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Ant Colony Optimization Based Energy Efficient Routing Algorithm (AERA) for Mobile sink Based WSN

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Abstract*— WSN means for Wireless sensor network .WSN consists of a large number of nodes which communicates together through sensing and by monitoring the physical world. There are many application of WSN .In this paper, different protocol of WSN has been discussed, the analysis has shown that the most of the presented technique has abandoned the issues like the effects of the mobile descend in the most of the energy efficient protocols has been ignored. Moreover the effect of lossless data compression has been abandoned by the researchers. Also no optimization technique is considered for the effective route selection in ERA protocol. Therefore to overcome these issues, an Ant colony optimization based energy efficient routing algorithm (AERA) has been proposed Also the performance of AERA and ERA under mobile sink based wireless sensor networks has been evaluated.

***Index Terms*—Wireless sensor network, Protocols of WSN, Applications of WSN.**

I. INTRODUCTION

WSN means for Wireless sensor network .WSN consists of a large number of nodes which communicates together through sensing and by monitoring the outer world. An instant sensor network is composed of a massive number of servers (nodes) which are employed for sensing the outer world. The different sensor nodes are arranged in such a way so that they'll sense and observe the progress in the network. In WSN, sensor nodes collects the info and send the composed information to the key node which will be called as sink and it has the highest energy and then sink node collects the info which will be sent by the sensor nodes. These networks are mobile unprepared networks and also don't take the burden of receiver and sender. These networks, thus advances the time of a wireless network. It generates force balancing among the whole network. Wireless sensor networks are utilized in a numerous applications like medical, military. Different applications of WSN have been described below.

A. To monitor the area

To monitor the region is really a general usage of WSNs. In this, the Wireless Sensor Network is bought into action over a place where we should monitor some event.

B. To monitor health care

The medical applications of WSN are of two types: wearable and implanted. Wearable devices are made used on body surface of an individual being. The implantable medical products are those devices which are inserted in the human body. There are many other applications of WSN too e.g. to position body measurement and precise location of the individual, to overall monitor of ill patients in hospitals. Body-area networks are used to collect details about the health of an individual and fitness, and energy expenditure..

C. Air pollution monitoring

Wireless sensor networks have now been found in various places to monitor the awareness of risky gases present in the society. These networks mostly work on the ad hoc networks rather than on the wired networks, making them movable for testing different areas. WSN takes advantage of different ad hoc wireless links which makes them mobile suitable for testing the readings in different geographical areas.

D. Structural Health Monitoring

To monitor the civil infrastructure and related geo-physical processes close to real time use the appropriately interfaced sensors and over long periods through data logging.

E. To Monitor the Environment

Environment monitoring is also a great application of wireless sensor network. It is used to oversee various parameters which generally include water level , barometric pressure and various other parameters. Based on these analysis they provide various different kinds of applications and services for the end users. User can collect the information through any website or application in console terminal. Based on the information received user can use different data mining techniques to analyze when and where an action should be taken place and so that user can trigger some alarm once anything is detected in the environment The characteristics of wireless sensor Network has been discussed below.

- Communication failures
- Ability to endure severe environmental conditions
- Ability to deal up with failing of nodes.
- Homogeneity and heterogeneity of nodes
- Scalability to large range of deployment
- Easy to use.
- Stationary and mobility/ flexibility of nodes**.**

II. CLUSTERING TECHNIQUE

In clustering various sensor nodes are grouped in the form of clusters. In each and every cluster there is a cluster head which acts as a leader of the cluster. All nodes which belongs

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to that particular cluster have to send their respective data to the cluster head of that particular cluster and then cluster head is responsible for aggregating the data and sends that aggregated data to base station directly.

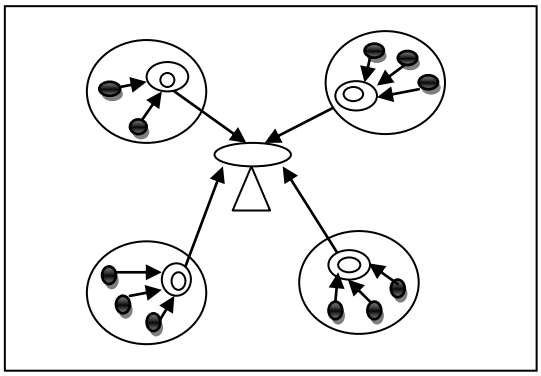

Fig 1: Architecture of clustering ([13])

Only cluster heads have the ability to perform direct communication with base station. Clustering is useful for Useful energy consumption and it also declines the communication overhead for both single and multi-hop networks.

III. ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORK

Routing in WSN varies from traditional routing in different networks in different behavior. There is no communications, wireless links are undependable, some sensor nodes fail, and routing protocols have to assemble authoritarian energy saving condition. Many routing methods were designed for WSN in general. All of the main routing protocols suggested for WSNs are classified into different categories as shown in the table 1. The evaluation of routing protocols in different category in prior sub-sections.

Table 1. Routing Protocol

Category	Representative protocols
Location Based Protocols	MECN, SMECN,GAF,GEAR,span,TBF,BVGF,GeRaF
Data- Centric Protocols	SPIN, Directed Diffusion, Rumor Routing, COUGAR, ACQUIRE, EAD, Information-Directed Routing, Gradient-based routing, Energy Aware Routing, Information Directed Routing, Quorum-Based Information Dissemination , Home Agent Based Information Dissemination.
Hierarchical Protocols	LEACH, PEGASIS, HEED, TEEN, APTEEN.
Mobility Based Protocols	SEAD, TTDD, Joint Mobility And Routing , Data MULES, Dynamic Proxy Tree- Base Data Dissemination .
Multipath Based Protocols	Sensor-Disjoint Multipath , Braided Multipath, N to 1 multipath discovery
Heterogeneity Based Protocols	IDSQ,CADR,CHR
QoSBased Protocols	SAR, SPEED, Energy Aware Routing.

IV. LITERATURE SURVEY

Hady Ohydrates. Et al. [1] offered different approaches from the literature to manage a lot of the simple complications challenged by a good indicator multilevel layout. Consequently, method makers were required to deal with individual's popular difficulties. This, in a roundabout way, features a primary impact within the complexness in the protocols as well as upon energy usage of protocols. Rather than making use of that will strategy, they offered BEES, the mild structure methods. Amgoth, et al. [2] suggested an energy conscious routing formula intended for cluster dependent WSNs. The formula relies upon over a amazing tactic involving cluster brain (CH) variety, continuing energy in the CHs and the intra-cluster distance intended for cluster progress. To complete data routing, the focused exclusive anchor involving CHs is created that may be rooted for the kitchen sink. The suggested formula may be shown to stability energy consumption of CHs throughout data routing procedure. Beheshtiha et al. [3] produced OR-AHaD, it really is a good Opportunistic Course-plotting formula with specially Adaptive Harvesting-aware Obligation Riding a bicycle. From the suggested formula, applicants are mostly prioritized by making use of usage of physical zoning as well as later synchronized in a very timer-based fashion by swapping coordination emails. Simulation effects indicate that will OR-AHaD can make the use of readily available energy assets with incredibly efficient way so because of this enhances consequence compared to some other opportunistic routing protocols intended for WSN-HEAP. Chen et al. [4] designed a brand new distributed adaptive bunch pecking order routing process for networks. This routing technique will be distributed in nature and selecting bunch go had been solely motivated by means of the thought of vitality distribution among the nodes inside the community. The actual Working in the process had been split into a few key stages of development. Eventually, bunch needs to post facts for their bunch at the same time. This process overcomes every one of the cons associated with LEACH and LEACH-C process. Chamam et al. [5] reviewed distributed vitality efficient bunch formation opportunity for WSN's. This process elects this bunch go through the use of a few method message swapping idea. Furthermore that deemed the thought of recurring vitality with regard to selection of bunch go course of action. The actual Several key communications traded among nodes ended up. N. Dang et al. [6] suggested to be able to continually change the force specifications associated with sensor nodes depending on availability

