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Enhanced Dependable Multi-Path Assortment Based on Energy Competent Model with Proficient Data Communication

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Abstract: This study suggests a multi-path direction-finding technique for WSNs that is power-competent. The main problems limiting the lifespan of sensor associations are the characteristics of sensor nodes, which include limited battery capacity and ineffective protocols. This work aims to extend an improved direction-finding technique that may be applied in a wireless sensor network. The main achievement of the proposed protocol is reducing the disproportionate overhead that is typically experienced in the majority direction-finding procedures by using predefined clustering and reducing the number of CH transforms by using fixed CHs, including idle CHs. The performance analysis shows that because energy-efficient protocols can lower sensor node power consumption, lowering overhead greatly extends sensor node lifetime. Consequently, a WSN's scalability can be increased. Additionally, the deployment of transmit nodes has a positive impact on network power indulgence.

Keywords: *Wireless sensor network, Path selection, Energy efficiency, Data Transmission, Network lifetime.*

1. Introduction

Wide-area networks (WSNs) with several sensor nodes are utilized to detect environmental or physical conditions like temperature, light, noise, anxiety, trembling, and electromagnetic fields that are larger than a field of view [1]. Sensor nodes usually consist of one or more sensors, a computer unit, a wireless communication mechanism (e.g., a broadcast transceiver), and an energy-storing battery. WSNs have been considered an active research area since their introduction since they may be equipped with a variety of Wireless Sensor Network appliances in different disciplines. WSNs were first created for military applications, such as monitoring combat zones, but they quickly spread to the health sector, habitat surveillance, ecological monitoring, traffic monitoring, home computerization, disaster relief, and sophisticated cities [2].

Large numbers of sensor nodes are positioned around the area, particularly for surveillance equipment, in order to detect a suspected incident. An event is detected by the sensor node, which then reports it to the pedestal situation [3]. Base locations are measured discrete WSN hardware and are the opportunities between end users and sensory nodes. They have greater communicative possessions, processing capacity, and power when compared to sensory nodes. The longevity of a sensory set of connections is significantly impacted by the supremacy expenditure limits of sensory nodes [4].

Each sensor node has a limited power supply, and as they sense, distribute, and communicate data, they use power. Compared to the communiqué component, the sensory and dispensation components consume less power. Several communiqué and direction-finding protocols for WSNs have been developed in the works that are currently in existence [5]. An important indicator for assessing the cooperation of WSNs or WSN protocols is the network longevity. The distance between two sensory nodes determines how much energy they use if they broadcast their detected data to base locations without fail. The sensory node that is not linked to base locations may quickly run out of battery power and fail due to undeviating communication [6].

The lifetime of a sensor network will be constrained by this type of data collection. Recent developments in micro electro mechanical systems

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technology have led to the improvement and complexity of WSN sensors, making them suitable for use in complex applications. Typically, sensory nodes are equipped with a variety of media devices, including cameras that may retrieve audio streams, images, and movies [7].

While sensory nodes in wireless sensor networks have defective memory, dispensation capability, authority, and transmission bandwidth, multiple media information has high QoS requirements [8]. As a result, a substantial amount of energy is needed to achieve the strict QoS requirements for multimedia data. However, the necessary Quality of Service and set of connections presentation will not be reached if the sensory nodes fail quickly. Therefore, an economical device is needed to guarantee a fair amount of network time, which will satisfy the proper quality of service. Battleground supervision, real-time irrigate channel surveillance, objective tracking, ecological surveillance, farmland monitoring, catalog organization, health surveillance, and biological management are just a few of the many potential uses for WSN [9].

Unwavering communication between the resource and intention nodes is made possible by information transmission that never veers off course. However, this isn't always the situation. Roundabout is the most often used method of transporting information. Information is transmitted indirectly when it travels via one or more intermediary nodes from the resource to the destination [9].

