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Multipath routing protocol based on backward routing with optimal fuzzy logic in medical telemetry systems for physiological data measurements

Suryadevara Kranthi[1], Pallavi Deshpande[2], Shadab Pasha Khan[3], Amedapu Srinivas[4]

[1] *Department of IT, V R Siddhartha Engineering College, Vijayawada-520007, Andhra Pradesh, India*
[2] *Department of Electronics and Telecommunication, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune-411043, Maharastra, India*
[3] *Department of IT, Oriental Institute of Science & Technology, Bhopal-462021, Madya Pradesh, India*
[4] *Department of CSE, Sreenidhi Institute of Science and Technology, Hyderabad-501301, Telangana, India*

ABSTRACT
Mobile ad hoc network (MANET) performance is critically affected by the mobility and resource constraints of nodes. Node mobility will impact on connecting stability, and node resource limitations will result in congestion, so the development of a routing protocol that promotes quality of service (QoS) in MANET is quite difficult. In particular, frequent interrupting connection may degrade QoS performance in the high-speed node drive scenario, so it is required to build the MANET protocol routing which can be adapted for changes in the networking architecture to support QoS. Moreover, MANET's multipath routing is the most necessary for secure transmission that can be achieved if self-centered nodes in the MANET network are ignored. Secure routing guarantees the reliability of data, confidentiality, authorization and authentication and non-denial. A novel safe multi-way method for dependable data transfer, which depends on the quality of service, is offered in this study. The Ad Hoc on Demand Backward Routing protocol with Optimal Fuzzy Logic (OFL) is also designed to provide multi-path routing. The hybridization of the bat optimization approach provides the optimum route by generating rules in OFL, and hence chooses an optimal rule. The efficiency of the planned technique is evaluated for factors such as final delay, the packet delivery ratio and so on. When the node is 150, the proposed hybrid bat algorithm achieved 0.61 of average packet latency, where the existing technique Particle Swarm Optimization achieved nearly 1.2 to 1.3 packet latency. In this communication network, measurement of packet delivery ratio is an important task for establishing the communication network. The results show that our suggested work has more energy efficiency and network lifetime than existing ones.

Section: RESEARCH PAPER

Keywords: Authentication; quality of service; mobile ad hoc network; multipath routing; optimal fuzzy logic

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Corresponding author: Suryadevara Kranthi, e-mail: kranthisri41@gmail.com

1. INTRODUCTION

A mobile ad hoc network (MANET) has several sensor nodes [1] that are connected without central infrastructure via wireless media. To execute a fundamental routing activity like transferring data packets from one source to a location, routing techniques such as dynamic basis [2] and ad hoc remote vector [3] were devised. The MANET properties should be taken into account in routing methods. The fundamental requirements of a MANET are data dependability, multipath selection [4] and security [5] that improve network presentation. To attain this purpose many of the investigations have been developed. One of the important MANET functionalities is on-demand routing [6]. In an ad hoc setting, the routing arrangements [7] must be confident, resilient and flexible. Dynamic topology and node connection failure restricts the routing function. The mobility of the node makes it harder to route because it causes the nodes' connection failure. This frequent link failure leads to expensive routing and topology management, degrades reliability of data transfer and reduces network efficiency. The failure of the connection in MANET therefore becomes a serious issue. Furthermore, such a link failure often results in a trajectory of tragedy. As a result, data transmission reliability is diminished; the lower the packet transmission ratio the greater the delay from end to end. The measurement of data packets in a MANET increases the overhead control message pricey and reduces routing function performance. This is in turn more useful method in physiological data measurement and transmission via cognitive radio-based networks.

Therefore, the selection of an alternative way or the creation of several paths is vital to ensure that the data transfer is reliable when the link is unsuccessful. And there is a lot of interest in loop-free paths to determine an ideal path between several routes between the source and destination of a network. In order to improve the reliability of the data transmission, multipath routing is constructed in a MANET [8], providing for a load balance between the nodes. Using several split pathways, the data has been sent parallel and the delivery rate is greatly improved. The problem of scalability, confidentiality, integrity and the life of the network is addressed in the multi-routing systems [9]. The dependability of data communication in a MANET is ensured by multi-way [10] routing between source and destination. Existing multipath routing systems in a MANET cause flooding, empty neighbourhoods, flat management, widespread data, high energy consumption, meddling and load balance concerns. The efficient multi-way routing strategy is therefore presented to tackle one or more of these problems. In the dynamic environment changes and frequent path failures [11]-[12] also the existing multi-path routers are not good. They also produce an overhead route in the network. The overhead routing takes up a significant part of the bandwidth of the network and the power of the mobile node quickly exhausts. Therefore, in order to limit the mobile node's participation in a route discovery phase to maintain dependability of data communication, with minimum overall costs, a reliable multi-path protocol is essential [13].

