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A NOVEL METAHEURISTIC GRAY WOLF OPTIMIZATION (GWO) ALGORITHM TO ENHANCE THE LIFE TIME OF WIRELESS SENSOR NETWORKS

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ABSTRACT

Wireless sensor networks (WSNs) are made up of several sensors (a few tens to thousands), with characteristics such as self-organizing, low cost, and random deployment. They have predominantly been used for habitat monitoring, disaster prevention, health care, agriculture, monitoring regions, and fire tracking. Researchers have studied numerous energy-efficient WSN operation strategies using clustering. Clustering has been an efficient technique for reducing energy utilization, increasing the stabilization of topology of network and the life time of the network. Energy efficient operation is a captious issue that has to be addressed with wireless sensor network deployments. Cluster based protocols are developed to tackle this problem, and the Low energy adaptive clustering hierarchy (LEACH) is the best-known protocol of this type. However, certain aspects of LEACH offer room for improvement, one such aspect is the arrangement of sensor networks with the fixed base station location. In this paper, an algorithm known as Gray Wolf Optimization (GWO) algorithm is used to compute the effective performance based on energy consumption, packet delivery ratio, end-to-end delay and network lifetime. The proposed algorithm is compared with previous algorithms such as PSO, ACO and GA on the basis of the given parameters to show that the proposed algorithm is better for network life enhancement of WSN. The result is carried out in MATLAB.

KEYWORDS: Wireless sensor networks, clustering, LEACH, GWO.

1.0 INTRODUCTION

Wireless Sensor Networks (WSNs) has become the most important techniques because of their significant use in different applications such as agriculture, healthcare, fire tracking, disaster prevention, monitoring areas and other real-time applications. By prolonging the lifetime of WSN, it can be employed for a wide variety of applications. WSN has the method for improving the network's lifetime which is known as the clustering. Researchers have studied various energy-efficient WSN operation strategies using clustering. The effective clustering approach find its use in reducing energy utilization, increasing the stabilization of the topology of network and also increasing the network lifespan.[1] A typical WSN comprises of huge no. of sensors distributed randomly over the network. The sensors picked up the signals of all types and transmitting them to the BS. Nodes in this scenario are energy constrained sensors. Energy conservation is very crucial for the network's lifetime.[2] Conservation of energy is required for moving more packets within the nodes. Various energy saving and routing methods are available to perform this.[3] In WSNs, the routing protocol determines the path for transferring the information to base station using the least amount of energy.

Clustering is the most popular techniques for the WSN. Clustering process organizing nodes into large number of groups called as clusters.[4] The network consists of sensor nodes and each sensor in the cluster involves the transfer of message across corresponding CH and CH conveys the combined information to base station. Each cluster consists of various nodes inside it. These nodes can interact through the head node to get the data. Head of each cluster is called the cluster head (CH). Cluster head combines the information entirely from MN and communicates with the BS. A clustered network architecture is useful for the wireless sensor networks concerning with data accumulation and data transmission.[5]

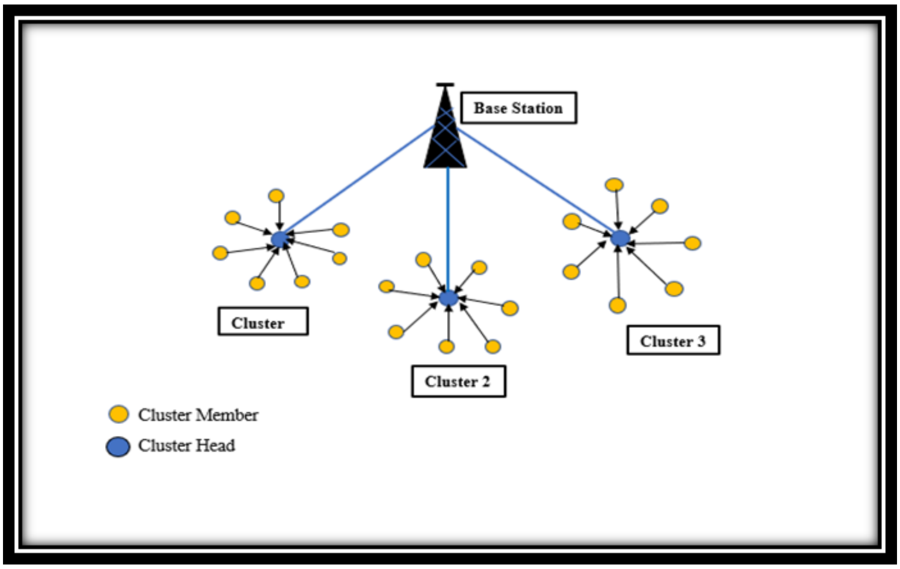

Figure 1: Clustered Architecture.