Because the mediator nodes' forwarding tendency is unknown and the sensory node might be malicious, this technique creates a number of issues. This affects the information transfer's speed, consistency, and steadiness. Therefore, in order to ensure the transmission of protected information, every variable needs to be measured. Even with all of its benefits—self-determination, self-motivated topology, low cost, and simplicity of use—IOTN is still constrained by memory, compute, and power [10].

Energy limitation is the most urgent problem that needs to be solved. Three components use the power of the sensory nodes: proclamation, dispensation, and sensing. The majority of these tasks require a lot of power for communication [10]. The majority of sensor communication's power-intensive operations involve direction finding. Because IOTN uses self-motivated topology, it is tough to find pathways from resource to target. When combined, IOTN actively engages in numerous real-time applications. Consequently, the routing technique needs to show increased consistency and tolerable data transmission times. These basic needs must be satisfied with very little energy usage.

This study's first section provides a succinct synopsis of WSNs. As mentioned in the second section, there are several ongoing research initiatives that use WSNs. The third section provided a comprehensive summary of the suggested approach, the workings of the suggested model, and the metrics for comparison. The suggested model and a few of the current methods used in this WSN are contrasted in the fourth part. The possibilities and expectations for WSN, together with details on upcoming research, are covered in the fifth and last section, the conclusion.

2. Review of Related Literature

Regardless of the multiple benefits acquired by IOTN, the primary problem is the power constraint. Sensory nodes are placed in uncomfortable settings in almost all real-time appliances in order to sense and process data. Because of this, it can't consistently restore or renew the sensory contents, which could lead to a node dying too soon. Only by using the available electricity effectively can this be prevented. The length of time the association will be in operation is negatively correlated with the amount of electricity used. While there are many ways to reduce power consumption, this effort focuses on putting in place a safe and energy-efficient direction-finding architecture. Out of all the steps needed to operate a sensor, routing uses the most energy. Consequently, the authors offer an IOTN routing policy that is dependable and power-efficient. The authors investigated the usage of the huddle sculpt to achieve the ambition of power competence [11].

The Cluster Head, represented by this archetype, is responsible for directing the activities of the CM sensory nodes. Over a specific time era, the Cluster Head varies. With this approach, the power of the sensory nodes is utilized equitably, and the prototype for power utilization is constant. The recommended method comes before a few pathways from a resource node to a target node when it wants to send a communication. The client can express the necessary degree of path reliability by adding together. Among the numerous possibilities displayed, the itinerary with the highest degree of reliability is selected. As a result, these exertions believe the sensitive nature of the information and add a minor worry about information protection. Consequently, these efforts spotlight on power competence, the dependability of the directions, and a minor apprehension about information protection [11].

In order to minimize redundant transmission and enhance load balancing, recent research concentrates on WSNs with densely placed sensor nodes. Relevance-specific sensory nodes are implanted in the association region. Consequently, information transmitted across sensor nodes within the same application over short distances is highly correlated, resulting in unnecessary sensing. The unnecessary data transfer caused by this extraneous information degrades network performance. Similar to TEAR, this article evaluates sensory nodes with varying strength and information velocity and multiple haphazard levels. It suggests that the transmission velocity of each sensory node determines how much information it transmits. Consequently, the sensory node processes hearsay data at different rates of communication. Sensory nodes with elevated information rates report more messages per round than sensory nodes with stumpy information rates [12].

This produces jagged power debauchery in the network. The concept of combination, which uses two or more sensory nodes in safe proximity and providing the same relevance form pairs for information sensing and broadcast, was employed by the proposed ETASA to get around this issue. The harmonizing nodes alter between slumber and awaken mode dependant on power and interchange rate.

The ETESA snooze-wake protocol accomplishes two goals. Using a round-robin cycle similar to SEED, the paired sensor nodes transition between wakeful and sleep modes at the beginning of the set of connections made. Following one round of information diffusion for each paired node in the collection of connections, the sensory nodes alternate between the wakeful and slumber modes according to their power and information transmission speed, to evade the premature demise of nodes with towering interchange rates [12].

