ORTMR - Optimized Routing Techniques for Mobile Adhoc Network using Network Resources

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Abstract: A mobile ad hoc network (MANET) is an dynamic wireless communication network that can be formed solely of any pre-accessible infrastructure that each gadget can function as a router, sender and receiver. It is well known in these networks that devices can roam arbitrarily anyplace in the network without revealing any information. So the mobility creates a disconnection that is uncertain between devices, that makes a device separation for the period of time. These kinds of frequent disconnections produce changes in device links and may create unstable network connections. Due to the unstable network, devices may experience a loss of energy that constructs the poor network lifetime. In the proposed, ORTMR-MANET a route has been established using network resources with optimized techniques, the network focuses on reducing the delay to transmit the packets successfully and controls the network stability primarily based totally on the link life incremental. To obtain the required accuracy in path selection ORTMR uses the fuzzy neuron computation to verify the device parameters. In which the results produces the high throughput with minimum delay transmission.

Key words: Network Separation; Unstable Network; Network Life; Minimum Delay; Throughput; Random Movement; Link Changes; Stable Path.

1. Introduction

Routing in the mobile ad-hoc network (MANETs) is a important mission. When it comes to proactive and reactive routing protocols, the route requests demands (RREQ) broadcast to the whole region of the network to find out how to get from source device to the destination. Most of the path demanding protocols is pointing the route selection with the shortest distance to reach the destination. Choosing the shortest path possible with the fewest hop counts. Selecting the minimum distance route, with low number of hop counts are measured in the traditional ad-hoc routing protocols. Improving the network path establishment, stable link loyalty (S_{LL}) is crucial to computing. This S_{LL} selection delivers high-quality services network outcome as per the network scalability. The most important concerns in path selection are the best way to acquire the greatest stable device connectivity links and path until the data transfers have been completed, by measuring certain parameters within the transmission region of the devices. If the right parameters aren't taken into account when choosing a route, it may guarantee a big chance of reducing the network outcomes. However, some of the usual protocols finding out the destinations may produce the uncreative limited results. The most vital and decisive concern for MANET routing is the way to opt for the stable connections between neighbors under random movement environments.

In this the proposed protocol ORTMR, move towards the route establishment of the MANETs are ensured to create sufficient degrees of results like high throughput, high packet delivery ratio, minimum delay and minimum control overheads. As a result of unplanned movements, the connectivity of the devices tends to break frequently. This implementation is capable of establishing a steady path, thus minimizes the network disunion. The reliability of the route was computed using an optimized artificial neural network technology and a fuzzy hybrid intelligence structure. The input, hidden, and output layers are used to represent the rules in this approach. The protocol makes use of the following parameters, The signal strength is calculated using the expected receiving power of packet receivers. (SS_{RP}), stable link loyalty is assessed by the duration of the link. (S_{LL}), The channel's capacity is calculated using the assignment frequency and the Euclidean distance. (D_{ij}) between neighboring devices is determined by the x,y coordinates of the device. By measuring the quality of path using these methods along with the parameters provided, the network produces the quality of service based trustworthy data paths. At initial the network calculated the fuzzy output values by fine-tuning the neural constraints. To create the final path from a source to destination, the fuzzy outputs are supplied as essential inputs to the neuron creation (N_C) and the final result of the highest N_C routes is chosen to convey the data's along with the ideas of defuzzification as Figure.1.

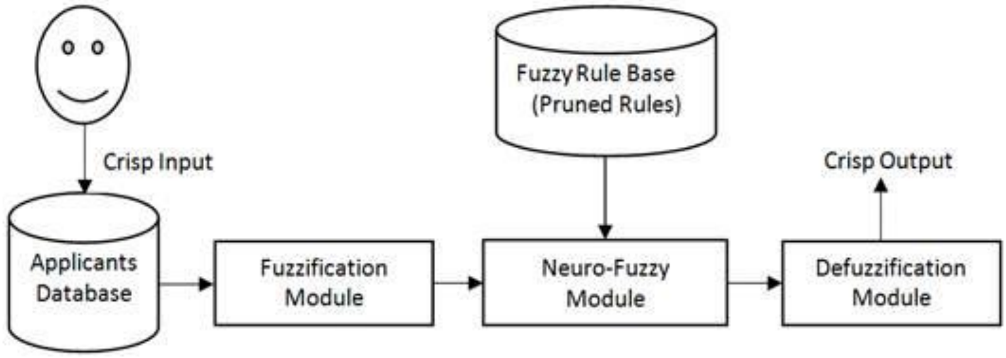


Figure 1: Robust Neuron - Fuzzy Structure.