Multi-routing protocols are continuously improved for one decade by updating the quality of service (QoS) support demand. As a matter of fact, the multi path routing protocol may liken the available node resources in various paths, such as the available bandwidth, battery level, etc., and choose the optimum path for data to satisfy QoS. Today, in the MANET path selection parameters not only the available path node resources but path stability is included. Researchers are looking for different parameters to measure path stability effectively. However, the routing protocol for adaptive link state, which is changing quickly to enable QoS, has not yet been fully researched in the high-speed movements of resource limited nodes scenario. Finding adequate criteria for road stability would also be harder. The major goal of this study is the development of a safe, nearby position verification protocol for the QoS performance of high-speed MANET, by measuring the packet delivery ratio. A backward routing technique is devised in this routing protocol to determine the confident nodes. In this work, the optimum Fuzzy [14]-[15] system is used to improve the QoS routing procedure. In fuzzy logic system, the optimal rule generation is identified by using the hybrid bat algorithm (HBAT) technique and compared its efficiency with other optimization techniques.

The paper is structured as follows: literary review is presented in Section 2. Section 3 delivers an explanation of the methods proposed. Section 4 provides validation of the methods proposed with current methodologies and measuring the packet delivery ratio. Finally, Section 5 offerings the conclusion of this study and its future effort.

2. LITERATURE REVIEW

This section mainly examines several routing methods in order to deal with changes in network topology and analyses their quality of service. Gomes et al. [16] introduces the industrial Wireless Sensor Network (WSN) Link Quality Estimator, and the dedicated WSN Node assesses connection quality depending on the signal intensity received. The estimate of connecting stability by distance alone, however, is not adequate for scenarios with high speeds such nodes that move with an average speed of 20m/s. Since node speed can be reflected in QoS performance through path life. Long lifetime paths can give superior QoS due to the long-term stability of the broadcast path. To improve the QoS, Cross-layer multicast routing (CLMR) protocol based on a tree is proposed in [17]. They take advantage of data on battery life, physical layer bandwidth, routing layer stability and application layer overhead to upgrade the tree and then calculate the cost function based on the attributes of each layer. To develop robust routing pathways, CLMR selects low-cost nodes. A Topological change Adaptive Ad-hoc multi-path distance vector protocol is developed in [18], which aims to minimize the data traffic by utilizing QoS. The protocol's limits are that it does not function well in dynamic arrangements requiring stability and node density both on routes. In general, this protocol improves a little when other protocols do far better in many circumstances. The notion of finding the efficient route with least energy consumption and shortest distance was proposed for the Fitness Function Adaptive Ad-hoc On-demand Multipath Distance Vector protocol (FF-AOMDV) [19]. This protocol employed AOMDV, and the broadcast will be performed over the alternate route with the shortest path in the routing table in the event of any breakdown or break in connection. The FF-AOMDV model took into account few QoS characteristics, which means that its presentation is not as high as AOMDV, while network improvement is very limited. The authors of [20] devised a routing technique which improves the network's quality with GA. This work took into account several circumstances including mobility speed and failure of the nodes. Compared to other protocols, the network performance was enhanced. However, the energy consumption issue was not taken into account. In the multi-track transmission control protocol in [21], the energy-efficient mobbing control technique was projected. The results show that this algorithm works better than Multipath Transmission Control Protocol because of its reduced energy use and improved throughput. The suggested approach did not however take into account the random loss regularly occurring in wireless connections in loss networks. Therefore, loss of packets is supposed to decrease the congestion window and degrade data performance as a result of congestion lost.

A routing procedure that takes into account the energy efficiency and certain QoS routing factors was proposed by the authors in [22]. In order to update nodes to QoD state, the method relies on the transmission of topological information to the whole network. This influx of information would raise the traffic overhead, especially with big networks. A protocol known as the Dynamic Energy Ad-hoc On-demand Distance Vector (AODV) protocol was suggested in [23]. The major goal is to reduce the time required to transmit packets, reduce the consumption of energy as well as to maximize the life of the network. It determines the shortest distance path and selects the intermediate nodes with high residual power and network authority. In case of any inattentive link breaking or low-energy nodes during packet delivery, this procedure gives external energy to nodes. This enhances the reliability of the route and the lifespan. This external energy supply can also be considered to minimize the cost of the network.