Based on a possibility determined by the node's power, square interchange, and number of pairings, the Cluster Head assortment is created. This selection technique avoids selecting isolated nodes for the Cluster Head position, which improves consignment complementary. Every sensor node joins the CH nearest to it as a result of the Cluster Head assortment. Based on the number of sensor nodes in a group, Cluster Head distributes moment slots to CMs in unadventurous TDMA. Therefore, if a node in a group has nothing to report to the Cluster Head, it should wake up through its assigned instance gap.

This results in energy waste due to an inactive maneuver that is flanked by the current Cluster Head and the associate node in this instance. The authors adapt the standard TDMA by distributing slots to CMs based on the quantity of paired clusters and inaccessible nodes inside the group to diminish the span of inoperative procedure of current Cluster Head and CMs to diminish power utilization [12].

The authors invented the power conscious multi-hop direction-finding process (EAMR), which communicates flanked by a sensing node and a pedestal station via fixed clusters. A sensory node in EAMR that has been allocated to a group stays an associate of that group for the period of time that the relationship is in effect. Goal of applying permanent grouping is to reduce the power use transparency required to establish creative groups after each communication circuit, which is a regular practice for the greatest part of Wireless Sensor Network related routing algorithms.

Groups close to the pedestal site use their CHs to steadfastly transmit composed information to the pedestal location under the EAMR. In order to facilitate multi-hop communication to the pedestal position, the remaining CHs transmit their collected data to communication nodes on the network. By reducing intermediary data transmission distances, the multi-hop technique not only increases the scalability of processes such as LEACH and its derivatives, but it also generally lowers communiqué power from a sensory node to the pedestal position [13].

The setup and stable-state phases are the two main stages of the EAMR approach. Fixed groups are assembled during the arrangement segment by picking the initial CHs, determining the group memberships of all notable sensory nodes, and selecting the initial transmit nodes. In the steady-state phase, every CH starts to gather data from its own cluster for transmission to the pedestal location, either directly or indirectly through the transmission nodes. During the stable-state phase, judgments are prepared as desired using CH and transmit node revolutionization in addition to information collecting and communication [13].

The authors suggested that two kinds of wayside nodes—sensory nodes and roadside units, which are placed on both elevations of a road—as well as vehicle nodes comprise the HSVN system. Two adjacent RSUs are connected via a highly dispersed network of sensory nodes. According to authors, RSUs and mutually sensing nodes share the same duty of collecting environmental data and relaying it to the network via transitory vehicles that are designated as transmit nodes [13].

Every sensor node in the association also has an IEEE 802.15.4 border, which enables communication with passing cars and pavement nodes. Moreover, two communiqué interfaces are shared by RSUs and vehicle inbounded nodes. The IEEE 802.11p border is intended for spontaneous communication between automobiles, while the ZigBee interfaces are used to connect to sensing nodes [14].

An isolated sub-network can be produced if a set of connections in a WMSN are bereaved according to distinct discontinue criteria, such as the primary node bereavement, the percentage of deceased nodes, or the number of deceased nodes that exceed a threshold that makes direction-finding to the descend node impossible. Superfluous nodes are one of the techniques used to address this isolation issue. This tactic lessens the effects of some nodes trailing because of a set of connection partitions or battery weariness. The network has a long lifespan as a result. However, if a specific percentage of deceased or disengaged nodes are met, the network can be considered inert and declared deceased [14].

Reliability and energy efficiency in data forwarding become critical when resources are scarce, like in Wireless Sensor Networks (WSNs). In the literature, data-centric routing techniques have been presented as a more energy-efficient alternative to address-centric systems, which are conventional end-to-end routing schemes.

The variable-power data-centric routing system, which we offer in this work, allows each sensor node (source) to adapt its transmission power according to the distance it has to the receiver (data recipient/sink). We describe how the energy involved with the reliable transmission of a single packet is affected by the error rate associated with a link, which in turn impacts the overall likelihood of reliable delivery. The analysis includes both fixed power and variable-power scenarios along with the End-to-End Retransmission (EER) and Hop-by-Hop Retransmission (HHR) techniques [15].

