International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 30 • 2017

Implementation and Analysis of PSO-Based Clustering and Cluster Head Selection Power Optimization Algorithm for WSN

Er. Kavita[a] Prashant Sahai[b] and Sonu Mittal[c]

[a]Ph.D Research Scholar, Department of Computer Science and Engineering Jaipur National University, Jaipur. India.

E-mail: dhullkavita@yahoo.in

[b]Professor and Joint Director, Department of computer science and engineering Jaipur National University India.

E-mail: sahai.prashant0@gmail.com

[c]Professor(Associate), Dept. of Computer Science and Engineering Jaipur National University, Jaipur India.

E-mail: sonum7772@rediffmail.com

Abstract : A WSN system integrate entry ways that provides wireless connectivity reinforce the wired world and distributed nodes.WSN has various advantages such as: Mobility, Easiness, Avoids bulk wiring, centralized monitoring. In spite of large no. of applications of WSNs, these networks also have many restrictions, *e.g.*, limit of energy supply, restricted computing power, and connecting sensor nodes bandwidth of the wireless links. One of the major design goals of WSNs is to realize data communication while trying to lengthen the life of the network and keep connectivity degradation by containing aggressive energy management techniques. In current sensor nodes, less battery ability problem is the major problem. Different energy proficient methods that can be used at network layer level by using diverse routing protocols with energy efficient routing algorithms and legitimate communications reasonably maximize the optimization of the power in transmission of packets and lengthen the life of the sensor networks. This research work stresses on power conservation in each sensor node by using AODV protocol with PSO-based clustering and cluster head selection power optimization algorithm. AODV allocate a direction for communication while the cluster head is selected using PSO, based on the distance from the cluster member node to sink node and the residual energy in that node. Due to which the proposed work not only find the route but also optimize the route as well with PSO on AODV protocol. AODV finds the route proficiently then further the route is optimized with PSO protocol.

Keywords : *Applications of WSN; Area Monitoring Applications; Data Aggregation; WSN vs. MANET; Base station; sensor network; cluster head; Health Applications; Nodes Heterogeneity.*

1. INTRODUCTION

WSN (Wireless sensor networks) introduce to a heterogeneous system consisting of multiple detection stations named as sensor nodes which contains communications infrastructure determined to monitor and record conditions at diverse locations. These networks contain SNs which are able to perform of monitoring and processing the data from a particular geographical position and then send the same data to remote location which is called as BS (Base Station) WSNs in general made up of small, economical, resource involving devices that communicate amongst each other using a multi-hop wireless communication [1]. Each node of WSN is named as a SN which integrates in itself one sensor, implanted processors, limited memory, less-power radio, and is in general processed with battery. Each SN is accountable for recognizing a required event locally and for passing along a remote event sensed by other SNs so that the event is transferred to the destination via BS. As SNs contains less energy that's why applications and protocols for WSNs should be designed carefully for optimized ingestion of power for prolonging the network lifetime [2].

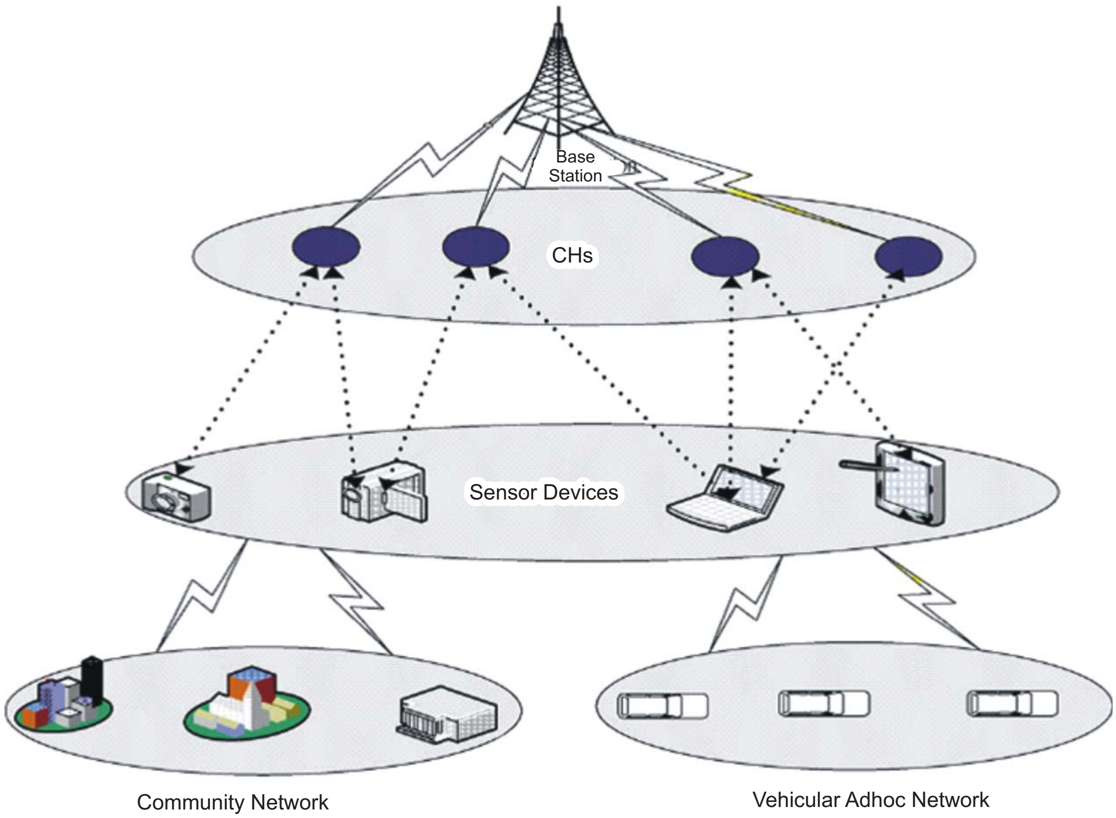

Figure 1: Generalized view of WSNs [1]

"Fig. 1" showing the generalized view of WSNs, which consists of a base station (BS), Cluster Heads (CHs) and SNs deployed in a geographical region [1].

