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Energy Efficient Data Aggregation Approach for Wireless Sensor Networks

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***Abstract*:- Power consumption is one of the most essential issues while designing a wireless sensor network. A proper selection of paths for data transfer can result in reduction of energy consumption which in turn increases the network lifetime of Wireless Sensor Networks (WSN). Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is considered as most important issue. Newer Routing protocols are required to fulfill the need of less power consumption in WSN. To minimize the power consumption of any wireless sensor network an energy efficient clustering algorithm known as LEACH is most widely used. There are several clusters of sensors in which LEACH is partitioned the localized coordination and control is utilized for constructing this approach. In this work, the mobile sinks are deployed in the network for data aggregation from the wireless sensor nodes. The proposed algorithm is implemented in MATLAB and results are analyzed in terms of dead nodes, alive nodes and number of packets transmitted. It is analyzed that in the proposed algorithm EDEDV (Enhanced Dynamic Estimation of Data Value), number of dead nodes are less, alive nodes are more and number of packets transmitted to base station are also high as compared to existing DEDV (Dynamic Estimation of Data Value) algorithm.**

Keywords*:- *WSN, LEACH, Dead Nodes, MATLAB, DEDV, EDEDV.

I. INTRODUCTION

A distributed type of network in which there are large numbers of sensor nodes are deployed such that the surroundings of the area can be monitored and important information can be gathered is known as wireless sensor network. The sensor nodes present within the network are very small in size and have very less power for processing the tasks [1]. The users can gather process and then transmit the important information that is available within the surroundings as per the changes. There are very strict computing and processing capabilities available. The small sized computers that gather information from the network are known as motes. They provide multi-functioning and are also energy efficient [2]. Within the area of interest, there are several small sized, low cost and multi-functioning sensor nodes deployed such that a wireless sensor network is generated. The data can be sensed, processed and communication facilities can also be provided by the sensor nodes due to the available sensors, microprocessors as well as radio transceivers, even though they are small in size. A wireless medium is used for providing short distance communications and for accomplishing a common task, these nodes collaborate with each other. There are several unique properties as well as characteristics of wireless sensor networks which differentiate them from other existing networks. Several physical conditions or parameters can be identified or monitored with the help of sensors. In comparison to the conventional wired sensors, there are particular advantages seen within wireless sensor networks [3]. Not only the cost or delays of deployment are minimized here but within any of the scenarios these networks can be deployed. Across the region of interest, these sensor nodes are distributed which communicate with each other using multi-hops [4]. Thus, an ad hoc network is generated here through such deployments. There are limited and irreplaceable energy resources present within the sensor nodes. The information that is gathered by the nodes from the network is processed and stored by the special sensor nodes which are known as sink node or gateway nodes. For performing data acquisition, battery is an important component present within these nodes. However, the replacement or recharging of these sensor nodes is not possible. There are few energy generating units known as photo-voltaic cells within are used to create batteries. Limited amount of energy of order 1 to 2 J is provided through node acquisition since these batteries are very small in size [5]. Thus, the life of a sensor is limited and the overall performance of the network is affected due to this. In comparison to conventional routing that was used in fixed networks, the routing of wireless sensor networks is very different. There are unreliable wireless links since the network is infrastructure less. There is failure of sensor nodes and strict energy-saving needs are to be provided through the routing protocols. Generally, there are several routing protocols introduced by different researchers. There are various categories into which all these routing protocols are categorized. The information about location of sensor nodes plays an important role within the location-based protocols. Initially, this routing protocol was proposed for MANETs. However, due to its property of providing energy conservation, WSNs also use this type of protocol. Depending on an energy model that provides energy consumption, the Geographic Adaptive Fidelity (GAF) protocol is generated [6]. In order to route the queries to the target regions present within the sensor field,The equipment of a localized hardware is important here by the sensors. Since the data is transmitted here from the source sensors towards the sink, the data-centric protocols are very different from other protocols. The data is sent independently by each sensor to the sink by each source in