The packet delivery ratio is a crucial design parameter for wireless sensor networks (WSNs) that must be optimized. A secure zone-based routing technique was incorporated into current systems to increase WSN lifetime. A new routing criterion was developed for packet transfer in multi-hop communication. The routing metric included protection against flooding, dropping, and message tampering assaults. The strategy skipped dangerous zones as a whole from routing and finds alternate path to route a packet in secured manner with minimal energy usage.

While energy efficiency and defense against attacks are attained, WSN congestion rises and reduces packet delivery ratio as a result. In order to solve this issue, The authors suggested using multiple factor solutions, such as routing, flow differentiation, flow-based congestion control with retransmission, and redundant packet coding, to increase the packet delivery ratio. Thorough examination and modeling are conducted to assess the effectiveness of the proposed task in contrast to the current solutions [16].

Wireless sensor networks are advancing quickly and are now present in every aspect of our life. They are in great demand and are widely utilized in transmission of data like temperature, pressure, humidity, speed etc. Since these networks are wireless, attackers can readily access them. Therefore, data security is the main priority. The network's nodes will communicate with one another to exchange information, but in the process, intrusions such as wormhole, black hole, sybil, and hello flood attacks might occur, corrupting data.

These assaults have an impact on the network's throughput and packet delivery ratio, among other characteristics that determine the network's efficiency. Black hole is a significant assault in network which affects most of the data before it is received at the sink, hence has to be recognized and stopped [17].

Because wireless sensor networks (WSNs) provide low latency and dependable message transmission, they are becoming more and more popular in mission critical and delay sensitive industrial applications. Reliable communication between the sink and the sensing nodes is crucial in applications such as industrial process control, pressure monitoring, and gas leak detection, among others. Sensing nodes in wireless sensor networks are typically dispersed widely across various settings and lack a clear network topology.

The positioning of the sensing nodes in an industrial setting is crucial because, above all, it boosts system throughput by effectively communicating the calibrated values and giving industrial equipment the highest level of security. The purpose of this research is to examine how packet delivery ratio (PDR) and end-to-end delay in wireless sensor networks are affected by various topological configurations. The performance analysis of three alternative network topological configurations for mission-critical applications is another major topic of this article. By allocating the sensor nodes to three distinct topological designs—Linear, Tier 1, and Split Tier 1—we were able to assess the efficacy of wireless sensor networks (WSNs) [18].

The purpose of this study is to develop an improved ant colony optimization method that aids in determining an appropriate data path that enhances energy efficiency and decreases packet delivery time. To analyze the energy utilized at the transmitting, receiving, and relay nodes, energy equations have been formulated. The network has been divided into more manageable virtual segments to facilitate the examination of the suggested method. It is believed that there are nodes with cluster heads in each segment.

As the sink travels from one segment to the next, it collects data from various cluster heads. The nodes not in close connection with the network used the overhearing method to share the information with the sink. Cisco Packet Tracer was used to conduct the simulation. The proposed technique has been applied to several types of wireless networks to measure their efficiency. Three wireless networks are taken into consideration for this: Bluetooth, Wi-Max, and Wi-Fi. Evaluations are conducted on packet delivery ratio, lifespan, collision, and end-to-end delay for various wireless network types. The resulting results are examined, and graphs are presented [19].

Wireless Sensor Networks (WSNs) are used to gather and send data to the Base Station (BS). Within the WSN network, routing problems are designed and analyzed in this sector. In WSN networks, maintaining the right energy levels is essential to minimizing power consumption, preventing packet loss or drop, preventing deterioration in node efficiency, and minimizing packet delivery delays across the networks. Routing decisions must be made more intelligently by evaluating node power consumption and employing machine learning algorithms to maximize network efficiency overall.

Maintaining load balance while maximizing the use of Cluster Heads (CH) and members is one of the primary challenges in clustering sensor nodes. A hybrid C-means donkey-smuggler optimization strategy has been proposed by the research to improve WSN routing efficiency. By assessing the performance of the proposed method using metrics like packet delivery ratio, network lifespan, energy consumption, and latency, the research has shown its efficacy. The suggested method outperforms the alternatives and results in a highly efficient network operation [20].