Authors of [24] proposed to do away with congestion and clustering in WSN a new protocol called Congestion and Clustering Routing. Congestion control and model-based bandwidth estimates were presented in sender side to TCP-traffic via containment-free Multiple-Access Time Division based MANETs [25]. Both protocols offer acceptable routing options based on preventing congestion but do not take account of the random loss that would unduly narrow the congestion window. Masood Ahmad et al. [26] introduced a clustering technique based on honeybee and genetic algorithm. The overhead of topology maintenance is reduced by this structure. Dynamic solutions with improved quality are provided by this combined algorithm, therefore, stable and balanced clusters are formed. However, multipath routing is done by this technique with high energy consumption. The energy issues and workload of CH are focused by Amutha et al. [27] by developing a Cluster Manager-Based CH selection scheme. The CH execute the packet transmission between sensor nodes in the network. Low bandwidth, reliable throughput and low energy are provided by this technique. However, there is a major problem developed in this study, which is use of extra mechanism for selection process that leads automatically low bandwidth.

2.1. Problem Identification

MANET's volatility and limited assets make it very difficult to communicate information via such networks.

- Because of inconsistent wireless channel, integrated device shortages, channel quarrels, portability, node control and affirmation device, assurance of QoS to MANET applications is also highly complex.
- The MANET mobile nodes do not provide adequate power and risk repetitive node failures, resulting in a variety of network topologies, network allocations, packet loss problems and the lowest signal quality.
- The current key organisation strategy of addressing an awkward node successfully does not deprive users of creating useful identities or the stealing of the individuality of individuals who do not participate in network activities.
- Moreover, MANETs generally require fresh limitations on problems related with QoS in wire-based networks. This is the projected dynamic behaviour of the respective networks and the controlled assets.

3. PROPOSED METHODOLOGY

In this study, a new optimum multi-track routing protocol is provided for MANET to improve the QoS, where network failures are reduced and will not use the information of individuals, who are not participate in the network activities. This is the four phases of the suggested model: The trust ideal for routing, the multipath routing, the optimal rule and Data Transmission. The phases of the proposed model are shown in Figure 1.

The secure adjacent position trust verification protocol (SAPTV) for analysis of trust value process is considered here. In our trust model each node maintains a value of trust for each of its neighbours. The Ad-hoc On-demand Distance Vector - Backward Routing (AODV-BR) is employed for the development of confidential packets in the multi-way outing process. If source S wishes to connect with destination D, the route delivery is initiated by the source at that time. To improve the QoS routing procedure, the optimum Fuzzy system is used. The rules are made in a fuzzy source- and target-based system. An inspired optimization model is proposed to optimize these rules.

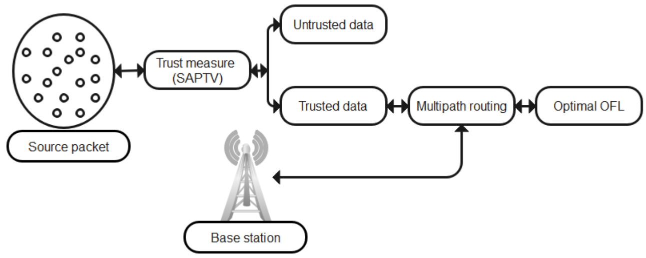

Figure 1. Proposed model Schematic diagram.

3.1. Trust Model for Multipath Routing

The source node begins the network-wide flood with the distribution of the route query packet, the most important waiting packets for the route response. The simulation process, the SAPTV protocol, is now intended. The data clustering updates the entry value. As demonstrated in (1), the trust measure is then taken into account

$$T_{v1} \sim T_{v2} = 1 - (1 - T_{v2})^{T_1} , \qquad (1)$$

where T 1 is the Trust Value suggestion and T 2 is the Trust Value Direct. The values are between 0 and 1. The innovative technique specifies an explicit trust relationship as the trust suggestion among two nodes in the similar collection, but the trust references are regarded by deliberation as a confidence association among nodes in the diverging collection. The trust warning for pathways is always active if it is less than the trust value.

3.2. Multipath Routing (MR) Process

In order to ensure the source-destination route, the routing protocols must show significant energy efficiency levels. In this respect, there are now a number of energy-efficient routing algorithms. The Protocols in this document propose that a considerable effort be made to depart from origin to endpoint