The following are some of the ORTMR's most notable features:

- The ultimate goal is to develop stable network communication in MANETs.
- SS_{RP} based gadgets signal deviation observing started to know the exact transmission distance range of neighbors.
- S_{LL} Observations considered calculating the link lifetime in the presence of uncontrollable random motions as well as by being aware of the energy levels of adjacent devices on the network.
- The stable path is constructed utilizing artificial intelligence-based neural design optimization techniques coupled with fuzzy output judgement.

The total flows of the paper are organized as follows: Section 2 discusses the prior principles that have been applied in relation to the ORTMR's current work. The proposed approach utilized in this study is described in Section 3. The simulation bounds and analysis results are clarified in Section 4 and lastly, section 5 give the concluding with a summary of the suggested method's features.

2. Related Works

Mobiles nodes might serve as router in a case of deciding the path for packet forwarding and they rely on one another to keep the network connected. The mobility of mobile nodes causes a dynamic alteration in the network's topology. In most cases, network users are looking for Information distribution that is dependable [5]. A wireless ad hoc network's nodes are spread in a two-dimensional plane and have a one-unit maximum transmission range[1]. A multi-hop wireless network consisting of mobile nodes interacting with each other without the need of permanent infrastructure such as base stations, wireless gateways, or access points. [3]. Mobile nodes can interact directly with nodes within radio range of one other, while other nodes require the assistance of intermediary nodes to route their messages. [7]. The expanding ring search (ERS) approach avoids network-wide broadcasting by scanning a broader region in the network centred on the broadcast source. [2]. When malicious nodes are added, the performance level of DSR falls, according to multimedia applications. [13]. In an Ad hoc network, a stable route is one that provides flexibility in a highly mobile network and does not fail for an acceptable length of data transfer. [4]. MANET performance is linked to routing protocol efficiency, which is determined by various parameters such as topology change convergence time, bandwidth overhead for appropriate routing, and power consumption. [8]. MANETs use multi-hop communication routes to link their nodes together. Simply said, all nodes in the hop must be ready to assist in the delivery of a packet by forwarding it from source to destination. [14]. The nodes are connected through wireless connections and can construct whatever topology they choose because they can join and leave the network at any time. They are capable of serving as both routers and hosts. [10]. Because the nodes' movement is unpredictable, MANET has a dynamic topology. Link failures in MANETs are common due to the approach of dynamic topology. [6]. Because the network is decentralised, all network activities, such as topology discovery and message delivery, must be handled by the nodes. Routing capability will be built into mobile nodes. [12]. The route with the highest minimal connect probability is chosen. Rather of the usual shortest hop path, the longest-lived route is used. [9]. The advent of products like laptops, wireless modems, and routers that allow wireless LAN with ease of mobility has fueled rapid growth in the field of wireless technology. Mobile Ad hoc Networks (MANETs) are made up of a collection of mobile nodes connected via wireless connections. [11].

3. ORTMR Implementation and Functions

Network Formation

The environment is built using a group of devices that form a network graph with a predetermined topographical region and transmission range as $G = \{D, N\}$, where $D = \{d_1, d_2, ...d_n\}$ D designates a group of devices that are put in the network at random and a set of neighboring devices defined as N, $N = \{n_1, n_2, ... n_n\}$.

Neighbor Discovery in Network

A HELLO message is transmitted on a regular basis among devices when the need arises to transmit few packets and to update RT, the routing table.

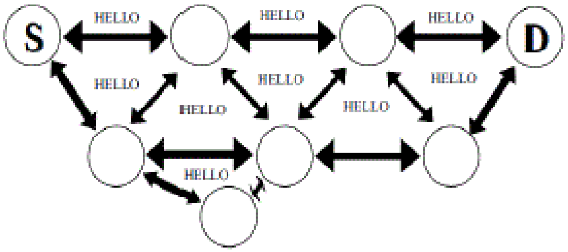


Figure 2: Sharing the HELLO Messages.

