Broadcast Tree Construction for Shortest Path Finding with Secure Data Aggregation Techniques in Wireless Sensor Networks

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Abstract: A wireless sensor network (WSN) consists of a large number of deployed sensing devices that consume little power and computing capabilities. Data packet switching in sensing devices is commonly achieved by using multi-hop transmission due to the limited range of connectivity and the dense distribution of sensor nodes. Dynamic routing in WSN has been increasingly popular in recent years. In modern times, sensor networks extensively employ the multi-path data transmitting technique to optimize system performance by using the available bandwidth. The main objective of this paper is to elucidate the concept of multi-path routing, along with its inherent challenges and fundamental justifications for its application in sensor networks. This study presents a method for finding the shortest path using the Broadcast Tree Construction (BTC) algorithm, which incorporates data aggregation techniques to reduce network overhead during communication. This method is suitable for both cluster networks and Wireless Sensor networks. The suggested work was assessed utilizing the NS2 environment in a thorough experimental investigation. Four alternative procedures were used to explore the system efficiency. Through rigorous experimental investigation, the system is able to conserve 15% of energy while operating with 100 internal nodes. Additionally, it improves network life by 7% when utilizing the SAODV routing protocol. This performance is superior to the distance-based method of determining the shortest path in a WSN. It also improves the data transfer rate and decreases the number of lost packets compared to previous methods of identifying the shortest path in WSN's.

1 INTRODUCTION

Restricted wireless sensor nodes have been introduced in recent advancements in wireless communication systems and the manufacturing of cheap wireless devices. WSN has been used for numerous applications, including medicine, target detection, and surveillance systems, due to their simplicity of deployment and non - linear and none of the edge devices (Le, Chong, et al. , 2010). The main function of sensor nodes in any application is to detect the target area and send the collected data to the base station for additional analysis. The lack of efficiency in sensor node resources and the unpredictable nature of limited wireless connections The user's text is (Kenc and Boudec, 2008), along with the varied throughput requirements of diverse applications, offer many difficulties in developing effective WSN communication protocols (Wang, Niu, et al. , 2007). Meanwhile, finding appropriate network algorithms to meet the varied performance needs of various workloads is a critical problem in wireless mesh networking. Several routing methods have been suggested in this area to enhance the efficiency needs of multiple applications via the network topology of the distributed sensing protocol stack.

The battery powers the sensor nodes, which in many cases, these devices cannot be changed. When the power goes out, and the network stops working, they die. As a result, a routing method is critical for extending the battery's life and effectively managing the battery. This feature encourages the development of energy-saving routing methods. Data is sent via intermediary sensor nodes in a WSN, which is a multi-hop infrastructure. The connections between

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iot devices are very vulnerable to failure. The probability of connection failure directly impacts the data packet transmission and the network's dependability. This problem drives the development of dependable routing methods. The movable sink may be used to address the energy hole issue. However, managing a transportable sink is a time-consuming job. Several routing algorithms function in the mobile sink context, but they have drawbacks such as inefficient management, high power consumption, and a lower data delivery ratio. To extend the broadcaster's life, it's critical to control the mobile sink effectively. The produced data should approach the network device as soon as possible in many instances. The later part latency is increased by the lack of a routine route, the placement of the sink, and the probability of hardware failures. As a result, methods to decrease latency must be included.

The primary goal of this study is to decrease energy usage while also reducing delay. Some methods may be used by the routing algorithm to enhance energy consumption and network lifespan. Below are a few smart energy methods that will be explored:

Energy model: In any routing algorithm, the energy storage system of the WSN nodes may assist to enhance connection speeds (Le, Chong, et al. , 2010). The precise definition of the energy balance equation may provide a more accurate estimate of the residual energy within every node. It simplifies and clarifies observation. The network lifespan may be increased by using a model with a comprehensive perspective and a proper methodology.

Reduce the control packet overhead: A sensor network uses the most energy during communication systems (Kenc and Boudec, 2008). The shortest path and preservation in the routing algorithm for neighbour node identification need many control signals to be sent between sensor nodes. The proposed method must limit the network's unnecessary circulation of control packets. The volume of the received packets may have an impact on the total amount of energy used.

Permit multi-hop communication: Straightforward data transfer requires more energy then multi-hop data transfer (Wang, Niu, et al. , 2007). The sensor node must maximize the wireless transmission capacity in direct connection, which produces higher expenditure at each node. To cut emissions, the routing algorithm must address these problems.

