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Stepwise Regression Based Resource Optimized Routing in Mobile Ad Hoc Networks

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Abstract: A mobile ad hoc network (MANETs) is a group of mobile nodes forming an ad hoc network without fixed infrastructure. The optimal path selection in MANETs is a challenging task to improve the routing performance and to optimize the resource utilization. In order to overcome such limitation, Stepwise Regression based Resource Optimized Routing (SR-ROR) Technique is proposed. The main objective of SR-ROR technique is to select the best route path for reliable data packet transmission in MANETs. The SR-ROR is used Stepwise Regression technique to choose the mobile node among the collection of nodes in MANETs for route path selection. The Stepwise Regression technique selects the mobile nodes with higher residual energy, minimum delay, and minimum bandwidth and subsequently removes the lower values nodes during each step for data packet transmission. The Stepwise Regression technique in SR-ROR measures regression coefficient for finding the relationships between mobile nodes in order to perform routing in MANETs. The regression coefficient is determined by considering the residual energy, delay, bandwidth of mobile nodes. By using the measured regression coefficient value, SR-ROR technique chooses the mobile nodes with higher residual energy, minimum delay, and minimum bandwidth for transmitting the data packets in MANETs. This in turn helps for improving the network lifetime and packet delivery ratio in an effective manner. The performance of SR-ROR technique is measured in terms of energy consumption, end to end delay, and packet delivery ratio and network lifetime. The simulations result demonstrates that the SR-ROR technique is able to improve the packet delivery ratio and reduces the energy consumption for routing the data packet in MANETs when compared to state-of-the-art-works.
Keywords: mobile node, route path, data packet, stepwise regression, regression coefficient, residual energy, delay, bandwidth.

I. INTRODUCTION

Mobile ad hoc networks (MANETs) is an infrastructure-free networks constructed by wireless mobile devices with limited battery life. In MANETs, each mobile node contains limited processing speed and power, battery, storage, and communication capabilities. The main significant issue in MANETs is their routing algorithms. Besides, resource optimized routing plays a considerable role in MANETs for improving the routing performance.

Recently, many research works has been designed for improving the routing performance in MANETs. For example, Power Aware Location Aided Routing Protocol (PA-LAR) was introduced in [10] using Linear Regression to reduce the energy consumption of routing in MANETs. But, resource optimized routing was not achieved. A Link stability based multicast routing protocol was presented in [5] that employs path stability as the route selection criterion to find out more stable paths between the source and destination. But, routing overhead was higher. An energy and delay aware routing method was developed in [13] that combine Cellular automata (CA) with the Genetic algorithm (GA) to discover a path from the source to destination by considering delay and energy constraints. An energy and delay aware routing method presents better performance in terms of packet delivery ratio and node lifetime. However, bandwidth utilization was remained unsolved. A cross-layer based stable and energy-efficient routing technique was presented in [18] where QoS monitoring agents compute link reliability metrics to discover the most reliable link which resulting in improved packet delivery ratio with lower energy consumption. A link estimation algorithm-based ad hoc on-demand multipath distance vector (AOMDV) called LQ-AOMDV was intended in [14] to find optimal path by using BAT meta-heuristic optimization. The LQ-AOMDV improves the routing performance. However, end-to-end delay was more. A novel MANET routing method based on Ad hoc on- demand Distance Vector (AODV) and Ant Colony Optimization was designed in [21] to handle link quality among nodes to find routes. This method reduces end to end delay with higher packet delivery ratio. But, resource optimized routing was not considered. A hybrid Meta heuristic approach was developed in [17] with aid of ant colony optimization (ACO) genetic algorithm (GA) to lessen the routing complexities in the dynamic environment. Though, routing overhead was more. An Energy-Aware Span Routing Protocol (EASRP) was employed in [3] to minimize the energy consumption with a better packet delivery ratio. Though, delay and bandwidth were remained unaddressed.

An Energy Aware OLSR (Optimized Link State Routing) Protocol called OLSR_EA was designed in [23] to choose the best path by considering energy cost and residual energy of node. The OLSR_EA Protocol improves the packet delivery ratio. But, energy consumption was higher. The multipath optimized link state routing (MP-OLSR) protocol was intended in [8] to determine multiple paths from source to destination and to improve the network lifetime with lower average end to end delay. But, routing decision based on dissimilar types of scalable streams was not considered to achieve the quality of service. destination pair with higher throughput and minimum delay. However, different queuing discipline for analyzing the effect arrival traffic was remained unaddressed. In order to overcome the above mentioned existing issues in MANETs, Stepwise Regression based Resource Optimized Routing (SR-ROR) Technique is introduced. The research objective of SR-ROR Technique is formulated as follows,

A. To achieve resource optimized routing process in MANETs, Stepwise Regression based Resource Optimized Routing (SR-ROR) Technique is designed.
B. To identify the optimal route path in MANETs, Stepwise Regression technique is used in SR-ROR.
C. To select the mobile node for data transmission and to improve packet delivery ratio in MANETs, regression coefficient value is estimated in SR-ROR Technique.