Figure.2 shows the neighbour discovery HELLO packets, as well as their initial energy status, packet transmission power (TX_P), device moving speed (S) throughout the network, and device location (L) points (X, Y).

Based on the starting energy, the device's initial energy is calculated (E_I) and used energy (E_U).

$$E = E_I - E_U$$

The device's speed also determines the rate of change in location (R_L) or the variations between the distance over time. It is computed as

$$S = \frac{R_L}{\text{Time}}$$

Each listening device is viewed as their placements of the identical transmission region taken as coverage neighbors. As a result of the listening the parameters in HELLO message, each device calculates the distance D between other transmission ranging neighbours and updates each one's energy level. The lowest distance (D_{ij}) between each network device and the nearest device is computed as

$$\left(D_{ij}\right) = \sqrt{|X1 - X2|^2 |Y1 - Y2|^2}$$

The Euclidean distance (D_{ij}) is calculated using the device location coordinate points (x1,y1) of the i th device and the device location coordinate points (x2,y2) of the j th device.

Also, it calculates the SSRP of the adjacent devices, based on the enclosed TX power value. As shown in Figure.3, each device creates neighbour specifications as a record in the neighbour register (NR). The values of E, SSRP, D, and L of each one hop immediate neighbour are stored in the NR. The one hop coverage neighbours are devices s,w,u, and v.

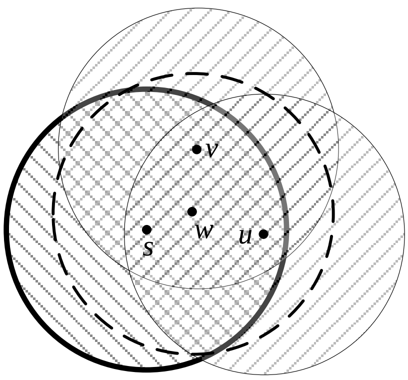


Figure 3: Device Neighbors.

Initiation of End-to-End Path Discovery

At the beginning the source device initiates the process of data transmission so that it checks the built-in routing table (RT) to get the next forwarding neighbor hop to reach the final destination. If there is no neighbor entries found in the routing table (RT), source starts to execute the path discovery (PD) procedure. It starts broadcasting the route requirement message RRQ enclosed with the following parameters, D_{ij}, S , E , and sequence number (SN) by the shared wireless communication channel. After updating the E and S, the RRQ message listening state devices validate the sender's current D_{ij} . The S metric is used to find out how far apart are the two angular deviations of the two devices from the network region.

PHYL collects signals and calculates the SS_{RP} when the RRQ message reaches the device's open system interconnection physical layer (PHYL).

$$SS_{RP} = \left(\frac{\text{RxP} - \text{Signal}}{\text{RxPN}}\right)$$

Where RxP denotes the receiving signal power and RxPN is the signal (SS_{RP})'s receiving noise power. In decibels the SS_{RP} computed as

$$SS_{RPdb} = 10\log_{10}\left(\frac{\text{RxP} - \text{Signal}}{\text{RxPN}}\right)$$

The SS_{RP} values that may be obtained are determined by the network's backdrop, mobility, and power consumption. The RRQ message was delivered to the device's next routing layer once the SS_{RP} estimate was finished.

Using channel propagation, determine the D_{ij} between the forwarding and receiving devices while the packet is in the routing region. When both D_{ij} is 1, devices A and B are positioned in the same range with strong signal strength, according to the scenario. When mobility occurred as Figure.4, As shown in Figure.5, device B relocated to the next site within the transmission range with the weakest signal. Each scenario depicts how the position of distinct time instances T varies.

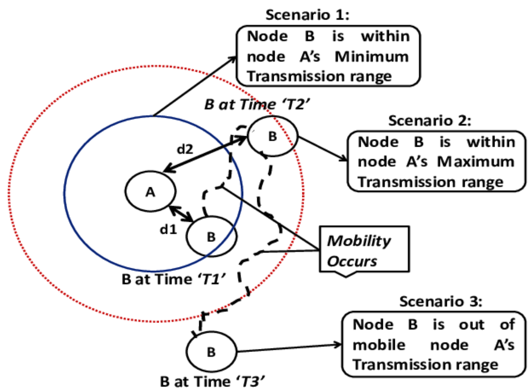


Figure 5: Device Transmission Range Deviations.

