Effective Aggregate Data Collection and Enhanced Network Lifetime Using Energy Efficient Aggregation Data Convening Routing in Wireless Sensor Network

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Accepted: 6 April 2023 / Published online: 19 May 2023
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Abstract
Wireless Technology is an integral part of today’s applications. It encompasses commercial and human-oriented environmental monitoring, military applications, robotics, and healthcare monitoring systems, home or factory automation, and logistics. A wireless sensor network is a network system that uses wireless sensor nodes to monitor physical or environmental conditions such as voice, temperature, and spatial dispersive movements. Each node can locally sense its environment, process information and data, and send the data to one or more collection points within the WSN. The existing solution is categorized into member nodes and group/cluster heads (CH). The CH election process increases the overhead of the network and reduces the network lifetime. The processing and energy limitations of the nodes are considered for the CH election process. In this cluster formation methods aiming at the Cluster head selection process and providing trust in hierarchical WSN are proposed. The Energy Efficient Aggregation Data Convening Routing (E2ADCR) is used to estimate the routing path, and aggregate data collection to improve the network lifetime. The major advantage of this technique is to avoid the malicious or selfish node from becoming a dominant cluster in a group of clusters. Initially sink node selection forwards the Configuration Message (CM) to every node on the network to construct the performing node. In this, cluster selection is based on connection density, degree of the node angle, and residual energy (Quality Factor) that is evaluated from the link robustness, energy, and degree of the node. Multi-hop link transmission support path optimization technique is estimated in the path when the obstacle is present in the WSN. To introduce an Aggregated Support-based Data Collection to evaluate each packet flow monitor on the network to if any unrelated packet will eliminate to forward to the sink node. The proposed routing path of computational simplicity is achieved by a simple method. The new routing protocols, which were developed during this research, have better energy efficiency.

Keywords Wireless sensor networks · Cluster head · Routing · Network lifetime · Hop formation

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1 Introduction

With the development of efficient wireless communication and advances in electronic information technology, wireless sensor networks (WSN) are widely used in various fields because of its low cost, miniaturization, and multi-functional characteristics. However, in most cases, the nodes in the wireless sensor network are powered by batteries and are usually deployed in unmanned outdoors or more dangerous environments, which makes it inconvenient to supplement energy. The cost of redundant deployment and node replacement is also usually higher. Therefore, effective policy routing is needed to minimize the energy consumption of the network and extend its life of the network.

Traditional strategic routing mainly uses the shortest path from the source node to the transmitted data as quickly as possible, as the energy of the sensor node is primarily used to transmit the received data. Think about how to do it. However, in energy-constrained sensor networks, large amounts of data are sent from the sink and source nodes in "many-to-one" mode, which can cause serious "funnel effects" and "energy holes". As a result, the energy consumption of the nodes located on the shortest left and right paths or sink nodes is much faster and faster than others obtained in the life of energy imbalances and sub-networks.

Aggregation is a communication technique based on the compressed data architectural set. Data communication and data compression methods are used here as energy storage systems. Therefore, the compression ratio is calculated from the data association and cluster size. The collective entropy of sink and compressed messaging depends on the way the CH aggregators read and send their message to the tank’s representative. High gain calibration data collection, sensor nodes to a cluster of very small, usually divided into clusters, which are out of line. Here, from each of the cluster nodes, it is called a preamble that is selected, and CH performs data aggregation. The sensor collects data on the environment through the sending node and other nodes, either directly or at the joint piece. Clustering of sensor nodes, many sensor applications are scalable, powerful, and have reduced network traffic.

In WSN, the energy consumed by the sensor is mainly sensed and compared with the processed data that sends and receives the data, and the amount of energy as described in the following data communication is greatly wasted.