3. Methodology

3.1. Methodology Design

By using the route indicated by the cluster head, or CH, the proposed model is an enhanced design that finds the shortest path with the most energy-efficient manner to transfer data from the resource to the target. The cluster head selection procedure will announce the CH in accordance with the guidelines given in 3.2.1 as soon as the source node sends out a request for data transmission. As illustrated in 3.2.2, the CH will choose the fastest path and create a data transmission link with high energy level nodes when it is proclaimed. The data will be transferred from the source node to the destination node after the CH has been chosen and the data transmission path has been established. The information relevant to data transfer in the proposed paradigm was illustrated in Figure 1.

3.2. Procedure

3.2.1. Cluster Head Selection Algorithm

Begin
Search for the nodes Choose the >90 energy level nodes Encircle the nodes with up to 25 nodes Select any three nodes randomly which are having >90 energy level Declare any one of the node from three nodes as CH Idle the remaining two nodes as idle CH Fix the selected node and declared it as CH If the CH crashed due to any reason Pick and Fix the highest energy contain as next CH from the idle CH
End

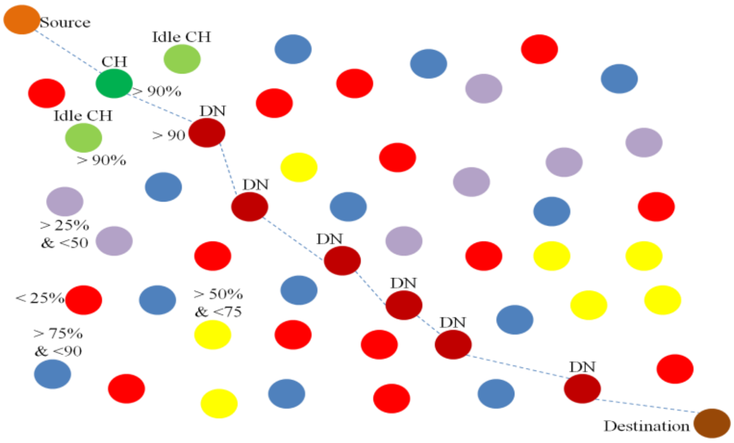

Figure.01 Proposed Methodology Design

3.2.2. Routing Algorithm

Begin
- Source node forwards the request message to active CH for data transmission
- CH verifies the available nodes status with highest energy level
- CH analyze the available shortest route to reach the destination with highest energy level
- Detect the paths to reach the destination
- If more than one path is identified
- Check the energy level of the nodes and then sorted it based on energy level
- If more than one route is available with > 90% energy then select the one route randomly
- Else
- Fix the available route as default route to send the data
- Set the path as default path which was received from CH
- Instigate the data transmission
- Verifies the data transmission end with the source node
- End the transmission
- End if
- End if

End

3.3. Comparison Metrics:

3.3.1 Average Latency

Network latency is a well-known barrier to communication between sets of connections. It shows the time it takes for data to move between a collection of connections. Squat latency networks counter quickly, while high latency networks have a greater barrier or lag. When calculating the typical latency of information communication from the resource to the target node, the amount of time that needs to elapse between starting at the source and arriving at the destination is taken into account.

It is crucial to minimize the delay period as much as possible.

3.3.2 Packet Delivery Rate

The PDR is the total number of packets that are efficiently sent to the intention node that is alienated by all of the packets that were sent in the first place. To determine the Packet Delivery Rate, divide the total number of packets sent by the number of successfully received packets, then multiply the result by 100 to produce a percentage. A standard routing technique needs to show that the packet delivery ratio is as high as is practically possible and that it is reasonable.

3.3.3 Packet Loss Rate

The packet loss rate is defined as the total number of packets transmitted minus the total number of packets received over a specific time period. Usually, network congestion or data transmission faults result in packet loss. The packet loss rate, expressed as a percentage, is the quantity of packets lost relative to the total number sent.