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associated with green vitality resources, community routing needs and application high quality restrictions - coping with these trade-offs will be distinctive taking part. They will displayed a new book criteria find the optimal consistent facts high quality with regard to predicted facts selection in a multi-hop Energy-Harvesting Wireless Sensor Network (EH-WSN). Y. Dong et al. [7] suggested some sort of redirecting requirements that separates the actual sensor nodes many arranging units along with watches the degree of energy of every sensor. That criteria bills electric power use amid devices, and thus runs the actual system life span. Simulation final results verify of which criteria outperforms the actual EECCR criteria**.** Elbhiri, Rachid et al. [8] made Distributed Electricity Productive Clustering strategy to double inside heterogeneous cellular sensor communities. That idea is dependent in enthusiastic along with good method of assortment of chaos brain. This system ended up being for the idea of dynamic balancing of one's equally one of many nodes within the system. Andrei Gagarin et al. [9] suggested a brand new heuristic answer to identify a amount balanced along with small weight redirecting spanning tress in a system. That idea is a superior kind of kruskal's spanning sapling seek criteria and it's also in regards to the perception of distributed seek by pecking order of clusters. Ganesh et al. [10] personalized the actual ad-hoc on need range vector redirecting simply by signal-to-noise relation (SNR) structured powerful clustering. Huang, Ru et al. [11] provided a Predication method structured Routing Algorithm dedicated to ACO (PRACO) to achieve the energy-aware data-gathering direction-finding framework throughout WSN. They executed collection design ARMA to gauge powerful habit throughout information traffic in addition to look at the structure of load element, which may help reveal the future strength reputation of sensor throughout WSN. By examining the stress aspect in heuristic element in addition to recommended simply by fresh pheromone modernizing idea, man-made ants can certainly foresee neighborhood strength condition of networks and the equivalent behavior might be adaptively consumed entirely to enhance the power effectiveness throughout direction-finding growth. Hong, Zhang et al. [12] proposed a useful in addition to powerful cluster structure protocol for heterogeneous multilevel WSN. This particular protocol centers just about the cluster scalp choice method. With this, cluster heads are generally chosen about the base of one's which they have inside a specific rounded in addition to moreover, you should consider the power that this node takes in throughout every single rounded. With this just about all nodes are generally assigned somebody position time, in addition to in people specific time slots node convey with cluster scalp in addition to dependant on designated slots conversation method maintains on-going after which it cluster scalp is liable for having every one of the information which was obtained simply by nodes after which it right after having which cluster scalp convey while using the bedrooms foundation section directly. This particular protocol is used to remove the actual negatives of LEACH, SEP, DEEC protocols. Kandasamy et al. [13] used the multipath non-redundant information distribution strategy for concern centered redirecting structure to help to boost usage of electricity with instant sensor network. Continuous expansion from the WSN need to have redirecting protocol that should be cautious pertaining to alternative electricity sources seeing that in comparison with dependable non-renewable electricity sources with sensor nodes. PISA can be a QoS aware redirecting useful for course collection predicated on target. Direction-finding determined by concern with photo voltaic power instant sensor network is actually achieved utilizing APOLLO in addition to PISA. So electricity preserving is actually obtained pertaining to real-time course breakthrough. Khan, Y. et al. [14] advised fresh clustering approaches with redirecting methods, Location-Aware Permanent CH (LPCH) in addition to User Defined Location-aware Long term CH (UDLPCH). Within equally these kind of methods, network subject is actually divided in to a couple of regions, comparative a number of nodes tend to be arbitrarily applied with each and every location.. J. Kim, et al. [15] advised Nutritional, the Virtual spinal Sapling Protocol pertaining to Lowest electricity use with WSN redirecting. Nutritional offers more energy-efficient redirecting compared to EVBT in addition to MCBT, on account of efficient picking connected with upstream url. Although the simulation studies, ViTAM in performed effectively along with little electricity use along with a adequate network life span with WSN redirecting. Pratyay Kuila et al. [16] described which clustering sensor nodes is a wonderful process which increases the scalability in addition to life time of a WSN.

V. PROBLEM STATEMENT

The review has shown that the most of the existing techniques has neglected the following use.

1. The effects of the mobile sink in the most of the energy efficient protocols have been ignored.
2. The effect of lossless data compression has been neglected by the most of the researchers.
3. No optimization technique is considered for the effective route selection in ERA protocol.

So in order to remove these issues two new approaches has been proposed in this work.

VI. PROPOSED METHODOLOGY

The methodology which has been proposed has been described below.

Step 1: Initialize the wireless sensor network with the various features.

Step 2: Define sensor field with the specific position of the sensor nodes and also the base station

Step 3: Now cluster head selection strategy come in action to choose some of the sensor nodes as cluster heads.

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Step 4: Now association of the member nodes with the cluster heads will be done by using the lowest distance formula between the member nodes and the respective cluster heads.

Step 5: Apply inter cluster data gathering technique to blend data from the cluster heads and compress it before sending to the base station .

Step 6: Now evaluate the route using the Ant colony optimization and communicate the data from the cluster head(s) to the base station.

Step 7: Count if any dead node and examine whether all nodes are dead. If all dead the show network lifetime and return else move to step 3.