The rest of this paper is organized as follows. Section 2 explains Stepwise Regression based Resource Optimized Routing (SR-ROR) Technique with aid of architecture diagram for optimal path identification. Section 3 and Section 4 presents the experimental section with details performance analysis. Section 5 explains the related works. Finally, Section 6 concludes this paper.

II. RELATED WORKS

A novel mechanism was designed in [6] to select stable and sustainable paths between all pairs of nodes in a network and reducing the average end to end delay. However, the remaining energy of the nodes constituting the path was not considered. The link stability estimation scheme was presented in [5] to estimate the link stability in both stationary and non-stationary scenarios with higher packet delivery rate. Quality of Service (QoS) based Multicast Routing Protocol using Reliable Neighbour nodes Selection (QMRPRNS) scheme was presented in [1] to choose the stable path based on reliability pair factor with higher packet delivery ratio. But, energy utilization was remained unsolved. A neighbor coverage-based probabilistic rebroadcast protocol was intended in [1] for minimizing the number of retransmissions to diminish the routing overhead and improving the routing performance in MANETs. However, reducing redundant rebroadcast performance was not efficient. A novel link-correlation-aware OR scheme was presented in [22] for efficiently improving the routing performance through exploiting the diverse low correlated forwarding links and to reduce number of transmissions. Though, efficient routing is remained unaddressed. A link quality-based cache replacement technique was designed in [7] for MANET that determine the link quality with the support of Received Signal Strength (RSS) value. But, avoiding network collision was not considered. An energy efficient cluster based routing protocol (ECCRP) technique was introduced in [20] to improve the performance of MANETs routing in terms of energy consumption and to lessen the number of transmissions. Though, node mobility, traffic, and transmission range was not considered. A Rebroadcasting Neighbour Coverage protocol (RBNC) was presented in [9] to decreases the high channel contention creating unnecessary request and to lessen routing overhead. But, optimal path selection between the source and destination was remained unaddressed. An adaptive reliable and congestion control routing protocol was designed in [16] to reduce congestion and route errors with the aid of bypass route selection in MANET and to attain higher throughput with lower packet drops and overhead. Though, average end to end delay was remained unaddressed. A novel method was presented in [4] for node mobility prediction in which link stability metrics is used to enhance network throughput.

III. STEPWISE REGRESSION BASED RESOURCE OPTIMIZED ROUTING TECHNIQUE

Let consider the MANETs is the structure of graph '$G(V,E)$' in which 'V' represents the mobile nodes and 'E' is denotes the links between mobile nodes. The number of mobile nodes in MANETs is characterized as'$MN_i = MN_1, MN_2, MN_3 \dots MN_n \in V$ that lies within the transmission range'R'. Thus, the data packet is transmitted from source to destination by using Stepwise Regression technique. The following diagram shows the MANETs structure.

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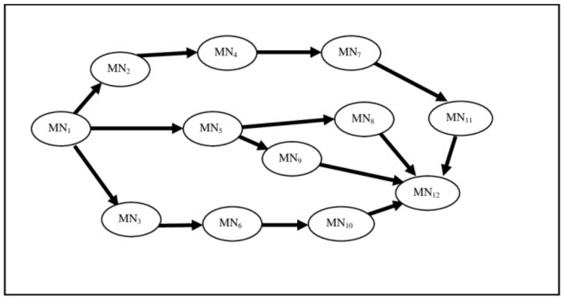