3.3.4 Energy Efficient Analysis

The planning, configuration, and upkeep of network infrastructures and protocols with the aim of reducing the energy consumption of data centers and network devices is referred to as "energy-efficient networking". A device's energy efficiency can be assessed and established by comparing the productivity it generates with the amount of electricity it consumes during manufacturing. An estimation of the power use of the sensory nodes is made based on the duration of the simulation. The amount of energy expressed in joules that is still available in the sensory nodes after a predefined number of instances.

3.3.5 Network Life Time Analysis

The term "network lifetime" refers to the amount of time that passes between the deployment of a network and the point at which it ceases to function (for instance, when a specific number of nodes fail or the network divides). If the overall outstanding power level in the set of connections is more significant than the power collapse in a single node, the lifetime can be defined as the total outstanding power of all the nodes in the set of connections. The definition of network lifespan determines the most effective strategy to improve energy efficiency. The lifetime of the network is evaluated with respect to the duration of its simulation. As the lifespan of the sensor rises, the set of connections will have more time to function as planned. When all of the nodes that have been active throughout a certain period of time are added together, the life span of the network remains constant. As the number of full zip nodes in the set of connections rises, so does the lifespan competence.

4. Results and Discussions

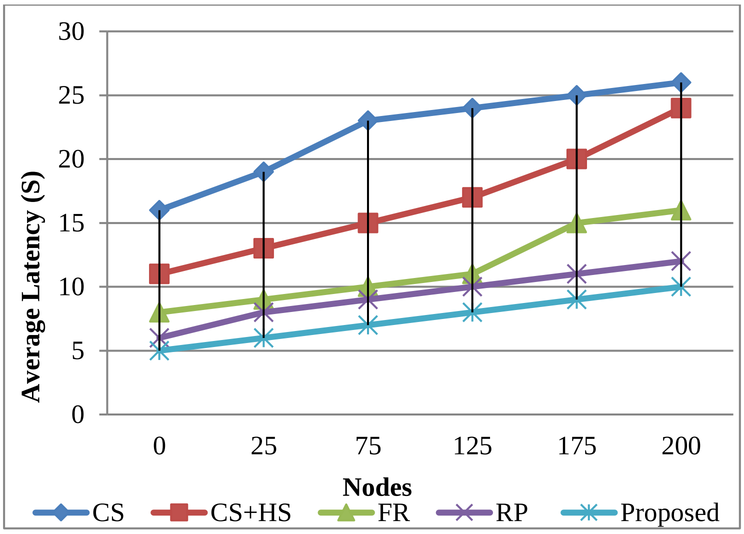

Figure.02 Average Latency

Table.01 Average Latency

Models	0	25	75	125	175	200
CS	16	19	23	24	25	26
CS+HS	11	13	15	17	20	24
FR	8	9	10	11	15	16
RP	6	8	9	10	11	12
Proposed	5	6	7	8	9	10

The comparison between the projected representations and the previously published model for average latency is shown in Table 01 and Figure 02 of the document. It illustrates how the projected representation outperforms the previously described approach in terms of average latency.