The clustering protocol here used is the LEACH protocol. LEACH represents Low energy adaptive clustering hierarchy. This protocol is based on schedule-based MAC protocol. The basic goal of LEACH is to improve the lifespan of wireless sensor networks. It increases the lifespan of sensor networks by rotating the CHs. The CH position will be circulated among the corresponding member nodes depends on the residual energy available in that particular node. In this LEACH protocol, we are dividing the network into clusters. Individual clusters are having its particular CH. The CH collects the information from the member node. Then the aggregated information is transferred to the sink node or the base station. CH is in the charge for creating and maintaining a TDMA schedule. In this LEACH protocol, we are utilizing this TDMA schedule. That's why it is called as a schedule-based protocol.

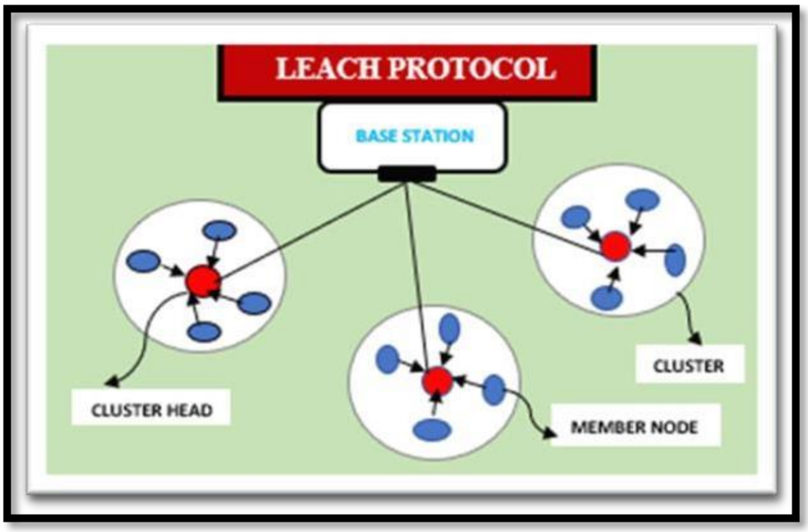

Figure 2: LEACH Protocol.

2.0 PROPOSED ALGORITHM

The Gray wolf optimization is the metaheuristic algorithm that solves many problems of the optimization. This was given by Seyedali Mirjalili and Lewis in the year 2014. It takes influence from the social hierarchy and the hunting mechanism of the pack of Gray wolves. GWO, a type of swarm intelligence algorithm copies the intelligent behaviour of gray wolves. The behaviour includes both the leadership and hunting characteristics of the gray wolf [6]. The flowchart of GWO is illustrated below:

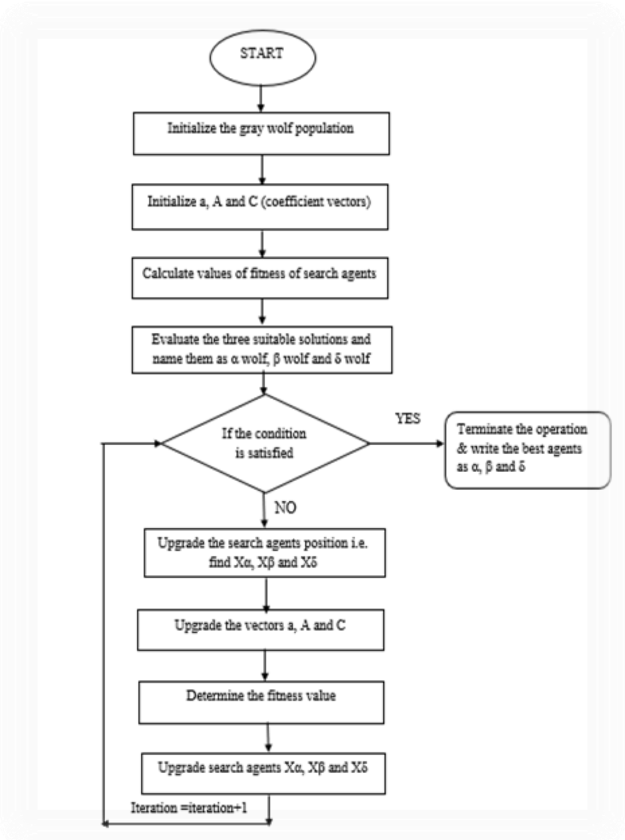

FIGURE 3: Flow chart of GWO.