Figure-1: An Example for MANETs Structure

As shown in Figure 1, a Manet's structure comprises of numerous mobile nodes such as$MN_1, MN_2, MN_3, \ldots MN_{12}$. Here MN_1 want to transmit a data packet to mobile node MN_{12} whereas MN_1 is a source node and MN_{12} is a destination node and other remaining nodes in are called as intermediate nodes in network. There are many route paths available for transmitting multimedia data content from MN_1 to MN_{12} such as MN_1 -MN_2 -MN_4 -MN_7 -MN_{11} -MN_{12} ,MN_1 -MN_5 -MN_8 -MN_{12} , MN_1 -MN_5-MN_9 -MN_{12} , MN_1 -MN_3 -MN_6 -MN_{10} -MN_{12} etc. But, we cannot know which route path is optimized resource route path for transmitting data efficiently from source node MN_1 to destination MN_{12}. Therefore, A Stepwise Regression based Resource Optimized Routing (SR-ROR) Technique is designed with the objective of selecting the resource optimized path for reliable data packets transmission in MANETs with the optimized resource utilization. The SR-ROR Technique optimizes the resource utilization of mobile nodes in order to efficiently transmit data packets in MANETs by using Stepwise Regression technique. The Stepwise Regression technique determines the regression coefficient value for each mobile node in MANETs. The regression coefficient value is estimated based on residual energy, delay, bandwidth of mobile nodes. With the aid of determined regression coefficient value, SR-ROR Technique selects the mobile nodes with higher residual energy, minimum delay, and minimum bandwidth for transmitting the data packets form the source to destination node in MANETs. This in turn helps for achieving SR-ROR Technique in MANETs. Therefore, SR-ROR Technique to increases the packet delivery ratio with lower delay and reduces the energy consumption of data transmission in MANETs. The overall architecture diagram of SR-ROR Technique for reliable data packets transmission is shown in below

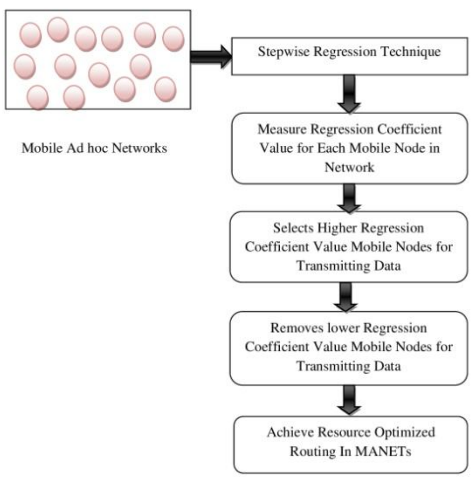

Figure-2:Architecture Diagram of Stepwise Regression based Resource Optimized Routing

As shown in Figure 2, MANETs consists of numerous numbers of mobile nodes. The SR-ROR Technique used Stepwise Regression Technique for identifying best route path for reliable data packet transmission in MANETs. By using the Stepwise Regression Technique, SR-ROR Technique initially computes the regression coefficient value for each mobile node in network. The regression coefficient value of mobile node is estimated based on three resource factors such as residual energy, bandwidth, and delay. After that, SR-ROR Technique selects optimal mobile nodes in network with aid of measured the regression coefficient value for broadcasting the data packets form the source to destination. As a result, SR-ROR Technique ensures the resource optimized routing in MANETs which results in enhanced packet delivery ratio. The detailed explanation about SR-ROR Technique is described in forthcoming sections.

A. Stepwise Regression technique

In SR-ROR, Stepwise Regression technique calculates regression coefficient value for each mobile node in network for selecting the optimal route path. The following diagram shows the process of Stepwise Regression technique for performing the resource optimized routing in MANETs.

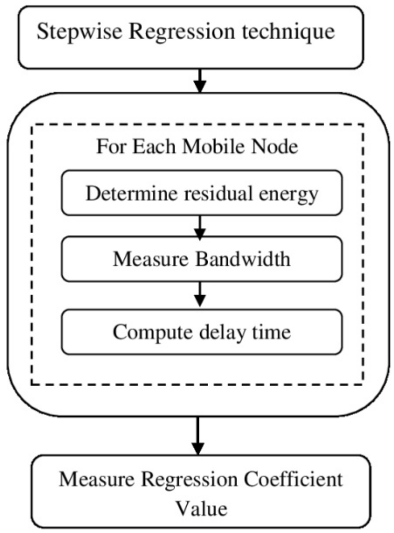

Figure-3: Process of Stepwise Regression technique

\As shown in Figure 3, SR-ROR Technique considers the residual energy, bandwidth and delay time of mobile node for evaluating regression coefficient value. With help of measured regression coefficient value, then SR-ROR Technique selects mobile node with higher residual energy, lower delay, and minimum bandwidth for data packet transmission. Therefore, the SR-ROR Technique optimizes the resource utilization for broadcasting data from the source node to destination in MANETs. This in turn prolongs the network lifetime and packet delivery ratio.

