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Article

IMPROVING QOS PARAMETERS IN WIRELESS SENSOR NETWORK USING ENHANCED CENTROID BASED ENERGY EFFICIENT ROUTING ALGORITHM

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Abstract: An arrangement of sensor nodes used for environmental perception and data broadcast to the base station is called a wireless sensor network (WSN). In order to improve network performance, WSN uses a variety of Quality of Services (QoS), such as energy efficiency, throughput, latency, congestion control, etc. To control the shortest path between a source and a destination, networks employ a variety of routing methods. A packet is sent from the source node to the destination node in a wireless sensor network. This research presents the Enhanced Centroid Based Energy Efficient Routing Algorithm (ECEERA) to improve the QoS metrics for WSNs, including end-to-end delay, network lifetime, packet delivery ratio, packet loss ratio, throughput, and energy consumption. The recommended approaches are compared to the various methods that are currently in use, such as the Cluster-based Opportunistic Routing Protocol (CORP), the Secure Energy Efficient Routing Protocol (SEERP), and the Eye Vision Routing Protocol (EVRP).
Keywords: Wireless Sensor Network (WSN), End-to-End Delay, Network Lifetime, Packet Delivery Ratio (PDR), Throughput, Packet Loss Ratio (PLR), Energy Consumption

1. Introduction:

In this expanding area of information technology, several Sensor Nodes (SNs) are used to let the systems interconnect with one another in a network field [1]. A WSN is defined as a gathering of SNs that have been taught to detect physical occurrences in their immediate surroundings. The collected information is then managed and directed to the Base Station (BS), either as a typical or cumulative amount. Wireless sensor networks are isolated, comparatively self-organised systems that rely on a great amount of inexpensive, tiny devices that are dispersed throughout the network and have inadequate memory, calculation, energy, and transmission aptitudes [2,3]. The WSN is an assembly of communication networks composed of numerous independent sensors that record different ambient or material properties at different places, including motion, vibration, temperature, sound, and pressure. For locations where standard networks are impractical to employ, wireless sensor networks have developed a low-cost, fully distributed computing and sensing solution [4,5].

One strategy to deal with the energy problem is clustering, in which the SNs are separated into various collections known as clusters for effective routing. Each cluster has a selected Cluster Head (CH) who transmits and receives data on its way to its destination [6,7]. The chosen CH coordinates with other CHs and forwards the data [8]. This approach uses more energy in some situations, particularly when CHs are close to the destination nodes and use the same quantity of power and energy as CHs that are farther away. In a similar vein, the network experiences needless CH rotation, which likewise uses network energy [9]. While the transportations section, like CHs, is the greatest energy-intensive and significantly affects network longevity, the detecting and information dispensation mechanisms consume less than 1 MW of electricity [10].

To decrease the energy loss of SNs and prevent needless rotation of CHs, an energy-efficient clustering strategy must be developed [11]. Since the nodes have incomplete non-rechargeable batteries, computing energy, and information storing, energy conservation is a critical task for encompassing the network's life expectancy [12,13]. The mainstream of routing procedures now in use for WSN systems do not make energy their top priority and may not be able to adjust to the networks' changing needs. One of the key components of a network to reduce data volume and save energy is data aggregation. It is stimulating to substitute or refresh the network's batteries when they run low, particularly in intricate situations [14]. To encompass the life of the system, power preservation is crucial. The SNs serve as routers, and figuring out the optimal direction-finding strategy is crucial to cutting down on energy use.

To increase network longevity, the authors of [15] introduced the Energy Efficient Fuzzy Routing Algorithm (EEFRA) for WSN. This protocol uses computational intelligence approaches to deliver active and approachable statistics communication tracks and to handle various inconsistencies in WSN. Additionally, this protocol chooses the CH and splits the entire system into clusters. The suggested protocol's enhanced data speed and network longevity are contrasted with those of current protocols. However, this protocol ignores crucial routing characteristics like interference, disconnections, and load balancing. A Multiple Pheromone Ant Colony Optimisation (MPACO) strategy was presented by the authors in [16] in order to improve residual energy, density, and distance between SNs. Along with determining the well-organized way to the BS, this technique uses less energy and offers a long system lifetime. According to the testing consequences, the MPACO has a greater ability to support more SNs and extends the network lifetime when compared to current systems. Nevertheless, this protocol's shortcoming is that it has too few parameters to compensate for packet loss in WSN.

An Energy Effective Sleep Awake Aware Sensor Network Routing Algorithm (IEESAA) for heterogeneous WSNs was proposed by the authors in [17]. The federation notion, which forms node collections with comparable request kinds and announcement assortments, is the fundamental idea underlying the suggested protocol. One SN each group stayed energetic after clustering, while the others went into snooze mode. According to network lifetime, the CH selection process begins when the first node dies. According to the experiment's findings, the IEESAA protocol performs better than other protocols. The centralisation approach of this suggested protocol, which relies on BS, is a disadvantage, nevertheless. The inventors of the Energy-Efficient Routing based on Genetic Algorithm (ERGA) algorithm in [18] recommended by means of a genetic algorithm (GA) to advance system longevity and energy effectiveness. Additionally, load balancing is used when developing the fitness function to allocate the power feasting among the nodes. In terms of power consumption, system lifetime, and load balancing, the suggested protocol is contrasted with current methods. This protocol's disadvantage is that it just uses a metaheuristic approach, and it's unclear what the best selection strategy is. Energy-efficient routing strategies are wanted to inferior energy consumption and improve the system's life expectancy. This study suggests an Improved Centroid-based Energy Efficient Clustering (ICEEC) procedure for WSN for CH rotation and selection in order to reduce sensor node power consumption, optimise network energy consumption, and improve system lifetime. The following are this paper's additional goals:

- Create a serverless architecture with an emphasis on event-driven and stateless execution to manage networks efficiently.
- Provide a protocol that uses less energy and incorporates more useful routing metrics for cluster creation, election of the Cluster Head (CH), and subsequent CH selection.
- Create a procedure that allows data passing and Cluster Head rotation while using the least amount of energy possible over the network.
- Estimate the performance of the QOS parameters, such as Packet Delivery Ratio, Packet Loss Ratio, End to End Delay, Network Lifetime, Throughput, and Energy consumption.