Gray Wolves mostly search accordingly position of alpha wolf, beta wolf and delta wolf. Wolves diverge away from each other for searching the prey and come closer to attack the prey. Encircling the prey takes place during the hunt. The proposed equations are:

$$\vec{D} = |\vec{C}.\vec{X}p(k) - \vec{X}(k)|$$

$$\vec{X}(k+1) = \vec{X}p(k) - \vec{A}\cdot\vec{D}$$

The vectors $\vec{A}$ and $\vec{C}$ are find accordingly as

$$\vec{A} = 2\vec{a}.\vec{r} - \vec{a}$$

$$\vec{C} = 2.\vec{r}$$

After searching and encircling the prey, the next step is to attack. The equations are formed as:

$$\vec{D}\alpha = |\vec{C}1 . \vec{X}\alpha - \vec{X}|$$

$$\vec{D}\beta = |\vec{C}2 . \vec{X}\beta - \vec{X}|$$

$$\vec{D}\delta = |\vec{C}3 . \vec{X}\delta - \vec{X}|$$

where $\vec{D}\alpha, \vec{D}\beta$ and $\vec{D}\delta$ are the modified distance vector for the alpha, beta and delta.

$$\vec{X}1 = \vec{X}\alpha - \vec{A}1.\vec{D}\alpha$$

$$\vec{X}2 = \vec{X}\beta - \vec{A}2.\vec{D}\beta$$

$$\vec{X}3 = \vec{X}\delta - \vec{A}3.\vec{D}\delta$$

where $\vec{X}1$ is the new position using $\vec{X}\alpha$ and distance vector $\vec{D}\alpha$, $\vec{X}2$ indicates the new position $\vec{X}\beta$ and distance vector $\vec{D}\beta$, $\vec{X}3$ represents the new position $\vec{X}\delta$ and distance vector $\vec{D}\delta$.The coefficient vectors $\vec{A}1, \vec{A}2$ and $\vec{A}3$ are computed as:

$$\vec{X}(k+1) = \frac{\sum_{i=1}^{n} \vec{X}i}{n}$$

where $\vec{X}(k+1)$ is the final vector obtained from sum of all the positions using alpha wolf, beta wolf and delta wolf and n shows the wolves i.e. α, β and δ. [6,7]

3.0 PARAMETERS FOR EVALUATION

Table 1: Simulation Parameters.

S.NO.	PARAMETERS	VALUES
1	Number of nodes	1000
2	Simulation Area	200*200
3	Rounds	1000
4	Cluster Head (CHs) formation	LEACH
5	Number of sink nodes	1
6	Techniques Used	GWO (Proposed), PSO, ACO and GA
7	Channel Type	Wireless Channel

4.0 RESULTS

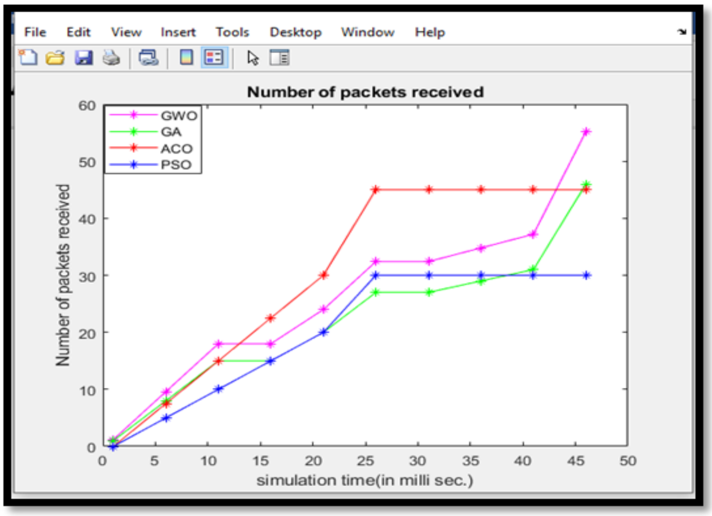

FIGURE 4: Number of packets received.