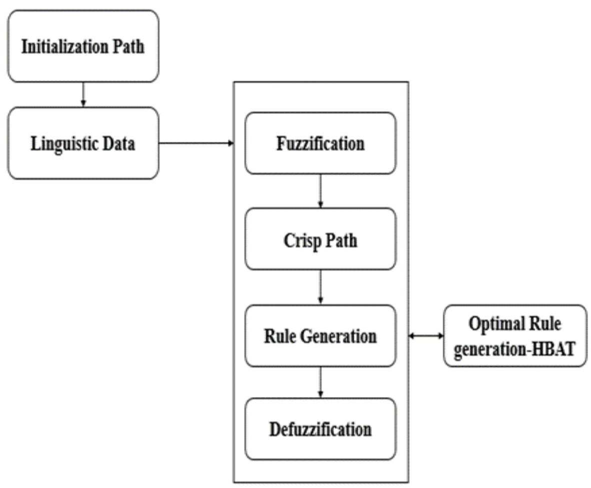

Figure 2. Fuzzy logic process.

node on the most energy-efficient path. A new routing method for MANET is developed called AODV-BR that identifies the least node's residual energy in the paths and classifies the descending path in the descendant order of nodal residual energy.

Figure 2 provides an ideal Fuzzy Logic (FL) method block diagram. After several interactions, the connection quality of a route is likely to be significantly diminished. Thus, the HBAT algorithm, which works admirably efficiently, selects the best way among the traditional route in the network.

3.2.1. AODV-BR Protocol

The response messages and data packets are checked, and local repair is conducted in the AODV-BR by a backup route. The source and endpoint nodes have the ability to change the data in the AODV-BR. Thus, with the assistance of this strategy, the finest overheard backup route is taken up. When the data packet is eradicated, it is transmitted via a substitute path in the AODV-BR.

3.3. Routing Process on Optimal Fuzzy Logic

In this study, QoS is improved by providing the shortest route using the Optimal Fuzzy Logic (OFL) algorithm, where HBAT is developed for optimal rule generation in OFL algorithm. Initially, the description of OFL is provided, where FL consists of four phases: flushing, generating a rule, membership, and defuzzifying. The values of a number of rules are properly translated into linguistic variables which in fluid logic describe the strength of settlement with the arithmetic value of the targets. Three separate kinds of values of trust like friends, acquaintance and strangers are characterized correspondingly by the three fuzzy as (high, medium and low).

3.3.1. Fuzzification

The hard value of any fuzzy collection is subjected to fluctuation to describe the value of the relationship. It also demonstrates the ability of a higher system to adjust the real scalar quality to a fluffy value. A floating X-collector partition represents a job A: x an L, where L reaches [0, 1], otherwise known as the membership feature.

3.3.2. Membership Function

This function is educated by many forms in order to evaluate the very comfortable Member Company, by put on the easiest separate Member Function from one another, through straight lines.

3.3.3. Rule Generation Process

The collection of IF-THEN rules builds on the data of a human expert to detect the preferred performance of the scheme. The rules can be maintained with the aim of achieving the entire functionality of the system. Under Table 1 below are presented sample fuzzy rules.

Table 1. Fuzzy Rules.

S.No	Mobility	Trust value	Delay	Route
1	Low	Low	Low	Below optimal
2	Medium	Low	Medium	Below optimal
3	High	High	Low	Sub optimal
4	High	Medium	Low	Sub optimal
5	Low	High	Low	Low optimal
6	Low	High	Low	Optimal
7	Medium	Medium	Low	Optimal

3.4. Data Transmission

After receipt of the message from the destination, the data packet is sent to the destination node. There are several transmissions in preferred pathways, and the link quality is likely to be lost. Thus, because of loss of the connection value, the source node does not accept any recognitions from the target node. The network opts for an ideal way from the basis routes. The best way to reach the goal should be energy-effective and must be the shortest. Therefore, in order to identify the shortest route in an optimal way, the research study uses HBAT algorithm in OFL, which is explained as follows:

3.4.1. Bat Algorithm

Bat algorithm (BAT), which was projected by Xin-She Yang in 2010, is a swarm-intelligence algorithm. In the algorithm, the search process is motivated by the fats, by the ability to search and locate the proofs.

The bats emit noise and can make a difference between the food and beasts, and estimate the distance, using the reflected sound waves. The following equation (2) is used to update the location of the bats (solution) during the optimization procedure:

$$x_i^t = x_i^{t-1} + v_i^t\,, \tag{2}$$

where the current solution is signified by x_i^{t-1} and the new, updated position at iteration $i-th$ solution is represented by x_i^t. The velocity is represented by v_i^t. The velocity at time step t is designed as follows in (3):

$$v_i^t = v_i^{t-1} + (x_i^{t-1} - x_*)f_i\,, \tag{3}$$

where x_*, denotes the current best global location, and f_i specifies the $i-th$ bat frequency. The solution frequency is consistently taken from the specified range from the least to the maximum frequency and is evaluated as follows in (4):