Transmission range modification: WSN is several co networks in which data must pass via intermediary nodes to reach its destination. During implementation, it is common to discover that the following accessible access points are almost always near the sender node. As a result, instead of transmitting data at full power, the RSSI (Xu, Liu, et al. , 2010) may modulate the network throughput. This method may assist in decreasing energy usage and increasing network lifespan (Quang and Miyoshi, 2010).

Data aggregation: At some time, comparable data packets may be consolidated, and the collected information can be sent to the sinkhole (Batwada, Tripathi, et al. , 2012). Combining similar data across the network reduces traffic on the web (Paul, Nandi, et al. , 2008). Collisions and energy consumption are decreased as a result of less traffic. To extend the broadcaster's lifespan, the routing algorithm must use the clustering algorithm.

Using MAC protocol: The node in the network detects its surroundings, produces data, and sends it to the reservoir (Karaki and Kamal, 2004). Sensor networks must go into standby mode even when they're not seeing or routing. As a result, for networking energy saving, an appropriate Proposed technique is needed.

Minimize the collision: Every data could reach a wireless network device without even any intervention in the packet forwarding (Chong and Kumar, 2003). Each node must be capable of communicating in a traffic delays atmosphere, according to the standard. Alternatively, it may result in data recapture, which directly impacts the platform's fuel efficiency.

The primary contribution of our research is outlined below.

The objective is to create an algorithm that finds the shortest path from the source node to the base station.

To provide a robust data aggregation technique at the Cluster Heads' location.

To deploy the suggested solution across multiple network protocols, including AODV, DSDV, SOADV, and DSR.

The rest of the paper is divided into the subsequent sections: Section II examines various contemporary methodologies that previous researchers have devised to uncover routes between source and sink nodes. Part III demonstrates the recommended system structure and execution, while part IV outlines the proposed method specification for implementation. The experimental configuration for evaluating the proposed work and the results obtained using our strategy, together with a comparison study against various cutting-edge methodologies, is detailed in section V. The conclusion and potential future developments are addressed in Section VI.

2 LITERATURE SURVEY

Since the transmitted signal is dependent on electricity, many studies have looked at the impact of power in improving broadband services. The maximum lifespan for the shortest route aggregation tree was investigated by Luo et al.. The issue was modified to a job scheduling scheme for each level of a structure resembling a fat tree. The researchers showcased the possibility of managing the problem with a time complexity by using the min-cost max-flow approach. They demonstrated the suitability of their choice by showing that the produced shortest route tree is superior, and their simulation confirmed that it beats the random approach.

An efficient way for low latency data transmission in wireless sensor networks (WSNs) is the use of the lowest route routing, as described in (Vetrivelan, 2019). A proposed routing system in Wireless Sensor Networks (WSNs) is LWSP (Shortest path without Latency), which aims to efficiently determine the shortest paths with minimum command processing overhead time and low latency. Based on performance tests and simulation data, our proposed protocol demonstrates superior performance compared to existing protocols in terms of latency and additional processing time for commands. The shortest path technique is used for the establishment of a wireless sensor network (Nakas, Christos, et al. , 2020). The purpose is to implement the quickest route method in a wired communication network, which will facilitate the transmission of protocol and ensure real-time arrival at the destination. This will include determining and identifying the shortest path algorithm in a wireless communication system.

An extensive examination of energy-conserving techniques in wireless sensor networks (Kandris, Dionisis, et al. , 2020). This paper provides an analysis of both conventional and modern methods proposed for attaining energy-efficient routing in Wireless Sensor Networks (WSNs). The protocols were classified into four main areas based on their important structural or operational characteristics: Customized System, Network Structure, Topology, and Reliable Routing. They analyzed the pros and cons of many common examples of the aforementioned techniques. They have a same goal: to save energy by optimizing their routing strategies. Our investigation uncovered several variances in both the structural and functional aspects.

A recent publication (Osamy, Walid, et al. , 2019) has presented new findings on the uses of wireless sensor networks. A comprehensive and current survey of traditional and emerging applications of Wireless Sensor Networks can greatly enhance comprehension of this scientific domain and the recognition of inventive uses. To achieve this purpose, we outline the main categories of applications in Wireless Sensor Networks and analyze specific instances of each category. Their distinctive characteristics are examined, along with their benefits and drawbacks. Subsequently, there is an examination of the many concerns linked to each of these specific groups. Lastly, there are a few concluding remarks.