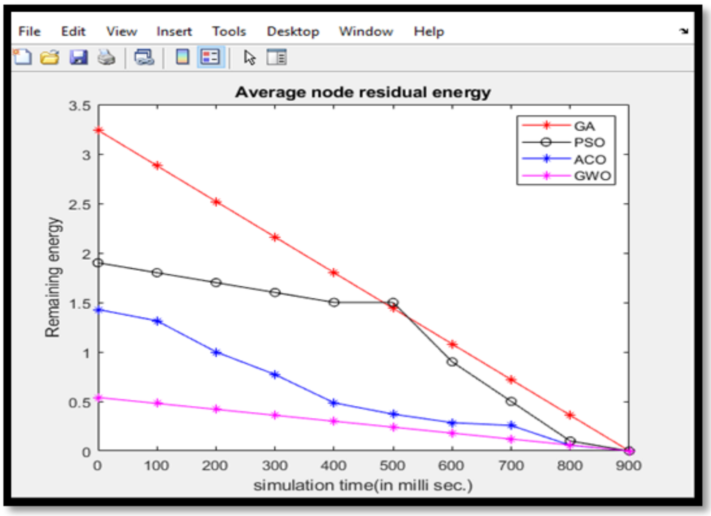

FIGURE 5: Nodes Residual energy

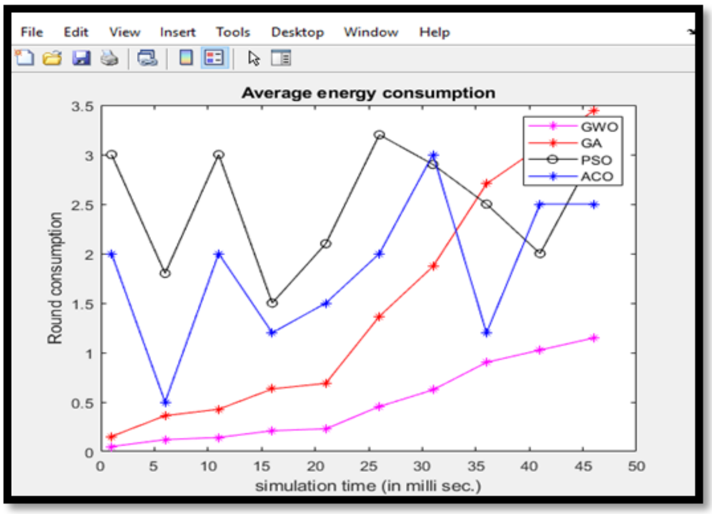

FIGURE 6: Energy Consumption.