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which appropriate data is available in case of the address-centric protocols [7]. A protocol through which the classic flooding protocols were enhanced and several problems being faced by them were solved is known as Sensor Protocols for Information via Negotiation (SPIN). There are several viewpoints with respect to which the hierarchical clustering in WSN has been studied by different researchers over time. For transmitting the sensed data towards the sink, an energy-efficient communication protocol known as clustering is utilized. The power consumption is minimized by applying the energy efficient clustering algorithm known as Low-energy adaptive clustering hierarchy (LEACH). Depending upon the duration, the task of performing clustering is rotated amongst the nodes through this approach.

In the proposed algorithm EDEDV, the mobile sinks are deployed in the network for the data aggregation from the wireless sensor nodes. All the simulation work is implemented in MATLAB and it is observed that, the proposed algorithm is effective to reduce the number of dead nodes which will increase the number of alive nodes. Numbers of packets transmitted to base station are also high as compared to existing algorithm.

The rest of the paper is organized as follows: Section 2 presents related work in this area, In Section 3, the proposed work has been defined, Section 4 describes results & discussions and section 6 is having future work.

II. RELATED WORK

RaminYarinezhada, et al. (2018) observed that the closeness of sensor nodes towards the sink leads to more traffic loads in the wireless sensor network, due to which large amount of energy is depleted. It is also required to know the position of the mobile sink prior to senor nodes in order to transfer their data into it [8]. There is more consumption of energy and increase in the delay of network when the nodes are informed about the sink position. A routing algorithm based on the virtual grid infrastructure and mobile sink is proposed. With the help of proposed method and with the use of virtual infrastructure some of the nodes were selected using which the position of the sink was maintained. On the basis of obtained results, it can be concluded that the proposed method shows better performance as compared to the other methods in terms of energy efficiency and delay.

Anu, Silki (2018) presented a Revised Low Energy Adaptive Clustering Hierarchy- Ant Colony Optimization (RLEACH-ACO) routing protocol for enhancing the energy efficiency of WSNs. Performance of proposed approach was evaluated on the basis of varying number of nodes, number of rounds and position of base station. Simulation results have shown that proposed protocol reduces total energy consumption; increases number of packet delivered, reduces the number of dead nodes and provides an optimal route.

Hassan Oudani, et al. (2017) presented that the lifetime of the network is affected due to the more consumption of the energy by each node within the wireless sensor network. Therefore, reduction in the network traffic toward the sink is possible by developing some hierarchical protocols to deal with this and to increase the lifetime of the network. The survey was performed on the energy-efficiency using hierarchical cluster-based approach namely LEACHES. [9]. A new method was proposed in order to maximize the lifetime of network sensor. With the help of this method large amount of energy was consumed when data was transmitted to the base station.

Nukhet Sazak, et al. (2017) proposed an active node determination method (ANDM) for WSN MAC design in order to improve the energy efficiency. The most significant design issues faced while deploying the nodes in the constrained of resources in the remote location is energy efficiency as these nodes are left unattended for long time within the wireless sensor network [10]. The presented integration of ANDM with ETDMA was compared with E-TDMA and it was concluded that it provides better energy usage up to 31 %approximately.

Harshita Jain, et al. (2017) studied that the limited lifetime of the battery is considered as the major issue in the wireless sensor networks. It is not an easy task to change the battery of WSN all the time as it is not possible for a human to reach in the region of difficult area where nodes are deployed. They discussed some energy efficient routing protocols of WSN in their work. The frequent updation of the routing tables leads to the reduction in packet overhead due to which energy consumption can also reduced [11]. They combined the dynamic source routing (DSR) with power efficient gathering in sensor information system (PEGASIS) with the help of which optimal path is determined as it used the GA and BFO.