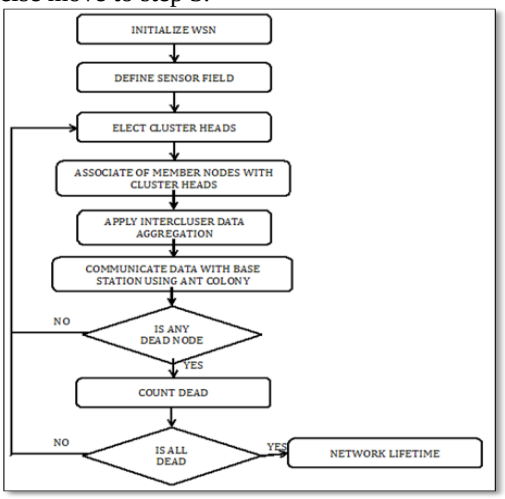

Fig 2: Proposed Methodology

VII. RESULTS OF ERA

Figure 3. is showing the area of sensor networks where white diamonds represents sensor nodes. Blue diamonds are cluster heads. Stared blue is depicting the cluster head and magenta lines are representing the communication between the cluster head and the base station and green diamond symbol is representing the base station and blue lines are depicting the cluster area**.** Figure 4 is showing the dead network and at the end all of the nodes present in the network has become dead. The no. of dead nodes in the network is equal to total no. of nodes present in the network initially. In this case we have initially taken 100 nodes and total no. of dead nodes in the network at end are also 100.

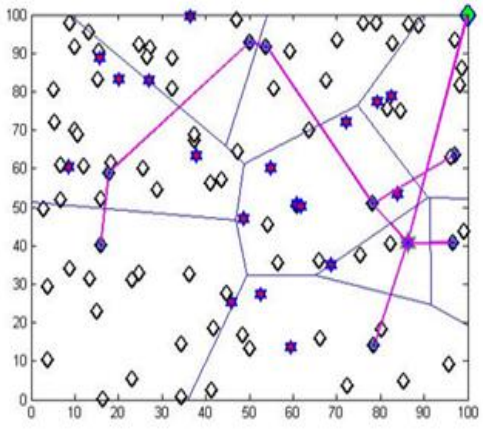

Fig 3: Network Model of ERA

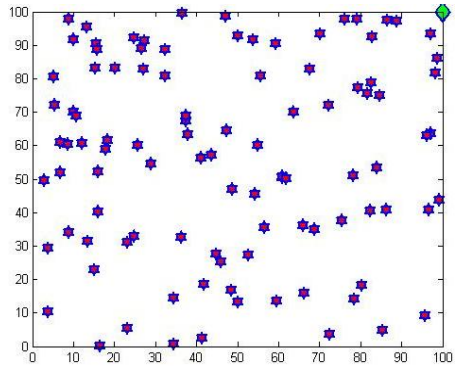

Fig 4: Dead nodes

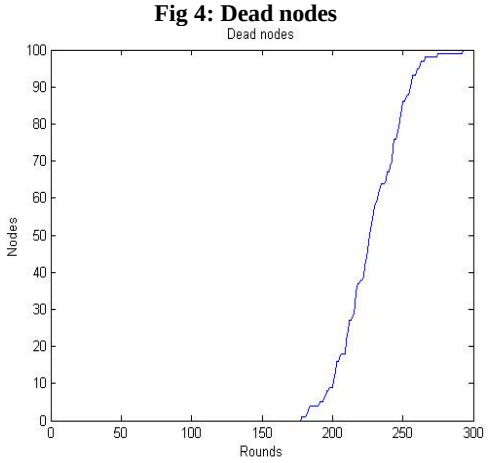

Fig 5: Graph of dead nodes

Figure 5 is clearly showing the dead nodes present in the network. It can be easily concluded from the graph that the time taken for first node to become dead is 175 rounds and last node has become dead at 290 rounds. Figure 6. is showing the remaining energy of the network. Initially the remaining energy of the network was full which was assumed to be 10 (full) and as the no. of rounds goes on increasing the remaining energy goes on decreasing and after 250 rounds it has become zero.

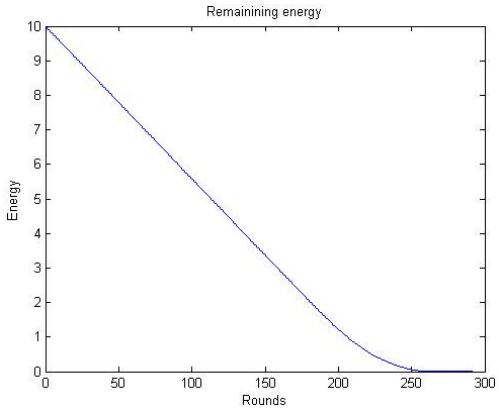

Fig 6: Graph of remaining energy of nodes

VIII. RESULTS OF ACO ERA

Figure 7 is showing the area of sensor networks in which white circle represents sensor nodes. Blue circles are cluster heads and blue lines are depicting the cluster area. Green line is depicting the distance between sink to relay cluster.

