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Accurate and Effective Data Collection with Minimum Energy Path Selection in Wireless Sensor Networks using Mobile Sinks

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Abstract

In many significant characteristics of the modern world, including particular industry, agriculture, and military applications, Wireless Sensor Networks (WSNs) have begun to emerge. Even though energy consumption is the greatest challenge confronting WSNs, it is essential to analyse the feasibility of the use of mobile components for the data collection on WSN networks. To collect information from their sensing terrain, WSNs use significant numbers of wireless sensor nodes. The method of acquiring data from the sensor nodes and forwarding this data to the node or base station is Data Collection (DC). In such methods, data collection is effective and efficient in data transfer for an extended WSN lifetime. The scientific and investigational analysis demonstrated that Routing Path Selection-DC has the robustness and low energy, is required to reduce the mobile sink's energy demand, which provides better results, and is adaptable dynamically to multiple situations, including the variance between the ground robot and the cost of energy. The research paper developed an approach that creates a data collection schedule that is collision-free where appropriate power limits are allocated and verifies its overall performance of virtual environment network latency.

Keywords: Wireless sensor network, Base station, Connection request, Data collection, Mobile elements, Collision-free, Latency

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Introduction

Current wireless networks and embedded systems technologies have led to the formation of sensor nodes known as Wireless Sensor Networks (WSN) with lower energy consumption (Zheng, Ping, et al, 2021), lower costs and a few different uses. A sensor node, which would be an electronic device, would be used for the objective of defining physical situations, communication and manipulation. Sensor networks composed of a large number of sensor nodes, i.e. clients are responsible for monitoring data (Krichen, et al, 2021), sensing networks in addition to communicating with one another and (Khalaf & Ogudo, 2021) A sensor network consists of a collection of sensor nodes that comprise functionality for sensing, data processing and communication (Khalaf, & Ajesh, F, 2020). They use everyone's processing information to communicate simple computations locally and only send the considered necessary and partially processed data, rather than to send raw data to the sensor nodes. Network monitoring, environmental monitoring, industrial and machine health monitoring, investigations of wastewater and disaster monitoring are among the typical sensor network applications (Hamad, & Al-Obeidi, 2021). It is appropriate to collect the information sensed by the sink node so that it could be stored. As in Figure 1, in a fully-connected layer, data can indeed be communicated wireless communication via radio links to a sensing station or data sink. In other cases, mobile node carriers like animals, humans or Robots could be configured with sensor nodes to act as a sink node for collecting all sensed data from sensor nodes (Wisesa, 2020). A few different data collection techniques have been reviewed in WSN applications to gather data.