The structure of the paper is as follows: The serverless design for a wireless network is presented in Section 2. The suggested algorithm strategy and expansion stages are designated in depth in Section 3. The simulation's energy and packet delivery outcomes are covered in Section 4. The study is concluded with a future orientation in section 5.

2. Wireless Sensor Network Architecture:

A serverless architecture for WSN networks is suggested in this section. The suggested conceptual architecture functions similarly to FaaS cloud computing, in which all operations are controlled independently of the server. For all WSN applications, the suggested architecture supplies and controls the resources as needed. In order to operate the applications, the conventional server-based architecture requires server provisioning, management, and configuration. Serverless networks regulate the distribution of resources, expanding, and accessibility so that applications running on WSN can concentrate on their business logic and performance. They also handle and analyse information without any requirement for expensive servers or architecture. Cloud services are utilised in these serverless systems to manage workloads with more affordable, scalable resources. When an event is triggered by an API call, these systems offer roles that carry out a mission or role in a serverless stage. Every function operates independently, and resources are dynamically distributed to handle incoming demands. The anticipated serverless manner affords numerous topographies as tracks:

- Event-driven Implementation: This functionality, which offers functions like file upload and database updates, is utilised in serverless architecture. The events for effective resource use are also carried out by this function. The reception of temperature statistics from SNs and the forwarding of data via HTTP requirements, MQTT, or additional statistics transmission conventions are the primary instances of event-driven functions.
- Automatic Scaling: Based on workload, this feature automatically scales computation possessions to accommodate and manage received requirements. This level handles all dimensions, development, and grading conformation. This functionality allows resources like transmission, storage, and processing power to be dynamically adjusted. Initiation active grading based on ecological circumstances is another application for this functionality.
- Stateless Execution: Without server-side state in between calls, this function offers stateless services. External services like data storage and object storage usually handle these services. Additionally, stateless execution functions simplify programming, manage transient data, and use less memory.

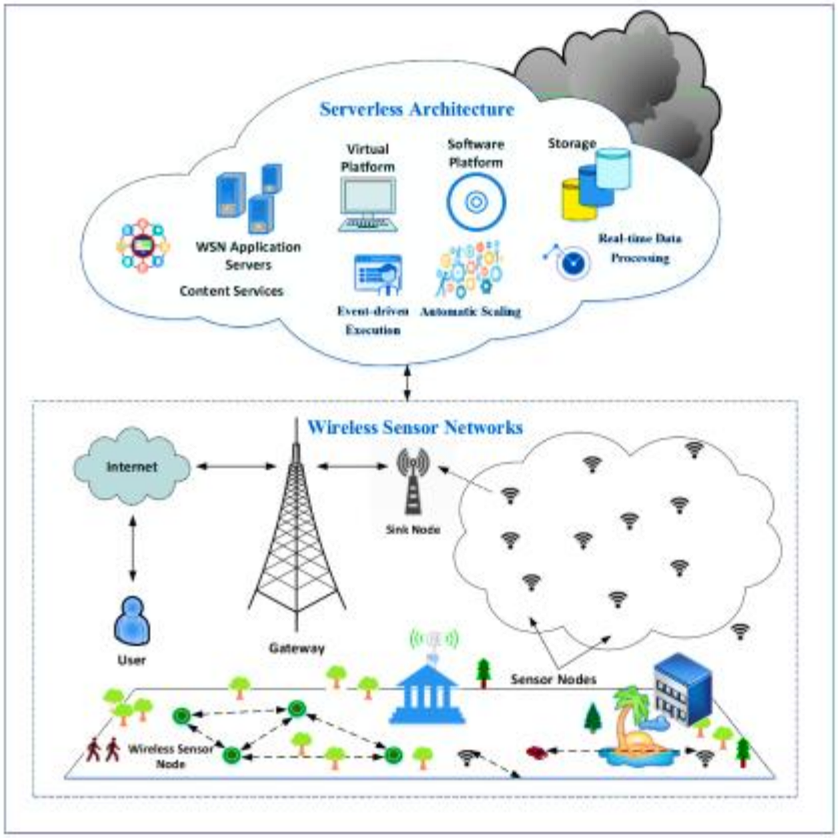

Figure 1: Proposed Wireless Sensor Network

This function determines the amount of moisture in the soil and sends the information to a central repository. Time is saved, scalability is enhanced, complexity is decreased, and cost-effective services are offered by the developed serverless manner. The suggested WSN is depicted in Figure 1.

3. Proposed Enhanced Centroid Energy Efficient Routing Algorithm (ECEERA):

This function determines the amount of moisture in the soil and sends the information to a central repository. Time is saved, scalability is enhanced, complexity is decreased, and cost-effective services are offered by the suggested serverless architecture.

3.1. Network setup module

Sensor nodes (SNs) and a single Base Station (BS) are scattered over the network. After data sensing, all SNs direct the statistics to the adjacent CH, which, dependent on the distance amongst the BS and the CHs, either sends it directly to the BS or through the key node.

3.1.1. Design of energy consumption

Data transmission consumes most of the energy of the SNs. Equation (1) displays the most widely used and prevalent energy design.

$$E = \begin{cases} l\left(e_r + e_t + \epsilon_{fs}\ a^2\right) if\ a \le a_0 \\ l\left(e_r + e_t + \epsilon_{mp}\ a^4\right) if\ a \ge a_0 \end{cases} \tag{1}$$

Where l is the size of packet and e_r and e_t are the energy levels for data communication and response, total energy is represented by E used to move the l-bit packet from node to BS in the equation above. The transmission energy consumption, fsd2 and mpd4, depends on the threshold distance do and the distance “a”. Free space conditions are presented by ∈fs when $a \le a_0$, while multi-path fading is presented by ∈mp when $a \ge a_0$.