Based on distance discrepancies, this D_{ij} estimate gives position coordinates. In addition, the P_D protocol computes SS_{RPdb} to obtain the real output of the power deviation. The normalization costs of these factors are computed as follows: SS_{RP} and D_{ij} computations are approximated from the whole path.

$$P_D = SS_{RP} * \frac{R_L}{H_C} + D_{ij}$$

Additionally, compute the S_{LL} from device link connection duration dependent on the distance between one site and another location, as shown below.

$$S_{LL} = D_{ij} < SS_{RP\max}$$

Furthermore, the speed S deviations S_{Dev} derived from environmental changes are time T dependent,

$$S_{Dev} = D_{ij} XT$$

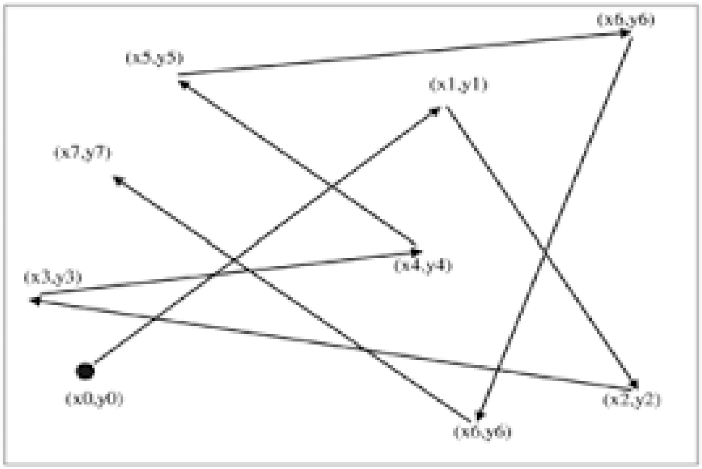


Figure 4: Device Movement Deviations.

Additionally, owing to energy depletion, the gadget may be unable to communicate. The energy-based S_{LL} was calculated as follows.

$$S_{LL} = E < CE_{Thresh}$$

As a result of all of these factors, the connection channel might frequently vanish, as seen in Figure 6. In this Figure.6 C to E and C to D are disconnected.

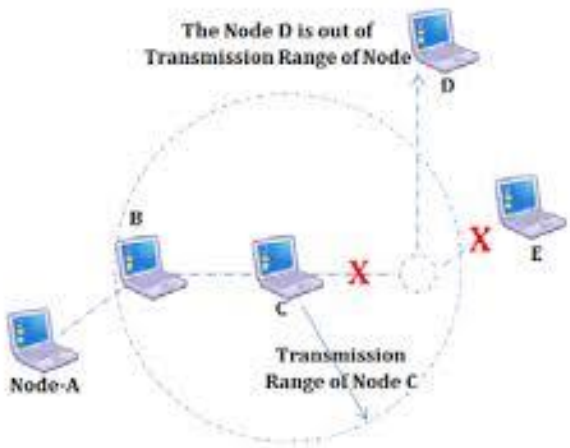


Figure 6: Network Link Disconnection.

In order to include learning and adaptation into the FIS, a hybrid system was developed combining fuzzy inference techniques and gradient conjunction with the least square estimate learning method.

The network design has five layers, with three input variables of D_{ij}, SS_{RP}, and S_{LL} from each device's routing table, d1,d2,d3....dn being the types of their equivalent linguistic conditions (small, medium, and big), r1,r2,r3…,r4 being the noticeable control of the fuzzy rules, and r1_,r2_,r3_ being the normalized control. Each device communicates with one language expression of each of the inputs in the initial layer. In other words, this level's harvest denotes the R_V relationship, which specifies the scale to which an input belongs in a fuzzy rule set.