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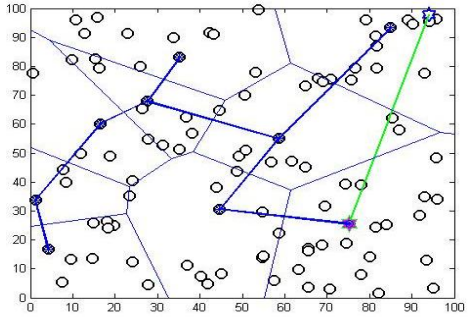

Fig 7: Network Model of ACOERA

Figure 8 is depicting that all the nodes in the network has become dead. In this figure it is being shown that red circles are the dead nodes and in it no. of dead nodes are 100. Figure 9 is showing the remaining energy of the network .As no. of rounds goes on increasing the remaining energy of the network goes on decreasing and at the end remaining energy of the network has become zero.

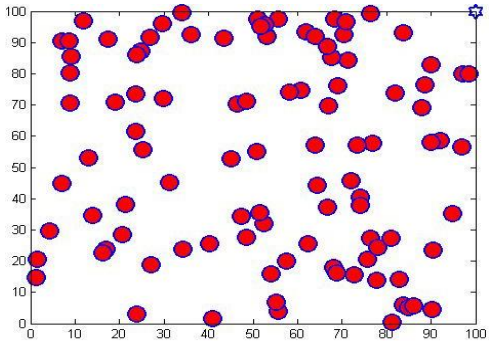

Fig 8: Dead nodes present in the network

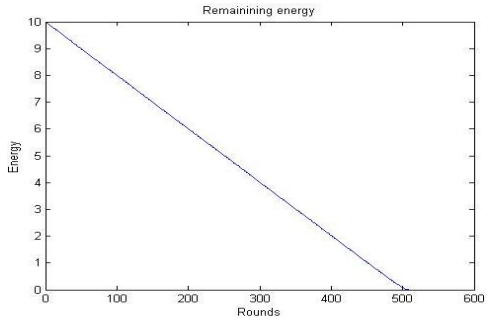

Fig 9: Graph of remaining energy of network.

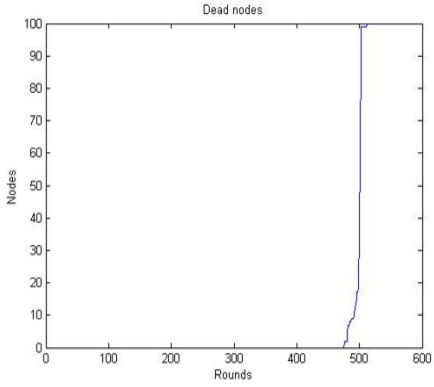

Fig 10: Graph of dead nodes of network

Figure 10 is showing the graph of dead nodes present in the network .As no. of rounds goes on increasing the no. of dead nodes in the network goes on increasing and at the end the total no of dead nodes present in the network becomes 100.

IX. RESULTS OF MOBILE ERA

Figure 11 is showing the area of sensor networks in which white diamond represents sensor nodes. Blue diamonds are cluster heads. Stared blue is depicting the cluster head and magenta lines are representing the communication between the cluster head and the base station and green diamond symbol is representing the base station and blue lines are depicting the cluster area.

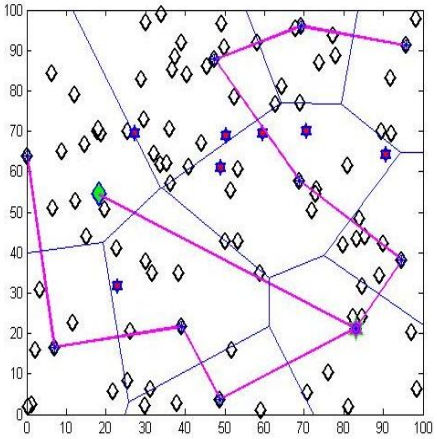

Fig 11: Network model of mobile ERA

Figure12 is showing the remaining energy of the network of sensor nodes in which the remaining energy was assumed to be full initially at starting of zero round and as the no. of rounds goes on completing the remaining energy of the network goes on decreasing and at the end of 270thround the total remaining energy of the network has become zero. And there is no more energy left in the network.