The article titled "Tree building and scheduling techniques based on simulated annealing decrease duration in wireless sensor networks" discusses the use of simulated annealing to reduce the duration in wireless sensor networks (Zantalis, Fotios, et al. , 2019). In order to gather data with a specific schedule for node transmissions, the researchers devised an innovative method for constructing trees using simulated annealing, known as SATC. The delivery time for aggregated data to the sink is reduced by 50% utilizing SATC. The proposed strategy utilizes the average time delay as the fitness value for the simulated annealing (SA) process. This fitness value is assessed using routing aware MAC scheduling techniques. Simulation is used to evaluate the efficiency of the proposed method and compare it to current state-of-the-art techniques, primarily by analyzing average delay and latency.

Smart transportation is increasingly being influenced by the growing importance of machine learning and the Internet of Things (Khedo, Bissessur, et al. , 2020). Intelligent transportation encompasses several aspects such as optimizing routes, managing parking, improving street lighting, preventing and detecting accidents, addressing road imperfections, and implementing infrastructure applications. The objective of this article is to provide a comprehensive summary of machine learning (ML) techniques and Internet of Things (IoT) applications in Intelligent Transportation Systems (ITS) in order to get a thorough understanding of the advancements in these fields and identify any possible areas that have not been adequately addressed. The analyzed articles indicate a possible deficiency in machine learning applications for Smart Lighting Systems and Smart Parking Applications. Furthermore, the prevailing

ITS applications favored by scholars include route optimization, parking management, and accident detection.

The researchers in (Tasgaonkar, Pankaj, et al. , 2020) developed an earthquake early warning system with the aim of increasing the duration of time available before an earthquake occurs, allowing individuals to take precautionary measures. The researchers established a Wireless Sensor Network (WSN) on Mauritius, an island characterized by significant seismic activity. The technique utilizes primary waves to observe seismic activity. The system determines the local velocity and hypocentre location by analyzing the time delay between the arrival of P-waves at the sensors. The paper titled "Vehicle Search and Traffic Estimation for Intelligent Transportation Systems Using Sensor Technologies" is referenced as (Tasgaonkar, Pankaj, et al. , 2020). Vehicle detection strategies include both invasive and non-intrusive sensors. The objective of this research is to provide a comprehensive inventory of the sensors and technologies used in vehicle identification and traffic estimation. By establishing a connection with the monitoring station on the vehicle's existence on the road, these sensors will provide crucial information. Sensors and communication technologies are extensively used in intelligent transportation systems. An assessment is conducted to evaluate the most recent tools and techniques used to determine the number of vehicles, their classification, location, speed, traffic volume, density, and traffic estimation. Sensor fusion enables the seamless integration of data from several sources, hence enhancing accuracy.

The Social Internet of Vehicles employs a Cross-Layer Protocol for Traffic Management (Jain, Bindiya, et al. , 2018). A considerable quantity of sensors transmit data via wireless means in the proposed Vehicular Social Networks that rely on the VIoT. The wide range of hardware capabilities and quality of service requirements for different applications hinders the effectiveness of traditional layered protocol solutions and modern cross-layer solutions for wireless sensor networks. The innovative Vehicular Social Network Protocol (VSNP) based on Wireless Sensor Networks (WSN) in the context of Vehicular Internet of Things (VIoT) provides an optimal level of global connectivity and outperforms current layered systems. The introduction of the new SIoT cross-layer module is the first phase in establishing dependable vehicle-to-vehicle communication and optimizing traffic management. We presented a methodology for effectively handling traffic congestion and enhancing road safety in the context of VIoT.

Deep learning is used in data-driven pavement imaging. An evaluation of analysis and automated problem-solving ((Gopalakrishnan, Kasthurirangan., et al. , 2018). An exposition of recent research in this field, highlighting present achievements and challenges. The provided information includes a comparison of deep learning software frameworks, network architecture, hyper-parameters utilized in each study, and the performance of crack detection. This serves as a solid basis for future research in the field of intelligent pavement and asset management structures. The work continues by proposing future research directions, including the use of deep learning techniques to accurately identify and classify various types, quantities, and severities of distresses in both 2D and 3D pavement photos.