The process of dividing a network into interconnected sub-structure is called clusters. Each CH acts to temporarily connect the other cluster heads with the base station (BS). Each cluster is identified by selected measurements on a specific metric or selective basis (mobility, angle, density). A specific node for each cluster is selected as a metric or a combination of CHs based on the metric identifier. Each CH acts to temporarily connect the other cluster heads with the BS in that cluster. This information contains a list of nodes within each node of the cluster path. CH’s responsibility is to communicate with all nodes in the cluster within the communication network. However, the CH must be able to communicate with other clusters that can communicate directly or through the corresponding CH or gateway node. Communication takes place in three stages. Initially, CH receives the data sent by its members. The compressed data and final data are then sent to the base station or other CH. Appropriate CH can reduce energy use and improve the life cycle of the network.
2 Related Work

In [1], a new type of tree routing called event detection tree (EDT) has been proposed to achieve savings and high efficiency and energy complex event detection. EDT at the cost of data transmission over increasing distances reduces the amount of data to be transmitted by aggregating data in the event of achieving this aggregation. A routing protocol that belongs to the first category, furthermore, can be divided into flat or hierarchical. Based on the coherent routing protocol, only [2] minimal processing is a highly efficient energy-saving mechanism performed by the sensor node. Routing-based processing with non-coherent data, the sensor node processes the actual data locally and sends it to other nodes for further processing. In [3] discussed Bypassing Void Routing Protocol Based on Virtual Coordinate (BVR-VRC) using an edge network topology without routing the gap. BVR-VRC adjusts the mapping to solve the problem of virtual gaps using gap detection, and then establishes a path based on the virtual coordinates of the edge nodes around the gap.

This routing protocol used in wireless sensor networks is being considered more uniformly [4] than the broader polymorphic ones. A detailed study of the latter is expected to meet the requirements of different applications. Link coordinates of this Random projection-Polar coordinate-Chain routing (RPC) method [5]. This method uses polar coordinates to establish a chain structure that forms a path to find a node and applies random projections to achieve a compressed dataset. The energy-efficient centroid-based routing protocol (EECRP) formal cluster of [6] by solving the problem of managing energy in WSN-assisted IoT based on the distance to the center of gravity. An optimization algorithm based on the number of dead nodes and the number of cluster head nodes.

Linear Path develops an improved protocol for so-called straight-line routing (SLR) using two-hop information, for wireless sensor networks constructed without the help of geographic information. Taking that into account has been proposed to measure the energy in the routing process in the routing process due to the lack of reliability of links [7, 8]. It is impractical to route to this optimal energy-constrained network as it requires future knowledge. Keeping Paths Straight Provides a natural way to solve the energy cost issues of existing geographic routing protocols. Communication between wireless sensor nodes is handled by the routing protocol. The nature of links, low power consumption, and limited dependencies makes designing energy and performance-efficient routing protocols for wireless sensor networks a daunting task [9]. Dynamic Source Routing (DSR) is a common protocol commonly used in wireless sensor networks, but it does not provide fault tolerance and energy efficiency. In this paper, the modification is a new fault-tolerant routing and energy-saving protocol that the traditional DSR protocol has proposed [10].

Acting on a Controller this new routing algorithm establishes a queue based on the distance collected from the nodes and calculates the node closest to each node that sends the data. Simulation results show that the new routing algorithm has better performance [11] by extending the life cycle of the network and improving traffic throughout the network. Also, battery power cannot be transferred from one node to another. The study conducted a final analysis of the energy-aware routing protocols, their features, benefits, limitations, and classification of energy-efficient routing protocols [12].

Clustering is used as a key technology for the energy efficiency balance of resource fear networks loaded in wireless sensor networks. It supports cluster heads in the longevity network. Wireless sensor networks are relying on multiple guidelines clusters [13] to show that there is a considerably large network of life. A wireless sensor network is a wireless network with the latest trends in which human intervention is complicated by the sensor
network system and is a type of portable electronic device. In wireless sensor networks, different environment-sensitive sensors are grouped to monitor and control the physical properties of the environment. WSN energy-saving routing algorithms are required to perform a given task while maintaining a long network life cycle [14].