1.1. Characteristics of WSN

1. First characteristic of WSN is, it is Dynamic network topology
2. It consumes Limited power that can be harvested or store
3. It support Nodes Heterogeneity
4. It provides Mobility of nodes
5. It has Ability to hold harsh environmental conditions
6. Provides large scale of deployment
7. It has Ability to cope with failures of node

1.2. Applications of WSN

WSN suggest a multi-disciplinary, rich area of research, which contains a number of tools and concepts can be applied to address a whole different set of applications. Sensor networks may consist of diverse types of sensors such as thermal, magnetic, seismic, radar, visual, and infra-red and these all are capable to monitor a wide variety of conditions. These sensor nodes put for motion sensing, continuous sensing, location sensing, and event finding [3]. The idea of micro-sensing and wireless connection of this sensor node assure many new application areas.

Some examples of their applications are as follows:

1. **Area Monitoring Applications:** It is one of the credible applications of WSNs. While monitoring area, where some physical action or phenomenon is to be discovered, there WSN is implanted over a region. When the sensors sense the monitored event (sound, vibration), event is communicate to the base station, which then takes proper action (*e.g.*, send a message on the to a satellite or internet) like as, wireless networks can be deployed in security systems to detect movement of the unwanted traffic control system to observe the existence of high-speed vehicles. Also WSNs finds huge application in military area for battled observations, observing friendly forces, equipment and ammunition, reconnaissance of opponent forces and terrain, targeting and battle demolish assessment [4].

2. **Environmental Applications*:*** A few environmental applications of sensor networks contain forest fire detection in, landslide detection, monitoring of green house, air pollution and finding of flood. They can also be used for monitoring the movement of insects, birds and small animals, planetary survey, monitoring situation that affect livestock and crops and facilitating irrigation.

3. **Health Applications:** for many of the health application wireless sensor networks are providing interfaces for the person who is disabled, incorporated patient monitoring, diagnostics, drug supervision in hospitals, monitoring internal processes and the movements of insects or other tiny animals, tele-observation of physiological data of human; and monitoring and tracking doctors and patients inside a hospital.

4. **Industrial Applications*:*** WSNs are now broadly used in industries, for example in machinery condition based maintainer. Locations which are formerly inaccessible, rotating machinery, dangerous or restricted areas, and mobile valuable applications can now be achieved with wireless sensors. These can also be used to measure and observe leachate accumulation and removal and observe the water levels within all ground wells [5].

5. **Other Applications:** Sensor networks now find in awfully large applications in appliances like ovens, refrigerators, vacuum cleaners and VCRs which are used on daily basis. Other commercial applications include constructing monitoring product value, managing catalog, factory instrumentation and many more [6].

1.3. Issues and Challenges in Designing a Sensor Network

Though the infinite applications of WSNs, these networks also have many restrictions, *e.g.*, limited supplied energy, limited computing power, and concerning sensor nodes bandwidth of the wireless links. One of the chief design aim of WSNs is to achieve data communication while trying to extend the life of the network and keep connectivity degradation by containing aggressive power management techniques. Routing protocols designing in WSNs is influenced by many challenging factors [7]. These factors must be overcome to achieve the efficient communication in WSNs. In the following, we study some of the designing issues and routing challenges that affect routing process in WSNs.

1. **Data Aggregation:** Since sensor nodes may produce meaningful duplicate data, and from multiple nodes related packets can be aggregated so that the number of transmissions is reduced. Data collection is the grouping of data from different sources according to certain aggregation function, e.g. maxima, minima and average, suppression of replacement data. This technique has been used to produce efficient power and of data transfer maximization in a number of routing protocols. Signal processing techniques can also be used for aggregation of facts. So it is referred to as data blend where a node is capable of given that a more precise output signal by using some methods such as beam forming to mingle the incoming signals and dipping the noise in these signals [7].

2. **Quality of Service (qos):** In some applications data should be brought within a definite period of time from the instant it is sensed otherwise the data will not work. So for data delivery restricted latency is another condition for time-constrained applications. However, in many applications, power conservation, which is directly linked to network lifetime, is considered comparatively more valuable than the value of data sent. As the energy goes insufficient, the network may be needed to reduce the quality of the results in order to minimize the energy indulgence in the nodes and hence lengthen the whole network lifetime. Therefore to capture this requirement power-aware routing protocols are needed [8].

1.4. WSN vs. MANET

A (MANET) Mobile Adhoc Network is a combination of wireless mobile nodes which form a provisional network without the use of any centralized administration, access point, and infrastructure. The processing control of all the nodes is hypothetical to be the same. Because there is no preset infrastructure and centralized power in MANETs so nodes can join or leave the network at any time. Any node can be a host or a router to throw the packets from source to destination. In MANET mobile device have less Battery power and communication choice. Every node cannot be in every another node's communication range. Also a need of many intermediate nodes for communication between the nodes which are not in the range of each other. That's why, all nodes perform as routers and are able of finding and maintaining routes to reproduce packets to their destinations. There is requirement to self organize the network by means of the cooperation between the mobile devices. Mobile Ad hoc networks (MANETs) have huge much importance to both the research community and the military because of the impending to obtaining a communication network in any position that involves emergencies. Examples are operations of recover-and-search, military operation in hostile environment, and numerous kinds of police operations.

Without any pre installed fixed network infrastructure and with the quick configuration of wireless connections on the fly, network topology in MANETs keeps on changing regularly. Thus, adopting data communication between wireless nodes in MANETs with better QoS parameters has turn into a challenging task. To bring about this, one has to focus on the routing protocol. Mobility of the nodes makes the situation even more convoluted and designing a routing protocol for MANET has to face the challenge of frequently changing topology, less transmission power and asymmetric links.

WSN applications require wireless ad hoc networking techniques. Although many algorithms and protocols had been suggested for customary wireless ad hoc networks, but these are not well suited for the distinctive features and application necessities of WSNs. The basic differences & similarities in both i.e. wireless sensor networks and traditional wireless ad hoc networks are:

1. As compared to the nodes in a wireless ad hoc network, the build of sensor nodes in a wireless sensor network can be higher magnitude.