- $R_V = \mu small(D_{ij})\ to\ z$
- $R_V = \mu Mediumlow(D_{ij})\ to\ z$
- $R_V = \mu high(D_{ij})\ to\ z$
- $R_V = \mu small\left(SS_{RP}\right)\ to\ z$
- $R_V = \mu Mediumlow\left(SS_{RP}\right)\ to\ z$
- $R_V = \mu high\left(SS_{RP}\right)\ to\ z$
- $R_V = \mu small\left(S_{LL}\right)\ to\ z$
- $R_V = \mu Mediumlow\left(S_{LL}\right)\ to\ z$
- $R_V = \mu high\left(S_{LL}\right)\ to\ z$

Table 1

Fuzzy Value Ranging	Linguistic	Output Level
P1 = 16.0026	Low	0
P1 = 136.783	Medium	1
P1 = 47.5843	Low	1
P1 = 36.4422	Low	0
P1 = 123.272	Medium	1
P2 = 0.252178	Medium	1
P2 = 0.217221	Medium	0
P2 = 0.11498	Low	0
P1 = 113.069	Medium	0
P1 = 113.917	Medium	1
P1 = 96.7738	Low	1
P2 = 0.256788	Medium	1
P2 = 0.203735	Medium	1
P3 = 4.21217	Low	1
P2 = 0.164206	Low	1
P2 = 0.128746	Low	1
P2 = 0.176634	Low	0
P3 = 3.23831	Low	1
P3 = 3.06325	Low	0
P3 = 2.08622	Low	1
P3 = 3.13854	Low	1
P3 = 0.379554	Low	0
P3 = 4.24471	Low	0
P3 = 3.79409	Low	1

The inputs of z are D_{ij}, SS_{RP}, and S_{LL} and the membership function (M_F) is represented by the linguistic terms "small", "medium" and "high", which is used to define the level of the inputs as

$$f(M_F) = \frac{1}{1 + \left| \frac{k-m}{x} \right| 2g}$$

Where m decides the midpoint of the equivalent M_F x is the semi-width and g jointly controls the inclines with x at the intersection points. Calculate the fuzzy set's rules at the next level. Each device calculates the level of its condition as follows:

$$R_V\ State = \mu Small\left(SS_{RP}\right)\ X\mu Small\left(D_{ij}\right) X\mu Small\left(S_{LL}\right) to\ z$$

$$R_V\ State = \mu Medium\left(SS_{RP}\right)\ X\mu Medium\left(D_{ij}\right) X\mu Medium\left(S_{LL}\right) to\ z$$

$$R_V\ State = \mu High\left(SS_{RP}\right)\ XHigh\left(D_{ij}\right) X\mu High\left(S_{LL}\right) to\ z$$

The scale of an equivalent fuzzy rule set is determined by the outcome of this level. Each device computes the z[th] fuzzy rule's relationship to the summing of all fuzzy rules at the next level, as illustrated below.

$$NR_V = \frac{R_V}{R_V 1 + R_V 2 .... R_V n \ |} z$$

The yields of this level are considered as normalized level. Each device has a function in the next level, which multiplies the R_V with their weight values that are relevant as mentioned below.

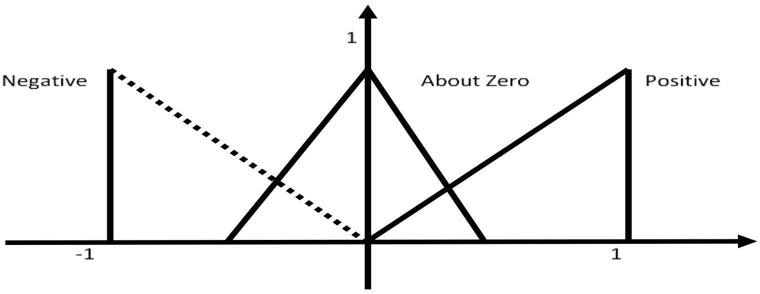
$$WR_V\, State = R_V\ (\mathrm{PS}\left(SS_{RP} \right) XPS\left(D_{ij} \right) XPS\left(S_{LL} \right)$$

Here, the PS stands for a set of parameters of each device. These can be modified if the network is updated continuously using the least means square estimation. The gadget at the next level calculates the complete outcome. (C_{Out}) as the summation of all received signals as computed below

$$C_{Out} = \frac{\sum R_V f}{\sum R_V}$$

The processed output was subsequently deffuzzified into a crispy output that represents the predicted result of the supplied inputs. Table 1. Outcome of fuzzy ranges and linguistic factors

The ORTMR protocol was executed using Network Simulator – 2 NS2.



