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Research Article

Quality of Service Management for Fast Data Transmission in Industrial Mobile Communications Using PSO-Based Computer Vision Technique

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Mobile ad hoc networks (MANETs) have rapidly expanded in recent years, mostly as a result of the mobile devices' obvious low cost, heterogeneity, and flexibility. When communication networks are down or inaccessible, sensors can quickly create a reliable network that can be used as a rescue data system. Industrial mobile communication has developed into a significant study area for both industry and academia in recent years. The need for data interchange between various smart devices with various latency flows is enormous. Nevertheless, there has not been as much research done in this area. The suggested work suggests a fuzzy-based improved PSO optimized in MANET to alleviate the drawbacks of the conventional routing approach. The suggested study offers a numerical modelling that can be used to carry out adaptive transmission optimization with a variety of programmable module structures and guarantee cost-effective route establishment with greater throughput, goodput, and lowest delay requirements. To find the best route, the proposed approach combines energy-optimized route construction with data-driven cluster head (CH) selection based on swarm intelligence. Particle swarm optimization- (PSO-) based clustering achieves improved delay, goodput, throughput, and path difference degree as compared to other conventional approaches, according to the extensive simulation results. The energy efficiency of a network that is decentralized is more important. The MANET device's energy efficiency helps to extend battery life and improve network performance. This research demonstrates how the fuzzy-based improved PSO optimized in MANET helps to raise the network's energy efficiency. As a result, network energy conservation improves network performance and battery life. Additionally, this method enhances the quality of service methodology. End-to-end delay, energy consumption, packet delivery ratio, and normalized routing overhead are measured and compared between the simulation and conventional routing protocols.

1. Introduction

The Internet of things (IoT), artificial intelligence (AI), and industrial wireless networks (IWNs) are all potentially stronger in the present improvement in wireless communication standards. With regard to various latency restrictions, the vast range of industry-oriented IoT applications necessitates a greater level of information flow control. Different forms

of data are currently exchanged between various devices, equipment, and users in smart manufacturing. In the context of IIoT communication and networking activities, routing is critical due to the diverse data flows at various levels. There has been significant advancement in this area of study, where multipath transmission protocols, the cloud, and edge computing help to simulate industrial IoT (IIoT) systems with improved performance and adaptable designs. The idea of IIoT has arisen as an integrated IoT ecosystem that is especially made for the control of industry-based operations. The slower routing operation due to the greater data flow rate in different IIoT layers has an impact on the quality of service (QoS) characteristics that are related to the network performance measure.

Energy conservation is one of the biggest challenges in the mobile ad hoc network (MANET) technique for the traditional to a now-a-day approach, which causes the researcher to be involved in many of the approaches to enhance the energy conservation and increasing the QoS methodology in the network. The mobile ad hoc network (MANET) is one of the most important and crucial techniques. The battery life of nodes determines how long a wireless ad hoc network will last. Most applications seem to make it impossible to recharge or change the battery. Data packets must therefore be sent using the least amount of energy possible from one node to the next. However, malicious nodes in vampire attacks use more energy than they normally would, which causes node power to drop and the network to crash. Attacks by vampires deplete a resource, which causes the battery to drain faster than usual. Honest and dishonest nodes are the central idea. A dishonest node will use more energy than usual to transport data packets to a neighboring node if it is situated in the centre of honest nodes. In this research, we have introduced a new hash value- and timestamp-based vampire attack detection and prevention mechanism for MANET [1].

It is made up of several mobile nodes that connect with one another decentralizedly. Due to the self-organizing nature of a MANET, each mobile node connects to the others through wireless networks in a topology that is unpredictable. The wireless ad hoc network is thus vulnerable to attacks from malicious nodes [2].

The energy optimization in the clustering approach using a hybrid K means algorithm provides a similar enhanced approach in the network system [3], but moreover, it does not produce the enhanced results when compared to our proposed technique.

The traditional MANET is used in the way of the TCP protocol; thus, it has a connection-oriented network when this approach provides more algorithms since it is not corrected for today's approach but it is used in many applications nowadays also [4, 5]. This problem will be overcome by using the cross-layer design protocol; it is based on the OSI model approach [6].

The cross-layer design approach is a widely used one; thus, it produces the wavelength to the adjacent nodes, but it suffered from a security problem; this problem can be rectified by using the SCLD [7].