Considering the residual energy is important to choose the mobile nodes with more residual energy for avoiding the path breakdowns while broadcasting the data packets. The residual energy determines the amount of available or remaining energy in the mobile node. Accordingly, the residual energy of mobile node (RE_{MN_i}) is estimated by using following mathematical expression,

$$RE_{MN_i} = Initial\ Energy_{MN_i} - (N_S \times T_{Power} \quad (1)$$

From the equation (1),N_S denotes the number of bytes transmitted whereas T_{Power} is a transmission power (i.e. energy) per byte. Here, $Initial\ Energy_{MN_i}$ indicates an initial residual energy of a mobile node before the route identification process. By using the equation (1), residual energy of a mobile node is determined for route selection. In addition, the bandwidth availability of the mobile node is also considered as essential factor is to be measured for improving the performance of resource optimized routing in MANETs. The bandwidth availability of the mobile node is determined using below mathematical representation,

$$Bandwidth_A = Bandwidth_{raw} - Bandwidth_C \quad (2)$$

From the equation (2),$Bandwidth_{raw}$ denotes the raw channel bandwidth and $Bandwidth_C$ refers an overall utilized bandwidth for transmitting the data packets. By using the above equation, the mobile node with higher bandwidth availability is selected for optimal path selection. Besides, the delay time of mobile node is measured by using below mathematically formula,

$$Delay\ Time = L^i_{queue} \times T^i_L + T^i_T \times N_{hops} \quad (3)$$

From the equation (3), L^i_{queue} represents the queue length at mobile node i and T^i_L denotes the local processing time of any data in mobile node i. Here, T^i_T refers transmission time between two neighboring nodes and N_{hops} is the number of hops between the source and destination node in MANETs.

The SR-ROR used Stepwise Regression Technique for performing resource optimized routing based on three parameters namely residual energy, bandwidth availability and delay time. By measuring these three parameters, the best mobile node in network is selected for data packet transmission in MANETs. The Stepwise Regression Technique computes regression coefficient value (RCV) for each mobile node in network in order to select the best mobile node for routing the data packets which is mathematically formulated as below,

$$RCV_{MN_i} = high\ residual\ energy + lower\ bandwidth\ availabilty + lower\ delay\ time \quad (4)$$

From the equation (4), regression coefficient value is determined based on the nodes residual energy, bandwidth availability and delay time between the nodes. The algorithmic process of Stepwise Regression based Resource Optimized Routing is shown in below,

// Stepwise Regression based Resource Optimized Routing Algorithm
Input: Mobile nodes '$MN_i = MN_1, MN_2, MN_3 \ldots MN_n$', Data Packet '$DP_i = DP_1, DP_2, DP_3, DP_n$'
Source Node 'S', Destination Node 'D'.
Output: Select resource optimized route path for data transmission
Step 1:Begin
Step 2: **For** each mobile node
Step 3: Measure residual energy using (1)
Step 4: Compute bandwidth using (2)
Step 5: Calculate delay time using (3)
Step 6: Determine regression coefficient value using (4)
Step 7: Select the mobile node with higher regression coefficient value as optimal path for transmitting data packets between the source and destination node
Step 8: Removes mobile node which has lower regression coefficient value
Step 9: **End for**
Step 10: End

Algorithm-1: Stepwise Regression based Resource Optimized Routing

By using the above algorithmic process algorithm 1, SR-ROR Technique chooses the resource optimized route path for data transmission. This improves the packet delivery ratio with minimum energy consumption and improves the network lifetime in MANETs.

IV. SIMULATION SETTING

The Stepwise Regression based Resource Optimized Routing (SR-ROR) technique is implemented in NS-2 simulator with the network range of 1200*1200 m size. The number of mobile nodes chosen for performing simulation is 500. The results of SR-ROR Technique is compared against with existing link stability estimation model [1],energy and delay aware routing method [2] to measure the effectiveness of our work. The simulation parameters employed for conducting experiments is shown in below Table 1.

Table-1: Simulation Parameters

Simulation factor	Value
Protocol	AODV
Node density	50, 100, 150, 200, 250, 300, 350,400,500
Simulation time	100s
Pause time	10s
Mobility model	Random Way Point
Transmission range	300m
Network area	1200m * 1200m
Data packets	9 – 90

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V. RESULT AND DISCUSSIONS

In this section, the result analysis of SR-ROR Technique is evaluated. The performance of IPDOR Technique is compared against with existing Power Aware Location Aided Routing (PA-LAR) [10],Deterministic Multicast Link Based Energy Optimized Routing (DML-EOR) [11]. The performance of SR-ROR Technique is evaluated along with the metrics such as energy utilization, packet delivery ratio and average end to end delay, routing overhead and bandwidth utilization.