3.1.2. Energy_Centroid

The hypothetical centre of mass attention, where all of an object's mass is concerted, is referred to as the "centroid" in mathematical notions. In a similar vein, the energy centroid of a cluster is an SN with a high, distributed energy density. The energy centroid can be expressed using equations (2) and (3), respectively.

$$X_{ec} = \frac{\sum_{i=0}^{n} \frac{E_{i_{rs}}}{E_o} X}{N} \tag{2}$$

$$Y_{ec} = \frac{\sum_{i=0}^{n} \frac{E_{i_{rs}}}{E_o} Y}{N} \tag{3}$$

The node residual energy I is represented by $E_{i_{rs}}$ in Equations (2) and (3), the starting energy by E, the nodes of the entire cluster by N, the coordinates of node I by X and Y, and the energy centroid by Xec and Yec.

3.1.3. Key Node (KN)

The main responsibility of CHs is to collect statistics from SNs and provide it to BS. Data must be managed by CH in a number of ways, and sending data to the BS straight or finished other CH uses a lot of electricity. Consequently, during transmission, CHs used greater network energy. In order to send information to the BS, CH establishes a key node. Cluster nodes that are nearer to a nearby CH are known as key nodes. By measuring the space between cluster nodes, the space among neighbouring CHs, and the residual energy of CHs, each CH determines the mass of the key node. The function is described by equation (4).

$$G(i,j) = \left[\frac{S(i).E}{S(i).Max}\right] + \left[a(i,j)^2 + a(i,x)^2 + a(j,x)^2 + \frac{a(j,s)^2}{a(i,s)^2}\right] \tag{4}$$

In Equation (4), the CHs' residual energy is denoted by E,

- $S(i).Max$ is the initial energy,
- The distance among the $i\ and\ j$ cluster heads is denoted by $a(i,j)$,
- $a(i,j)$ is the separation between CH_i and the CM node x, which is close to CH_j,
- The distance between CH_j and CM node x of CH_i is denoted by a (j, x),
- The distances between CH_j and BS are denoted by d (j, s) and CH_i and BS by a (i, s).

The cluster's weight determines which cluster key nodes are chosen. The cluster key node is designated from among the nodes with the uppermost weight in the cluster.

3.2. Process module

Energy is a significant concern in SWSN networks since SNs have limited resources. This paper's main area is to deliver a method that efficiently uses resources and less energy when processing data. The CH assortment, gate-way collection, data communication, and CH rotation phase are the three components that make up the clustering method.

3.2.1. CH phase Selection

During this phase, BS broadcasts Hello-Messages, including the BS's position and ID, across the network. The SNs reply by sending the position MESSAGE, which is seen in Figure 2 and includes the energy level, sensor node ID, message type, and SN position. In this case, the communication between BS and SNs is represented by the message type.