Life-Time (LT), in elevation energy consumption and controller networks, wireless sensor networks, suited to improve energy efficiency. Clustering is widely used to reduce power consumption, and LT is a powerful technique to improve network transmission. Based Clustering Novel Rank Based Clustering (NRC) developed ARSH-FATI Head Cluster Selection (ARSH-FATI-CHS) power sensor nodes and the traffic between the base, the top LT order to reduce the lifetime of the available functional network-based [15] should improve. It is a hierarchical cluster head of energy-saving wireless sensor networks based on a communication protocol that plays a key role. In most collection methods, Cluster Head (CH) sends data to the sink node. Wireless sensor network technology has become traditionally energy-optimized. Sensor Networks and choose effective leadership Cluster [16] Ridge Method Cluster Head Selection mode (RMCHS) the new synchronous transfer mode.

Cluster Head replication options for increasing network reliability and data network. A wireless sensor network, based on information received from each cluster head is responsible for the collection of data transmits to the base station. Sensors in a wireless sensor network and type-2 fuzzy Logic and three factors (energy, distance, density) are used to select the hierarchical set of cluster heads. Layer routing protocols are based on the first communication. Dividing the network protocol into smaller clusters, and creating a hierarchical structure of nodes [17, 18]. Selected some of the cluster heads (CHS) and collected them, then collected data from the ME (Mobile Environment) cluster heads and collected data from regular nodes. Approximately deployed sensor networks, the new CH option is based on the density of nodes. Surrounded by multi-node deployment nodes [19] is likely to be the cluster head.

The algorithm maintains this information preparation method according to the clustering, cluster head collected data from a cluster node, ready to be transmitted to a mobile environment. This way only need CH to access each cluster node individually for access. The ME [20] is the optimal path determined by the CCP (Critical Control Point) algorithm by connecting all CH/Collection Points (CP). The associative zone-based method [22] provides a better lifetime of network and energy efficiency.

3 Implementation of the Proposed Method

The key aspect of the proposed Energy Efficient Aggregation Data Convening Routing (E2ADCR) algorithm is to perform reliable data collection and eliminate outliers and redundant data from the network. In this cluster election and routing algorithm are follow the features of the node to be considered. The energy-efficient protocol has the best chance of becoming the node cluster head with the shortest distance to the base station with the most residual energy. The sensor node (SN) is even to detect the information and collect it to transmit high energy node. In this CS verify the node request and process the correct order data to be sent further unrelated data eliminate
from CH. It performs aggregation data reduction by using a locality-sensitive hashing function. Selecting a vice-cluster head is the primary head in case of failure the node performs a CH. The sink disseminates the event of interest and gathers sensed data from the cluster heads via the relay nodes. This sink node sends cluster head data to the relay node.

This proposed method to modified the selection feature in the clustering algorithm to solve the efficient cluster head and reduce the cluster election time shown in Fig. 1. The redundant data and unrelated data eliminate by using aggregation data estimation. This proposed method (shown in Fig. 2) performs in three stages there are (i) hop formation using sink tree construction, (ii) energy efficient cluster formation, (iii) Multi-hop link transmission support (MLTS), and (iv) Aggregated Support based Data Collection. In this process of step process in the following section is discussed.

### 3.1 Hop Formation Using Sink Tree Construction

The sink node establishes a hop for data transfer. The hop distance is calculated from each node-shaped sink node to locate the adjacent relay node and cluster head. In this sink, tree formation finds the unknown nodes and route discovery by using an outbound configuration message to all the nodes. The configuration message contains two fields: ID and Number of Hops (NH). The configuration message gets the information on node location, identity (ID), and the number of hops (NH) indicated to the sink node. In this node, information helps to identify the node distance it will be stored on the database.

![Cluster-based approach for communication](image)
Algorithm steps

Start

Initialize the network node (i)

Broadcast the configuration message (CH) over the network.

Initial hop count (NH) = 1

The sink node (S) construct the network formation tree based on CH.