The battery life of a sensor node determines how well it operates. Once batteries are placed in a remote or unattended location, it is proven to be impossible to replace them. Numerous studies have been done to try to solve this problem, but they all fall short in some way. The cluster head selection problem and the sink mobility problem are both addressed in this research using a particle swarm optimization (PSO) algorithm integrated with an energy efficient clustering and sink mobility (PSO-ECSM). A lot of computer simulations are run in order to figure out how well the PSO-ECSM performs. Five variables include average energy, node degree, distance, residual energy, and energy consumption rate (ECR) [8–15]. The experiment's results also demonstrate that the developed model outperforms conventional methodologies in terms of final results. The paper's contributions include the following:

(i) To make managing fewer communication resources easier, an edge computing software defined network architecture is presented

(ii) By classifying the data into low and high priorities based on the latency restrictions of the data, an effective adaptive data transmission routing approach is proposed

(iii) The suggested approach addresses the issue of quality of service degradation brought on by energy and delay limits

(iv) To create an energy-optimized path, the proposed approach incorporates a bioinspired particle swarm optimization technique

(v) Using the MATLAB simulation environment, the performance of the planned work is assessed by comparison to industry-standard practices

1.1. Objectives. This paper implements that improved fuzzy-based particle swarm optimization for enhancing the energy efficiency and the QoS methodology in the wireless MANET. Thus, the comparison results provide better-enhanced results when compared to the existing technique.

2. Review of Literature

Jahir et al. [16] implemented the survey of routing protocols and architecture for disaster area network. In this paper, implementing the distance area network (DAN), this paper is aimed at reducing the disaster in the network coverage area. The main objective of this paper is to reduce the disaster in the network and help to enhance the accuracy, and improve efficiency, improve delay and the reduction of the packet loss, and also reduce the overhead in the network.

Mirza et al. [17] implemented the introduction to MANET. In mobile ad hoc network, it is the wireless network; thus, it does not require any centralized points and that provides better security and the MANET provides the wide band of applications. This paper discussed the architecture of MANET and the routing protocols details and the challenging task for the mobile ad hoc network.

Sharma [18] implemented the secured reputation-based architecture for MANET routing. The mobile ad hoc network is one of the most crucial ones in the wireless network; thus, it provides better accuracy and network coverage sensation in the mobile. It provides wireless communication between one to another; thus, it does not require any other basic infrastructure.

Thus, it does not require any basic infrastructure and the MANET are affected by major attack such as denial of service (DoS) attack; thus, the malicious node attack is considered the DoS attack and the vampire attack arrives from the vampire node. The source of resource depletion is considered the vampire attack.

Karlsson [19] implemented the secure routing for MANET connected of Internet of things systems. In this paper, it implements the several security threats of the mobile ad hoc network in both static and dynamic conditions. The MANET mostly suffered from the attacks, most probably affected by two attacks, namely, DoS attacks and vampire attacks.

The DoS attack is probably considered the interrupting attack if any unwanted or unavailable users are interrupted at a certain time the network is shutting down, and this type of attack is the one way this attack mostly arrives in the malicious conditions of the nodes. The vampire attack is considered the resource depletion attack; this paper implements the prevention of the attack and enhanced the security in the MANET and also encouraged the communications between the source and the receiver in the Internet of things.

Abdai et al. [20] implemented the optimized particle swarm optimized algorithm for the realization of an enhanced energy aware location-aided routing protocol in MANET. Normally, the mobile ad hoc network provides better communication between one network and another network without having the basic infrastructure in the wire. In a multihop network, the mobile ad hoc network provides the dynamic source routing. In multicast routing, the nodes are moved in the dynamic arrangement and this causes the node splits, which causes the energy consumption in the MANET; this reduction can be overcome by using the PSO algorithm.

Robinson et al. [21] implemented the particle swarm optimization-based bandwidth and link availability prediction algorithm for multipath routing in mobile ad hoc networks. Multipath network plays a wide range of communication, and their application is probably more height. The MANET in multicast network provides better communication between the source and the receiver, but at the same time, it suffered from many attacks, like denial of service attacks and the vampire attack. Thus, this paper implements the particle swarm optimization-based bandwidth and link availability prediction algorithm for the multipath routing mobile ad hoc network for enhancing the optimization of the bandwidth energy and the network performance.