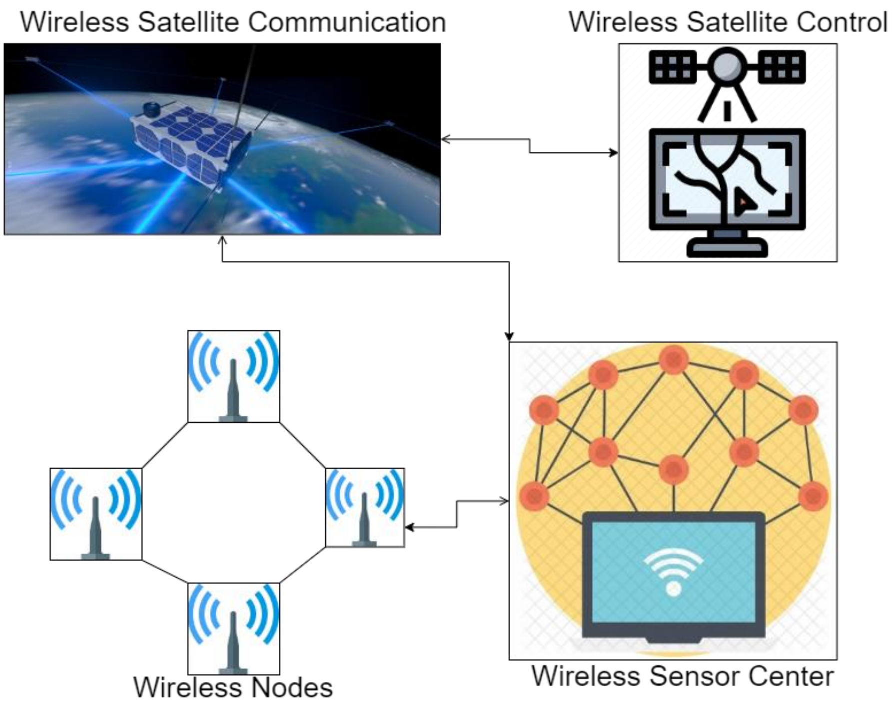

Figure 1. WSN Model

In this work, researchers suggest collecting data with mobile sink (MS) from fixed sensor nodes. It is essential to plan the best route for MS to travel for significant sensing regions with many sensing nodes. Total routing time, energy consumption and the choice of a suitable route optimization algorithm must be viewed.

This paper seems to be about the MS dynamic optimization issue. Mobile devices perform as transporter machines that keep moving around the sensing network to collect and connect data from the sensor nodes to the BS. The Shortest Time to visit each node from and to a fixed base station (BS) is one solution for the MS (Thivagar, 2020). His is the standard Routing Path Selection based on travelling salesman problem and will be used as a primary solution in some cases. Either single / multi-hop is the communication between the source sensors and the MS. The data will be collected over a long time depends on the maximum storage capacity of a sensor node and the sensor's battery life. If data is collected at a level that exceeds the node's storage capacity during the battery life of the unit, then perhaps the node must be recovered entirely or the data transferred to a different stage before full battery expenditure (Subahi, 2020).

Through the latter particular instance, when assessing the deployment time for sensor nodes, the energy costs for the data transmission must be taken into consideration. The data collection method is proactive and flexible (Xiang, & Li, 2021). Data distributed continuously across the network and retransmitted subsequently by the proactive method, sensed and mobile device. Reactive sensors transmit their data to a mobile sink as a reaction for sensing sink requests for information in the method of data collection.

This research deals with the issue of mobile data collection in order to implement the following key features:

- This article needs to clearly define for MS' routing path selection for data collection throughout most of the Sensor Nodes (SN). And all SN are encompassed by the location and range of the SN. This path is the best path to be configured, subject to certain restrictions.
- Maintain that the absolute minimum time delay is equal to the timespan of delay enforced by the recommendation under review. And the travel time of a mobile element is significantly reduced while multi-hop communication prevented.

Literature Review

WSNs received significant attention and problem from research and business for more than a decade. A WSN is high-performance computing implemented from a collection of individual wireless sensor nodes, which generally send information directly to the fundamental datasets for assessment via wireless networks (Dawood Salman, 2019). The growth of light and straightforward sensors for factors such as linear and angular acceleration, magnetic field strength, temperature, pressure, moisture, audios and videos have led to significant advances in Micro-Electro-Mechanical application system. Consistent with low-cost sensors and small, low-cost and battery-operated WSN computing and communications systems (Ogudo, & Muwawa, 2019). The modest data processing and communication statistics are combined to each sensor node. (Thivagar, & Hamad, 2020) A network of many of these nodes can way of measuring high spatial and time-resolution climatic factors with the only power grid needed to return the data to the database via a sink node.

The energy limitation of each sensor node means that energy conservation in the sensing networks has been one of the main challenges. (Abdulsahib, 2018) Wireless communications in WSN consume a considerable amount of energy in a node. The consumed energy is directly commensurate with the corresponding transmission distance. (Sulaiman, & Abdulsahib, 2014) However, information sharing between long-range node-base stations is usually not motivated. Sensor nodes in multi-cluster two-hop networks are coordinated in networks that use LEACH.