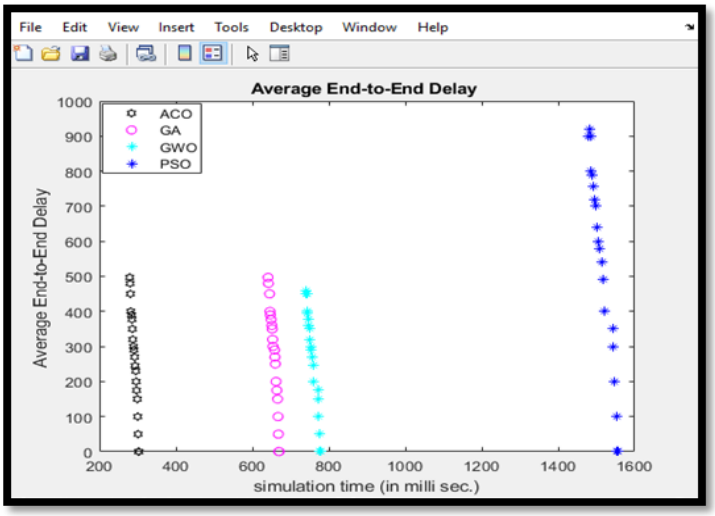

FIGURE 7: End-to-end delay

5.0 COMPARISON

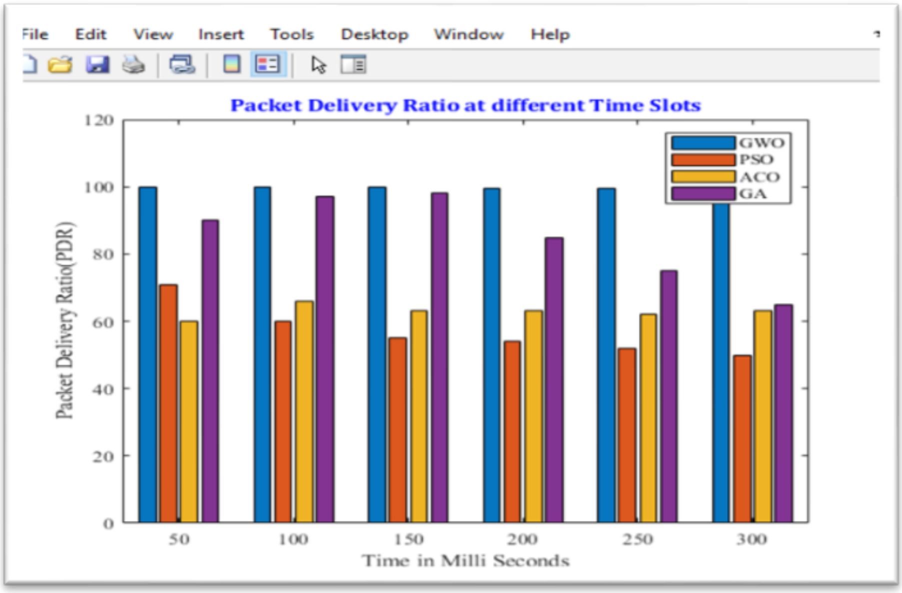

FIGURE 8: Comparison of Packet delivery ratio

The term Packet delivery ratio means “the total packets transferred from source to the destination”. In the above shown graph, proposed protocol GWO generates the greater no. of packets that are transmitted to the base station. This parameter affects the network’s lifetime of WSN.

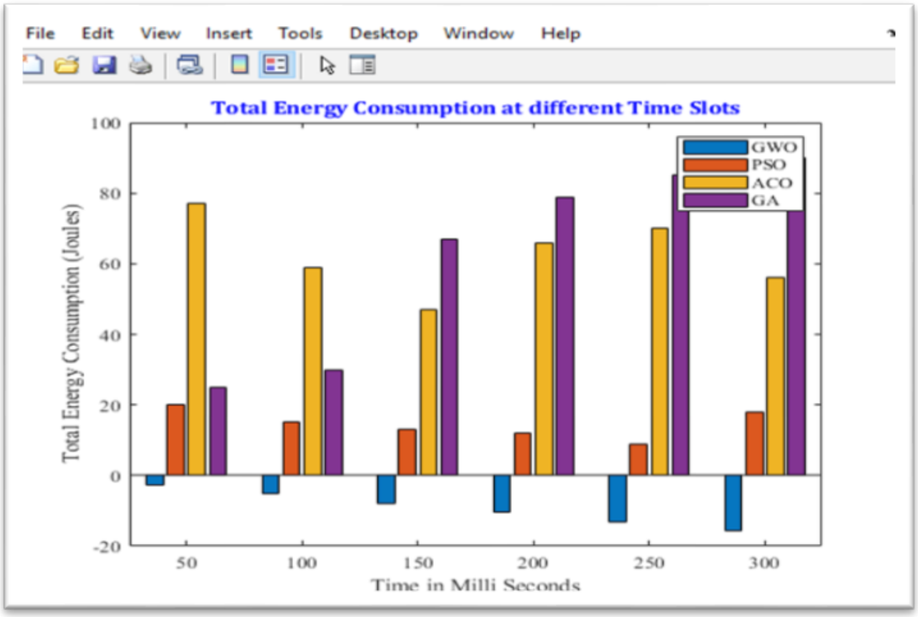

FIGURE 9: Comparison of Energy Consumption.

Energy consumption is another parameter that is important for proving the validation of the result. By comparing the results from all the protocols, proposed one consumes the lesser energy among all the other protocols as displayed in the figure 9.