Ali et al. [22] implemented the energy-efficient clustering in mobile ad hoc networks using multiobjective particle swarm optimization. The MANET is used in a wide range of applications in the modern world. The major challenge of this paper is energy efficiency, so this paper implements the clustering techniques in MANET network. The clustering technique is also used for the reduction of packet loss and overhead and increasing throughput; thus, it increases the network performance.

Singh et al. [23] implemented the survey of energy efficiency and load balancing in MANET. In wireless networks, the MANET plays a vital role, in most communication networks. Working with the wireless network, dynamic routing acts in the MANET lead to power dissipation in the network. Thus, energy efficiency and load balancing are one of the major problems in the network devices; the energy efficiency is caused because of the node movements and another reason of the vampire attack in the MANET; thus, this paper implements the various techniques for the reduction of the load balance problem and the energy-efficient problem in the MANET.

Khan et al. [24] implemented the energy-aware multipath routing scheme based on particle swarm optimization (EMPSO); this paper implements particle swarm optimization by enhancing the energy conservation and the optimization of the network using increasing the bandwidth constraints and the reduction of the packet loss and also reduces the overhead problem in the network system.

Suresh et al. [25] implemented the energy-efficient cluster-based routing protocol using the fuzzy firebug swarm optimization algorithm in WSN; this paper proposed a new method like the honey badger algorithm used to enhance the energy efficiency in the MANET network; thus, the fuzzy-based proposed method helps to increase the better communication and the throughput power and increase the end-to-end delay in the network.

Shreyas et al. [26] presented the need for data sharing across various smart devices with various latency flows extremely high in the Industrial IoT. There has, however, been relatively little research done in this area. The suggested work suggests an adaptive data transmission strategy for the IIoT using software-defined networks (SDN) and edge computing to alleviate the shortcomings of the conventional routing method.

Khalifa et al. [27] presented the vehicle flow monitoring; illegal vehicle type recognition, incident detection, and vehicle speed estimation are all tasks that need vehicle detection in Intelligent Transportation Systems (ITS), making it a critical component of assuring road safety. Although it is becoming more and more common in research, it is still a difficult problem that has to be resolved. Radars and LIDAR are two examples of hardware-based solutions that have been suggested; however, they are too expensive to maintain and provide little useful information to traffic monitoring system operators.

3. Overview of MANET

The mobile ad hoc network is considered as the collection of the number of nodes; mostly, it acts like the dynamic routing like the multicast routing and the MANET is an independent network when compared to the other network; thus,

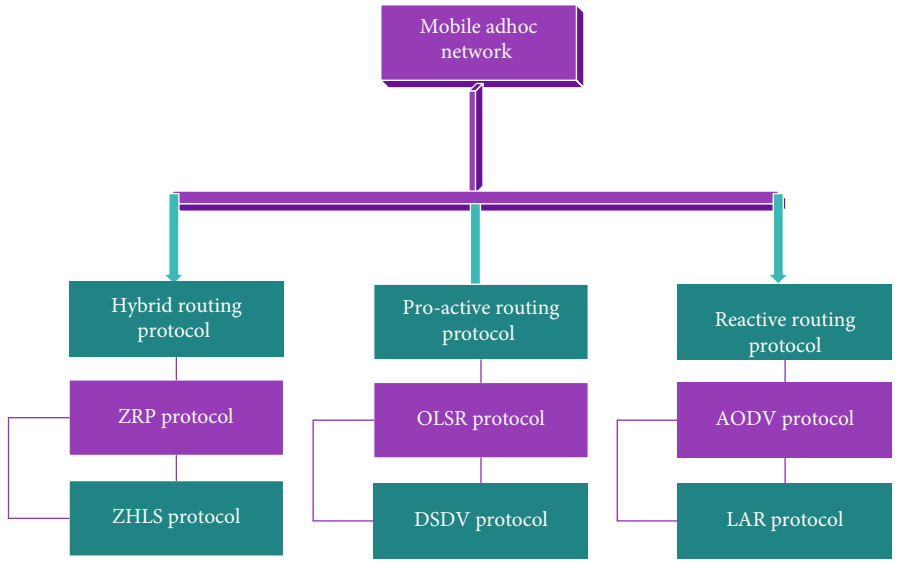

Figure 1: MANET routing protocol.

