \overrightarrow{y_r} - \vec{y}\right| (6)$$

$$\vec{y}(u+1) = \overrightarrow{y_r} - \vec{B} \cdot \vec{E} (7)$$

Here the WOA algorithm is used to select the next node from neighbour node

Neighbour node selection

The operation of the algorithm is based on the routing of the data from the source to the sink through the neighbour nodes. Initially, in all setup phase all nodes send the data considering their current energy status and location to the source. With these data, the source node calculate the mean excess energy and then the node with the more excess energy compared to mean energy value would be selected as the neighbour node. The best node is determined using the optimal fitness value.

The WOA performance is on the randomly deployed stationary nodes in the sensor network. Let *m* nodes represent the best neighbour node (NN= NN_1, NN_2, …, NN_m). The search agent position is represented by NN_j representing the node's position in the 2D space. To select the optimal neighbour node the best search agent position is used.

Algorithm

WOA-BASED NN SELECTION

while $s<s_{max}$

do [For each round s]

while $u<u_{max}$

do [for each Whale (search agent) NNj]

do:

Clone the nearest node to NNj

Compute fitness according to Eq. 8

Calculate the coefficient vectors according to Eq.: (1-7)

Update the positions of the Whales [Update the * best position if *y* is better than '*y**']

Update the fitness function for all search agents

end for

end while

NN = Nearest node to the *y** position

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end while

For all the search agent the fitness value is evaluated and reference is chosen from the best one .The parameters of WOA is updated such that the other search agents position themselves with respect to the best agent. The fitness function is given by Eq.8:

$$F(NN_j) = Z_1|M(NN_j)| + Z_2\Sigma(NN_E) \quad (8)$$

Where theZ_1 andZ_2 are randomly chosen between 0 and 1. M (NNj) is the list of all the node neighbours NNj, and the NN_E is the neighbour node's residual energy level. The largest fitness value is the best solution and hence it will have enough excess energy and adequate number of neighbouring nodes.

VI PERFORMANCE EVALUATION

Performance evaluation metrics

The following metrics have been used to measure the performance of the proposed algorithm :

Average end to end delay – It is defined as the average time taken by the packet to deliver from source to the destination.

Average packet delivery ratio – It is defined as the ratio of average number of packet received to the sink to the average number of packet transmitted from source.

Average throughput-- It is the total haul over the entire session divided by the total time. Itis calculated by taking the difference in time-stampsbetween the first and last packet.

VII SIMULATION AND RESULT ANALYSIS

Simulation in NS 2

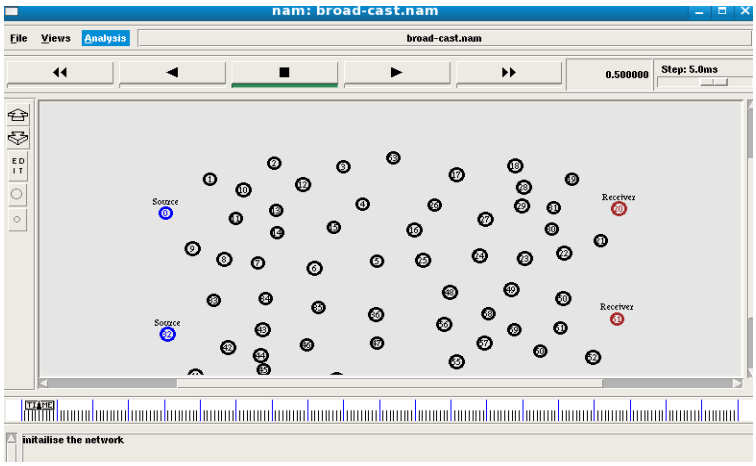

Fig.1 Node creation

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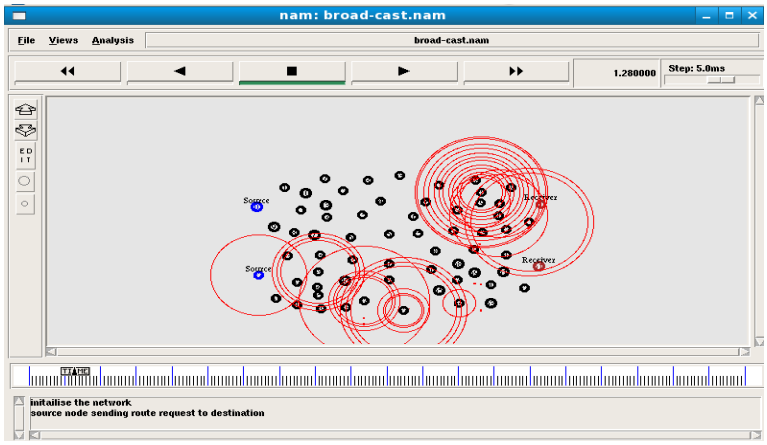