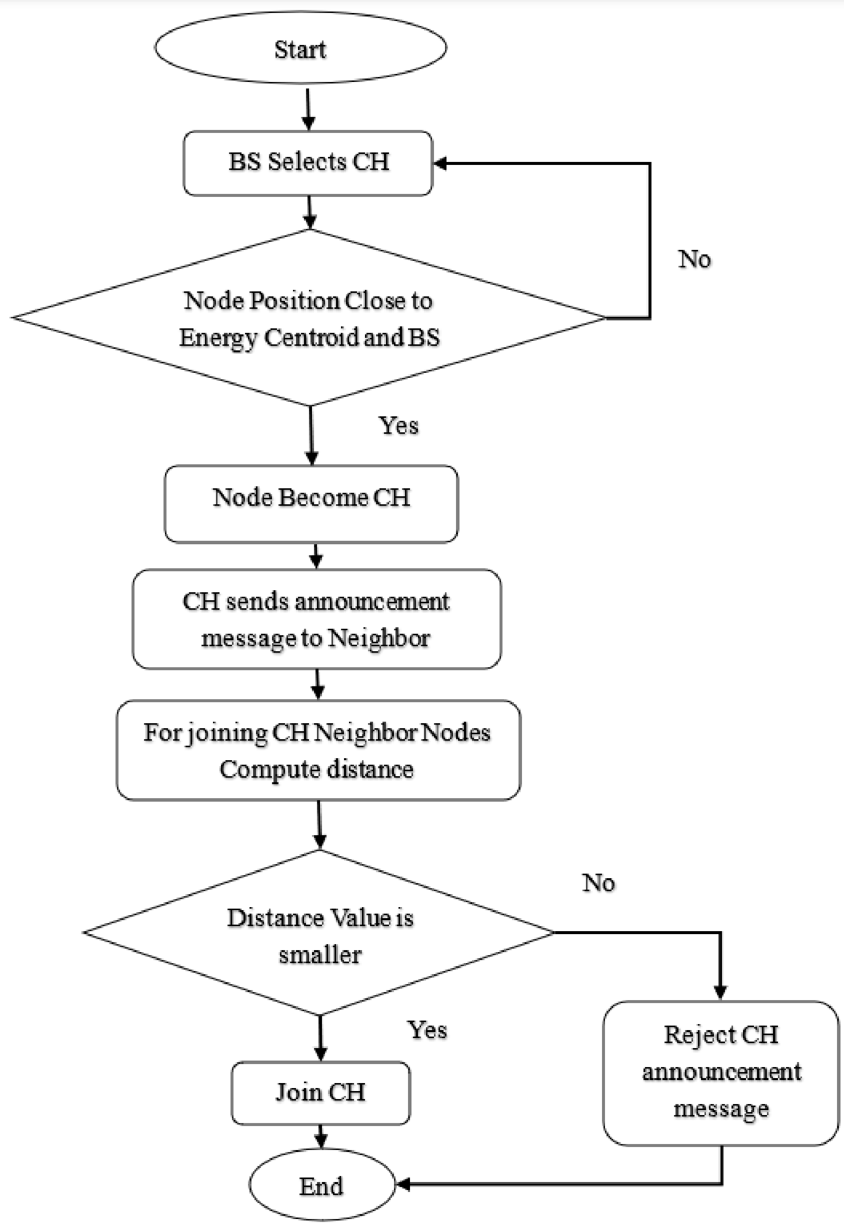

Figure 2: Flow chart of CH Selection Process

In addition to calculating the node's distance from BS, BS also determines the system's regular energy and Centroid Energy position. The BS chooses the CH and splits the system into clusters across the centroid energy location after identifying the centroid energy sites. BS picks the CH that is neighboring to both BS and the energy-centroid point. The BS sends the FEEDBACK communication to the suitable cluster after choosing the CH. The CHs ID, regular energy, and the message type—which contains information about the feedback message—make up this FEEDBACK message. After receiving the ANNOUNCEMENT message, the SNs determine the minimal distance between themselves and the CH. If there is not, they reject the CH announcement message and do not join the CH as a CM. The CH assortment procedure is depicted in Figure 2.

4.2.2. Phase of Key selection

The Key Weight (KW) is determined by each CM that obtains neighbouring CH assembly requirements after the CHs have been chosen. The key is then moved to CH after that. The key -node-weight rating of the cluster is used to choose its key -node. After that, the key node requests the nearby CH for its key node and sends a key communication to the neighbouring CH with its position and CH ID. When a key node's neighbouring CH receives a message, it uses multi-hoping among nearby key nodes to control the path to BS. The space among the CH and the BS disturbs how much information the CH transfers over the key node. If the space between CH and BS is less than the edge space, CH sends statistics to BS directly; if not, CH sends data to BS over a key node.

Algorithm 1: key node selection

```
for j=0: CM
if (node(j) accept adjacent CH connection request)
Calculate the weight of key node for the adjacent CHs
Transmit the value of key node weight to cluster head
else
Round will begin, CM periodically transfer their data to their CH
end if
end for
if (node(j) key weight value higher)
Node(j) choose as key node through CH
else
Node(j) Discard as key node by CH
end if
The key node updates the neighbouring CH key node on its status.
while (the information of adjacent CH key Node Accept)
Find route
end while
if (dist(CH,BS)<d0
Through single hop cluster head directly transfer their data to base station
else
CH send their data by using multihop key nodes
end if
```

Algorithm 1 displays the facts of the ECEERA key node collection. Lines 1–8 in Algorithms 1 find the key by the nodes that agree to join information from CHs, whereas lines 10–15 are selected as key nodes based on the key. Depending on the distances between the two, lines 20–23 regulate whether CH statistics is transmitted straight to the BS or over a multi-hop key node.

3.2.3. Phase of CH rotation and Data transfer

Once the CH and key nodes have been selected, the communication begins. According to the chosen threshold distance, the CM senses the statistics and forwards it to its CH, who subsequently transmits it to the BS either directly or via GN. The CH's residual energy is assessed following each round. When the quantity of nodes is larger than or equivalent to the sum of clusters, and when the initial CH's remaining energy (Er) falls below a predetermined energy threshold (Eth) value, the CH rotation phase begins. 0.5j is the predetermined energy threshold value. In order to start the CH rotation process, the current CH broadcasts an advertisement message to each sensor node that includes the current CH's location and residual energy once the initial CH's remaining energy reaches a predetermined threshold

(Eth) value. Each CM then responds by sending CH its position and remaining energy. CH determines the centroid energy location and average energy. For the subsequent applicant CH, the CM that is closest to the centroid energy location and has an energy level better than the normal cluster energy is chosen. The newly chosen CH now notifies other nodes of the CH change.

Algorithm 2: Data transfer and CH Rotation Development
do
CM detects and sends detectable information to CH
if (dist(CH,BS)<d0
In a single hope, CH transmits data to BS directly
else
CH sends data to BS using a key node
end if
while (just before round over)
if (residual energy (RE) of CH < Eth
if no. of nodes>= no of cluster
Current CH initiate the CH rotation process
CH broadcasts an ADVERTISEMENT MESSAGE contain RE and location to all CM
Each CM node(k) send residual energy and location to their CH
CH Compute clusters's average energy
CH compute centroid energy of cluster
If energy level of node (k)>E0 && have smallest distance
Initial CH change the status of node(k)=CHk
Initial CH withdraw responsibility
end if
Initial CH remains as CH and transmit information towards BS
end if
end while
CHk tranmit ADVERTISEMENT MESSAGE

The specifics of CH rotation and ECEERA data transfer are covered in Algorithm 2. Data transmission from CH to BS, either directly or via a key node, is represented by lines 1–8. The CH rotation mechanism is shown in lines 8–26. The CH alternates only when the initial CH's residual energy is less than the predetermined energy threshold value, Eth, which is the initial CH for starting the CH rotation process. Each CM then communicates to CH its position and remaining energy. CH analyses the centroid energy location and average energy. For the next applicant CH, the cluster member (CM) closest to the energy-centroid position and with an energy level better than the average cluster energy is selected. The recently chosen CH now informs other SNs of CH changes. If not, the original CH sends data to BS and stays as CH.

4. Results and Discussion:

Network Simulator-2 has been used to implement the proposed work, and Table 1 shows the simulation properties. In increments of 20, the simulation's node count is adjusted from 100 to 600. The mean performance for one second is considered from the simulation's 10-second runtime. Each node's buffer size is set at 12 packets. Generally speaking, the majority of simulations set the buffer size at 20 packets. Twelve packets are allocated in the simulation because this is a significant value for real-world implementation. One metre is the fixed gearbox range.

The current EVRP, SEERP, and CORP are contrasted with the proposed ECEERA. Tables 2, 3, 4, 5, 6, and 7 compare the EVRP, SEERP, CORP, and suggested ECEERA approaches based on transmission delay, packet loss ratio, average delivery ratio, energy usage, network lifetime, and throughput, respectively.