Vivek Kumar Singh, et al. (2017) studied that the efficiency, reliability, heterogeneity, scalability, robustness, privacy and security are some of the major challenges faced by the WSN [12]. They proposed a method using which the life of sensor in wireless sensor network can be enhanced and can be made more reliable and energy efficient using new cluster based approach. The prevention of the crashes of cluster head node means the network reliability and the election of cluster head is take care by energy efficiency within the new cluster technique.

Sheikh Tahir Bakhsh, et al., (2017) proposed Adaptive Sleep Efficient hybrid medium access control (AEH-MAC) algorithm which is widely used for making improvements in the wireless sensor networks. The proposed approach minimizes the scheduling time which adjusts the sleep time of the nodes. The proposed [13] technique increases the network lifetime and energy efficiency in a very effective manner. The sleep time can be adjusted dynamically with the help of this introduced approach on the basis of the traffic load and wakeup timing of the neighboring nodes. Further improvements are required for in which ACK packets re generated which can be transferred to the receiver as they consume very less time. According to the simulations performed, it has been concluded that the proposed algorithm has high performance in terms of runtime, energy consumption and slot reservation.

III. PROPOSED ALGORITHM

The proposed methodology is based on sink relocation in wireless sensor to increase lifetime of the networks. The

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whole network will be divided into fixed size clusters and in each cluster heads will be selected. The data of nodes in cluster will be aggregated data sent to its cluster head. The proposed technique will be based on some assumptions as sink knows location of all sensor nodes. The sink will move to cluster head where it wants to take data and it will get location from the stored location of cluster head. The Sink node will adjust its location according to signal strength. The location gets its best position when maximum numbers of cluster heads are in the range of sink. In this work, we have proposed the equation that will calculate signal strength and to judge that how many cluster heads are in the range of sink. The movement of sink will be decided using technique of bee colony optimization. In bee colony algorithm The ABC calculation accepts the presence of an arrangement of operations that may look like some elements of the bumble bee conduct. The "fitness value" alludes to the sustenance source quality that is unequivocally connected to the nourishment's area. The procedure impersonates the honey bee's quest for important sustenance sources yielding a similar to prepare for finding the ideal arrangement. The step by step description of proposed algorithm as shown in Fig. 1 is as follows:

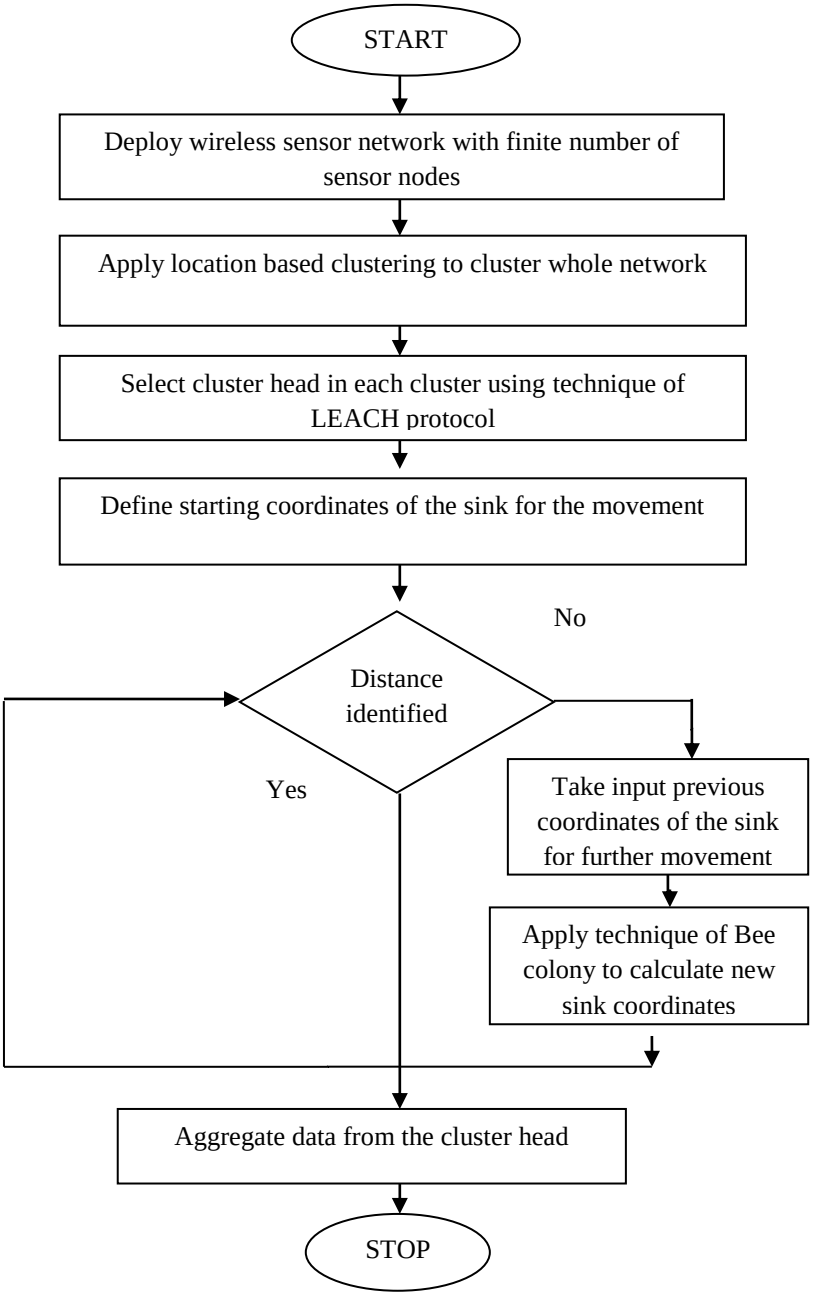

Fig 1: Process flow of Proposed Algorithm

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Step 1: First of all, wireless sensor network is deployed with the finite number of sensor nodes and deployed network is divided into fixed size clusters using location based clustering.
Step 2: The cluster head is then selected in each cluster using LEACH protocol in which node which has maximum energy and least distance to the other nodes is selected as the cluster head. The other nodes in the cluster will aggregate their data to the cluster head.
Step 3: The coordinates of the sink are defined for the initial population for the sink movement. The sink will check the signal strength and change its location of the basis of initial population and aggregate the data from where it will get maximum data.
Step 4: Step 3 is repeated until required data get aggregated to base station
Step 5: The cluster heads which are selected in the network which will aggregate the data to the base station.

IV. RESULT AND DISCUSSIONS

The proposed work is implemented in MALTAB and the results are evaluated by making comparisons against proposed and existing approaches in terms of several parameters. Table 1 shows the simulation set up used in this work to evaluate the performance of proposed algorithm. The area of network is given as (0, 0)–(200, 250). Base Station is located at (150, 250) coordinates in the sensor field. Initial energy of each sensor node is 0.5 J, free space energy is 50 nJ/bit, multipath energy is 0.0013pJ/bit/m^4. The distance threshold is 87m and Data Aggregation Energy is 5 nJ/bit/signal. For the comparison of data packet transmission, Data packet size is taken as 4000bits and Control Packet Size is 200 bits. The simulation have been performed and analyzed using performance metrics including total energy consumption, number of packet delivered and number of dead nodes.

Table 1: Simulation Setup

Parameter	Description	Value
A	Area Of Network	(0, 0)–(200, 250)
L-BS	BS Location	(150, 250)
N	Number Of Nodes In Network	100
$E_{initial}$	Initial Energy Of All Nodes	0.5 J
E_{fs}	Free Space Channel Model	50 nJ/bit
E_{mp}	Multi-Path Fading Channel Model	0.0013 pJ/bit/m^4
d_0	Distance Threshold	87 m
E_{DA}	Data Aggregation Energy	5 nJ/bit/signal
DP size	Data Packet Size In Bit	4000
CP size	Control Packet Size In Bit	200