Utilizing GPS trace, autonomously detect traffic signals, street intersections, and urban roundabouts during the act of driving(Organero, Mario, et al. , 2018). A novel approach is centered on the automated identification of street elements such as traffic signals, intersections, and circular junctions. These elements may be used to generate street maps and fill them with traffic-related infrastructure characteristics such as traffic signals. The system utilizes just the residual GPS data obtained from the mobile device while driving to reduce system demands and streamline data collecting from many users with little effect. The GPS data is used to construct time series for speed and acceleration. At first, an outlier identification method is used (which may be caused by infrastructure components or specific traffic situations). Deep learning is used to analyze speed and acceleration patterns at each anomaly in order to extract essential characteristics, which are identified as a traffic signal, pedestrian crossing, urban roundabout, or another component.

The paper titled "Duty-Cycle Multi-hop Wireless Sensor Network with Structure-Free Broadcast Scheduling (Chen, Quan, et al. , 2021)" is being referred to.

1. Instead of depending on a predetermined structure, a two-step scheduling technique is suggested to concurrently generate the broadcast tree and calculate a timetable that avoids collisions. As far as we know, this is the first endeavor to combine these two types of processes.

The paper introduces concurrent broadcasting, an innovative transmission mechanism for wireless networks, and investigates other methods to further reduce the broadcast latency.

3. The introduction of broadcasting algorithms that may independently create a series of broadcast schedules without a pre-determined tree was made possible by taking into account collisions in both the current and prior broadcast schedules, as well as the broadcasting of simultaneous messages.

The most efficient path with risk management for a malfunctioning wireless sensor network (Wang and Na, 2019). Compromised Regions (CRs) consist of a cluster of densely connected nodes (CNs) and seem to provide a greater threat to networks compared to individual CNs. In order to protect against CR attacks, we have devised a Secure Shortest Path Routing Algorithm (SPRA) that redirects packets around, rather than through, CRs. For instance, a source node computes the most direct path to a sink node, avoiding any intersections with CRs. It then identifies agent nodes along the route indirectly by using a set of virtual locations. Ultimately, a complex system using geographical data is created to ensure that packages may be passed via intermediary nodes until they are successfully delivered to the final destination node. In a series of experiments, we evaluate our strategy by comparing it to the dynamically Greedy Perimeter Stateless Routing (GPSR) and Directed Diffusion (DD) methods.

The issue of transmitting data along the most direct route (Younes, 2018). The problem of the smallest broadcast tree was discussed and an efficient genetic algorithm was shown to solve it. The approach examines the connection, cost, and bandwidth matrices of a network and constructs a tree of least-cost routes. This tree is rooted at a specific node s and takes into account bandwidth limits. The construction of the tree is based on the minimal broadcast tree algorithm. The genetic algorithm (GA) was evaluated using three distinct situations, and the results conclusively showed that the proposed GA is very efficient. The paper WSN (Sun, Xiao, et al. , 2019) proposes a method where the integrated two-hop neighbourhood information is used to create a transmission radius that is twice as large, resulting in efficient code transmission. The TNI-DBR technique is introduced to efficiently and quickly provide codes in duty cycle-based WSNs by using a Two-hop Neighbourhood Info with double Broadcast Radius. Here are the most notable breakthroughs discussed in the essay. The TNI-DBR approach utilizes surplus energy to increase the broadcast radius in the given region, enabling a greater number of nodes to receive up-to-date code via a continuous broadcast, hence decreasing the latency in code dissemination. Unlike traditional methods of distributing code, which choose broadcasting nodes based on information from nearby nodes within one hop.

3 PROPOSED SYSTEM DESIGN

The below figure 1 describes the proposed system architecture for secure pathfinding using a broadcast reconstruction algorithm. During the execution of the proposed system, first generate multiple clusters in a network, each cluster having a cluster node that contains at least one cluster head; others are cluster members. The two basic algorithms have been demonstrated for data aggregation and secure data transmission between source to destination. In order to the selection of source is the cluster head and destination is the base station. The cluster head eliminates data redundancy while BTC gives assurance, that recommended channel or path is stronger than other available resources. The major benefit of the proposed BTC, that reduces the network overhead and higher energy consumption. It selects strong nodes which are having higher energy from the neighbour's list. Based on that, BTC constructs the entire path and transmit the data security. As a result, both algorithms improve quality of service of the entire simulation.