2. In a wireless sensor network, Sensor nodes are tightly implemented; Sensor nodes are also prone to failure.

3. The topology of a wireless sensor network Very recurrently changes.
4. Sensor nodes principally use broadcast communication example whereas most customary ad hoc networks are rely on point-to-point communications.
5. Sensor nodes are definite in control, computational capabilities, and memory.
6. Sensor nodes have not global identification because of the excess amount of overhead and huge number of sensors.
7. WSNs and MANETs both are wireless networks which due to their distributed nature required self-management. Battery powered nodes They employ generally and that's why there is a vast concern on minimizing consumption of power.
8. Mainly nodes in the network are devices used by human beings such laptop computers, PDAs, mobile radio terminals means to humans MANETS are often "closed". sensor network stress on interaction with the environment as compared to human being interaction.

2. RELATED WORK

The examine work performed in this field by diverse researchers is presented as follows:

1. **Gandham et al. [2003]:** Suggested to deploy multiple, mobile base stations to the life span enhancement of the sensor network. Lifetime of the sensor network is separated into equal periods of time known as rounds. Relocation of base stations is done at the start of a round. Projected approach uses an integer linear program to find new positions for the base stations and a flow-based routing protocol to guarantee an energy efficient routing during each round. Four metrics are proposed and evaluated solution using these metrics. Simulation results showed that employing multiple, mobile base stations in correspondence with the solution given by proposed schemes would significantly enhance the lifetime of the sensor network.
2. **Domingo et al. [2008] :** Studied the consumption of overall energy in underwater acoustic sensor networks considering two dissimilar scenarios: shallow water and deep water. Different basic functioning principles for routing protocols in underwater WSNs (relaying, direct transmission and clustering) are proposed and analyzed the total energy consumption for each case, establishing a relationship between them.
3. **Li et al. [2009] :** Evaluated some popular WSNs routing protocols for their fittingness to WSNHA. (GAHR) Greedy-algorithm heuristic routing protocol and an A* algorithm for route finding are proposed. With the ad-hoc on-demand distance-vector protocol this heuristic routing is compared using a simulation. The simulation outcome showed that this routing protocol considerably reduced the routing overhead and the average packet delay without impacting consistency, and demonstrated that WSNHA-GAHR adapts repeatedly to changes in the network topology.
4. **Misra et al. [2010] :** Proposed a routing protocol with one-level data aggregation which is simple, least-time, energy-capable it also ensures enhanced life time for the network. This protocol was compared with admired ad hoc and sensor network routing protocols namely AODV (Royer and Perkins, 1999; Das et al., 2003),(Perkins and Bhagwat, 1994), DSR (Johnson et al., 2001), DSDV DD (Intanagonwiwat et al., 2000) and MCF (Ye et al., 2001). It is concluded that the proposed protocol outperformed over them in throughput, latency, average power consumption and average network lifetime. This protocol ensures reliability and congestion prevention using time and node energy as the strategy for routing

5. **Othman and Yahya [2010] :** EQSR protocol Based on the notion of service differentiation, employs a queuing replica to handle both real-time and non-real-time traffic Energy Efficient and QoS aware multi route routing protocol (abbreviated shortly as EQSR) proposed that through matching energy utilization across multiple nodes maximizes the network lifetime, it uses the concept of service differentiation to allow delay responsive traffic to reach the sink node within an acceptable holdup, it also minimizes the end to end delay through dispersion out the traffic across multiple paths, and minimizes the throughput through introducing data redundancy. EQSR to expect the best next hop through the paths production phase uses the residual power, node available buffer size, and (SNR) Signal-to-Noise Ratio..

6. **Huanga et al. [2011] :** Developed a routing protocol to tackle problems in underwater WSNs. A forwarding node selector is employed to conclude the appropriate sensors to onward the packets to the destination, and a forwarding tree trimming mechanism is adopted to avoid excess spread of forwarded packets. The suggested protocol is compared with a routingrepresentative protocol for UWSNs in the literature. The experimental results prove the effectiveness and feasibility of the proposed work.

7. **Mohajerzadehet al.[2010]:** A Tree based Energy and Congestion Aware Routing Protocol (TECARP) protocol is an energy efficient routing protocol which tries to handle jamming and to supply fairness in network. Simulation results shown in this paper imply that the TECARP has attained its goals.

8. **Saleem et al. [2011] :** Provided an extensive survey of routing protocols and discussed the general principles of swarm intelligence and of its application to routing. Introduced a novel taxonomy for WSNs routing protocols and use it to classify the surveyed protocols.

9. **Basioni et al. [2011] :** He proposes various modifications on it to improve its performance through studying the QoS of an energy-efficient cluster-based routing protocol called (EAP) Energy-Aware routing Protocol in terms of lifetime, holdup, loss percentage, and throughput. In terms of packets loss, delay, and throughput, but a little affects lifetime negatively the adapted protocol offers better characteristics. The modified protocol considerably outperforms EAP in terms of packet loss percentage by on average 93.4% Simulation outcome showed that.

10. **Kandris et al. [2011] :** Simulation results demonstrated the effectiveness of the recommended scheme. a novel dual scheme called PEMuR suggested for capable video communication, which aims at both energy saving and high QoS attainment. It attains its objectives, PEMuR implying the combined use of an energy aware hierarchical routing protocol with an intellectual video packet scheduling algorithm. The adopted routing protocol authenticate the choice of the most energy proficient routing paths, arranges the network load according to the power residues of the nodes and secure useless data transmissions through the suggested use of an energy threshold. The algorithm may get by with slender available channel bandwidth by selectively dipping less significant packets prior to their transmission.

3. PROPOSED WORK

3.1. Problem Formulation

A hotspot problem in current sensor nodes is low battery capacity therefore, systematic use of the sensor node's energy setback is important. The sensor node utilizes its built-in battery for purpose of communication and sensing, during battery's exhaustion, the sensor's functionality completely stops, definitely leading to losing parts of the network's functionality. By using different routing protocols with energy efficient routing algorithms and authentic communications Different energy efficient techniques can be worn at network layer level. The optimization of the power in transmission of packets and lengthen the life of the sensor networks increased by mechanisms described in these algorithms. The research work suggested will execute the PSO on AODV protocol with PSO in clustering and for optimal collection of cluster head to increase the advancement in the remaining energy of node by sending a data packet to the cluster head which is situated adjoining to the Base station. As alone PSO have following disadvantages:

1. Suffers from the inclined optimism, which causes the less exact at the ordinance of its speed as well as the direction.