The assumption of synchronising can significantly reduce the amount of long-path transmissions. At LEACH the nodes are often local clusters, and one node behaves as the head of the clusters. Each non-cluster head node will transmit its data to the destination, and the head node will send data from all active nodes and must carry out the necessary channel estimation on the cluster head. It's so much fuller of energy than a non-cluster head node as a cluster head node. If it was feasible to which was before-select and conformed the cluster heads during the system's lifetime, these nodes would rapidly use their reduced power. Once the cluster head is powerless, the cluster head is no longer functional, and all cluster nodes lose communication capabilities. (Khalaf, Abdulsahib, & Kasmaei, 2020) In important to deter a sensor system battery drained in the network, LEACH, however, would provide a random motion of the high-power cluster head position between the sensors. This collects the energy load between the nodes of a cluster head efficiently (Prasad, Rachna, 2020).

The purpose is to balance the network's power by changing the mobile element position during the operation and transmit the collected data through sensors to MBS without a long-time buffer. (Osamh Khalaf, 2020) An optimal dynamic way of saving energy by replacing the foundation. Every round, when the base station changes its location, the energy of the sensor nodes is less residual. A rendezvous method has been proposed, that large amounts of data can be collected with mobile elements without roaming for a long-range to reach extensive bandwidth data with the lowest communication delay. (Abdullah Hamad, 2020) In which specific nodes act as meeting points where data from the source node were saved. Mobile elements approach RPs and collect cached data before reliable Time and transfer it to the base station.

Proposed Methodology

Data are sensed and transferred to the sink via sensor nodes, which are implemented in a specific field. Then, by end-users of applications, the base station is again analysed for the data. Furthermore, there is a problem when broadcasting data directly to sink nodes at the sensor nodes with low energy resources. The suitable data algorithm to obtain data from the sensor nodes therefore needs to be created energy-efficient to accomplish the objective of the sensor network, used to boost network lifetime significantly.

Researchers understand that there are 'N' numbers of dynamically uniformly located sensor nodes for data collection or event monitoring in a square area, given by a geographical location. In the squared controlled region, a single mobile sink navigates the data collection in one-hop communication. It continues to follow the proposed model of mobility for the collection of data throughout the coverage area. Sink collects sensor data, which are within the sink's radio transmission range. One data collection process is followed. The steps, data collection is carried out.

There are two types of data collection: one is proactive and the other reactive. Data are distributed and stored in the entire network for the later recovery of the sink in a proactive data collection method. Data are sent to the sink after the discovery of the presence or query of the reactive data collection process. Our model follows the collection of reactive data. Figure 2 presents the data collection case diagrams. The case diagram shows that the data collection happens in one hop with a set of process. The experimental setup of the sink must be mentioned. The sink movement is then compared with the proposed model of mixed mobility.

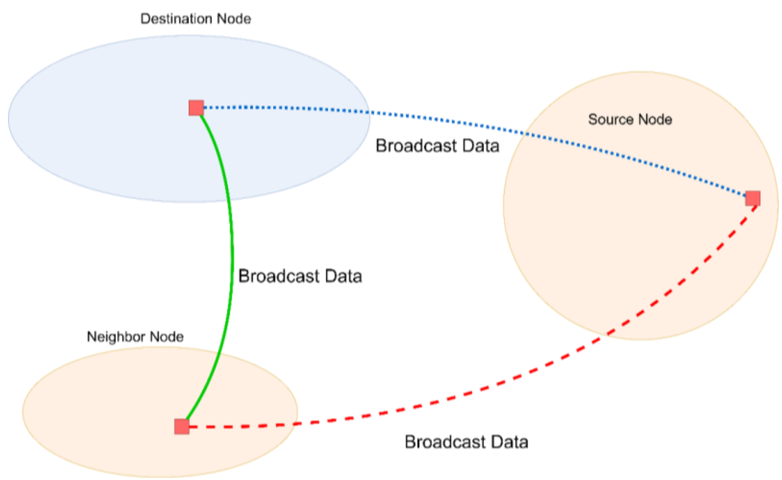

Figure 2. Data Collection Flow of WSN

Data Collection Techniques Using Mobile Elements

For WSNs, it is critical to creating a cost-effective data collection method. For large-scale sensor networks, several types of data collection technologies have been developed. Based on previous work, there are three main approaches to the collection of sensory data from the sensor in the sensor networks: Wireless Base station (WBS), Wireless Data Centre (WDC) and gathering methods. The way of regularly changing the WBS location is to guarantee a balanced time- and power-use of the high-energy loops near the base station. The WDC should, therefore collect and exchange data from sensor nodes via the network to the dataset and gather information from the selected node hop communication networks.