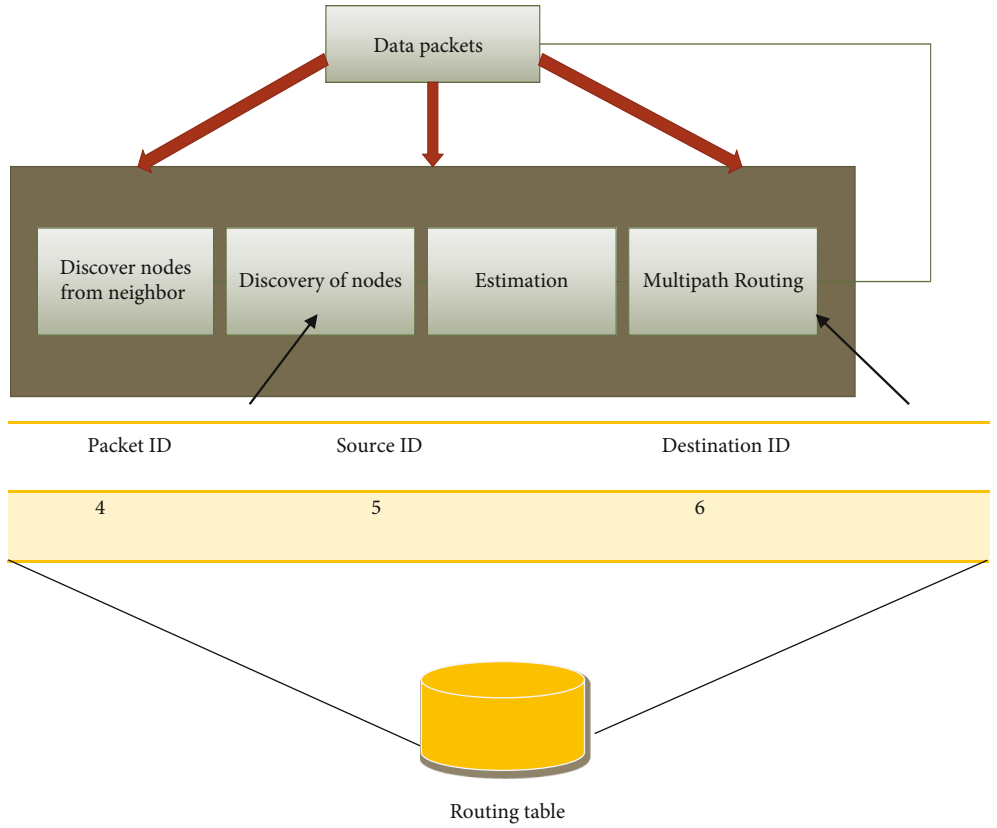

Figure 2: Multipath routing.

it is self-inbuilt with their own wireless protocol without having any basic infrastructure and it works with the host and routers; it is one the advantage of the wire MANET.

Figure 1 implements the MANET routing protocol; the MANET routing protocol is nothing but the network topology ensures the adaptable method; due to the change of the network topology, this is reason the network moves in the forward method. The MANET is further classified into three types, namely, hybrid routing protocol, proactive routing protocol, and reactive routing protocol. The hybrid routing protocol is nothing but the combination of the advantages of the proactive and the reactive protocol; it has the zone

positioned protocol and it contains the zone routing protocol and the ZHLS protocol. The proactive protocol is nothing but the protocol that gathered all the information when the system did not require it; thus, it maintains each and every node in the MANET. Thus, it contains OLSR and the destination sequenced distance vector DSDV protocol. The reactive routing protocol is nothing but the protocol providing bandwidth efficiency in the whole network system. The reactive routing protocol contains the ad hoc on-demand routing protocol and the LAR protocol.

4. Power Dissipation

Mobile ad hoc networks are decentralized network; it does not have any basic infrastructure network, and they only have the access point; thus, they conserved the whole energy. In multicast routing protocol, it provides the dynamic source routing, and the MANET in normal source provides the movement of the node. In the case of the multicast routing, the nodes are moved in a dynamic way; therefore, it produces the power loss; the packet loss also arrived in the improper form of the node movements.