2. The method cannot work out the problems of spreading.

3.2. Proposed Work

The network lifetime can be enhanced by using appropriately lots of routing protocols and cluster-based algorithms are used to achieve the execution necessity in WSN. Optimization of energy in communication becomes very critical according to existing research approaches. For maximizing lifetime of the WSN, energy consumption of each sensor node has a significant Part of a role while communicating among other sensor nodes. In this dissertation we have proposed a protocol based on PSO with AODV protocol to enhance the lifetime of a network. Firstly AODV protocol finds the route for communication of nodes. The selected route must be optimized. Because different routes consume different energy, the more energy is required as the nodes increases in the route of network. Therefore PSO protocol is used for optimization of route. The optimized route consumes less energy.

4. RESULTS AND ANALYSIS

A WSN of 50 nodes with a simulation time of 20 seconds is considered. The mobile nodes are placed on a 1200 X 1200 flat grid. Thus, 50 different nodes were involved in the communication.

Table 1
Simulation Parameters

Parameter	*Value*
Channel type	Wireless channel
Number of nodes	50
Area (deployment)	1200*1200 M
Initial energy	100 joules.
MAC type	802.11
Antenna model	Omni Direction Antenna
Propagation model	free space/two-ray ground
Transmission power	10.32*e*-3 Watts
Receiving power	5.28*e*-3 Watts
Queue type	Priority queue
Simulation time	5-20 S

The key constraint of study is the network lifetime. Energy consumption of AODV and AODV-PSO are compared below:

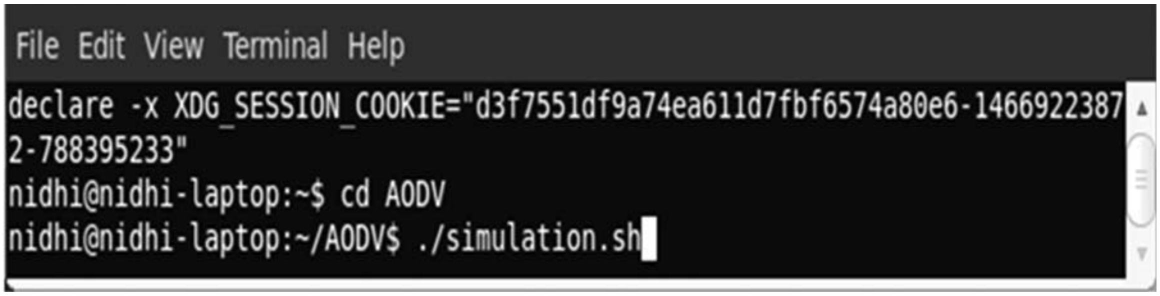

Figure 2: Simulation of AODV

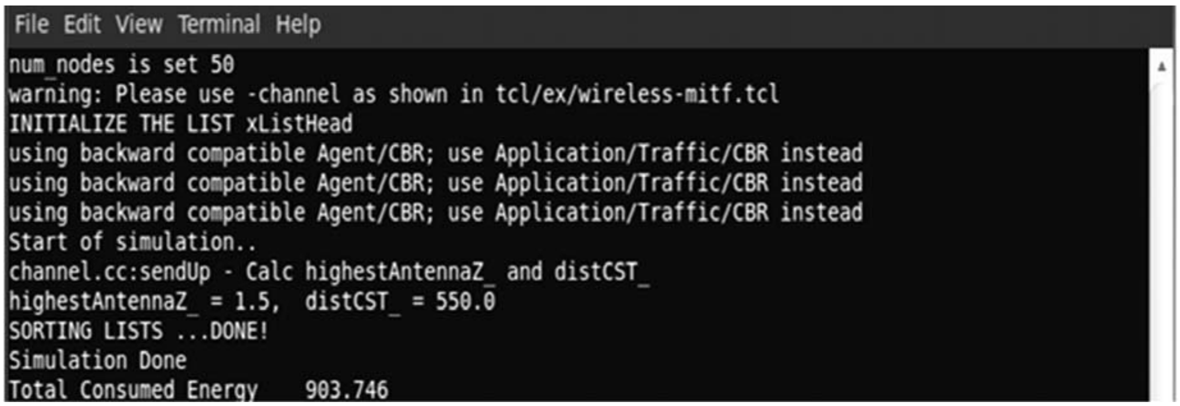

Figure 3: Consumed energy of AODV

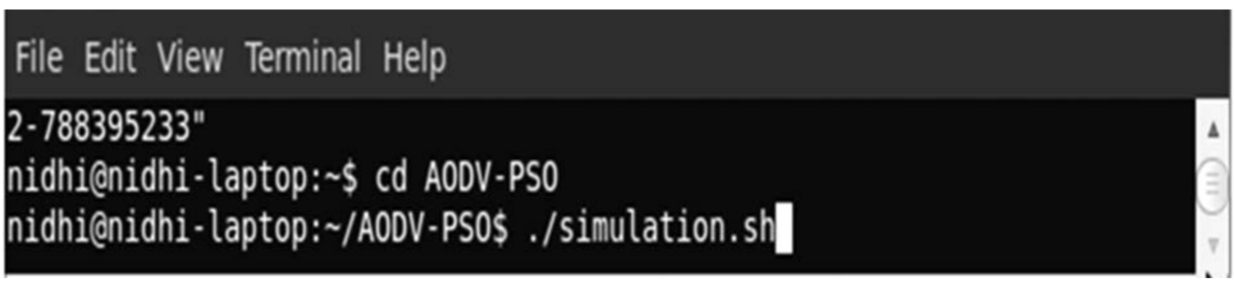

Figure 4 : Simulation of AODV-PSO

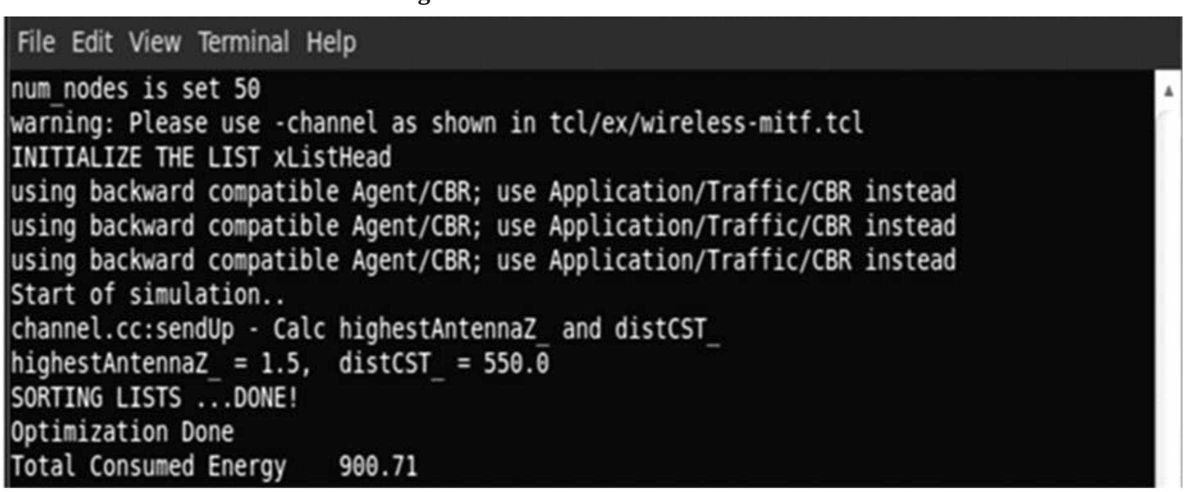

Figure 5: Consumed energy of AODV-PSO

Table 2
Energy consumption of AODV & AODV-PSO

	AODV	*AODV-PSO*
Total Consumed Energy	903.746	900.71

In the table 2 there is a association among the consumed energy of the simple AODV and the modified AODV-PSO. Table 4.1 indicate that at simulation time 20s the entire consumed energy in AODV is 903.746 and in AODV-PSO is 900.71

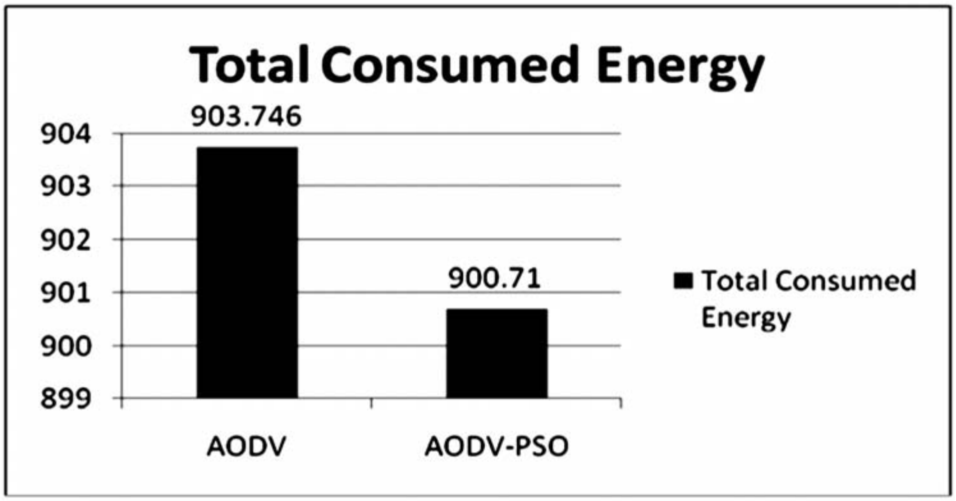

Figure 6: Total consumed energy of AODV & AODV-PSO

The "Fig. 6" indicates the graphical analysis of comparing of total consumed energy of simple AODV and the modified AODV-PSO.

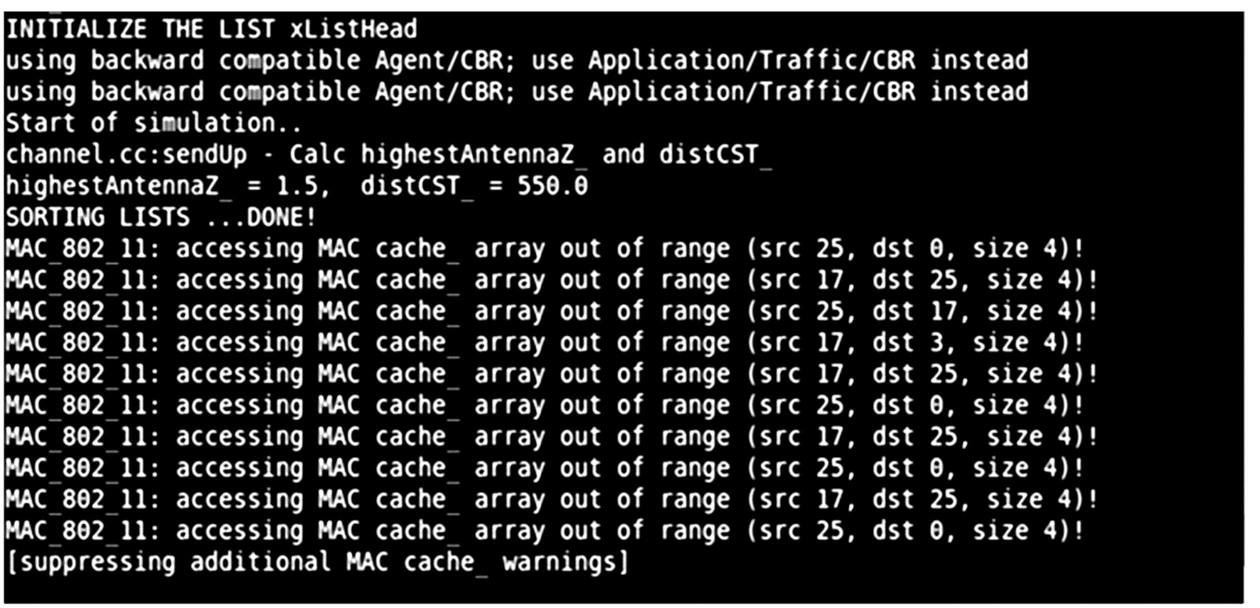

Figure 7: Lifetimes of AODV & AODV-PSO

Figure 8: No. of Dead Nodes in AODV & AODV-PSO

The "Fig. 8" depicts the graphical view of comparing of dead nodes in simple AODV and the modified AODV-PSO. At simulation time 750s AODV reported all the nodes dead while in AODV-PSO dead nodes are 42.