Table 1: Factors used in simulation

S.NO.	Factors	Value
1	Simulation time	1 second
2	Number of nodes	600
3	Transmission Range	150 meters
4	Node Initial Energy	0.5 joules
5	ε_{amp}	100PJ/bit/sq.meter
6	Data packet size	30 bytes
7	E_{elec}`	50Nj/bit
8	Type of node queue	Priority Queue
9	Rate of transmission	512 kbps
10	Length of queue (Node)	10-25 packets

4.1. Network Lifetime

Nodes ranging from 100 to 600 were selected for the investigation and positioned in the assigned location. Each node explorations at a speed of two meters per second, and among them, 10 to 25 packets are sent per second. ECEERA outstrips the further results in terms of possession the mainstream of nodes alive for a longer amount of time. Calculating the network lifespan (s) is done by

$$T = minT_k$$

where $$T_k = \frac{Initial\ Energy}{Energy\ Consumption\ per\ unit\ time} = \frac{E_o}{E_k}$$

When the group size is set to 600, the outcome of ECEERA is approximately to keep the nodes alive for 850 seconds, as shown in Figure 3. This is a much longer period than the other architectures. The ECEERA technique's maximum network lifetime is displayed in Figure 3. As demonstrated by the ECEERA results, the top-performing representations were recognized at different time points. Table 2 displays the evaluation limitations for the observed routes' maximum life duration for the ECEERA and current methods.

Table 2: Comparison factors between the maximum life time of the routes estimated for ECEERA and the existing systems

S.NO.	Nodes	Developed (ECEERA) (s)	SEERP	EVRP	CORP
1	100	950	920	900	870
2	200	914	900	890	850
3	250	900	880	870	840
4	350	895	850	840	820
5	400	890	840	830	800

6	450	885	830	860	790
7	500	870	825	830	780
8	600	850	820	800	730

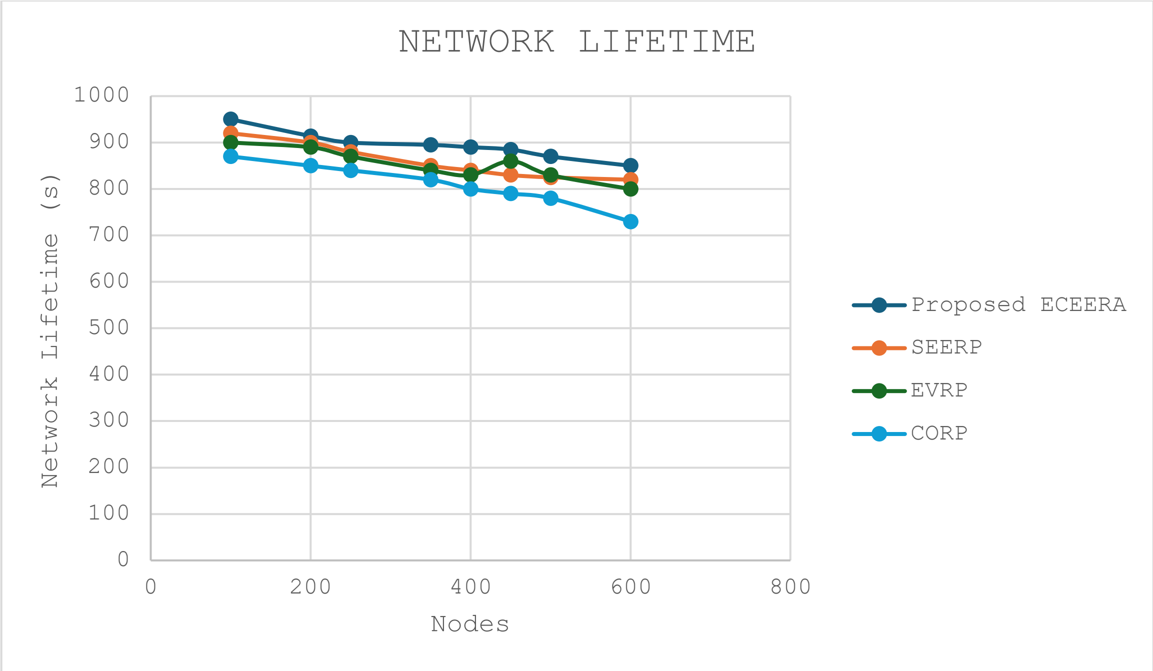

Figure 3: Recorded maximum route lifetime for ECEERA technique.

4.2. Throughput

The number of packets communicated regulates the throughput. The recommended method's throughput is evaluated in relation to the current processes. With nodes positioned at random confidential the designated regions and a flexibility capacity of 8–30 mts/sec, statistics was transferred at a rate of 5 packets per second in the challenging environment. The calculation of the throughput (kbps) is done using

$$Throughput = \frac{I}{T}$$

where I= quantity of packets generated each time

T= duration of time needed to create the packets

ECEERA has a slight decrease in performance in addition to an increase in node mobility, as seen in Figure 4 of the experimental data. Table 3 displays the throughput evaluation constraints for the recommended ECEERA and the existing techniques.

Table 3 Metrics for comparing throughput between the Developed ECEERA and existing methods

S.No.	Nodes	Developed (ECEERA) (kbps)	SEERP	EVRP	CORP
1	100	0.999	0.94	0.89	0.88
2	150	0.96	0.92	0.88	0.84
3	250	0.95	0.88	0.82	0.81