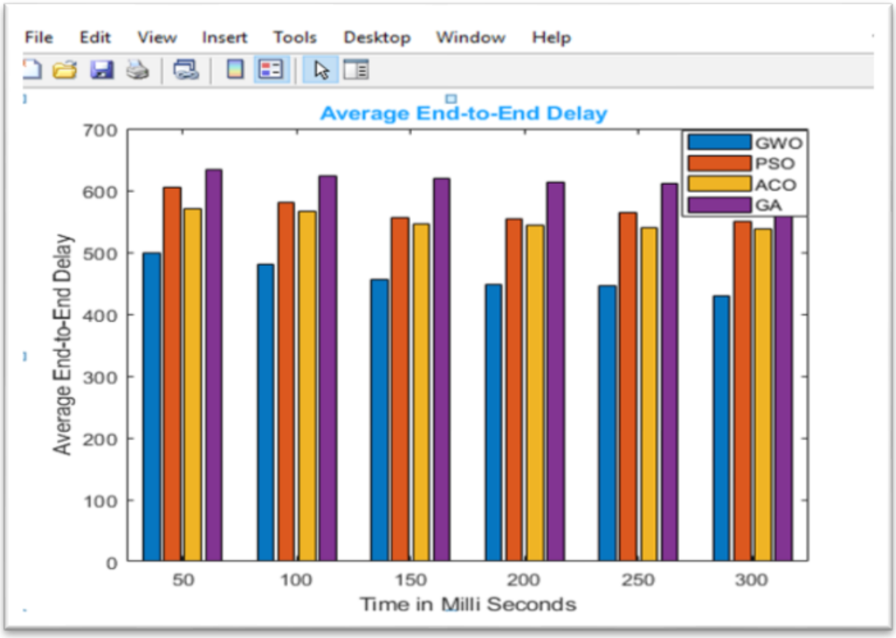

FIGURE 10: Comparison of End-to-End delay

End-to-end delay means the time taken for a packet to transferred from source to the destination in a network. From the figure 10, GWO produces the minimum delay which means that lesser the delay, a larger number of packets are transmitted in a short time.

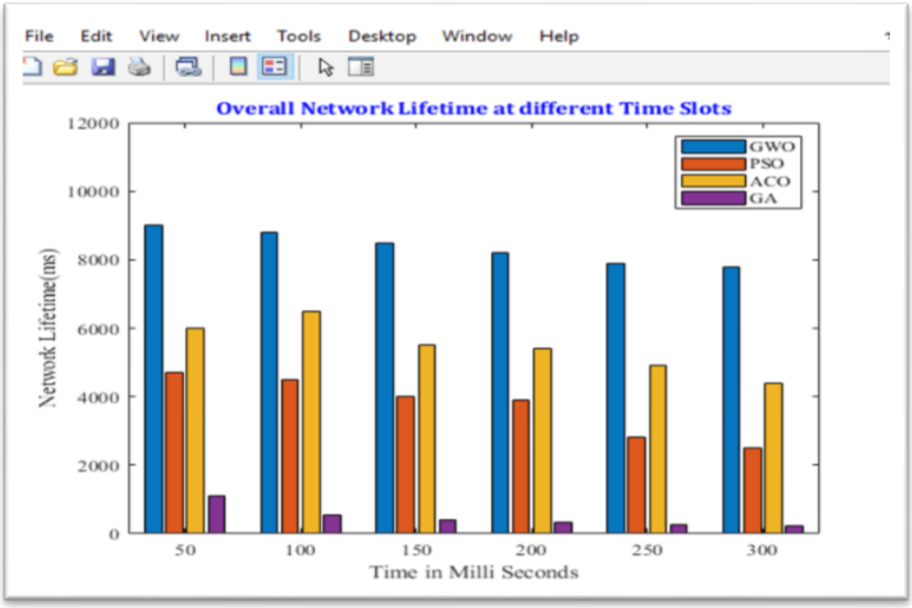

FIGURE 11: Comparison of Network Lifetime.

By comparing all the parameters, we have seen that GWO performs better among other protocols. So, by concluding the results from all the simulation graphs, a network lifetime graph is plotted among the proposed protocol and the others that shows the values of network lifetime. From the figure 11, we have seen that lifetime of GWO has been increased by 90%, PSO by 47%, ACO by 60 % and GA by 12%. GWO shows better results than the others and thus extend the overall network lifetime.

6.0 CONCLUSION

Because of low cost and easier installation, industries pay more attention to the wireless networks than the wired networks. WSN plays a unique role in different applications like military, agriculture, security and surveillance etc. Scientists developed many energy efficient protocols to extend the life time of WSN. This study proposes an algorithm known as Gray Wolf Optimization (GWO) that is proposed for clustering problem in WSN. The objective of clustering optimally selects the CHs. This algorithm divides the sensor networks with suitable number of cluster heads. Hence by using this GWO algorithm, the life time of WSN is prolonged proficiently.

Implementation of work in performed smoothly in MATLAB. Results are obtained successfully. The results are compared with different protocols in terms of packet delivery ratio, energy consumption, end-to-end delay and the network lifetime. The obtained results indicate the proposed protocol is better than the previous protocols relating to all the mention parameters.

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