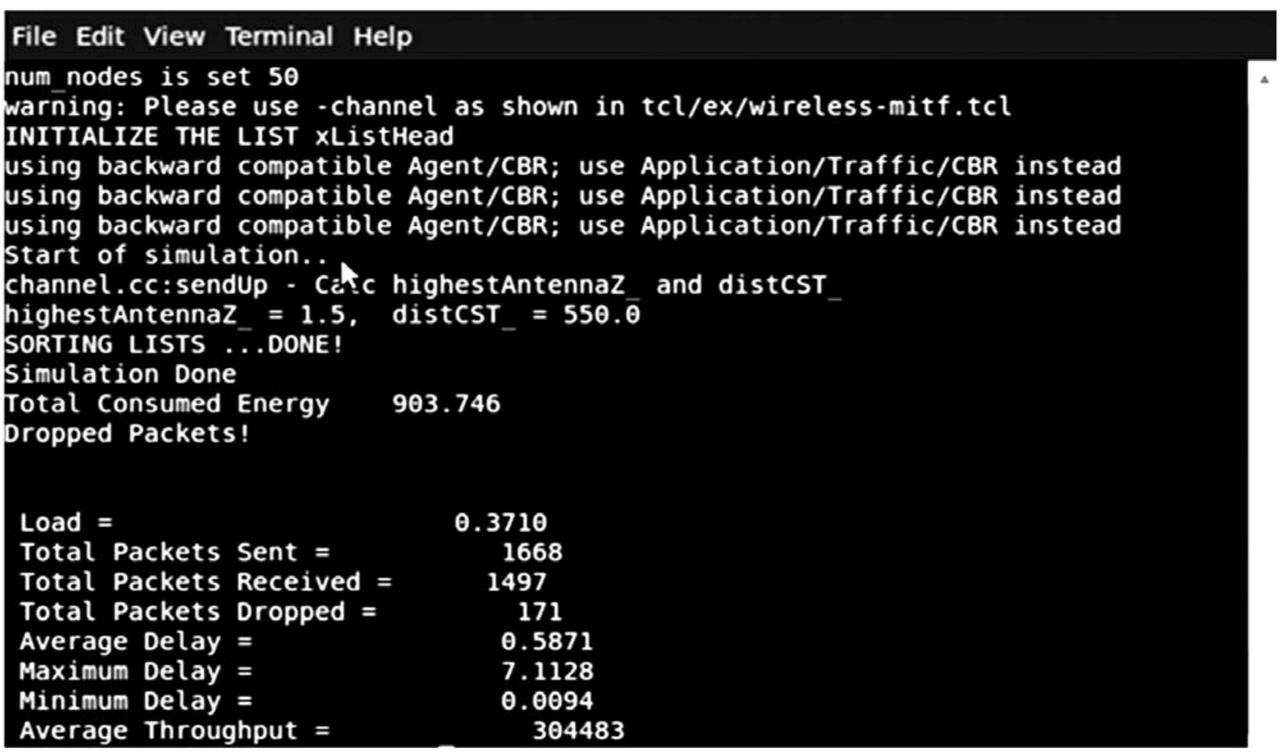

Figure 9: Performance evaluation of AODV

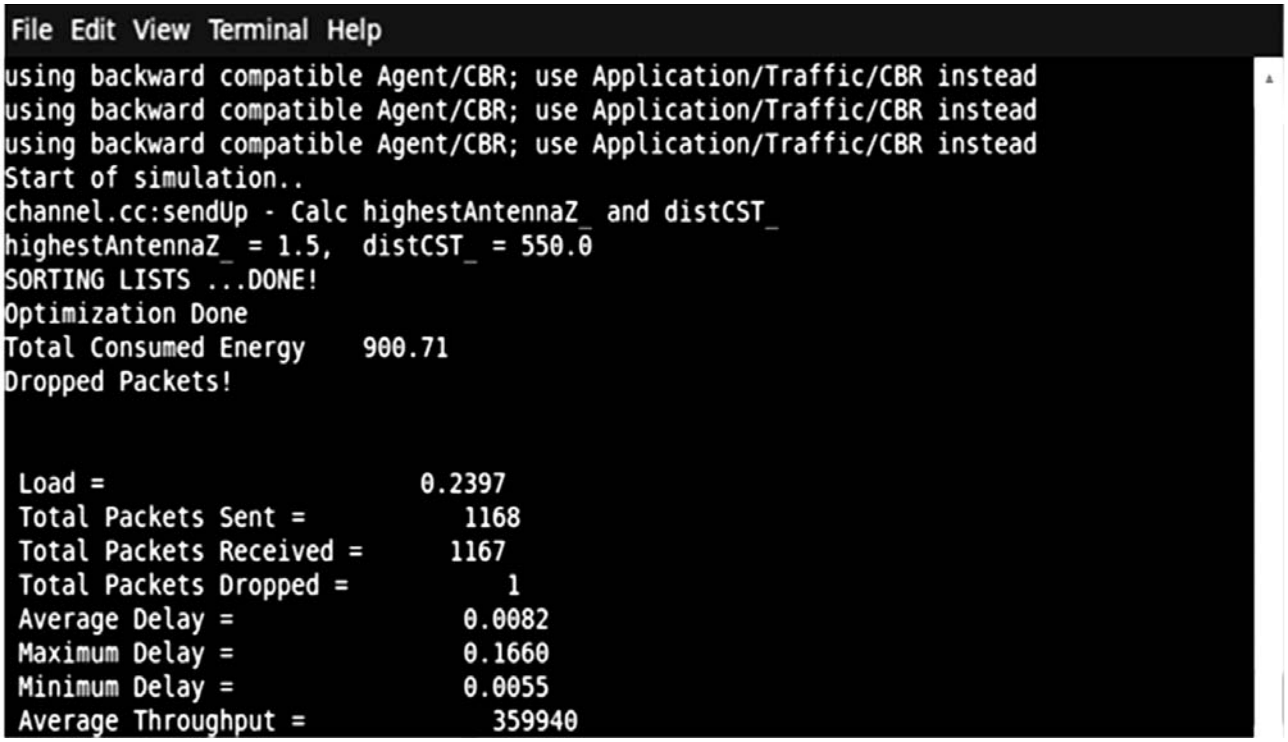

Figure 10: Performance evaluation of AODV-PSO

Table 3
Performance metrics

Performance Metrics	*AODV*
Total Packets Sent	1668
Total Packets Received	1497
Total Packets Dropped	171
Packet Delivery Ratio	0.8974
Average Delay	0.5871
Maximum Delay	7.1128
Minimum Delay	0.0094
Average Throughput	304483

The table 3 is about the evaluation of the modified AODV-PSO. The evaluation is performed on the basis of Total packets dropped, Packet Delivery Ratio, Average delay, Minimum delay, Maximum delay and Average throughput.