$$f_i = f_{\min} + (f_{\max} - f_{\min})\beta, \tag{4}$$

where $f_{\min}$ and $f_{\max}$ are represented as the minimum and maximum frequency, correspondingly and β is represented as a random number, $\beta\ \in\ [0,1,$ which is defined as follows in (5):

$$x_{\text{new}} = x_{\text{old}} + \epsilon A^t\,, \tag{5}$$

where β is a scaling factor with random values among 0 and 1, when the average loudness of all bats is given by A^t. The latch is updated as follows, after the prey is found by a bat and that are shown in (6) and (7):

$$A_i^t = \alpha A_i^{t-1}, r_i^t = r_i^0[1 - \mathrm{e}^{-\gamma\, t}] \tag{6}$$

$$A_i^t \to 0, r_i^t \to r_i^0, \qquad \text{while } t \to \infty\,, \tag{7}$$

where A_i^t designates to the loudness of $i-th$ bat, at iteration t, and r is the pulse emission level. The values of α and γ are constant.

3.4.2. Hybridized Bat Algorithm

The process of exploitation is strong in the unique bat algorithm, but it is caught in local optimum when exploring the search space. In this paper, the hybridized bat algorithm is used to improve the exploration phase of the Bat Algorithm with the search of bees from the algorithm for an Artificial Bee Colony, in this way, it is prevented to get trapped to the local optima. Randomly inside the lower and lower limits are generated the initial solution populations as in (8);

Table 2. Hybridized bat algorithm control factors.

Notation	Parameter	Value
N	Population size	20
γ	Constant parameter	0.9
A_{min}	Constant minimum loudness	1
α	Constant parameter	0.9
A_0	Maximum initial loudness	100
$f_{\min}$	Minimum frequency	0
$f_{\max}$	Maximum frequency	1
MaxIter	Maximum iteration	30

$$x_{i,j} = lb_j + \text{rand} \cdot \left(ub_j - lb_j\right) , \tag{8}$$

where lb_j and ub_j are referenced to both the lower and the upper bound; rand is a random number of uniform distribution, $\text{rand} \in [0, 1]$; and $x_{i,j}$ is a solution where the items are referenced by j. The fitness value is calculated as shown in (9) for each individual in the population after the generation of the starting population.

$$F_{x_i} = \begin{cases} \dfrac{1}{f_{x_i}} & if\ f_{x_i} \geq 0 \\ 1 + |f_{x_i}| & \text{otherwise,} \end{cases} \tag{9}$$

where the fitness function of $i - th$ individual is denoted by F_{x_i}, and f_{x_i} is the objective function of the $i - th$ individual. Table 2 shows the parameters used in proposed algorithm.

Two alternative methods improve the exploration of search space. The counter (t) determines if the search procedure of the bat algorithm or the observer bee mechanism will be used. At each step, the persons move and update the position in accordance with the Eq. (2), however the observer technique uses the following equation (10) if the value of t is odd:

$$x_{i,j}^{t} = x_{i,j}^{t-1} + \text{rand} \cdot \left(x_{i,j}^{t-1} - x_{k,j}^{t-1}\right), \tag{10}$$

where the novel solution at time step t is denoted by $x_{i,j}^{t}$. The $j - th$ element of the $i - th$ individual is denoted by $x_{i,j}^{t-1}$and $x_{k,j}^{t-1}$ denotes the $k - th$ neighbor solution, $\text{rand} \in [0, 1]$.

The random walk of the solution according to (5) will utilize the promising area.

The selection probability that is expressed as follows in (11) determines whether the newly produced solution is established or discarded:

$$p_i = \frac{F_{\text{avg}}}{\sum_{i=1}^{n} F_{x_i}} , \tag{11}$$

where p_i means the selection possibility and F as the fitness value.

Algorithm 1. hybridized bat algorithm

$Objective\ function\ f(x)$
$Initialize\ the\ population\ of\ bats, the\ values\ of\ v_i, r_i$
$and\ A_i, define\ the\ frequency\ of$
$pulse\ (f_i) at\ x_i, the\ value\ of\ the\ maximum\ iteration$
$(MaxIter), and\ set\ the\ iteration$
$counter\ (t)\ to\ 0$
$\boldsymbol{while}\ t\ <\ MaxIter\ \boldsymbol{do}$
$\boldsymbol{for}\ i$
$\quad =\ 1\ to\ N\ (each\ N\ individuals\ in\ the\ population)\ \boldsymbol{do}$
$\boldsymbol{if}\ t\ is\ even\ \boldsymbol{then}$
$\quad Calculate\ the\ velocity\ and\ frequency\ value$
$\quad using\ (3)\ and\ (4)$
$\quad Perform\ the\ bat\ search\ procedure\ using\ (2)$
$\boldsymbol{else}$
$\quad Perform\ the\ onlooker\ search\ procedure\ using\ (11)$
$\boldsymbol{end\ if}$
$\boldsymbol{if}\ rand\ > r_i \boldsymbol{then}$
$\quad Select\ the\ fittest\ solution$
$\quad Perform\ the\ random\ walk\ process\ using\ (5)$
$\boldsymbol{end\ if}$
$\boldsymbol{if} p_i < A_i\ and\ f(x_i)\ <\ f(x_*)\ \boldsymbol{then}$
$\quad The\ newly\ generated\ solution\ is\ accepted$
$\quad Reduce\ A_i\ and\ increase\ r_i\ utilizing\ (6)$
$\boldsymbol{end\ if}$
$\boldsymbol{end\ for}$
$\quad Find\ and\ save\ the\ current\ best\ solution\ x*$
$\boldsymbol{end\ while}$
$Return\ the\ best\ solution.$