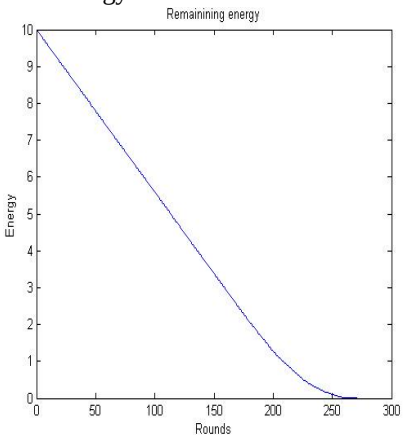

Fig 12: Analysis of remaining energy of nodes

Figure 13 is showing the no. of dead nodes present in the network .Initially all the nodes are alive in the network means there is no dead nodes. At the end of 150th round first node has become dead and at the end of approximate 260th round all the

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nodes present in the network has become dead, showing that at the end of 260th round total no. of dead nodes are 100.

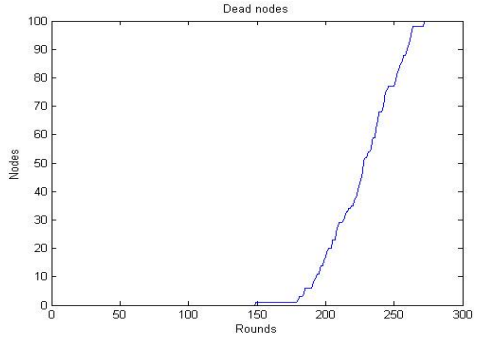

Fig 13: Analysis of dead nodes

Figure 14 is showing the no. of dead nodes. All the blue color diamonds are depicting the dead nodes and at the end whole of the nodes in the network are dead which is being shown in this figure and green diamond symbol is depicting the base station.

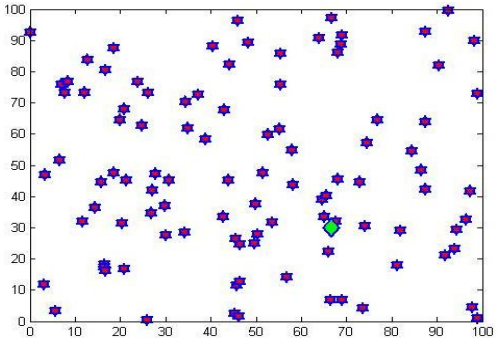

Fig 14: Dead nodes analysis

X. RESULTS OF MOBILE ACO ERA

Figure 15 is showing the area of sensor networks in which white circle represents sensor nodes. Blue diamonds are cluster heads. Stared blue is depicting the cluster head and blue lines are depicting the cluster area. Figure 16 is showing the remaining energy of the network. Initially energy was assumed to be full at the starting of the 0th round and as the no. of rounds goes on increasing the remaining energy of the nodes goes on decreasing and at the end of the 500th round the remaining energy of the network has become zero.

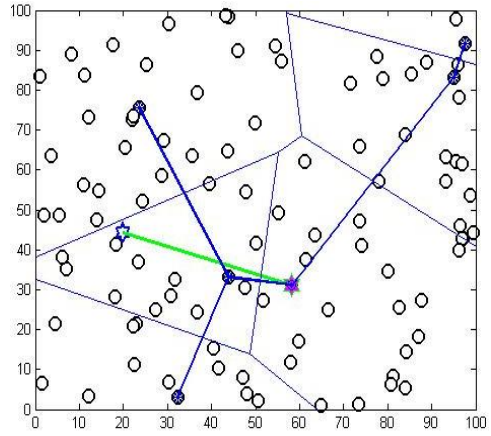

Fig 15: Mobile network of ACO ERA

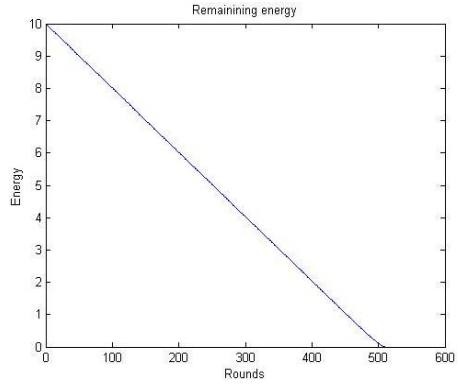

Fig 16: Analysis of remaining energy

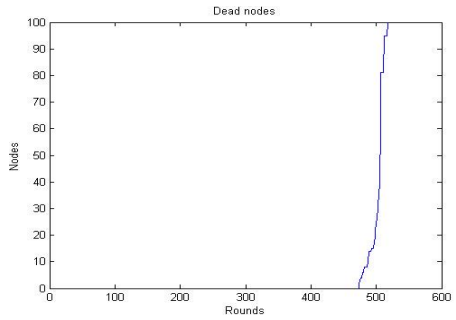

Fig 17: Dead Nodes Analysis.