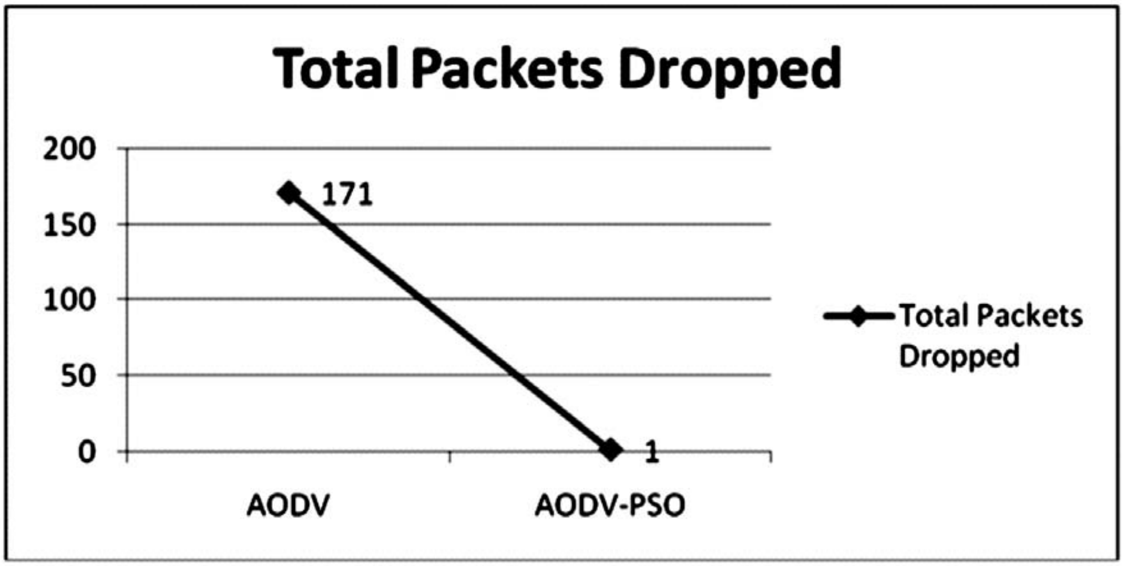

Figure 11: Packets dropped of AODV & AODV-PSO

The "Fig. 11" depicts the graphical view of comparing of total packets dropped of simple AODV and the modified AODV-PSO.

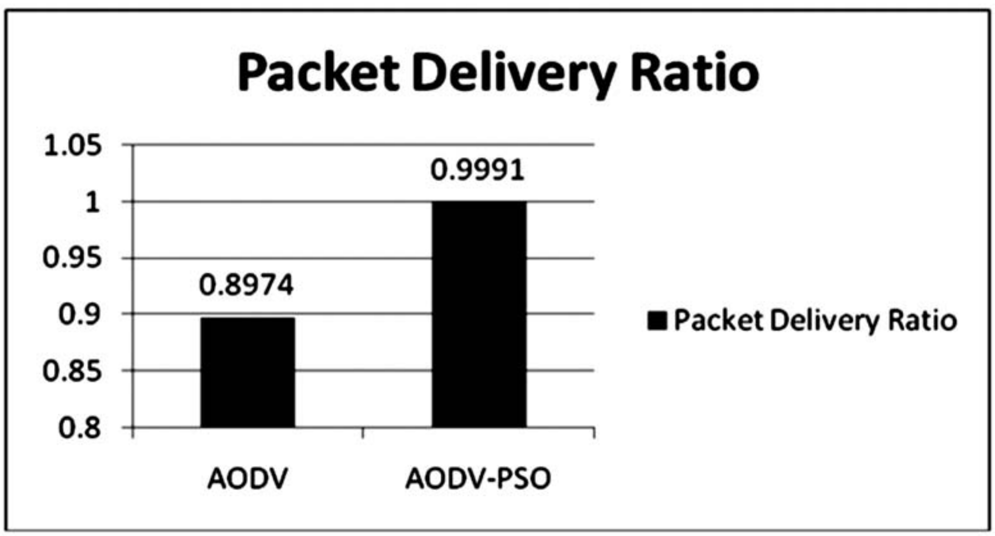

Figure 12: Packet Delivery Ratios of AODV & AODV-PSO

The "Fig. 12" depicts the graphical view of comparison of Packet Delivery Ratios of simple AODV and the modified AODV-PSO.

The "Fig. 13" depicts the graphical view of resembling of average delays of simple AODV and the modified AODV-PSO.

The "Fig. 14" depicts the graphical view of comparison of average throughputs of simple AODV and the customized AODV-PSO.