A. Measurement of Energy Consumption

In SR-ROR Technique, the energy consumption is measured using the energy consumed by a single mobile node with respect to the total mobile nodes in MANETs. The energy utilization rate is measured in terms Joules (J) and formulated as,

$$Energy\ \text{Consumption} = \frac{Energy_{DP}}{Total_{DP}} \qquad (5)$$

From the equation (5), the energy consumption of routing process is obtained. '$Energy_{DP}$' represents the ratio of energy consumed for single data packet and total energy consumed for all the data packets '$Total_{DP}$' in the network. While the energy consumption is lower, more efficient the method is said to be.

Table-2: Tabulation for Energy Consumption

Number of Mobile Nodes	Energy Consumption (J)		
	PA-LAR	DML-EOR Mechanism	SR-ROR Technique
50	0.15	0.11	0.08
100	0.18	0.13	0.10
150	0.20	0.14	0.11
200	0.21	0.17	0.13
250	0.23	0.19	0.16
300	0.27	0.20	0.17
350	0.30	0.23	0.19
400	0.31	0.25	0.22
450	0.33	0.26	0.24
500	0.37	0.29	0.27

Table 2 depicts the measure of energy consumption for data packet transmission based on different number of mobile nodes in the range of 50-100. From the table, it is illustrative that the energy consumption of proposed SR-ROR Technique is lower while compared to existing PA-LAR [10].

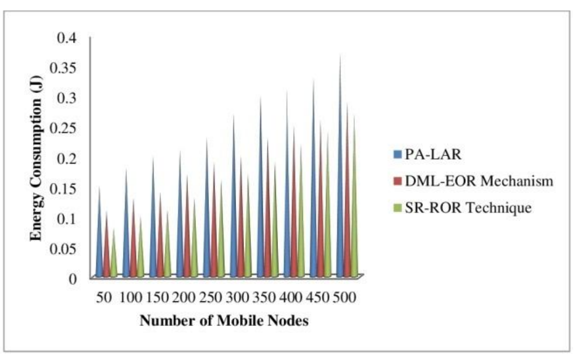

Figure-4: Measure of Energy Consumption

Figure 4 shows the impact of energy consumption for data packet transmission versus diverse number of mobile nodes in the range of 50-100 using three methods. As exposed in figure 4, proposed SR-ROR Technique provides better energy consumption for data packet transmission in MANETs when compared to existing PA-LAR [10],DML-EOR [11]. In addition, while increasing the number of sensor nodes, the energy consumption is also increased using all the three methods. But comparatively energy consumption using proposed SR-ROR Technique is lower. This is because of application of stepwise regression in SR-ROR Technique where it measures regression coefficient value by considering the residual energy of mobile node. Therefore, SR-ROR Technique chooses the mobile node with more residual energy for transmitting the data packets in MANETs. This in turn helps for reducing the energy consumption in an effective manner. As a result, proposed SR-ROR Technique reduces the energy consumption by 36 % when compared to PA-LAR [10] and 17 % when compared to DML-EOR [11] mechanism respectively.

B. Measurement of Average End to End Delay

In SR-ROR Technique, the average end to end delay measures the time consumed for a packet to be transmitted across a network from source to destination. The average end to end delay is measured in terms of milliseconds (ms) and mathematically formulated as,

$$\text{average end to end delay} = \text{Receiving time of packets} - \text{sending time of packets} \quad (6)$$

From the equation (6), the average end to end delay is obtained. While the average end to end delay is lower, the method is said to be more efficient.

Table-3 Tabulation for Average end to end delay

Number of Data packets	Average end to end delay (ms)		
	PA-LAR	DML-EOR Mechanism	SR-ROR Technique
9	9.5	6.9	4.3
18	15.1	11.5	9.5
27	22.8	16.8	14.2
36	27.6	21.9	17.6
45	31.2	26.8	22.1
54	38.7	32.8	28.3
63	45.4	37.1	31.8
72	49.6	42.7	35.9
81	52.3	46.8	38.4
90	58.9	51.7	42.5

The comparative result analysis of average end to end delay based on different number of packets in the range of 9-90 is demonstrated in Table 3. From the table, it is descriptive that the average end to end delay using proposed SR-ROR Technique is lower while compared to existing PA-LAR [10],DML-EOR [11].