Routing Path Selection (RPS) - Data Collection (DC)

Selection of route – like the MS path routine where the MS travels the precise locations of each sensor node. To collect information, the MS must visit each sensor node. The network consists of sensor nodes that test data at different rates. In this case, some sensor nodes must be visited in comparative analysis to others several times. They needed to mitigate the loss of information due to a buffer overflow two heuristic algorithms, Deadline First and Minimum Weighted Sum First. This proposed algorithm will give priority to visiting sensor nodes with the close Time, the cost of visiting a node will be essential to meet this Node of the previous Node, and this cost is used to weigh the node's time limit so that the sensing node with the minimum amount weighted will be first visited.

Algorithm for Mobile Sink based Routing Path Selection

Step 1. Initialization

Step 2. E_t= Execution Time

Step 3. S_t= Simulation time

Step 4. I_t= Ideal time

Step 5. $SN_p(p, q)$ = Sink Node Position

Step 6. Broadcast (ID, Initial Phase / End Phase) = Broadcast of Sink Node Beacon

Step 7. Setup Sink Node Position = $SN_p(p, q)$

Step 8. $Z=I_t$

Step 9. $E_t=0$

Step 10. Recall SN

Step 11. SN= Broadcast (ID, Initial Phase)

Step 12. For While ($Z \leq E_t$)

Step 13. SN= Receive Data Packets

Step 14. End For

Step 15. If ($Z \leq E_t$) Then

Step 16. SN= Broadcast (ID, End Phase)

Step 17. End If

Step 18. Fresh SNp = (p1,q1)

Step 19. Until ($E_t = Z$)

Step 20. End

Routing Path Selection Refinement

The distance of the path of the moving element can be improved on the individual node, where it is a collection point. However, the mobile element is fair enough to visit communication areas where the disconnected loops are located. This was reducing the overall routing time of the mobile element. A new collection of an isolated node as a middle line of the link between the intersection between the transmission range of that node and the path line of the mobile element is determined in the proposed algorithm. This scenario for many isolated nodes is clearly shown in Figure 3.

Moreover, a collection point that is connected with several sensor nodes is possible, since another adjacent collection point has linked these nodes. Transform to lead to an increase of the mobile element's track length; remove the collected points. To do this, assume the mobile element travel after the RPS algorithm is computed.

The distribution centres are then excluded from S_T if the sensor nodes linked with S_i are linked to

$$S_i-1,\ S_i+1 \tag{1}$$

For instance,

$$S_T = \{S_1, S_2, ..., SM\ , S_1\} \tag{2}$$

$$S_i = (S_i \cap S_i+1) \cup (S_i \cap S_i-1) \tag{3}$$

Figure 3 illustrates the example of a) randomly distributed, defined intersection points sensor nodes for this scenario. b) RPS applications at the transition point. c) update ME path to every single node.