The vampire attack is one of the major reasons for the power dissipation in the network. The TCP is one of the traditional approaches in the MANET. It is a connection-oriented network; it produces a huge algorithm when compared to the modern technique, but this technique is now actively used in the many applications. To overcome the time consumption and the advanced technique problem in the TCP, the researcher involved cross-layer design protocol (CLD); this technique helps to enhance the adjacent node communication and the normalization, and it helps to dissipate the energy from the entire node. But it lacks the security problem; thus, the researcher is involved to make the secured cross-layer design technique.

The SCLD provides better communication between the source and the receiver; in multipath communication in the network, the SCLD suffered from many attacks because of node movement and improper communication between the nodes. The vampire nodes majorly suffered from this attack. The energy depletion in the resources is considered the vampire attack. The vampire attack majorly suffered from the energy drained problem, when the message sends through the malicious node it has more energy consumption which makes a loss in the network [1].

This vampire attack is further classified into two types, namely, the carousel attack and the stretch attack. The carousal attack suffered from the sequence of the loops since the same nodes work many times which causes the energy consumption in the network system. The stretch attack is caused by the long routing loops since the original path in the vampire attack is placed at the minimum distance and the malicious nodes are placed at a long distance; thus, the vampire nodes communicate with malicious nodes; it tries to make the long routing path; it causes the energy dissipation in the network system [2].

The CLD contains the OSI layer for the basic architecture; each layer suffered from different types of the attack such as the application layer suffered from different attacks like worms and the virus, the transport layer suffered from the jellyfish attack and session hijacking attacks, and the network layer suffered from the black hole attack, wormhole attack, and grey hole attack, and the data link layer suffered from the stealth attack and the QWEP targeted attack, and the physical layer suffered from the jamming attack and the malicious attack [2]. The overall power dissipation in the MANET can be overcome by using fuzzy-based improved PSO in this paper.

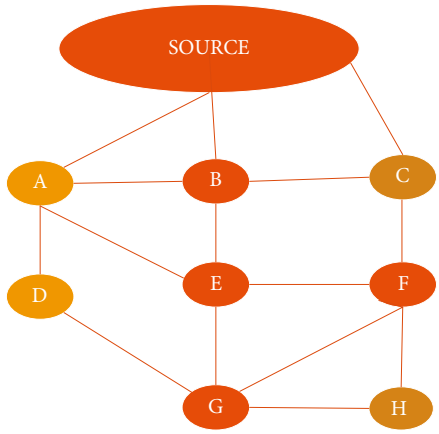

Figure 3: Multipath route formation.

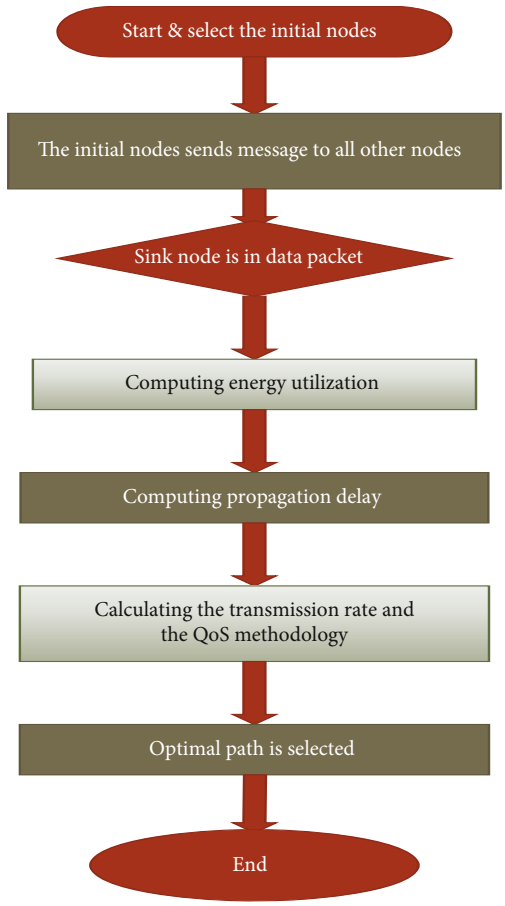

Figure 4: Flowchart for FIPSOEE.