Figure17 is showing the no. of dead nodes present in the network .Initially all the nodes are alive in the network means there is no dead nodes at approx. 470th round. But as the no. of rounds goes on increasing the total no. of dead nodes present in the network also goes on increasing and at the end of the 500 round, all the nodes present in the network are dead. Figure 18 is depicting that all the nodes in the network has become dead. In this figure it is being shown that red circles are the dead nodes and in it no. of dead nodes are 100.

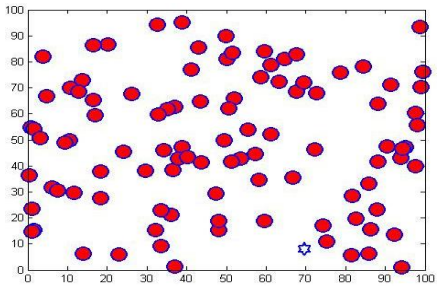

Fig 18: Dead nodes

The comparison analysis of different techniques has been discussed below.

Table 1.Last Node Dead Time

Energy	ERA	ACO ERA	Mobile ERA	Mobile ACOERA
0.1	323	511	271	517
0.11	312	561	297	563

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0.12	323	611	315	624
0.13	346	651	353	663
0.14	398	714	374	713
0.15	446	753	400	786
0.16	434	814	451	811
0.17	524	853	446	861
0.18	501	912	489	913
0.19	534	959	505	961
0.2	590	1005	522	1012

Table 1 shows the last node dead time of mobile based sink WSN in this table the comparison of ERA, ACO-ERA, Mobile ERA and Mobile ACO-ERA has been shown according to different energy levels. The graph of the output values has been shown in figure 19.

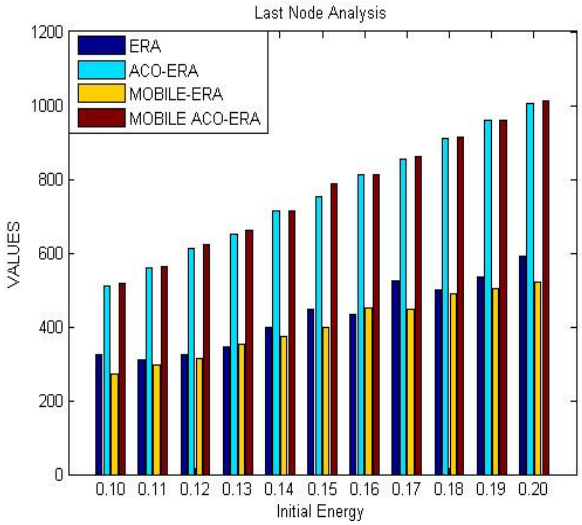

Fig 19: Comparison of Last Node Dead

Table 2 shows the First node dead time of mobile sink based wireless sensor network in this table the comparison of ERA, ACO-ERA, Mobile ERA and Mobile ACO-ERA has been shown according to different energy levels. The graph of the output values has been shown in figure 20.

Table 2. First Node Dead

Energy	ERA	ACO ERA	Mobile ERA	Mobile ACOERA
0.1	169	475	148	473
0.11	175	470	159	487
0.12	222	554	178	515
0.13	222	583	200	583
0.14	264	640	215	641
0.15	266	711	267	654
0.16	285	769	286	710
0.17	305	791	297	791
0.18	308	830	316	787
0.19	345	806	347	873
0.2	366	919	360	938

Table 3 shows the Packet Sent to Base Station of mobile sink based wireless sensor network in this table the comparison of ERA, ACO-ERA, Mobile ERA and Mobile ACO-ERA has been shown according to different energy levels. The graph of the output values has been shown in figure 21.