4. RESULTS AND DISCUSSION

In a series of simulated SAPTV scenarios, testing is performed with the proposed SAPTV-HBAT algorithm, existing SAPTV particle swarm optimization, Whale optimization Algorithm (WOA) and BAT algorithms. A C++-based NS-2 simulator implements the planned algorithm and uses the amount of node, node mobility, traffic load and halt time for several simulation scenarios. Table 3 lists the simulation parameters. Nodes are randomly positioned within a 1000-meter radius in all circumstances. Every mobile node's maximum transmission range is 250 m. Nodes often move with speed in the range [0, 10] m/s, based on the random mobility point model. In this concept of mobility, all nodes migrate to a new destination point and remain there for a certain duration termed a pause.

The channel is 2 Mbps and the IEEE 802.21 power save mode is used by the MAC protocol. Window size and beacon interval ad hoc traffic indication mode are 0.05s and 0.25s. Each simulation is performed for 900 s. Two ray floor models are employed to propagate. Average control messages, power consumption, packet delivery ratio (PDR), network service life and delay are involved in the investigation. Simulation outcomes were obtained after 10 runs to achieve stable status.

Table 3. Simulation structure.

Parameter	Value
Packet Size	256 bytes
Pause Time	0–600 s
Transmission Range (R)	250 m
Data Size	5 Mbytes
Data Rate	2 Mbits/sec
Simulation Period	900 s
Traffic Load	1 to 5 packets
Traffic Type	CBR
Sum of Nodes	100–150
Initial Energy	180 J
Maximum Node Speed	10 m/s
Network Area	1000 m × 1000 m

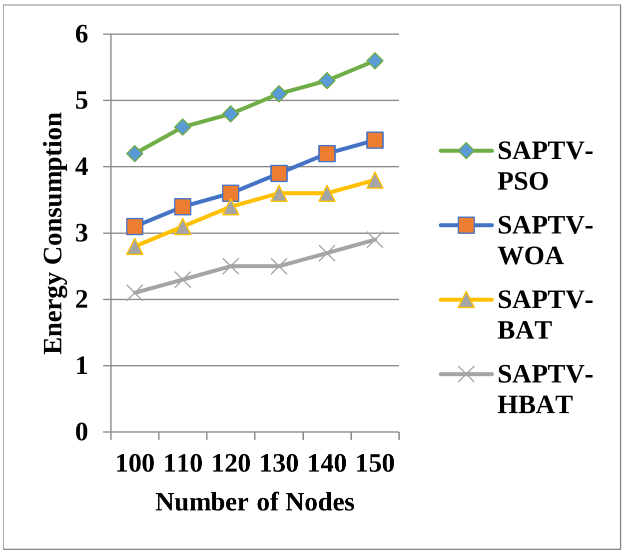

Figure 3. Graphical Representation of Proposed Model in terms of Energy Consumption.

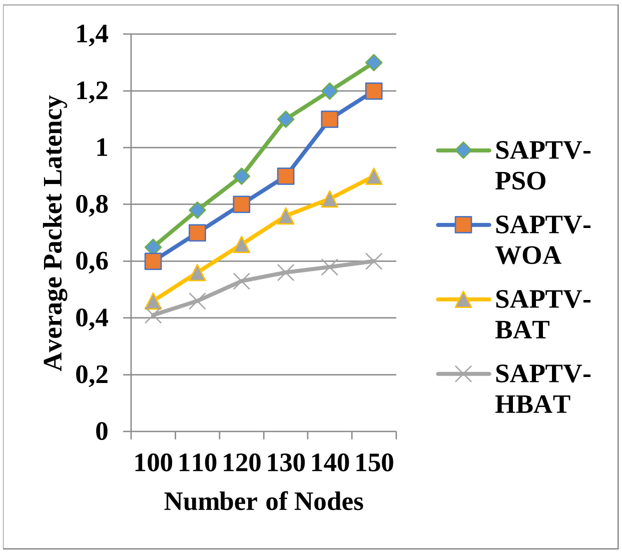

Figure 5. Graphical Representation of Proposed SAPTV-HBAT in terms of Average Packet Latency.