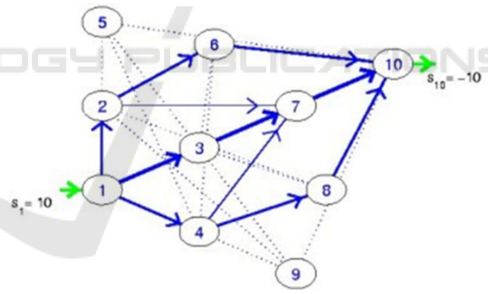

Figure 1: Proposed System Architecture using Minimal 10 Nodes by Minimal Spanning Tree

Existing hop-to-hop connectivity in wireless sensor networks is thought to be exposed to data transmission vulnerability. Due to the higher cost of packet transmission of hop-by-hop communication, the current system employs a security technique known as broadcast tree construction and authentication among network resources. The identity of intermediary nodes may be compromised from hop to hop, posing a security risk. They employ trust computation of each node at the node level for communication or packet transfer to prevent security threats. Message transmission in the current architecture occurs selective neighbour node using BTC algorithm between the source and destination nodes, resulting it reduces the overhead between nodes. In wireless sensor communication.

4 ALGORITHM DESIGN

This section displays a data aggregation process and a data transmission method that finds the shortest route effectively. By reducing network overhead and eliminating data redundancy, data aggregation helps make data transfer between source and sink nodes more efficient. Concurrently, internal nodes that use a lot of power are reduced via tree building. Together, the lists of internal nodes and their neighbours allow this method to build a reliable route up to the destination. Lightweight data communication and the assurance that no data will leak during transmission are both provided by this approach.

4.1 Broadcast Tree Construction for shortest path finding methods

Input: source node denoted as Src_node and sink node Snk_node is a collection of adjacent nodes. The neighbor node has an empty list, with the node's identification as Node_id and its energy level. The variable "Node_energy" is declared.

Output: Calculate the most efficient route from the source node to the sink node or base station.

Step 1: Generate and initialize the network Src_node and Snk_node with energy.

Step 2: Detect or choose the source file from the Src_node.

Step 3: Check whether the value of file_data_values is not null.

Step 4: Continuously read each byte, denoted as 'bytes', from the file data values until the file_data_values is null.

Step 5: Transmit the data and initialize cost_filed_A, cost_filed_B, parent_filed_A, parent_fileld_B

Step 6: Iterate over the nodes until the current node is not null.

The value of cost_filed_A is equal to the value of node[i].The variable "_energy" is assigned the value of "node[i]" from the parent field "parent_filed_A_values"._id cost_filed_B_values = node[i+1]._id The energy parent field B values are equal to the node ID of the next node in the sequence.

Step 7: Check whether the value of cost_filed_A_values is greater than the value of cost_filed_B_values.

The value of cost_filed_B_values is nil.

The value of parent_filed_B_values is nil.

Otherwise, the values of parent_filed_A will be equal to the values of parent_filed_B.

The values of cost_filed_B_values are assigned to cost_filed_A_values. The values of parent_filed_B_values are set to null.

The value of cost_filed_B_values is nil.

Step 8: Terminate the while loop.

Step 9: proceed check-out when reach to Snk_node

The method determines the next node by considering possible neighboring nodes, using the Parent_field as the node identifier and the cost_field as the remaining energy of the chosen node. The system develops routing and route based on energy trust to ensure that no interruptions occur in communication.

4.2 Data Aggregation Protocol

Input: The cluster head has received data in the current stack, which is stored in the Rec_Data[] array. The most recent packet received is stored in the New_Rec_data[] array.

Output: true if data aggregation is feasible; otherwise, false.

Step 1: Iterate over each read of data from Rec_Data using the equation (1) below.

The equation (1) represents the sum of the values in the array "Rec_Data" from index 0 to index n.

Step 2: Compute the cosine similarity between the arrays Data[] and New_Rec_data. The result will be a binary value (0 or 1) obtained by using the function Calc_Cosine_Similarity on the elements Data[k] and New_Rec_data.

Step 3: Terminate the for-loop

Step 4: Retrieve the Result_state and return it.

The method mentioned above performs data aggregation and validates the received data by comparing it with the presently received data. This approach mitigates the duplication of data by consolidating the information collected from various sensor nodes. Additionally, it reduces the network overhead involved in communication and conserves energy.