If (i==s) then

Compare the NH value in CH to configure network CN=NH(i) ∈ CH

CN=NH(i)+1

If NH(i) > NH(CM)

NH(i) ← NH(CM) + 1

Update the node ID into S, S ← ID

Node I broadcasts the new CM with updated value to its neighbors

Check the two nodes i, j

If NH(S) > NH(node I and J)

Check NH(node I) > NH(node J)

Discard the maximum value of NH

End if

End if

End if

First, initialize the Number of Nodes (NH) define to infinity and the neighbor node of the sink node set as 1. The configuration information (CM) broadcast helps sink nodes to get
each node ID and NH value list. All nodes in the network store the minimum NH, which is the minimum distance to the sink.

### 3.2 Energy-Efficient Cluster Formation

In Cluster Head (CH) selection phase, all sensor nodes maintain their receivers. Select the cluster head from all the sensor nodes existing in the communication network. The choice of CH (cluster head) is based on the degree of remaining energy, connection density, and node angle. The amount of energy remaining in the node of the current instance is called the remaining energy \( (E_{\text{res}}) \). A node should have more residual energy than its neighbors to become a CH.

Consider \( E_i \) be the initial energy of the node and \( n_{tp}, n_{rp} \) is node transmit and receiving packet. In this node energy consumption \( (E(t)) \) is to be calculated using the following Eq. 1 sequence T period time.

\[
E(t) = (n_{tp} \times \alpha) + (n_{rp} \times \beta)
\]  

\( \alpha, \beta \) constant range of the node.

Node connection density \( (c_n(x)) \) in the same cluster and inter-node distance is calculated at the rate of average distance.

\[
c_n(x) = \sum_{i=0}^{n(x,y)} [(x, y) \in \text{E} / o(i) \in n(x, y)] n(x, y)
\]  

where, \( o = \) node and \( n(x, y) \) neighbors.

\[
d(A) = \{d(x)\}
\]
At this initial node angle $d(x)$ the magnitude of the node position at the cluster node is calculated using Eq. 4. In these cluster nodes are located at minimum distance, and higher energy with a maximum number of neighbors to form the network.

3.3 Multi-Hop Link Transmission Support (MLTS)

The multi-hop link transmission support is the measure that represents the quality of the link to perform efficient data transmission. The hops of the route may be moving in a different directions and with different node locations. To perform efficient data transmission, the top of the route should be more stable so that the performance can be improved. The stability of the route has been measured in two ways one by multi-hop link quality (MHLQ) and Route Link Quality (RLQ) measures. The MHLQ measure represents the quality of the link at the specific number of hops because at least for a certain number of hops the route should be stable and it would reduce the retransmission frequency.

The list of hops in a route is identified as

$$R_{hl} = \{Hops \in R\}$$

The multi-hop constant $Mhc$ is measured as

$$Mhc = \frac{3}{4} \times size(R_{hl})$$

The Multi-Hop Link Quality

$$MHLQ = \frac{\sum_{i=1}^{size(Mhc)} Mhc(i).Mobility < NMTh}{size(Mhc)}$$

//Nmth-Neighbor Mobility threshold

The Route Link Quality is measured as.

$$RLQ = \frac{\sum_{i=1}^{size(R)} R(i).Mobility < Th}{size(R)}$$

//Here Th-mobility threshold

Finally, the MLTS value is measured as.

$$MLTS = MHLQ \times RLQ$$

Similarly, the RLQ (Route Link Quality) represents the suitability of the route in performing efficient transmission. The MLTS measure has been estimated using these two values.

3.4 Aggregated Support-Based Data Collection

The route and node selection apply the aggregation function to all the nodes and choose the trust data collection in every node. This method uses the elevation of a spatial and temporally relevant database for event-associated data from sensor nodes. Choose the data points used for the end delay and maintain the accuracy of data collection to minimize transmission and eliminate irrelevant data.
Algorithm steps

Input: Initialize network node

Output: selective node (Sn)

While (node position and node Weight List)

    Current Node ← Node ID- of- Least Weight of the node (WL)

    Neighbor list of Current node 

        (N1, N1-distance, N1-energy), (N2, N2-distance, N2-energy)... (Nn, Nn-distance, Nn-energy)

    }

    Current Node - WL = 1

    Temp = WL++;