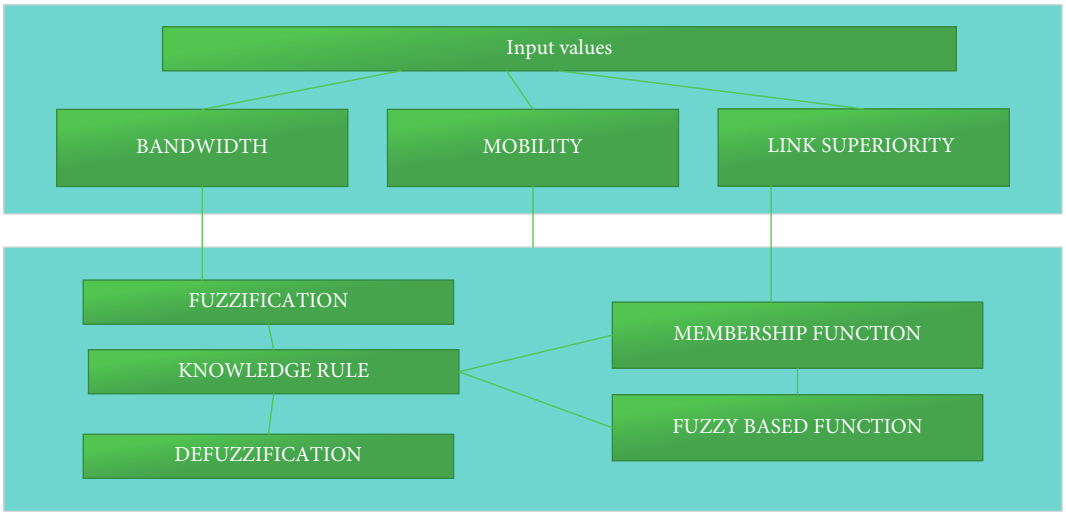

Figure 5: Prediction model in fuzzy.

5. Proposed Approach

5.1. Multipath Routing. The proposed method implements that the set of neighbor nodes is used to discover the message. This discovered message that is transmitted to the receiver increases the performance of the network. This algorithm like fuzzy-based improved particle swarm optimization helps to increase the optimal output in the entire network system.

Figure 2 represents the multipath routing approach in the MANET; thus, the multipath routing provides the wideband application; at the same time, it suffers from link breakage issues because of the nodal movement and the distance of a node from one to the other. These results in energy dissipation in the MANET; thus, the overall problems can be overcome by using the fuzzy-based particle swarm optimization in the MANET.

The breakage of a link is computed in the following equations:

$$F_n(a_i, b_i) = \sum_{i=1}^{m}\sum_{j=1}^{n} ai_{ij}\|Am_i - Bm_i\|. \quad (1)$$

ai_{ij} is the association of power approach, and $F_n(a_i, b_i)$ is considered as the link breakage association approach. The arrangement of the model is considered as Bm_i.

$$Bm_i = \frac{1}{bi_j}\sum_{i=1}^{n} a_{ij}bm_{ij}. \quad (2)$$

The vector form is considered as Am and Bm. Thus, the training prototype is considered as the nodes in the wireless mobile.

$$T_{P_i} = \frac{1}{T_P}\sum_{J=1}^{T_p} Fn(a_i, b_i). \quad (3)$$

Table 1: Simulation setup.

Name of the parameters	Value
Initial time	12.5 s
Recipient time	155 s
Number of nodes	100
Pause time of the network	55-365 s
MAC model	IEEE 802.11
Connections	25 nodes
Propagation delay	140 ms
Network model	Wireless network
Mode of mobility	Random waypoint model

Thus, the quality is measured by the following equations that should be expressed in

$$\text{Quality} = \frac{1}{1 + a_{xi}}. \quad (4)$$

After the completion of the quality value, the probability value can be assumed on the basis of the quality

$$\text{probability} = \frac{\text{quality}}{\text{additional of all quality}}. \quad (5)$$

Finally, add all value and get the utilization of the energy

$$\text{Energy}\,(x) = \text{energy}\, ay_i(mx_i, e_d) + \text{energy}\, y_i(mx_i) + \text{energy}\, y_0\,(mx_i). \quad (6)$$

e_d is considered as the distance of the equilibrium in the MANET. Thus, the energy that will be expressed in this node is the distance between the node and the energy consumed based on the equation

$$\text{optimal}_{\text{path}} = \text{maximum}\left(\text{propogation}_{\text{delay}}\right). \quad (7)$$