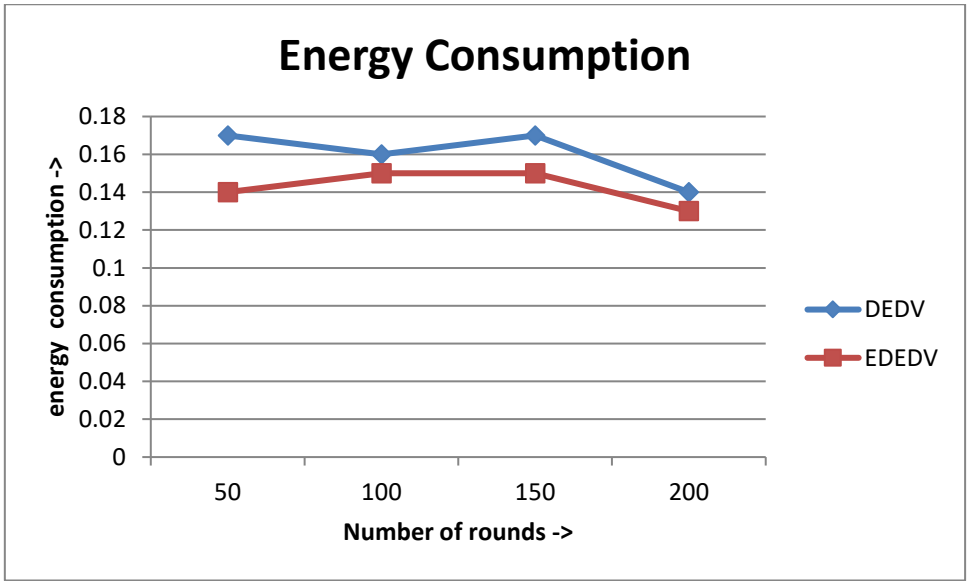

Fig. 2: Energy Consumption

Fig. 2 represents the comparison of existing technique with the EDEDV (Enhanced Dynamic Estimation of Data Value) technique. It results that the proposed protocol has minimum amount of energy consumption in comparison to the other techniques.

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Table 2: Number of Dead Nodes

No of rounds	DEDV	EDEDV
50	1	0
100	6	4
150	15	9
200	37	26

Table 2 show the comparative analysis of proposed algorithm with the existing technique for variation in number of rounds. It can be observed that number of dead nodes is lesser in proposed algorithm as compared with existing algorithm for variation in numbers of rounds.

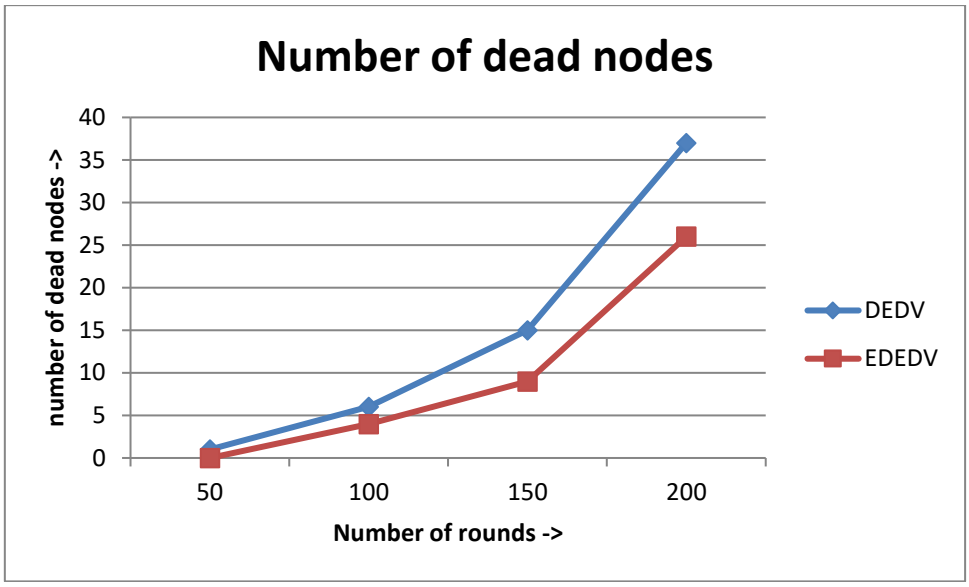

Fig. 3: Dead Node Comparison

Fig. 3 demonstrates the comparison between LEACH protocol and mobile sink technique in terms of the dead nodes. The proposed technique has fewer amounts of dead nodes in the give amount of rounds.