    While (temp!=0)

        If (Neighbor node ID- Status = is not alive)

            Remove the first neighbor from the Neighbor list

            WLCount = WLCount - 1;

        Else

            Apply aggregate value \( Ag = \sum_{n=0}^{\text{node id}} \{\sin^{-1} \text{trust value}(n) + 1 | \text{node id} \} \)

            WLCount = WLCount - 1

        End If

        If (Ag==true)

            \( Sn = \lim_{n \to \infty} \left( \frac{\text{node id} + \frac{\text{aggregate data size}}{\text{total number of data}}}{n} \right)^n \)

        End if

    End While

End While
This reduction information is updated with each cluster head and temporal characteristics of events related to the size of the dynamically realized aggregated data.

### 4 Result and Findings

The simulation developed in the NS-2 tool with OTCL (Object Tool Command Language) it’s similar to object-oriented language. In these tools used for network QoS parameter analysis like throughput, energy consumption, and time delays are evaluated. This section presents a relative analysis of the results obtained therefrom.

The above Table 1 shows that the proposed method developed a simulation parameter to analyze the WSN performance. In this proposed Energy Efficient Aggregation Data Convening Routing (E2ADCR) method results compare to existing methods there are Energy-Efficient Region- based Routing Protocol for Low-Power and Lossy routing protocol(ER-RPL), Mode-Switched Grid-Based Sustainable Routing protocol (MSGR) and Energy Efficient Region Source Routing Protocol (ER-SR).

\[
\text{Throughput} = \frac{\text{Packets Received}(n) \times \text{Packet size}}{200}
\]  

\[n = \text{number of nodes}\]

Table 2 represents an existing method and the proposed method throughput ratio. This analysis existing methods have lower throughput values than ER-SR because the data is sent
over an unrecognized relay gap base station, especially at the border. The throughput of the proposed E2ADCR method is improved by increasing the number of nodes.

\[
\text{Normalized Routing overhead (NRO)} = \frac{\text{number of routing packet}}{\text{number of data packet}} \times 100
\]  

This Fig. 3 is represent a network-normalized routing overhead of existing ER-RPL, MSGR, and ER-SR compared to the proposed E2ADCR method. This analysis of the proposed E2ADCR method provide a 21.5% less routing overload for 100 nodes. Similarly, the existing methods ER-RPL, MSGR, and ER-SR have 76%, 71.6%, and 64% of higher normalized routing overload for 100 nodes.
In this analysis, the proposed method has a 400 s higher network lifetime compared to the existing method ER-RPL, which has 335 s, MSGR has 348 s, and ER-SR has 385 s of low network lifetime. In this proposed method and existing method ER-RPL, MSGR, ER-SR method result analysis comparison is shown in the Fig. 4.

Figure 5 shows the average energy consumption of existing ER-RPL, MSGR, ER-SR, and the proposed E2ADCR method. In this result, the proposed method has 1.9 J of average energy consumption. Similarly, the existing method ER-RPL, MSGR, and ER-SR have a 3 J, 2.8 J, and 2.4 J of average energy consumption over the WSN.

5 Conclusion

Cluster-based energy efficiency protocol is critical for ensuring CH is selected. The closest node to choose the ideal position is CH in the wireless sensor network after the connection end. The difference between the exact CH position, and the actual CH node position, can weaken the energy efficiency capacity. In this proposed Energy Efficient Aggregation Data Convening Routing (E2ADCR) method CH selection is based on residual energy, connection density, the capability of the node, and the degree of the node. The aggregated Support based Data Collection helps to eliminate the irrelevant data from the sender to achieve the redundancy data error and higher delivery ratio. This Multi-hop link transmission support (MLTS) method estimates the link quality and route transmission support to improve the transmission quality in the overall network. This proposed method has better results, 588bps of throughput ratio, 1.9 J/s energy consumption with 21.5% low routing Overhead compared to an existing method.

Funding This research work received no external funding.

Data Availability Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

Declarations

Conflicts of Interest The authors declare that they have no conflict of interest.
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