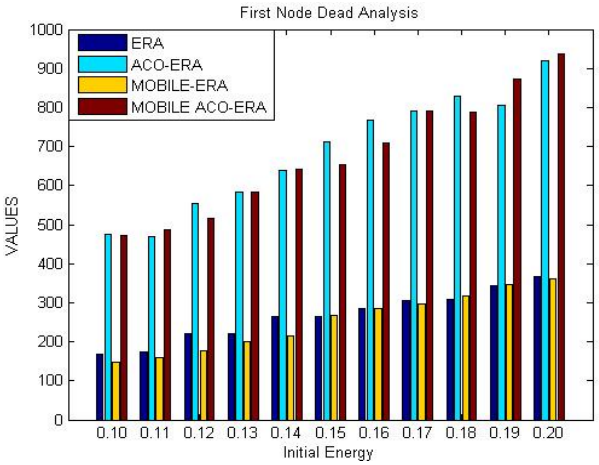

Fig 20: Comparison of First Node Dead

Table 3. Packet Sent to Base Station

Energy	ERA	ACO ERA	Mobile ERA	Mobile ACO_ERA
0.1	0.4060	0.5110	0.2770	0.6090
0.11	0.3490	0.5670	0.3540	0.5750
0.12	0.3900	0.6260	0.3470	0.6240
0.13	0.3730	0.6610	0.4370	0.6780
0.14	0.5020	0.7140	0.4240	0.7250
0.15	0.5380	0.7540	0.4980	0.8420
0.16	0.6040	0.8140	0.5340	0.8180

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0.17	0.7220	0.8610	0.4980	0.8670
0.18	0.5560	0.9660	0.6190	0.9130
0.19	0.6470	0.9840	0.5680	0.9750
0.2	0.6710	0.9136	0.5790	0.9345

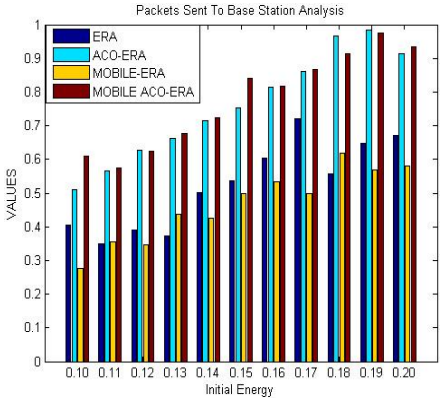

Fig 21: Packet Sent to Base Station

Table 4. Packet Sent to Cluster Head

Energy	ERA	ACO ERA	Mobile ERA	Mobile ACO_ERA
0.1	22.2240	49.2860	22.3480	49.5960
0.11	24.5190	54.4590	24.5090	54.3200
0.12	26.7430	59.2940	26.7390	59.3570
0.13	28.9260	63.3920	28.9010	64.2640
0.14	31.1490	69.1300	31.1717	69.3990
0.15	33.2810	73.8550	33.3790	74.5160
0.16	35.5530	79.0350	35.7660	79.0720
0.17	37.8090	83.4060	37.9070	84.2960
0.18	39.8620	89.1460	40.1380	89.5090
0.19	42.1940	93.2660	42.2270	93.9770
0.20	44.4240	89.4082	44.7080	89.9736

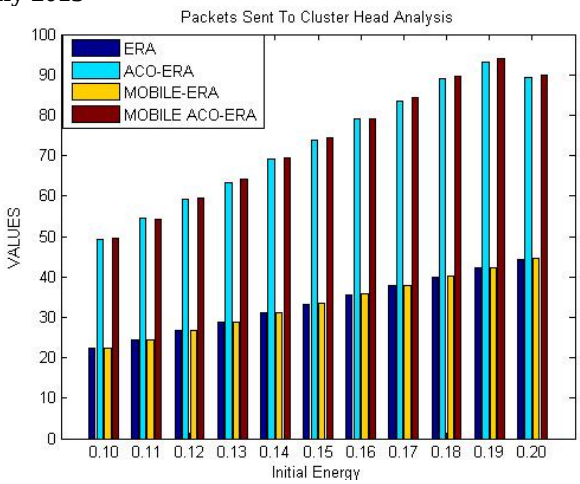

Fig 22: Packet Sent to Cluster Head

XI. CONCLUSION AND FUTURE WORK

In this paper, the review has shown that the most of the existing technique has neglected the issues like the effects of the mobile sink in the most of the energy efficient protocols has been ignored. Moreover the effect of lossless data compression has been neglected by the most of the researchers. Also no optimization technique is considered for the effective route selection in ERA protocol. Therefore to overcome these issues, an Ant colony optimization based energy efficient routing algorithm (AERA) has been proposed Also the performance of AERA and ERA under mobile sink based wireless sensor networks has been evaluated. The comparison has been drawn between ERA, and proposed AERA based on the following parameters like First node dead time, Network life time, Dead nodes, Remaining energy, Packets sent to base station and Packets sent to cluster head.

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