5 RESULTS AND DISCUSSIONS

An analysis of the current system as well as its potential successors is provided in this section. After outlining our experimental methodology and making use of several measures including throughput, packet delivery ratio, cost, and time, the quantitatively evaluates the study. Many methods exist for processing, filtering, and displaying vector and scalar data. We are located in the project folder's results directory. The findings of the simulation are stored in the Tr file. Our graph tool will be used by the mechanism. This file will display the result parameters in relation to the x and y-axis parameters. Any graphing program should be able to plot files with the awk extension. In Table 1 below, you can see the NS2 setup settings established for the suggested Ubuntu open-source simulation.

The setup environment for the proposed IEEE 802.11n implementation is described in Table 1. Using the SAODV Protocol, the findings shown in Figures 2–6 below show how the proposed system calculates quality-of-service parameters.

Table 1: Parameters and Values in wireless network with 100 nodes in NS2.

No.	Parameter	Values
1	Simulation environment	NS-allinone 2.35
2	Time for simulation	30 seconds
3	Type of Channel	Wireless channel
4	Model of Propagation	2 ray grounds
5	Network standard	MAC/802.11n
6	Simulation area size	1000*1500 cm
7	Total (Packet length limit)	1000 bytes
8	Ad hoc routing	DSR, AODV, DSDV, SAODV
9	Traffic	CBR
10	No. of nodes	100
11	Initial energy of nodes	10 Jules
12	No. of clusters	5
13	Hoping techniques	Single hop
14	Wireless Channel Type	AWGN, FWGN

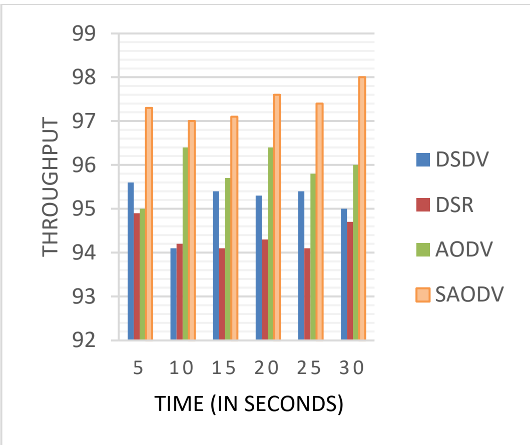

Figure 2: The suggested SAODV system's throughput compared to other protocols.

The suggested simulation's throughput as a function of simulation time is shown in Figure 2, which is located above. In accordance with Table 1, the network setup settings have been fine-tuned. With IEEE 820.11n, which offers bandwidth of up to 600 MB, the starting input nodes have been set at 100. Even while simulation time has grown with SAODV, throughput has declined with DSR, DSDV, and AODV, but it has improved with SAODV.

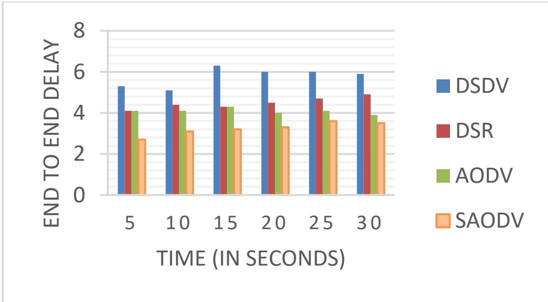

Figure 3: The suggested SAODV system's end-to-end delay SAODV metric in contrast to competing methods

Finding the logarithm of the time delay as shown in Figure 3 provides the basis for calculating the end-to-end latency. A packet's success rate is determined by two factors: the amount of packets transmitted by the internal load and the number of packets received by the destination node. The reduced packet overhead experienced by SAODV producers during communication is also shown in this experiment.