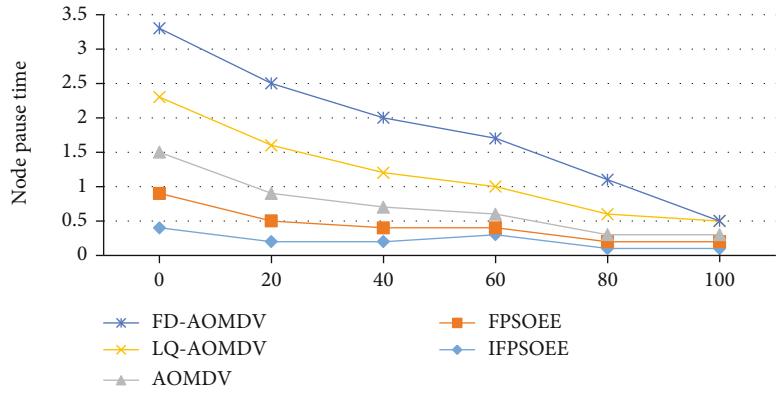

Figure 6: Delay.

The optimal path in the MANET is expressed as the basis of the maximum propagation delay. The sum of the energy utilized matrix can be expressed in the sum of

$$\mathrm{EU}_{XY} = \mathrm{EU}\left(m_x, m_y\right). \tag{8}$$

This equation is expressed as the whole utilization of the energy; this energy gives that the availability of energy from the packet after the completion of the energy keeps us the packet node, and the data they received power signal is evaluated. And finally, the energy efficiency is evaluated [21].

$$\text{Broadcast} = \text{energy consumed} + \text{radiated power}. \tag{9}$$

The flowchart describes the entire process in the network system [21]; based on the energy utilization technique in the network, the basis of the flowchart description, it enhances the broadcast power rate in the network.

$$\text{Power} = \frac{\text{power}}{\text{power} + x_i}. \tag{10}$$

The forward and backward nodes in the network system are explained in the existing paper; the forward route discovery procedure provides the enhancement of the adjacent nodes, and thus, forwarding data packet provides the proper communication between the source and the receiver. The backward route discovery exploits the whole network discovery also enhancing the packet loss because of the improper communication between the source and the receiver [21].

5.2. Algorithm Fuzzy-Based Improved PSO. This fuzzy-based IPSO technique helps to identify the utilization of the energy, power rate, and end-to-end delay in the wireless MANET. The improved particle swarm optimization is the technique used to calculate the location of node accuracy and every particle. Each and every particle swarm measures the lifetime and the network performance of the network [21]. It computed the memory of current and the memory of future in each and every particle; thus, it compares the quality method with current and the memory [21].

Figure 3 implements the multipath route formation in the network system.

Figure 4 describes the overall process for the entire network system. In our approach, it is used to detect the energy conservation in the MANET network and enhancing the QoS methodology.

5.3. Fuzzy-Based Prediction Model. The fuzzy-based prediction model is obtained with the three models, namely, link superiority, bandwidth accessibility, and mobility; this is considered as the input value, and then, the output is gathered from the defuzzification [21].

Figure 5 represents the fuzzy-based prediction model in the MANET. Our proposed method shows the low delay, better packet delivered ratio, enhanced optimal path, increased network throughput, and better energy utilized ratio when compared to the existing technique.

6. Experimental Results

6.1. Simulation Setup. Table 1 represents the simulation setup in our proposed method.

6.2. Comparison Analyses. This paper compares the energy utilized ratio, throughput, optimal path, delay, and the packet delivered ratio to the existing technique like AOMDV, LQ-AOMDV, FD-AOMDV, and FPSOEE [21] with our technique IFPSOEE. Thus, the comparison results are given below.

Figure 6 implements the delay in the network; thus, our proposed method produces a lower amount of delay when compared to the existing technique. From the graph, IFPSOEE produces lower amount of delay which is less than 0.3.

Figure 7 implements the packet delivered ratio; our proposed method shows a better result when compared to the other existing technique. From the graph, the packet delivered ratio of IFPSOEE is more than 300.