The fuzzy rule base was populated with 27 rules based on results.

4. Performance Analysis

The ORTMR routing technique sends out a Hello message to determine the number of neighbours and then updates the NR by exchanging the E, TxPr, and L points. Then multiply SS_{RP} by the number of high-power signal receptive neighbours. To find out if the S neighbours are consistent, update S_{LL}. Devices calculate the energy status at each interval to extend the lifetime of a network. The path selection was validated using the computation of fuzzy neuron estimate using these parameters. The neurons received the fuzzified outputs as inputs. It also does the three-layer procedure utilizing neuron. The input variables are represented by the first layer, while the fuzzy set rules are represented by the second. The productivity variables are implemented in the third layer. Fuzzy relationship weights are generated from the fuzzy sets. The final defuzzification result determines the data packet transmission path.

Simulation Environment

The network simulator-NS-2 was used to compare the mobile energy efficient routing (MEER) and ORTMR performance outputs in order to compute the ORTMR performance output. In the network 100 devices are used to create the communication with the transmission range of 250 metres. To determine the protocol strength, the packet generation time, also known as the interval, ranges from 0.5 seconds to 1 second. Random waypoint mobility creates a movement pattern for the devices that ranges from 0 to 4 metres per second, allowing them to travel in random directions and angles with the appropriate stop time. For this test bed with a topological size of 500 × 500 square metres, the simulation executed for a maximum of 200 seconds. The various simulation parameters used are given in Table 2.

Table 2: Simulation Parameters

500 Sqm	X
500 Sqm	Y
100	Devices
200.0 seconds	Simulation Duration
256 bytes	Size of Packet
250 mtr	Range

The packet interval variations from 0.5 second to 1 second were used to evaluate the performance result, and this can vary even more.

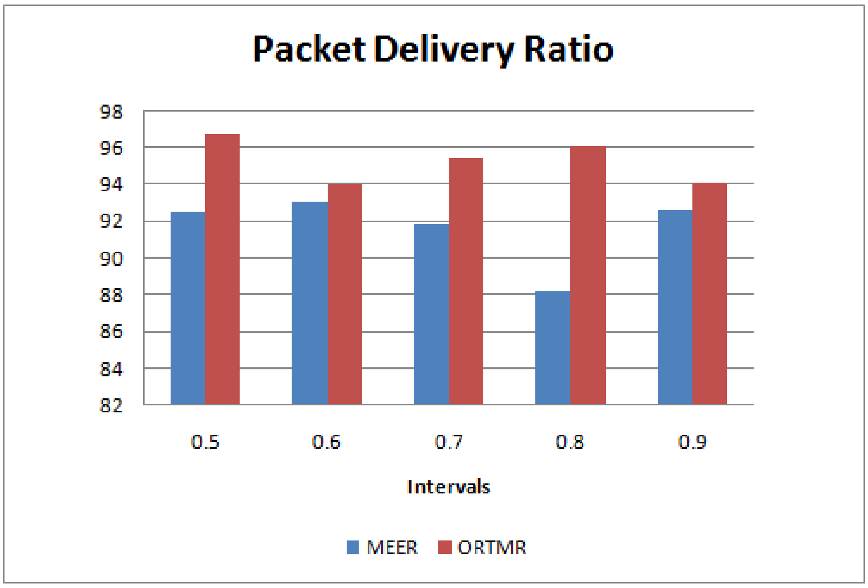


Figure 7: Packet Delivery Ratio.

Figure.7 illustrates the packet delivery ratio when the packet generation time of the MEER and ORTMR protocols is changed as an interval. The MEER protocol uses solely energy-based neighbour selection, but the ORTMR protocol uses optimised fuzzy with neuron computation through the use of the correct parameters. Because it picks the path based on connection reliability, strong signal capacity, and energy, ORTMR gives a result of 96.2 %, whereas simple MEER yields an average value of 91 % when the packet interval is changed.