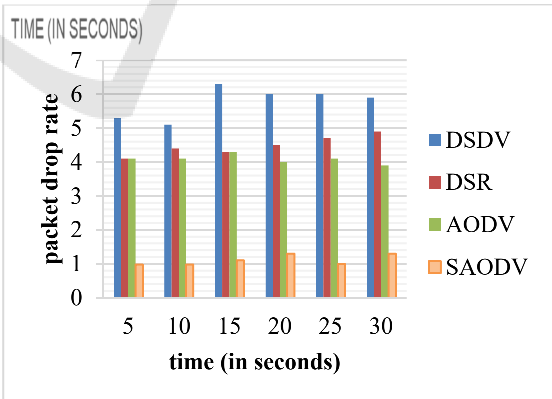

Figure 4: Packet drop rate vs simulation time

An example of how the packet drop rate is determined is shown in figure 4, which is the result of subtracting the number of packets successfully received by the destination node from the number of packets sent by the sensor node. During connection between heterogeneous nodes, DSDV causes a high packet loss rate but SAODV causes a lower one.

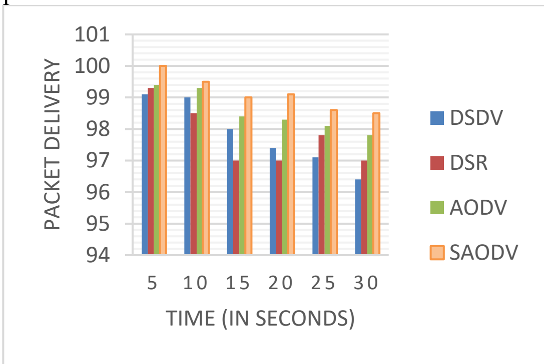

Figure 5: Evaluation of the suggested SAODV system's packet delivery ratio relative to competing protocols

Figure 5 shows the communication packet delivery ratio vs simulation time. The packet delivery rate is based on the number of successfully delivered packages sent by the source node. Both internal node communication and source-to-sink node communication may benefit from a comparable strategy.

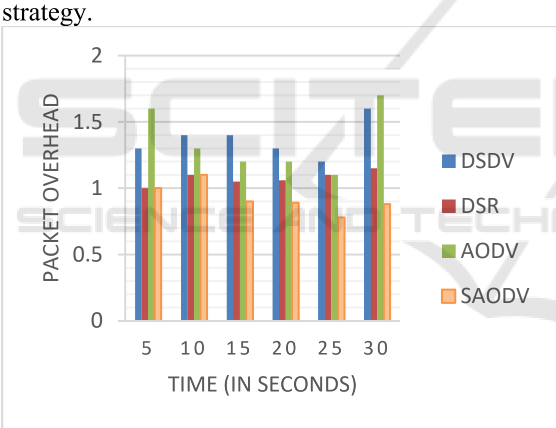

Figure 6: Compared to competing protocols, the suggested SAODV system's packet control overhead

Figure 6 displays the results of the entire experiment analysis, which includes a number of elements and a system performance analysis using several methods. Compared to other alternative Quality of Service (QoS) criteria, SAODVs deliver superior outcomes. Across all trials, SAODV outperformed AODV, DSDV, and DSR by an average of 3-5%.

6 CONCLUSIONS

This article introduces the method, which helps reduce power consumption and find the shortest path for data transmission in a wireless sensor network. Parent filed cost field and neighbour nodes. Identification is an important factor of the BTC algorithm. Before data transmission, we applied the data aggregation technique protocol at the cluster head level, which eliminates the data redundancy. Both algorithms provide different advantages to effective simulation. IT systems also skip the distributed path selection problem and cut generation during the data transmission. Data aggregation reduce the commutation cost and reduce memory and power consumption, respectively. We have conducted four separate tests using the AODV, SAODV, DSR, and DSDV procedures in our experimental research. From what we can tell, when it comes to SAODV, the system manages to keep internal nodes' energy consumption at 15% while improving the network life at 7%. Improve this study in the future by including packet scheduling and other methods for detecting and preventing network assaults.

Table 2: Performance evaluation of proposed system for IEEE 802.11

Details of technical parameters	Output achieved	Outcome inferred from output	Impact		Improvement
			Without BTC	With BTC	
Throughput	4.1 bit/s	High throughput even high traffic generated	3.5 bit/s	4.1 bit/s	0.6 bit/sec
E2E delay	0.019 sec	Reduce E2E delay by using BTC based data transmission	0.028sec	0.019 sec	0.09 bit/sec
Packet Drop	1.9	Low packet drop rate than traditional WSN and cluster networking	4.7	1.9	3.8
Packet Delivery	99.2	Achieve good packet delivery rate even we changed no. of nodes and size of data	95.20	99.2	4.0
Overhead	0.75	Packet overhead is almost noting.	1.85	0.75	1.10

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