Initially, the energy consumption of each model is test and the graphical results are shown in Figure 3.

The Particle Swarm Optimization (PSO) algorithm, WOA, BAT and the proposed HBAT of SAPTV achieved 4.9 J, 3.7 J, 3.5 J and only 2.4 J, when the node is 120. However, the energy consumption is increased, when the number of nodes upsurges. For instance, when the node is 150, the PSO, WOA, BAT and proposed HBAT of SAPTV achieved 5.8 J, 4.8 J, 3.9 J and only 2.8 J. This decrease is due to a decrease in energy, hops and traffic consumption in data transmission over the defined path. Moreover, hop-proportional energy is also available. Traffic loads hence reduce energy consumption when hop numbers are optimized. The packet size for the proposed SAPTV-HBAT protocol is shown in Figure 4.

It is experiential that the proposed SAPTV-HBAT has better PDR than SAPTV-PSO SAPTV-WOA and SAPTV-BAT. The PDR increases when the number of nodes upsurges. When the node is 100, the PSO, WOA, BAT and proposed HBAT with SAPTV achieved PDR of 65, 79, 87 and 96. In addition, these techniques achieved PDR of 72, 80, 88 and 97, when the node is 130. The increased sum of nodes makes sure the optimal route from the source to the destination is selected. The amount of backup and duration, i.e., path life, is also increased. Figure 5 displays the average packet latency in diverse network sizes for the proposed system.

When the node is 110, the average packet latency of SAPTV-PSO, SAPTV-WOA, SAPTV-BAT and SAPTV-HBAT is 0.66, 0.61, 0.47 and 0.42. The same techniques achieved 0.91, 0.81, 0.67 and 0.54 of average packet latency, when the node reaches 130th level. But, the existing technique PSO and WOA with SAPTV reaches high packet latency i.e. nearly 1.2 to 1.3, where BAT achieves 0.93 and proposed HBAT with SAPTV achieved 0.61 of average packet latency, when the node is 150. Compared to other approaches, the proposed SAPTV-HBAT is observed to be less delay. The growing number of paths between nodes results in the selection of the best path with fewer hop counts and node sharing. Therefore, this approach has a reduced latency and uses bandwidth better. Figure 6 displays the average sum of

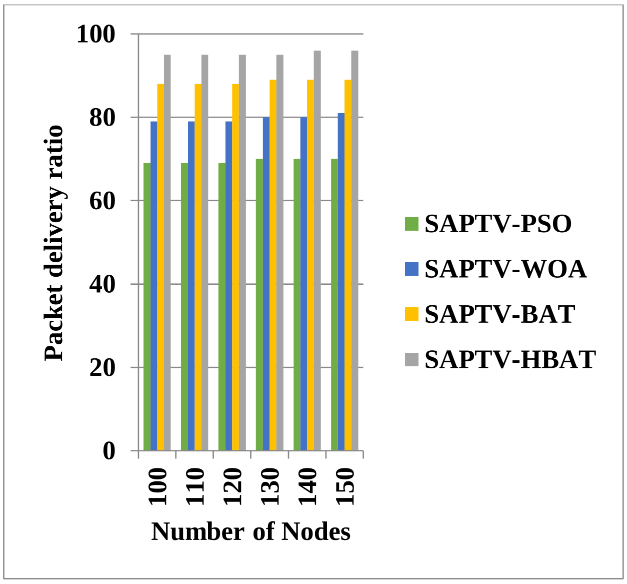

Figure 4. Graphical Representation of Proposed SAPTV-HBAT on the basis of Packet delivery ratio.

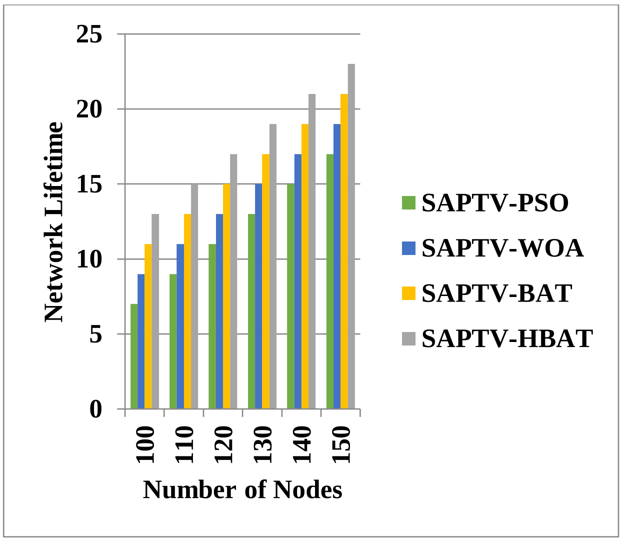

Figure 6. Graphical Representation of Proposed SAPTV-HBAT in terms of Average number of control packet.

control packets for the SAPTV-HBAT design for various network sizes.