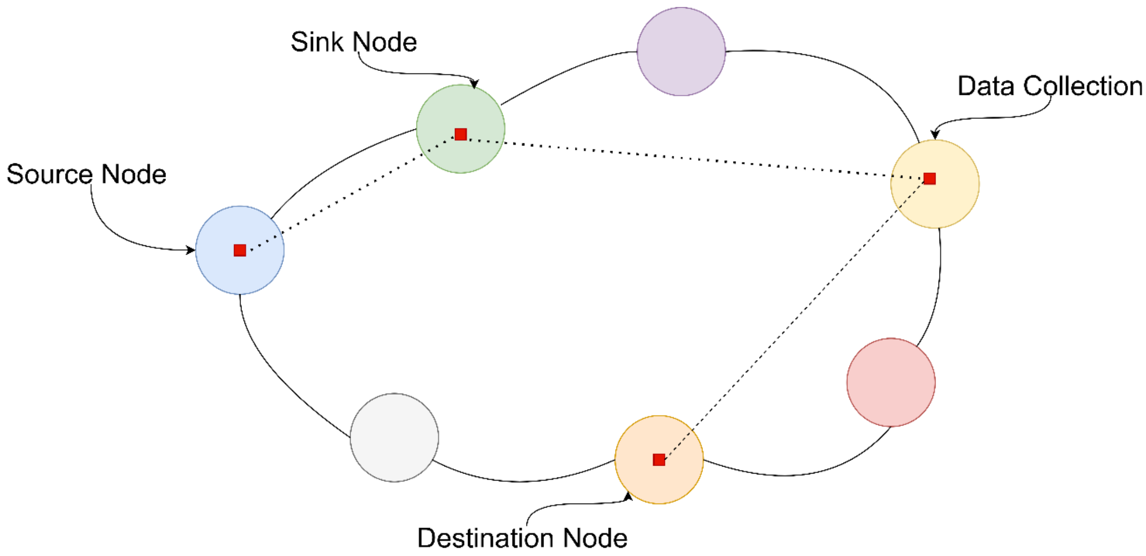

Figure 3. Data Distribution of Sink Node on WSN

Energy Consumption Model

WSN's expected lifespan depends on how long each sensor node performs. Thus, a model that describes the energy usage of each sensor node action impacts to a significant extent the lifetime of the networks. In the proposed work, we assume a method in which the broadcasting dissipates the transmitter/reception sensor with energy=100 J and the transmissions system with the transmitter = 100 J to achieve a satisfactory EB/No.

The energy needed for data transmission over a path length of L

$$EL = Energy + Time \tag{4}$$

And the energy to accept k bits of information is

$$ER = Energy \tag{5}$$

Where certain D the distance between the transmitter and the sink denotes. With a significant networking protocol, each sensor sends its data directly to the BS. When the BS is far away from nodes, for direct communication, a large volume of signal strength is permitted in each node. The nodes' battery is drained rapidly, and the network life is reduced. Nodes route their packets via intermediate nodes to the base station.

Therefore, nodes act in order to have access to remote sensing as routers for other nodes. In determining routes, existing routing protocols take into account the transmitter energy and neglect the recipient energy disoperation. The total energy used on the system could be higher in multi-hop transmission than direct transmission to the base station, depending on the relative cost of transmitter amplifier and radio electronics. Assume that the number of intermediate nodes is 'N' in the destination and that each adjacent node is also distinguished between them by the distance 'D.' The total distance from source to source is, therefore 'Nr.' When transmitting a single k-bit message from the 'N' base station to the base station, we consider energy costs for each node.

A node with the technique to direct communication located a distance from the base station

$$E_{Path} = ET\ (k, d = n * r) \tag{6}$$

The packet transfer via the intermediate "N" nodes, meaning that it requires transmitting 'N' times and receiving 'N-1' times

$$ER = (S_N - 1)\ Energy \tag{7}$$

However, the total energy preservation to be obtained is

$$Energy = k((2S_N - 1)\ Energy \tag{8}$$

The energy efficiency is in direct communication with the base station,

$$E = ET + ER \tag{9}$$

According to the above equations, the total energy is from one-hop communication at N-hop distance from the source to sink.

Result and Discussion

Throughout this article, we analyse the performance of the proposed model and compare it to the existing static network technology. The test was carried out in NS-3. In the 1000x1000 metre area, we have chosen to take 100 modifications sensor nodes. Each sensor node initially will have the same level of energy, which means 1 joule and 50 metres of transmission range. The transmission and energy receipt is 150 *J*, and the antenna is 200 *J* to reach a practical option. In this section, we evaluate our results Mobile Sink WSN model with the traditional Flooding Protocol and the Flat Routing Sensor Protocol. Source negotiates first between neighbours before data transfer begins. In this kind of network, which tends to the MAC sublayer, overhead communication becomes a significant issue. Sensors forward the packets to the sink node and collect them from the simulation model using the CDMA protocol (Figure 4).