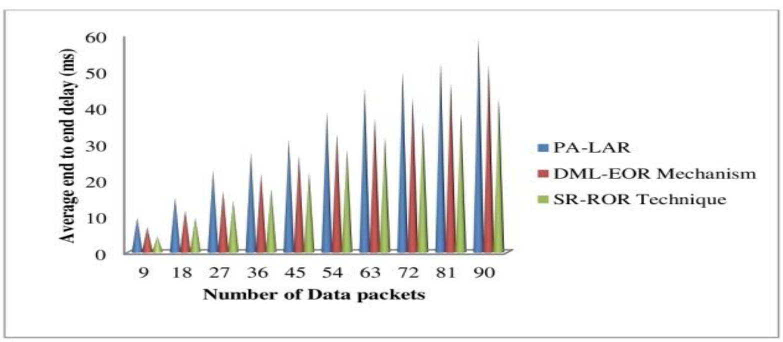

Figure-5: Measure of Average end to end delay

Figure 5 depicts the impact of average end to end delay versus dissimilar number of data packets in the range of 9-90 using three methods. As revealed in figure 5, proposed SR-ROR Technique provides better average end to end delay for data packet transmission in MANETs when compared to existing PA-LAR [10],DML-EOR [11]. Additionally, while increasing the number of data packets, the average end to end delay is also increased using all the three methods. But comparatively average end to end delay using proposed SR-ROR Technique is lower. This is due to application of stepwise regression in SR-ROR Technique where it measures regression coefficient value by considering the delay time of the mobile node. Therefore, SR-ROR Technique picks the mobile node with lower delay for transmitting the data packets in MANETs. This is in turn helps for reducing average end to end delay in a significant manner. As a result, proposed SR-ROR Technique reduces the average end to end delay by 33 % when compared to PA-LAR [10] and 19 % when compared to DML-EOR [11] respectively.

C. Measurement of Packet Delivery Ratio

In SR-ROR technique, packet delivery ratio is defined as the ratio of number of data packets received by the destination to the total number of data packets sent. The packet delivery ratio is measured in terms of percentages (%) and formulated as follows,

$$Packet\ Delivery\ Ratio = \frac{Number\ of\ data\ packets\ received}{Total\ number\ of\ data\ packets\ sent} * 100 \quad (7)$$

From the equation (7), the packet delivery ratio is obtained. While the packet delivery ratio is higher, the method is said to be more efficient.

Table-4: Tabulation for Packet delivery Ratio

Number of Data packets	Packet delivery Ratio (%)		
	PA-LAR	DML-EOR Mechanism	SR-ROR Technique
9	79.15	88.34	89.55
18	81.46	88.99	90.12
27	82.17	90.56	90.95
36	85.91	91.26	92.36
45	87.13	91.98	93.11
54	88.24	93.54	94.85
63	91.38	95.45	96.24
72	92.16	96.14	97.90
81	94.05	96.93	98.35
90	94.93	98.58	99.49

The result of packet delivery ratio based on diverse number of packets in the range of 9-90 is illustrated in Table 4. From the table, it is clear that the packet delivery ratio using proposed SR-ROR Technique is higher as compared to existing PA-LAR [10],DML-EOR [11].

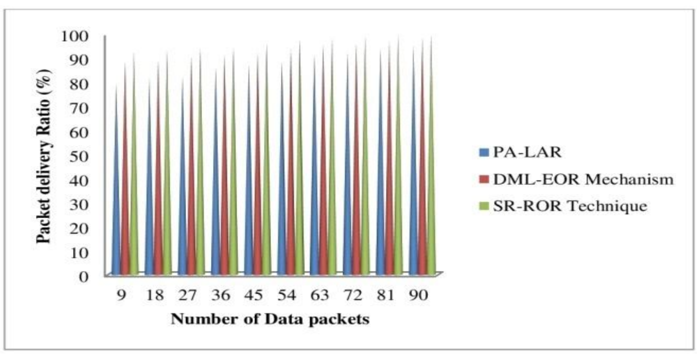

Figure-6: Measure of Packet delivery Ratio

Figure 6 presents the impact of packet delivery ratio versus different number of data packets in the range of 9-90 using three methods. As demonstrated in figure, proposed SR-ROR Technique provides better packet delivery ratio when compared to existing PA-LAR [10],DML-EOR [11]. Moreover, while increasing the number of data packets, the packet delivery ratio is improved using all the three methods. But comparatively packet delivery ratio using proposed SR-ROR Technique is higher. This is owing to application of stepwise regression in SR-ROR Technique that determines regression coefficient value by considering the delay time, residual energy, and bandwidth of the mobile node. Therefore, SR-ROR Technique selects the optimal path for performing data transmission in MANETs which resulting in enhanced packet delivery ratio. Thus, proposed SR-ROR Technique improves the packet delivery ratio by 10 % when compared to PA-LAR [10] and 4 % when compared to DML-EOR [11] respectively.