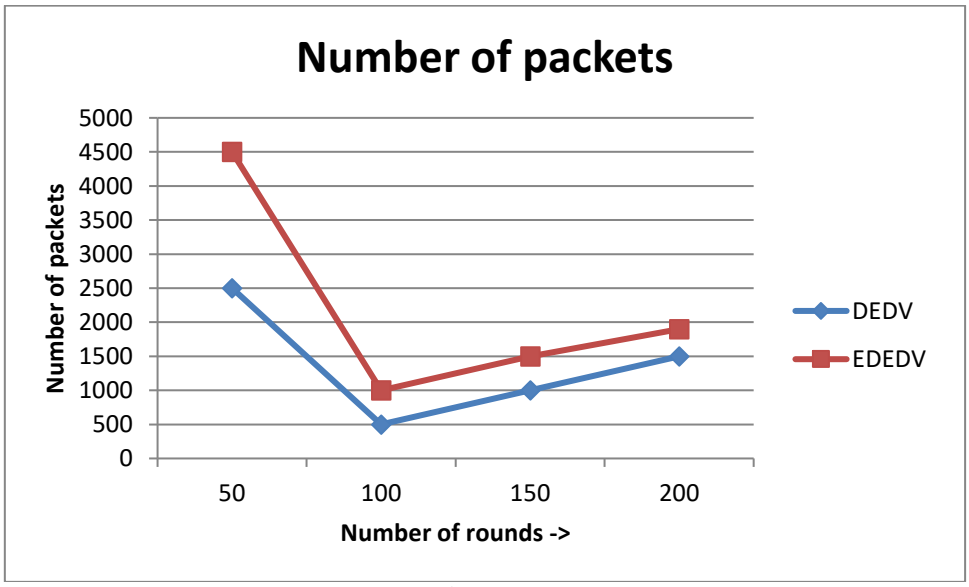

Fig. 4: No. of Packets Transmitted

Fig. 4 shows the comparison between the number of packet transmitted to the base station, in Existing DEDV and Enhanced DEDV technique. The proposed technique transmits the large number of packet in comparison to the other techniques.

Table 3: No of packets Transmitted

Number of rounds	Existing Technique	EDEDV Technique
50	2500	4500
100	500	1000
150	1000	1500
200	1500	1900

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Table 3 gives the comparison on the basis of packet transmission with different number of rounds. The proposed EDEDV algorithm is having better performance as compared to existing algorithm.
As, we can see from simulation results that the proposed algorithm outperforms the existing techniques in different aspects including energy consumption, number of dead nodes and number of packet transmission, so it can be considered as a superior choice for WSN networks.

V. CONCLUSION

The wireless sensor network is the decentralized and self-configuring type of network in which sensor nodes sense information and pass it to base station. Due to such type of network, energy consumption and security are major issues of WSN. The clustering is the efficient approach which increase lifetime of the wireless sensor networks. In the approach of the clustering, the cluster heads are selected on the basis of distance and energy. The cluster heads transmit data to the base station. In this work, the mobile sinks are deployed which aggregate data from sensor nodes and cache nodes with forward data to base station. The proposed Enhanced Dynamic Estimation of Data Value (EDEDV) algorithm is implemented in MATLAB and results are analyzed in terms of certain parameters. It is analyzed that proposed algorithm performs well as compared to existing algorithm in terms of certain parameters.

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