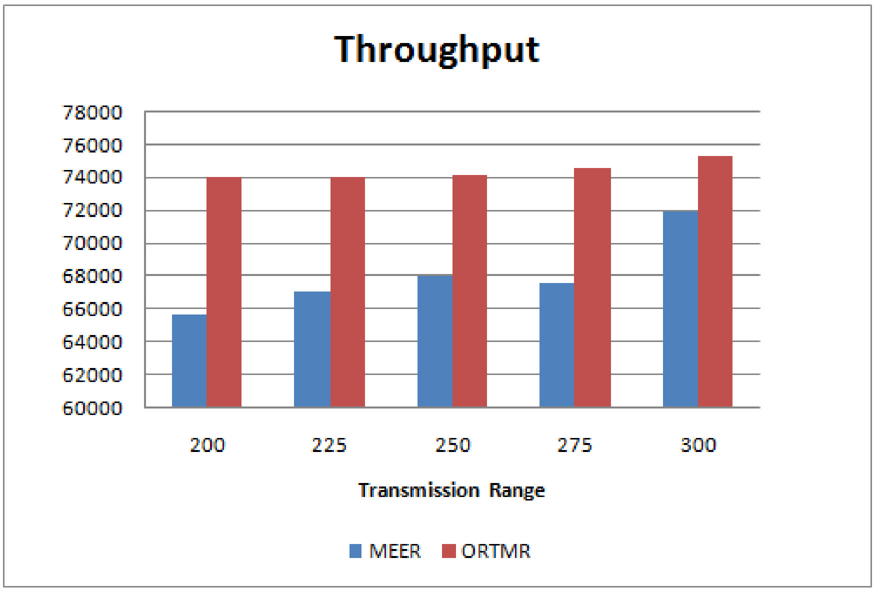


Figure 8: Transmission Range Vs Throughput.

Figure.8 This illustrates the output of throughput when the transmission range is changed from 200 to 300 meters; the results of the receiving packet bits per second are calculated using ORTMR and MEER, as demonstrated above. In ORTMR protocol, It shows the mentioned high throughput values; it receives more bits per second than the MEER.

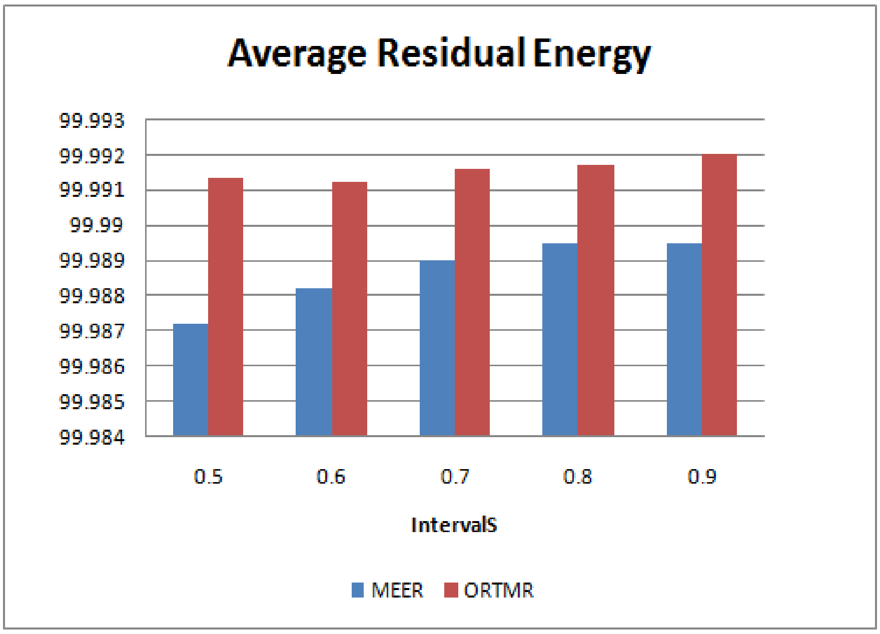


Figure 9: Interval Vs Average Residual Energy.