Table 1. Simulation Result Node Latency

Node	Proposed	Existing Method	No. of Bad Networks	SN Latency
10	230.13	219.37	5	21.12%
20	564.16	466.31	2	28.15%
30	778.27	585.48	1	31.17%
40	977.14	716.11	0	34.16%
50	1016.46	946.65	1	41.17%

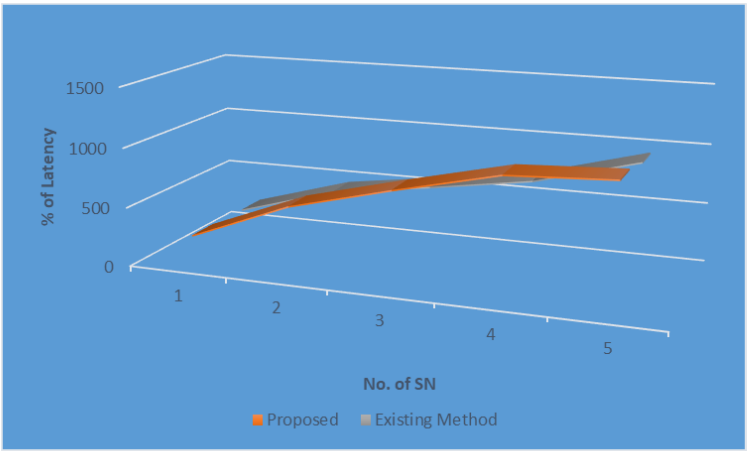

Figure 4. Simulation of Error

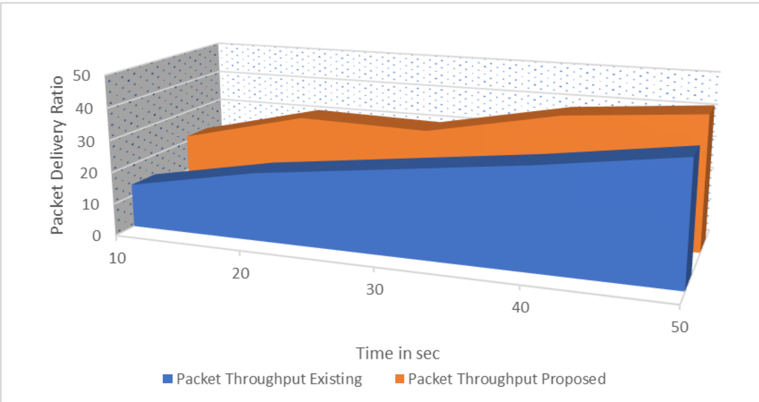

Figure 5. Delivery Ratio vs Time

Figure 6 illustrates the routing protocols delivery ratio. The flood supply ratio was significantly greater than that recommended due to its redundant nature of data demand. The delivery ratio has decreased as soon as the Node energy expires. The difference between the minimum and maximum supply is lower than floods in the proposal. The delivery ratio of the research methodology is almost 100.

Figure 6. Residual energy of the WSN vs Time

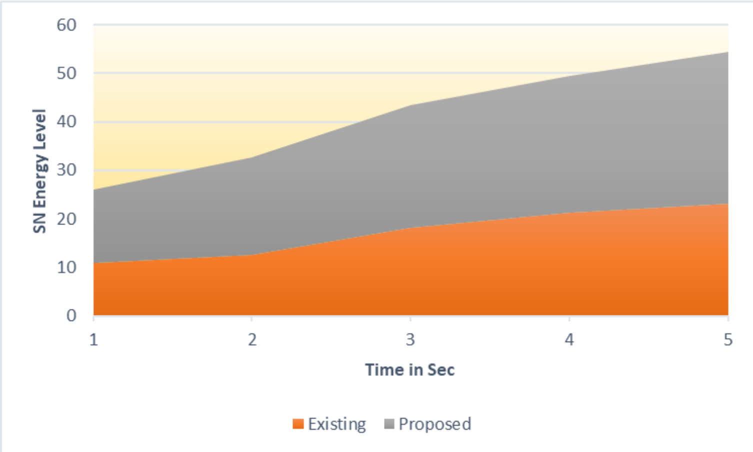

Figure 6 indicates the comparative analysis with network power consumption between the mobile sink data collection and ensure secure data collection. The remaining node energy of the network at the first simulation is 100 *J*. We have already presented the technique used for collecting data from mobile sinks for the WSN is especially in comparison. After a fixed period, because of the represent significant from the sink and distributes through the network, each node measures its key it changes energy consumption dramatically.