D. Measurement of Network Lifetime

In SR-ROR technique, the lifetime of the network is measured by using the number of mobile nodes in MANETs. The network lifetime is measured in terms of percentage (%) and formulated as,

$$Network\ Lifetime = \left(\frac{S_{addressed}}{Total_S}\right) * 100 \qquad (8)$$

From the equation (8), the network lifetime is obtained using the total number of mobile nodes '$Total_S$' in the network and routing addressed for the mobile node '$S_{addressed}$' in MANETs. While the network lifetime is higher, more efficient the method is said to be.

Table-5: Tabulation for Network Lifetime

Number of Mobile Nodes	Network Lifetime (%)		
	PA-LAR	DML-EOR Mechanism	SR-ROR Technique
50	80.55	89.14	90.26
100	81.82	89.99	90.95
150	83.46	91.14	92.53
200	85.16	92.78	93.12
250	86.34	94.54	95.03
300	89.74	95.23	95.98
350	90.12	96.36	97.38
400	92.65	97.11	97.52
450	93.51	98.01	98.85
500	94.80	99.45	99.91

The network lifetime result is obtained based on dissimilar number of data packets in the range of 9-90 using three methods is illustrated in Table 5. From the table, it is clear that the network lifetime using proposed SR-ROR Technique is higher as compared to existing PA-LAR [10],DML-EOR [11].

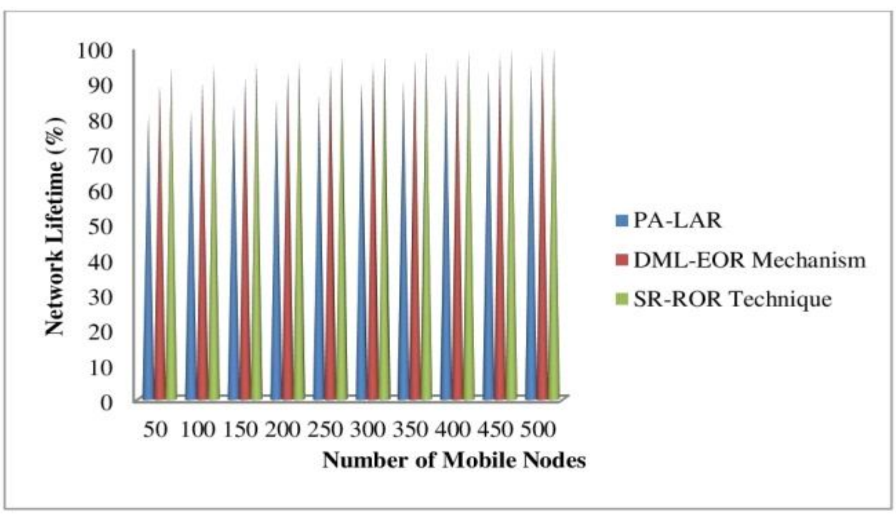

Figure-7: Measure of Network Lifetime

Figure 7 presents the impact of network lifetime versus diverse number of mobile nodes using three methods. As shown in figure, proposed SR-ROR Technique provides better network lifetime when compared to existing PA-LAR [10],DML-EOR [11]. Besides, while increasing the number of mobile nodes, the network lifetime is improved using all the three methods. But comparatively network lifetime using proposed SR-ROR Technique is higher. This is because of application of stepwise regression in SR-ROR Technique. With the aid of stepwise regression technique, SR-ROR Technique measures regression coefficient value through considering the residual energy of mobile node. Therefore, SR-ROR Technique chooses the mobile node with more residual energy for transmitting the data packets in MANETs. This in turn helps for improving the network lifetime in a significant manner. As a result, proposed SR-ROR Technique improves the network lifetime by 10 % when compared to PA-LAR [10] and 3% when compared to DML-EOR [11] respectively.