4	300	0.92	0.93	0.8	0.75
5	450	0.84	0.85	0.78	0.64
6	600	0.9	0.76	0.76	0.61

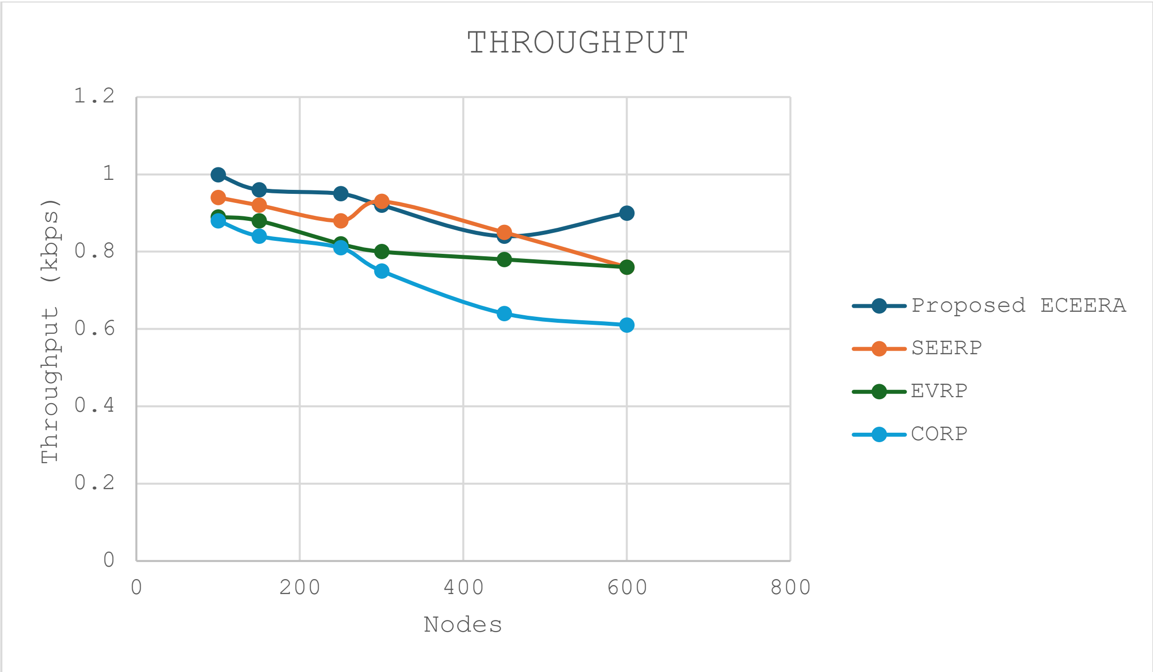

Figure 4: ECEERA's throughput in assessment to existing technologies

4.3. End-to-End Delay

Mobile nodes are scattered throughout the aforementioned regions during testing, processing statistics at a pace of five packets per second and travelling between eight and thirty meters per second. The ECEERA transmitted data at a much slower pace than earlier systems. The computed latency for multicast paths discovered using ECEERA and existing methods at various time intervals is shown in Figures 5 and 6. The calculation for the end-to-end delay is

$$Delay = \frac{1}{D}\sum_{i=1}^{n}(r_i - s_i) \tag{5.20}$$

Table 4 displays the end-to-end delay assessment features among the developed ECEERA and the existing techniques. Table 5 displays the end-to-end delay assessment features among the Developed ECEERA and the previous techniques at specific periods.

Table 4: Evaluation suggested ECEERA's end-to-end delay characteristics with those of the existing techniques

S.No.	Nodes	Developed (ECEERA) (ms)	SEERP	EVRP	CORP
1	100	0.044	0.04	0.039	0.033
2	200	0.043	0.041	0.035	0.037
3	350	0.045	0.042	0.037	0.035

4	500	0.047	0.044	0.04	0.038
5	550	0.043	0.042	0.039	0.035
6	600	0.041	0.04	0.038	0.032

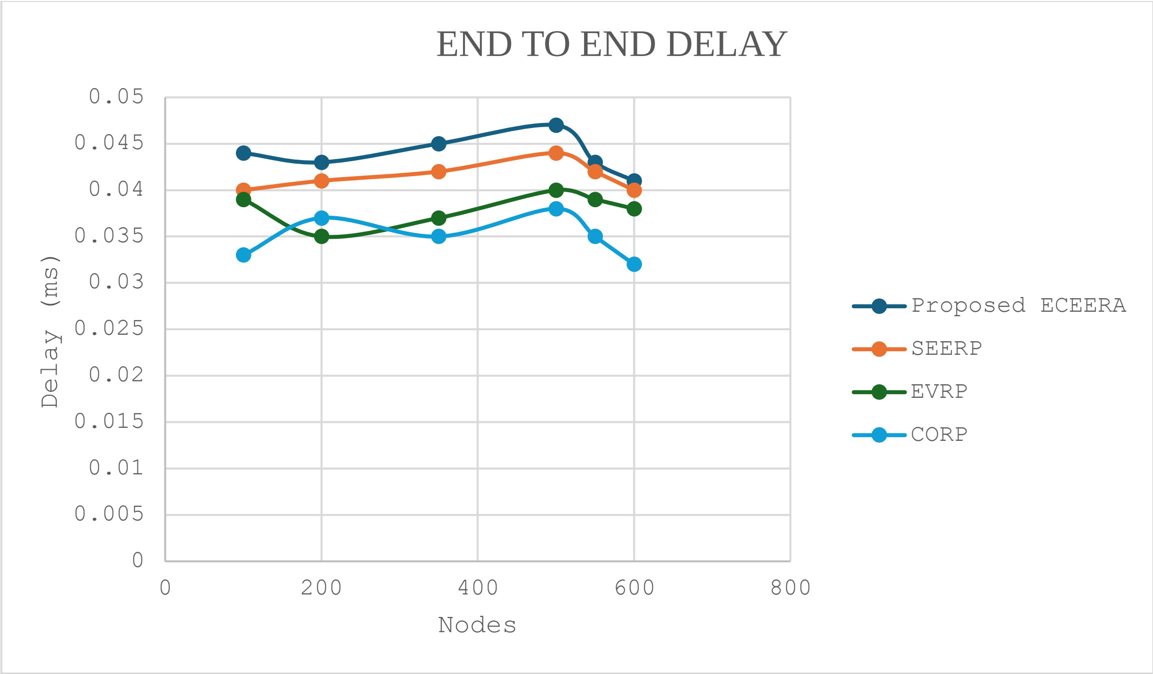

Figure 5: End-to-End Delays Evaluation

Table 5: The proposed ECEERA's and the current models' end-to-end delay assessment limitations at particular periods