As described in the introduction part, the network delay is significantly decreased through the use of additional mobile elements. This decrease, that being said, will cost the design and implementation of the network. In order to limit the maximum tour length, the number of mobile elements must be increased. The path restriction increases the latency of the data collection. This is because the ME is permitted to proceed through the long visit at high propagation restrictions and, consequently, a few mobile elements are sufficient to meet the full nodes. Figures 7 highlight that the number of mobile elements, predicated on the communication variations and the network area, are linked to the path limits.

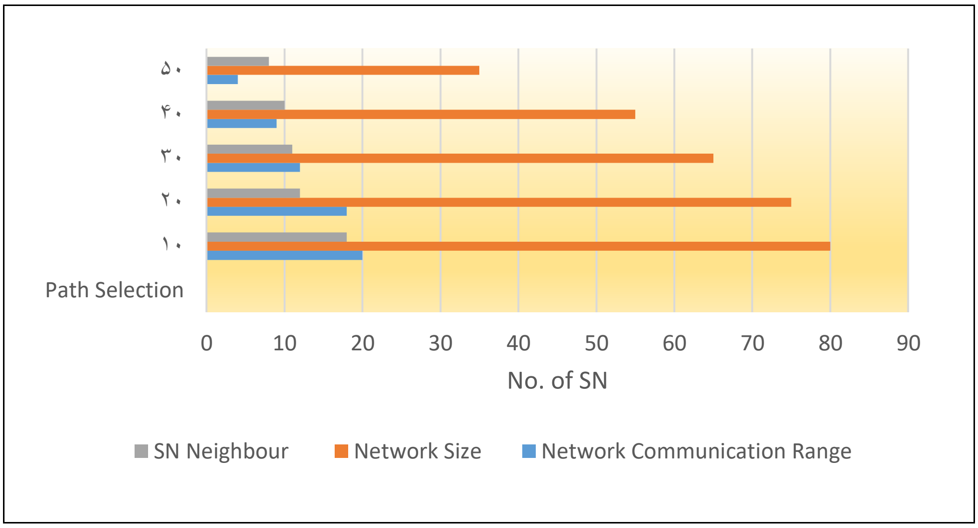

Figure 7. No. of SN vs Path Selection (SN Neighbour, n/w size, n/w range)

Result Comparison

In order to send sensor nodes data to base stations, we attempt to discover how many time slots are required. The number of elements varies between 4 and 64. Our framework is similar to that of LEACH. We are making a graph. The chart X-axis indicates the no. of sensor nodes (S_N), while the Y-axis demonstrates slow speed for data transmission to the base point. For the graph, our method is shown that the best compared to the top-down approach. In previous work, it has also shown that the scenario of faster data transmission, the greatest down approach is better than LEACH.

For example, when $S_N = 60$, 12 access points were taken, in which only the 6-time slots were collected. Our method is indeed best when the information is exchanged to the base station more quickly.

On the basic principle of network life, we try and compare our approach with others. This means that we count the number of rounds to which sensor nodes can transfer their data within a limited battery-powered base station. Researchers also evaluate our approach with others in this graph. The graph X-axis shows the numbers of sensor nodes (S_N) and the Y-axis shows how many data has been collected.