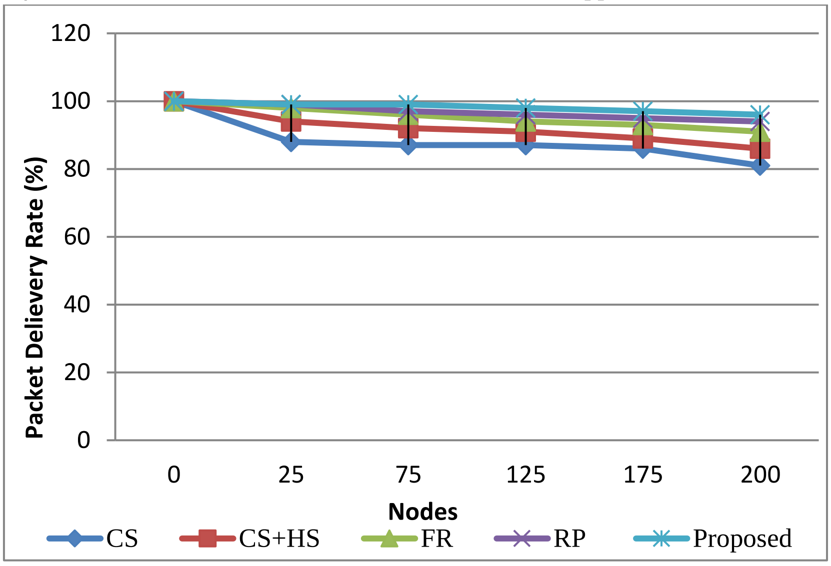

Figure.03 Packet Delivery Rate

Table.02 Packet Delivery Rate

Models	0	25	75	125	175	200
CS	100	88	87	87	86	81
CS+HS	100	94	92	91	89	86
FR	100	98	96	94	93	91
RP	100	99	97	96	95	94
Proposed	100	99	99	98	97	96

The comparison of the projected representations with the PDR model that has already been provided is shown in Table 02 and Figure 3. It illustrates that the projected representation is improved than the earlier presented way in the Packet Delivery Rate.

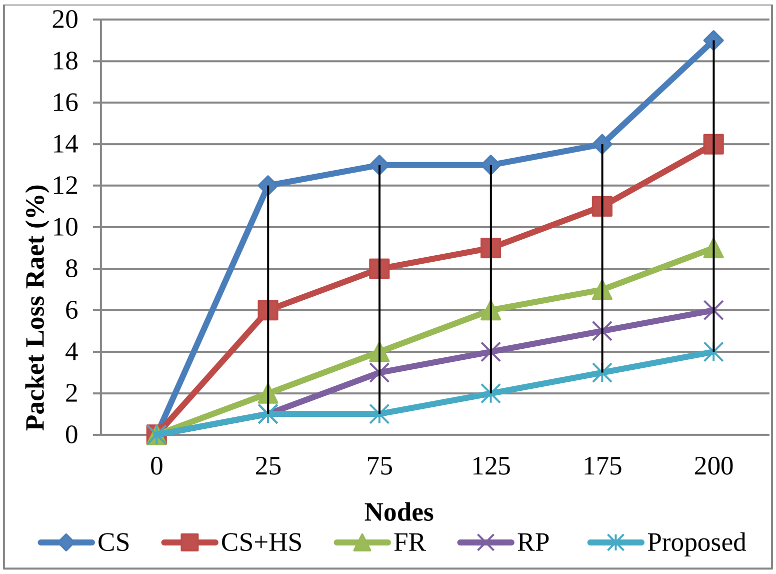

Figure.04 Packet Loss Rate

Table.03 Packet Loss Rate

Models	0	25	75	125	175	200
CS	0	12	13	13	14	19
CS+HS	0	6	8	9	11	14
FR	0	2	4	6	7	9
RP	0	1	3	4	5	6
Proposed	0	1	1	2	3	4

Table 03 and Figure 04 show how the projected representations and the previously available Packet Loss Rate model compare. It shows that the proposed representation outperforms the previously described approach in terms of packet loss rate.