VI. CONCLUSION

An effective Stepwise Regression based Resource Optimized Routing (SR-ROR) Technique is developed to select the optimized route path for efficient data packet transmission in MANETs. The main objective of SR-ROR Technique is to achieve resource optimized routing in MANETs. The resource optimized routing is achieved in SR-ROR by using Stepwise Regression techniques. With the application of Stepwise Regression technique, SR-ROR find outs regression coefficient for determining relationships among the mobile nodes in order to routing the data packets in MANETs. The regression coefficient value is estimated through considering the residual energy, delay, bandwidth of mobile nodes. With the aid of measured regression coefficient value, SR-ROR technique selects the mobile nodes with higher residual energy, minimum delay, and minimum bandwidth for broadcasting the packets from the source to destination node in MANETs. This helps for prolonging the network lifetime and packet delivery ratio in an effectual manner. The performance of SR-ROR technique is measured in terms of energy consumption, average end to end delay, packet delivery ratio, and network lifetime and compared with two exiting methods.The simulations results show that SR-ROR technique provides better performance with an improvement of packet delivery ratio and also reduces the energy consumption when compared to state-of-the-art works.

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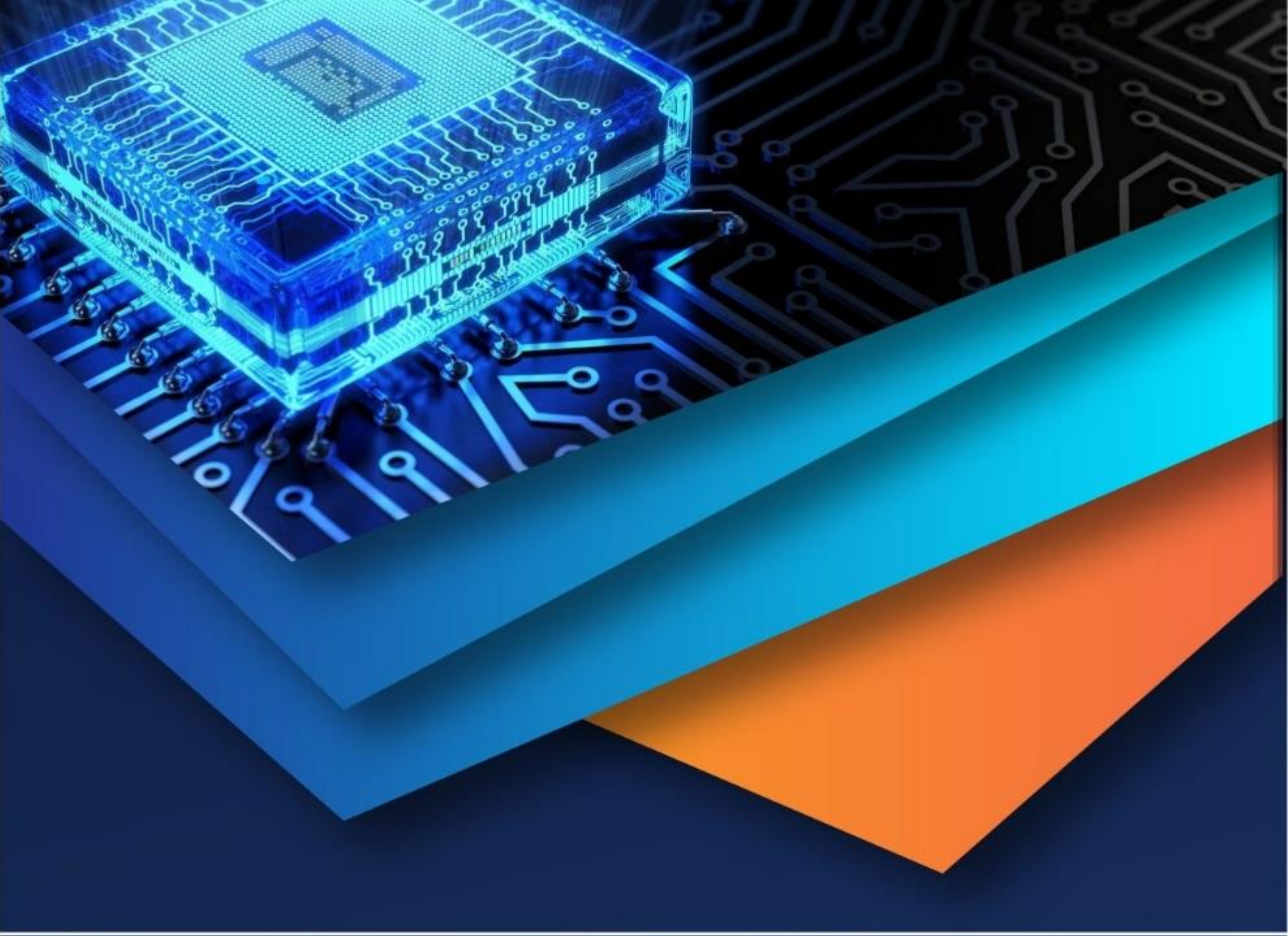

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45.98

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