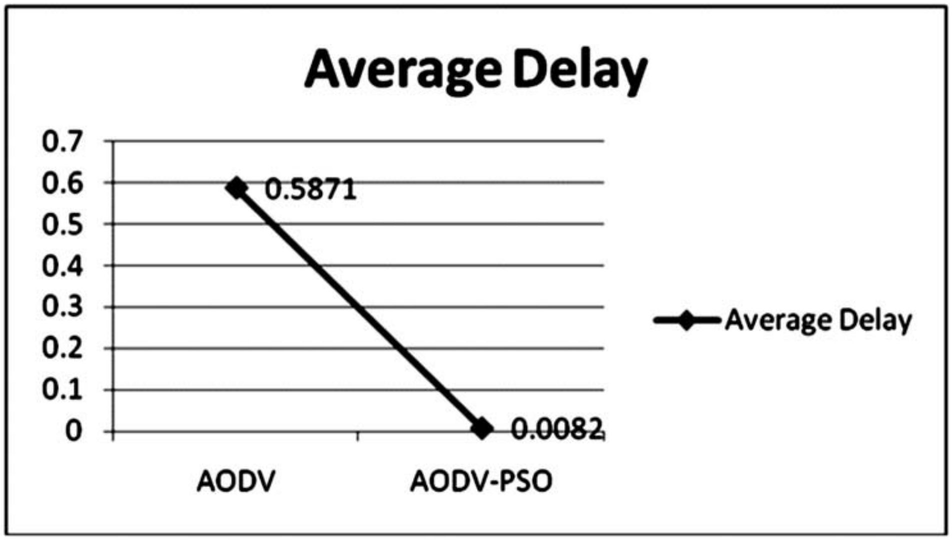

Figure 13: Average delays of AODV & AODV-PSO

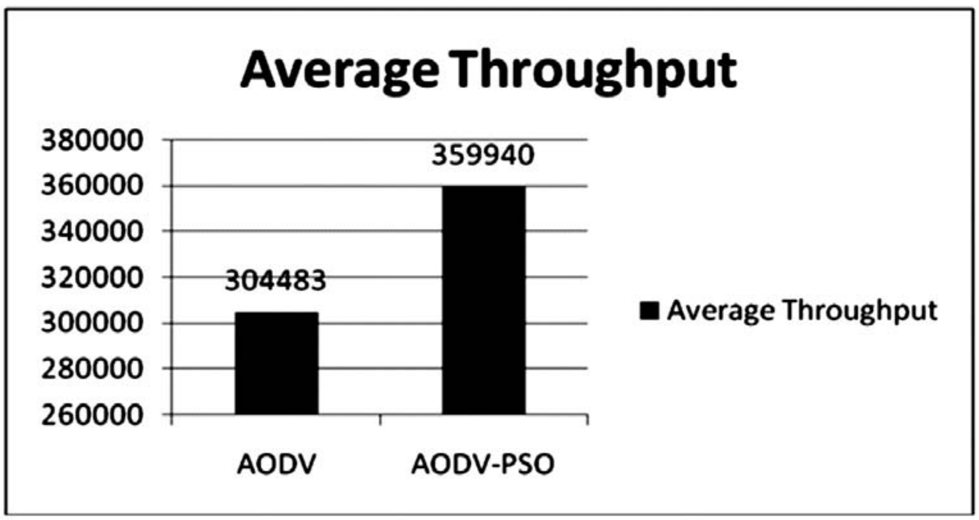

Figure 14: Average throughputs of AODV & AODV-PSO

5. CONCLUSION AND FUTURE SCOPE

The Performance of Wireless Sensor Network is enhanced by the proposed Algorithm based on AODV with PSO protocol in terms of increased Packet delivery ratio, decreasing the average delay, increased average throughput and decreasing total energy consumption during execution. The Proposed Algorithm first calculates the route and then the route is optimized with PSO. The performance metrics compared with the competitive AODV and these metrics are PDR, average delay, average throughput, total energy consumption are evaluated and. in the Network Simulator tool The assessment of work is done. The proposed scheme in the work provides improved performance according to simulation results.In future; in the proposed system the work can be extended to get better the lifetime of network by improving the “Throughput” metrics at various levels. By implementing multi-objective PSO on different routing protocols or Cluster head selection optimization techniques more reduction in the energy consumption can be achieved.

REFERENCES

[1] Shashidhar Rao Gandham, MilindDawande, Ravi Prakash and S. Venkatesa, "Energy Efficient Schemes for Wireless Sensor Networks with Multiple Mobile Base Stations", In the proceedings of IEEE Conference on Telecommunication vol. 1, pp. 377-381, 2003.

[2] Mari Carmen Domingo and Rui Prior, "Energy Analysis of Routing Protocols for Underwater Wireless Sensor Networks", Journal of Computer Communication, vol. 31, pp. 1227-1238, 2008.

[3] Xiao Hui Li, Seung Ho Hong and Kang Ling Fang, "A Heuristic Routing Protocol for Wireless Sensor Networks in Home Automation", In the Proceedings of 5th IEEE conference on Wireless Communication, Networking and Mobile Computing, pp.1-8, 2009.

[4] SudipMisra and P. Dias Thomasinous, "A simple, Least-Time, and Energy-Efficient Routing Protocol with One-Level Data Aggregation for Wireless Sensor Networks", Journal of System and Software, vol. 83, no. 5, pp. 852-860, 2010.

[5] Jalel Ben-Othman and Bashir Yahya, "Energy Efficient and QoS Based Routing Protocol for Wireless Sensor Networks", Journal of Parallel and Distributed Computing vol. 70, no. 8, pp. 849-857, 2010.

[6] Chenn-Jung Huanga, Yu-Wu Wanga, Hsiu-HuiLiaoa, Chin-FaLina, Kai-Wen Hub and Tun-Yu Changc, "A Power-efficient Routing Protocol for Underwater Wireless Sensor Networks", Journal of Applied Soft Computing, vol. 11, pp. 2348-2355, 2011.

[7] Amir Hossein Mohajerzadeh and Mohammad HossienYaghmaee, "Tree Based Energy and Congestion Aware Routing Protocol for Wireless Sensor Networks", Journal of Wireless Sensor Network, pp. 161-167, 2010.

[8] Muhammad Saleem, Gianni A. Di Caro and MuddassarFarooq, "Swarm Intelligence Based Routing Protocol for Wireless Sensor Networks: Survey and Future Directions", Journal of Information Science, vol. 181, pp. 4597-4624, 2011.

[9] Basma M. Mohammad El-Basioni, Sherine M. Abd El kader, Hussein S. Eissa and Mohammed M. Zahra, "An Optimized Energy-Aware Routing Protocol for Wireless Sensor Network", Egyptian Informatics Journal, vol. 12, pp. 61-72, 2011.

[10] DionisisKandris, MichailTsagkaropoulos, IliasPolitis, Anthony TzesandStavrosKotsopoulos, "Energy Efficient and Perceived QoS Aware Video Routing over Wireless Multimedia Sensor Networks", Journal of Adhoc Network, vol. 91, no. 4, pp. 591-607, 2011.