S.No.	Time interval	Proposed (ECEERA) (ms)	SEERP	EVRP	CORP
1	100	0.10	0.1	0.1	0.1
2	150	0.096	0.13	0.16	0.22
3	200	0.098	0.14	0.21	0.34
4	250	0.093	0.15	0.26	0.36

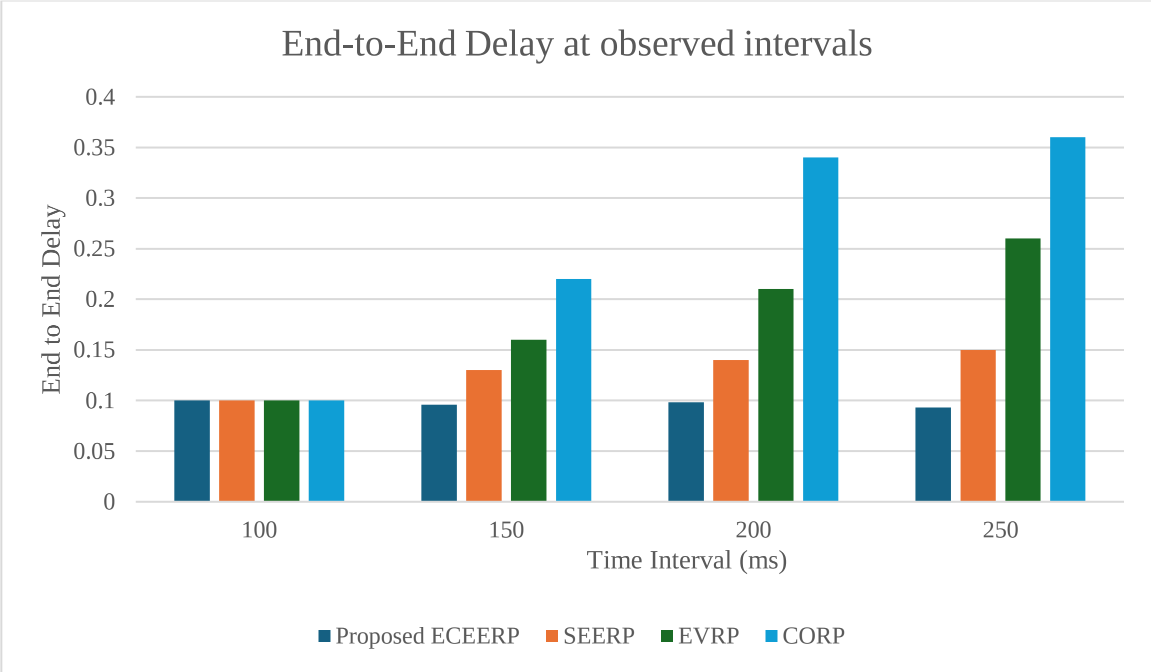

Figure 6: Assessment of end-to-end delays at particular times between the ECEERA and existing models

4.4. Packet Delivery Ratio

The experiment's consequences establish that the recommended technique performed the traditional method in terms of packet delivery. Figure 7 compares the PDR shown for routes created based on the number of nodes. The PDR is computed by

$$PDR = \frac{Total\ \ received\ packets}{Total\ transmitted\ packets}$$

Table 6 displays the PDR comparison criterion for routes depend on node count.

Table 6: Measurements of the PDR comparison for routes depend on node count

S.No.	Nodes	Developed (ECEERP) (%)	SEERP	EVRP	CORP
1	150	95	94.5	93	92
2	250	93	92.5	91.5	90
3	300	92.5	91.5	90	89
4	350	92	90.2	89.9	88
5	500	91.5	87	88.5	87
6	600	90	85	87	86

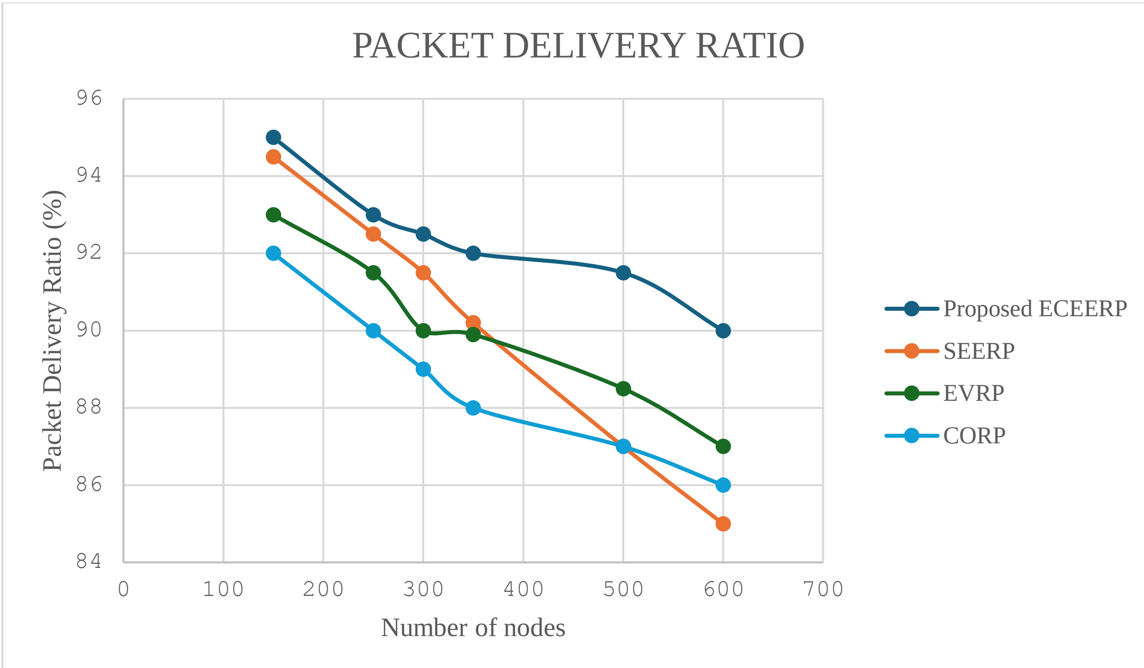

Figure 7: Contrasting the PDR of routes that were constructed using the number of nodes

The present section provides specifics on the outcomes of the suggested approach. A method that concentrates on receivers and the ECEERA algorithm has been developed to expedite packet delivery to multicast destinations. The ECEERA protocol uses information about the real locations of nodes to control the shortest path.