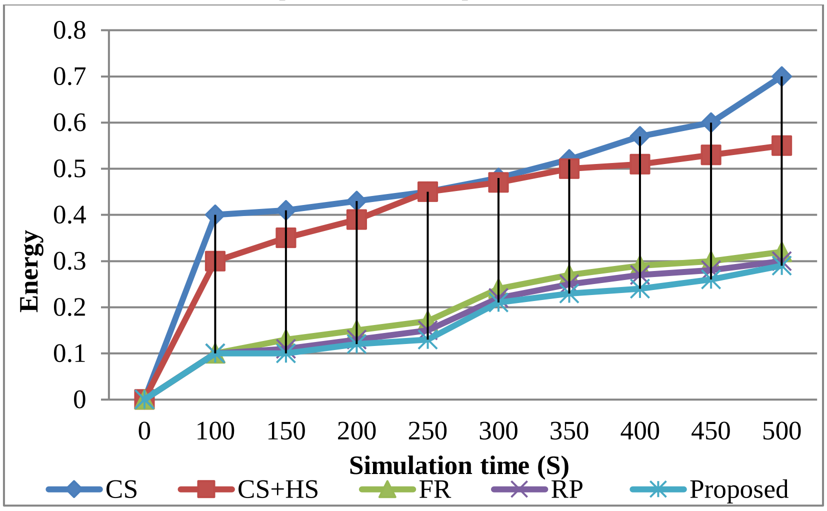

Figure.05 Energy Efficient Analysis

Table.04 Energy Efficient Analysis

Model	100	150	200	250	300	350	400	450	500
CS	0.4	0.41	0.43	0.45	0.48	0.52	0.57	0.6	0.7
CS+HS	0.3	0.35	0.39	0.45	0.47	0.5	0.51	0.53	0.55
FR	0.1	0.13	0.15	0.17	0.24	0.27	0.29	0.3	0.32

RP	0.1	0.11	0.13	0.15	0.22	0.25	0.27	0.28	0.3
Proposed	0.1	0.1	0.12	0.13	0.21	0.23	0.24	0.26	0.29

The comparison between the projected representations and the previously released model for energy-efficient analysis is shown in Table 04 and Figure 05. It proves that the proposed representation is superior to the approach that was previously provided in the Energy Efficient Analysis.

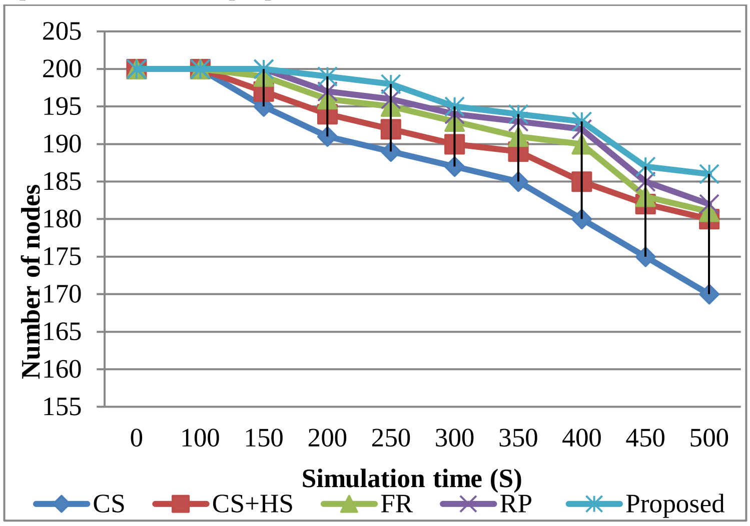

Figure.06 Network Life Time Analysis

Table.05 Network Life Time Analysis

Models	0	100	150	200	250	300	350	400	450	500
CS	200	200	195	191	189	187	185	180	175	170
CS+HS	200	200	197	194	192	190	189	185	182	180
FR	200	200	199	196	195	193	191	190	183	181
RP	200	200	200	197	196	194	193	192	185	182
Proposed	200	200	200	199	198	195	194	193	187	186

Table 05 and Figure 06 show how the projected representations and the previously released Network Life Time Analysis model compare. It shows that compared to the method previously described in the Network Life Time Analysis, the projected representation is superior.

5. Conclusion and Future Enhancement

The sensitive nature of the data to be transferred from the source node to the destination node and the path's dependability are both taken into consideration by the path selection system described in this research study. Since some data is extremely sensitive, there's a potential that it will be modified or removed while routing is taking place. There could be malicious and trustworthy nodes on every path. For very sensitive data, the path with hostile nodes present is not the best choice because the malicious nodes might do unwanted things. Given this, this study proposes a path selection technique that allows the user to ascertain the expected energy score of the path. Once again, the path that satisfies the target energy score is filtered with respect to its length. A CH manages every step of these procedures to save energy. This idea conserves energy and extends the lifetime of the network. In order to achieve the required level of data security, future work on this project intends to expand with other path selection models for different information transmission purposes.

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