Figure 8 implements the throughput of the wireless MANET since it produces an enhanced result when compared to the existing technique. From the graph, the throughput of the wireless MANET of IFPSOEE is less than 5000.

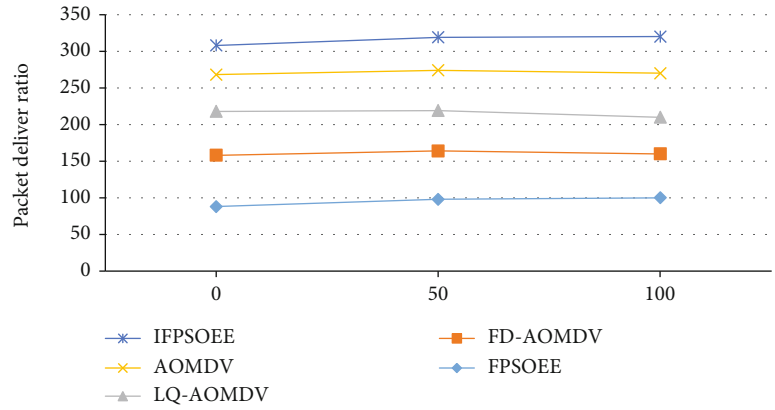

Figure 7: Packet delivered ratio.

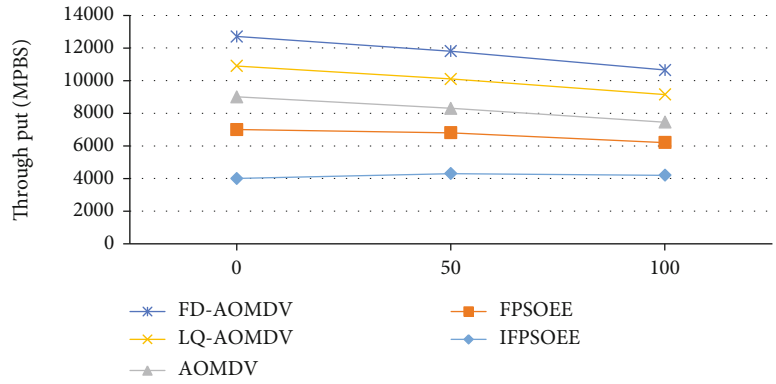

Figure 8: Throughput.

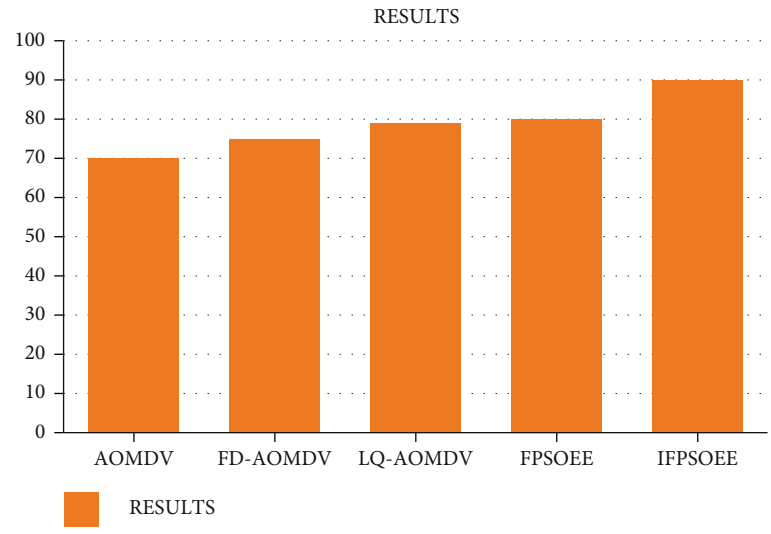

Figure 9: Results.

Figure 9 denotes the overall calculation like energy optimization and the QoS methodology. The comparison of all the results shows that our proposed method implements better accuracy when compared to the existing technique. The accuracy of IFPSOEE is 90%.

7. Conclusions and Future Work

This paper implements the improved fuzzy-based particle swarm optimization to increase the energy efficiency and enhance the QoS methodology and reduce the delay

increasing the throughput packet delivered ratio as shown in the figure. And finally, our paper compares the existing approach and gives better results. The PSO methodology's machine learning-based energy optimization will be the foundation of our future work.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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