4.5. Packet Loss Ratio (PLR):

When IP packets cannot get from their source to their destination, packet loss occurs. The fraction of lost packets relative to all transmitted packets is known as packet loss. In a network, packet loss can occur for a number of reasons, such as congestion, ineffective routing strategies, node memory limitations, etc. The packet loss is computed as:

$$Packet\ Loss\ Ratio = \frac{Packets\ transmitted - packets\ received}{packets\ transmitted} \times 100$$

Table 7: Comparison of PLR with existing systems

S.No.	Number of nodes	Proposed (ECEERA) (%)	SEERP	EVRP	CORP
1	100	5.24	8.56	10.76	15.76
2	200	4.34	8.78	10.78	15.76
3	350	4.09	8.34	10.67	15
4	500	4.05	8.22	10.00	14.87
5	550	4.01	8.00	10	14.98
6	600	4.00	7.98	10	14

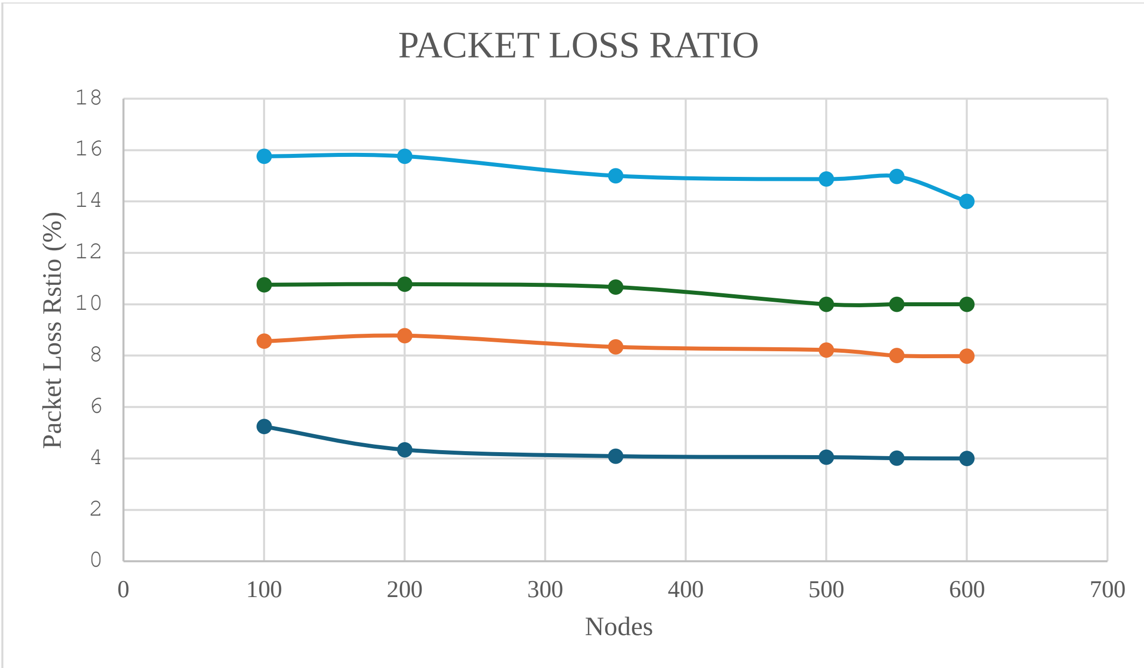

Figure 8: Contrasting the packet loss ratios of routes that were constructed using the number of nodes

4.6. Energy Consumption:

According to these simulation findings, the recommended ECEERA protocol uses the least amount of energy when associated to the SEERP, EVRP, and CORP procedures since it avoids the needless rotation of CHs, which uses a lot of energy. After every round, the CH is switched via the current protocols SEERP, EVRP, and CORP without determining whether or not the CH's energy has been completely used up.

Table 8: Comparison of energy consumption with existing systems

S.No.	Number of nodes	Proposed (ECEERA) (J)	SEERP	EVRP	CORP
1	100	50	80	90	100
2	200	80	100	105	120
3	350	100	120	130	140
4	500	200	220	230	235
5	550	220	240	250	255
6	600	230	250	255	300

Figure 9: Analysing the energy usage of routes that are constructed according to the number of nodes

5. Conclusion:

WSN networks are becoming more and more common for monitoring a variety of environmental and physical characteristics across a large area. Small nodes with low energy, processing, storage, and transmission power are found in WSNs. Each node gathers information from other SNs and sends it, either single-hop or multi-hop, to the base station. The limited battery and energy of nodes limits the longevity of WSNs, and the location of nodes in remote and hazardous areas makes it extremely challenging to regularly supply or replenish batteries. The suggested ECEERA improves the CH's rotating strategy while reducing the strain on SNs and CH. The suggested process is made for WSN, which selects the CH close to the cluster and base station centroid positions. The key node was chosen by the

CH to transmit data. Data packets are sent by SNs to CH, which either forwards them directly to BS or via the key node. The threshold distance (do) determines this. Data throughput, network lifetime, end-to-end delay, packet delivery ratio, packet loss ratio, and network energy consumption are the factors used to assess the suggested protocol. According to the findings from simulations, the recommended protocol outstripped the existing protocols in terms of load balancing, data throughput, network resilience, and energy usage. In the future, we improve the suggested procedure by accumulation a security element and taking into account additional networks, such as Wireless Body Area Networks (WBAN) and the Internet of Things (IoT).

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