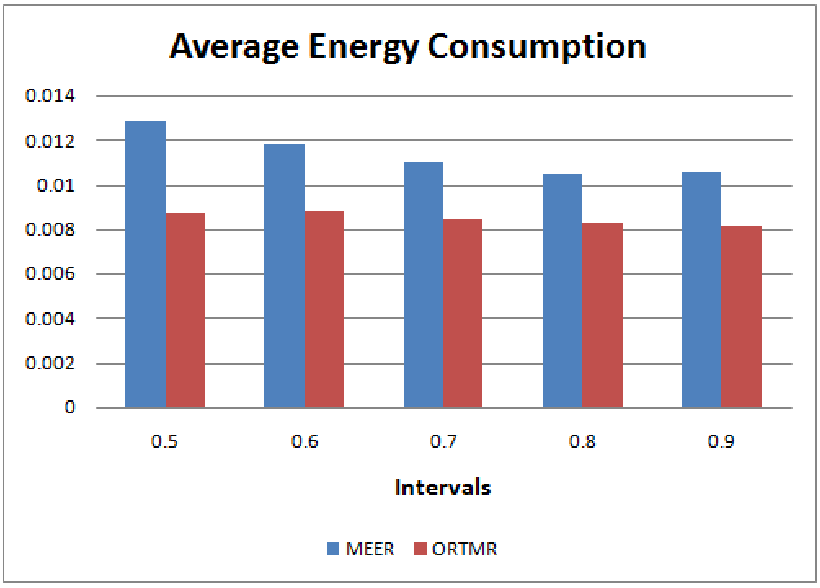


Figure 10: Interval Vs Average Consumed Energy.

Each node in the network's spent and remaining energy is depicted in Figures 9 and Figure 10. Because of the lower energy consumption and higher residual energy, the network's life span is extended. ORTMR protocol extends the network life by conserving residual energy with the help of improved path selection estimation.

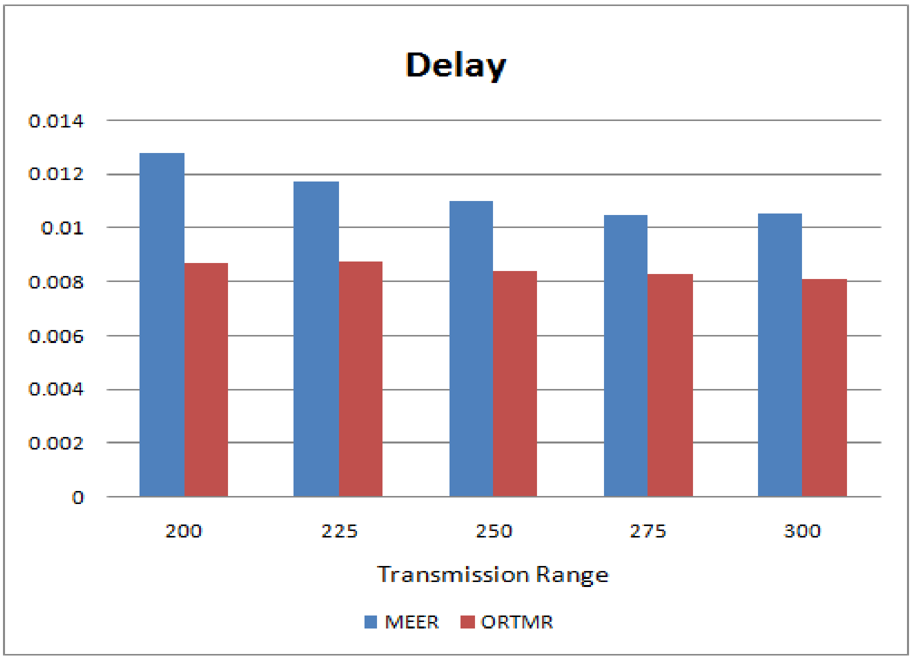


Figure 11: Transmission Range Vs Delay.

The results of an end-to-end delay from source to destination are shown in Figure 11.. If the path is not formed correctly during path establishment, the latency will rise in order to reconstruct the way that minimizes the receiving packets. Receiving packets are increased in ORTMR owing to the minimal delay factor, compared to the MEER protocol.

5. Conclusions

The protocol focused on continuous route selection from source to destination by utilizing an optimized fuzzy with neuron computation protocol to generate accurate neighbour selection to construct the path in this implementation. The output shows that the network receives more packets and the latency is reduced. To handle reliable and quick packet delivery, MANET requires the creation of a delay reduction channel. In the future, the ORTMR implementation can concentrate on channel and slot duration management to achieve the shortest latency possible compared to cluster routing results.

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