Fig.2Random deployment

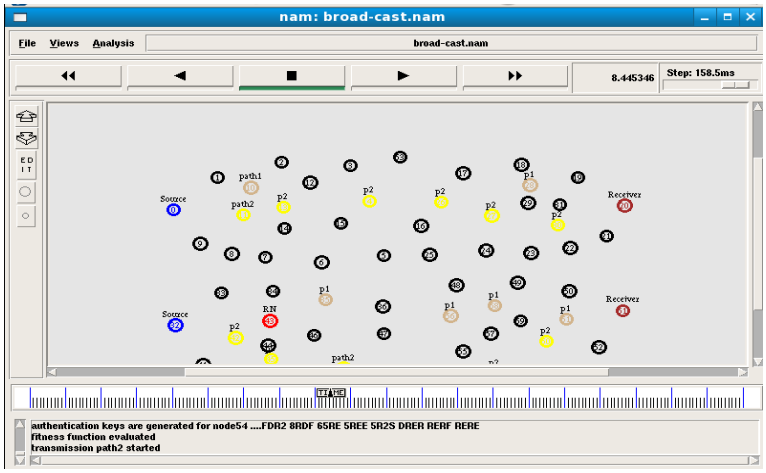

Fig.3 Fitness evaluation

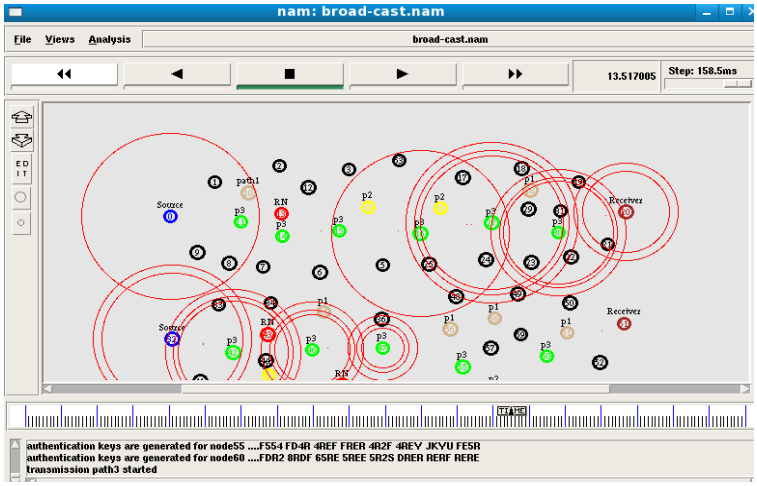

Fig.4 Path selection

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Performance Chart

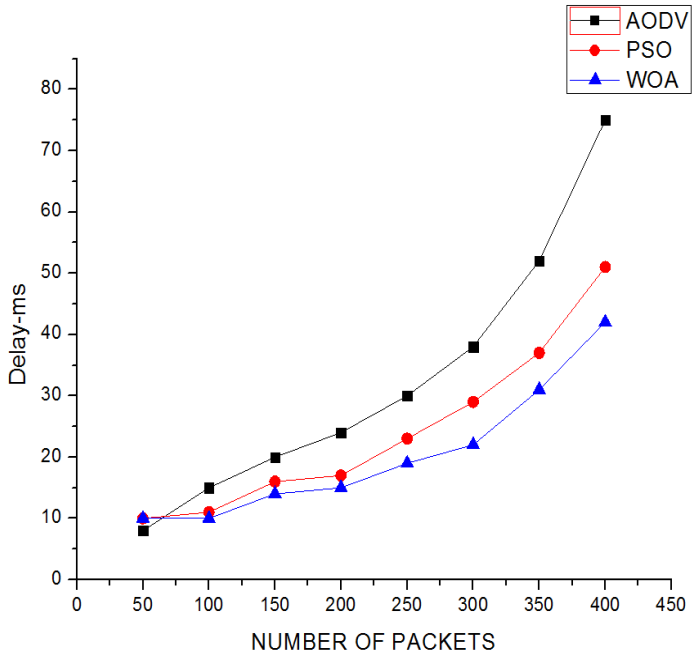

Fig.5 Delay(ms) vs Number of Packets

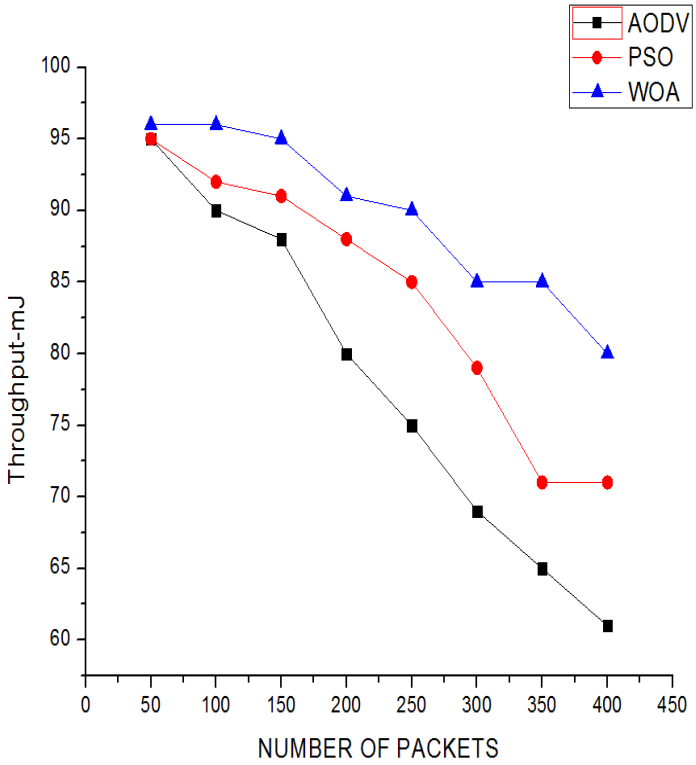

Fig.6 Throughput(mJ) vs Number of Packets

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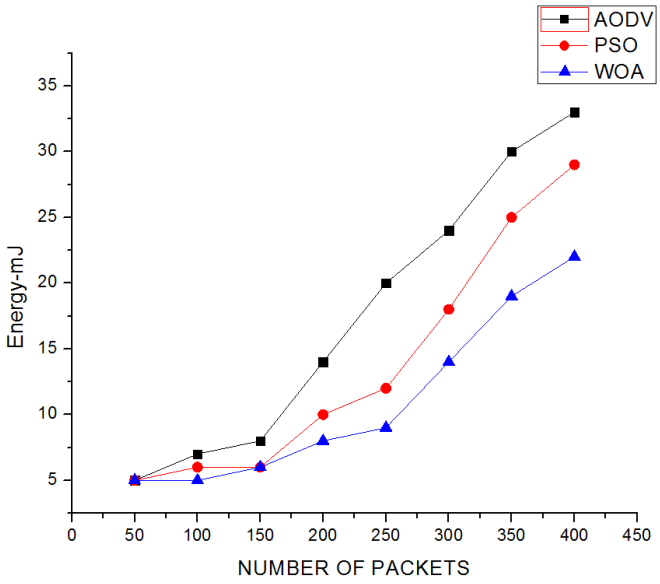

Fig.7 Energy(mJ) vs Number of packets

The proffer circuit are simulated and synthesised byusing network simulator ns2. Node creation is in fig.1,Random deployment is in fig.2, Fitness evaluation is in fig.3, path selection is in fig.4.Fig 5 compares delay and the number of packets delivered. Throughput and number of packets are compared in fig6.Fig 7 represents the comparison between energy and number of packets respectively.

VIII CONCLUSION

In this paper, the proposed Whale Optimization Algorithm is an energy efficient method of routing. The neighbour node is selected based on the fitness function that evaluates the excess energy of the nodes and the total energy of the close by nodes for reducing the energy utilization of the sensor nodes. In addition the WOA algorithm is compared with the PSO algorithm. The proposed algorithm has the high stability, throughput, energy efficiency and network duration.

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