When the node is 100, the average sum of control packets of PSO, WOA, BAT and HBAT with SAPTV is 1150, 1020, 950 and 830. The same techniques achieved 1250, 1158, 1059 and 950 of average number of control packets, when the node is 120. But, the existing technique PSO and WOA with SAPTV reaches high control packets i.e. nearly 1400 to 1500, where BAT achieves nearly 1200 to 1300 and proposed HBAT achieved 1120 and 1210 of average control packets, when the node is 140 and 150. It shows that control packets are increasing with the growth in the sum of nodes. The HBAT optimization approach used to locate paths from source to destination is employed in a multi-path network. Figure 7 shows the study of network life.

The lifetime of the network shall be measured as any of the nodes in the track are determined to be dead among the start of the data transmission into a particular path. When the node is 100, the average network lifetime of PSO, WOA, BAT and HBAT with SAPTV is 7, 9, 12 and 14. The same techniques achieved 8, 11, 13 and 15 of average network lifetime, when the node is 110. The average network lifetime of SAPTV-PSO, SAPTV-WOA, SAPTV-BAT and SAPTV-HBAT is 13, 15, 17 and 19, when the node is 130. But, the existing technique PSO and WOA reaches less network life time i.e., nearly 14 to 17, where BAT achieves nearly 18 and 20 and proposed HBAT achieved 21 and 23 of average path life time, when the node is 140 and 150. The lifetime of the network is better than everyone in the projected SAPTV-HBAT. It is because the path selection is based on a multi-target function. The data transmission will not involve the node with excessive electricity consumption and traffic backlog. High traffic losses lead to packet loss and needless energy use. The HBAT in SAPTV also displays better network lifetime than PSO, WOA and BAT due to the consideration of trustworthy routes.

5. CONCLUSION

MANET is an autonomous mobile node approach. QoS protocols which can be adapted to quick topology modifications would assist high-speed MANET network applications. A route may lose its link quality after the number of broadcasts. In this work, a multi-path routing system for the dependable exchange of data was suggested for QoS. OFL is developed to find the shortest route in multipath routing, where the optimal rules are generated by HBAT. The performance of the proposed model is compared with existing optimization approaches in terms of network life, PDR, energy consumption, average control packages and latency. The proposed protocol can be employed as an effective high-speed MANET solution with QoS necessities and limitations on resources such as multimedia communication between car and vehicle, the mobile video surveillance system etc. In the context of the previous energy-sensitive routing protocols the energy usage of the suggested routing protocol was quite small. As a future effort, the author will further examine the development of high-speed routing protocols that take into account both trajectory stability and node density. Furthermore, the next research will create the way forward by implementing effective protocols and maximizing the performance, the QoS and lowering communication delays.

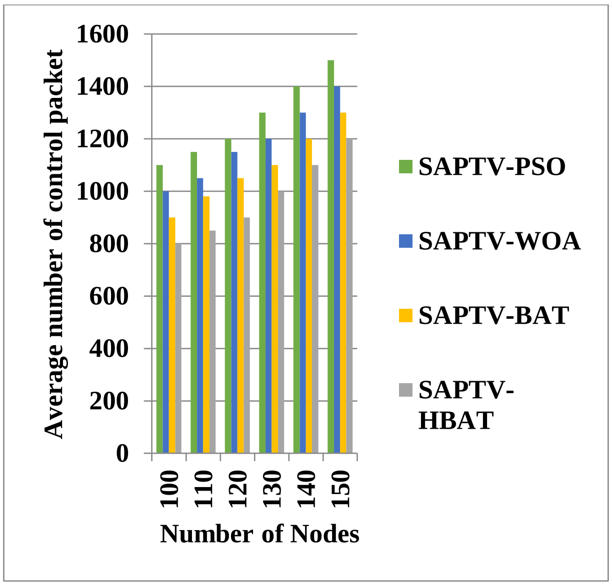

Figure 7. Graphical Representation of Proposed SAPTV-HBAT on the basis of Network Lifetime.

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