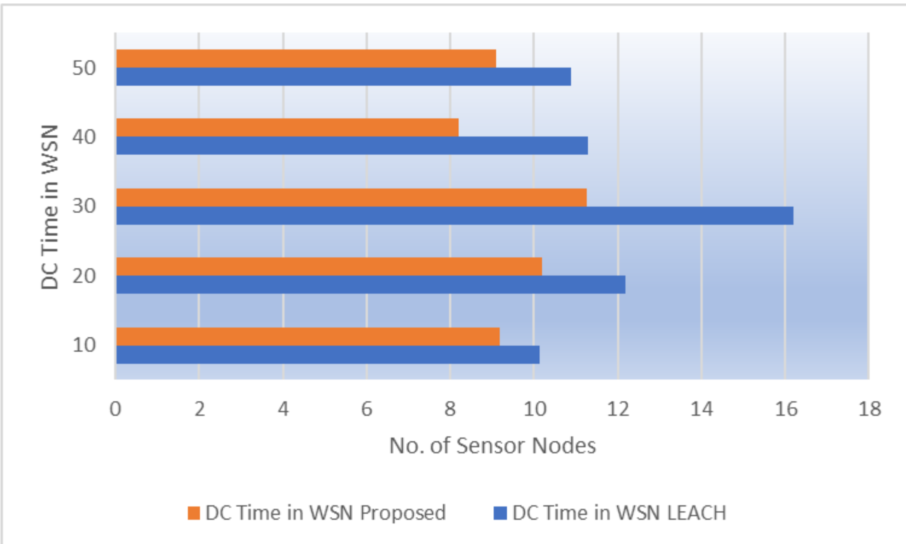

Figure 8. Average data collection time

The graph demonstrates that our option is effective than top-down approaches for energy-efficient use. Our system is appropriate than LEACH when there are more than 40 sensor nodes.

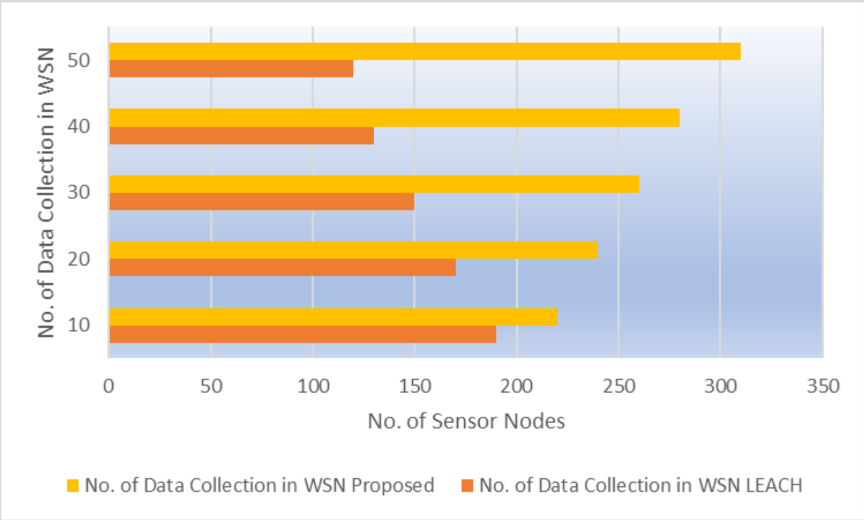

Figure 9. Average lifetime of the WSN

Conclusion

This article presents the WSN data collection for the analysis of information to reduce power consumption and throughput in WSNs, with the goals of decreasing energy consumption. The ultimate purpose is to save energy in an attempt to optimize the life of the network. Even so, the useful data collection in the WSN is overlooked by such algorithms. As for future research, it is scheduled to understand better the significance of the system algorithm and energy consumption and investigate other related problems like broadcasting with a similar approach.

Also, in comparative analysis to the wireless-based data collection and the routing path selection, the suggested methodology has proved high results as regards data collection and network performance. We have exhausted from a network structure throughout our studies so that the data can be collected as rapidly as feasible. Data is of high significance in many sensor network applications and should reach the base station as quickly as possible. The projected WSN structure can significantly energy reduce the data collection time while maintaining acceptable values of total communication distance and network life.

In future work, because the data from significant numbers of sensor nodes are collected in every mobile element, it should also be seemed to reduce the coverage area of mobile elements. Besides, it is important to continue investigating the way data is delivered via mobile elements to the sink node.

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