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PSO-DQ: An Improved Routing Protocol Based on PSO using Dynamic Queue Mechanism for MANETs

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The growth of mobile device technologies has given rise to widespread applications that led us to economic wireless networks, including with and without infrastructure. Efficient routing with Quality-of-Service (QoS) constraints is a challenging issue in substantial infrastructure-less and dynamic networks. To improve QoS constraints for such a network is an NP-complete problem. It is observed that Particle Swarm Optimization (PSO) is one of the most potent swarm-based optimization techniques to solve NP problems. Hence, PSO is chosen to boost QoS constraints and provide more reliable routes than existing on-demand routing protocols. This paper has proposed a PSO-based routing facility that uses a dynamic queue mechanism for efficient routing considering enriched QoS constraints. The uniqueness of the proposed technique is selecting the fitness function that is dynamic in nature and determined based on the data obtained by the successor node. The queue size is maintained dynamically to minimize the data drop. The simulation results revealed that the proposed algorithm performs better than the existing conventional algorithms like Ad-hoc On-Demand Distance Vector (AODV), Destination-Sequenced Distance Vector Routing (DSDV), and metaheuristics like ACO, PSO, QoRA, Enhanced-Ant-AODV, and Cuckoo Search Optimization AODV (CSO-AODV) in terms of packets sent, packets received, PDR, end-to-end delay and routing overhead.

Keywords: routing, dynamic queue, MANETs, ACO, PSO, quality of service

1. INTRODUCTION

A mobile ad-hoc network (MANET) is a self-configuring and framework-less network functioning without centralized administration where nodes move randomly. Consequently, the topology of the network may experience speedy and random changes [1]. As nodes in MANET usually have bounded communication ranges, some nodes cannot communicate independently. Data packets are sent from the source node to the destination node to support the multiple intermediate nodes in the communication network. MANETs include indispensable multiple hops. Each node in MANETs is responsible for acting as a host to generate data packets and a router to forward those data packets [2]. Each node has its wireless interface to communicate with the other. Fig. 1 exemplifies that nodes A and C are not within the range with each other, and thus node B can be used to forward packets between node A and node C. Here, node A and node C determine the route through node B; node B will act as a router. Mobile ad-hoc network allows its users to use it more frequently in those circumstances where a static framework is nonexistent or a static framework is challenging to build, like Military Environments, Personal Area Networking, Civilian Environments, or Emergency Operations.

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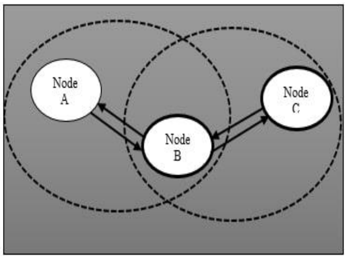

Fig. 1. Example of mobile ad hoc network.

But due to autonomous infrastructure-less limited resource availability, lack of centralized administration, and dynamic nature of MANETs, routing and providing QoS requirements becomes a tedious task in communication networks [3-6]. Routing is selecting a route between the source nodes to the destination nodes through which the source node delivers the data packets to the destination nodes in the network [7]. The traditional and well-known algorithms such as the Bellman-Ford dynamic programming algorithm and Dijkstra greedy algorithm has been used to find the shortest route, but they have the following significant drawbacks:

(i) They are not appropriate for the networks having negative weights of edges.
(ii) They are not fit for large and dynamic network topologies.

With the rapid development of network services in modern society, routing has become more and more popular. Therefore, selecting the appropriate routing protocol is an important and tedious task that must satisfy QoS parameters which are also known as performance parameters of a network like throughput, delay, jitter, packet delivery ratio (PDR), routing overhead (RO), and reliability [8]. QoS constraints directly affect routing; that's why routing is such a critical facet of network communication. The objective of selecting a routing protocol is to find the optimal routes with maximum PDR, minimum end-to-end delay, and minimum RO. When the source node sends the data packets within the network, QoS constraints may affect the network's performance. So, some extra means are required to tackle such situations in highly dynamic and extensive MANETs. Many routing protocols have been developed like AODV [9], DSR [10], OLSR [11], and DSDV [12]. However, in the case of an extensive and dynamic network and a combination of two or more QoS constraints, either additive, multiplicative, or a mixture of additive or multiplicative metrics contribute to NP-complete in nature and are not found suitable.

Most of the research is targeted towards considering either a single QoS metric or two QoS metrics, and very few are considering three metrics. However, real-time communications require a minimum end-to-end delay, maximum available bandwidth, high PDR, and low RO. A possible solution to these kinds of difficulties, which cannot be resolved with classical methods, is the application of stochastic optimization techniques. Stochastic optimization techniques are usually categorized into evolutionary algorithms, like genetic algorithm (GA) and nature-inspired algorithms like ant colony optimization (ACO) and particle swarm optimization (PSO). Compared to GA and ACO, the advantages of PSO are faster, cheaper, easy to implement, and a smaller number of parameters to be adjusted [13].

PSO, the population-based stochastic search algorithm, was first introduced by Dr Kennedy and Dr Eberhart in 1995 and based on the natural behaviour of birds flocking. In PSO, each particle flies through the multidimensional space, adjusts its position in every step based on its own and that of its peers' experiences until the entire swarm seeks an optimal solution.

Here, a dynamic queue-based PSO optimization is proposed to improve the QoS parameters. It is essential to understand routing protocols followed by a summary of a few already existing schemes listed in Section 2. The proposed dynamic queue-based PSO is presented in Section 3. The simulation outcomes of the proposed scheme are compared with AODV, DSDV, ACO, PSO, QoRA, Enhanced-Ant-AODV, and CSO-AODV methods in Section 4.

2. RELATED WORK

Researchers have offered numerous routing techniques to meet the dynamic topology challenges, which finds the optimal path with improving QoS constraints [14]. These protocols can be categorized into three types: – Conventional methods [15], evolutionary methods [16], and swarm intelligence-based methods [17].

A brief overview of the preceding works considering one or two QoS constraints for searching the optimal route in MANET is presented in this section. We have given an overview of existing conventional, evolutionary, and swarm-based routing protocols in this section.

2.1 Conventional Routing Protocols

Conventional routing protocols are categorized into three classes: –proactive, reactive, and hybrid routing protocols. Every node has its routing tables in the proactive routing protocols to contain routing information to every other node. It is periodically updated when a node observes any significant network topology change. However, the reactive routing protocols find routes only on-demand of the network. At the same time, hybrid routing protocols use the best features of both routing protocols.

DSDV [12] routing protocol based on Bellman-Ford routing algorithm [18] with specific modification such as loop-free, it offers the shortest single path to the final node. There occurs a large amount of routing overhead to the network if there are many nodes or extensively mobile, and it also consumes a large amount of bandwidth to update the routing data at each node. DSR [10] protocol is a combination of route discovery and route maintenance mechanism of the network route. In DSR, the network's overhead routing increases with increasing node density because each packet carries the full address of the whole route. Due to this reason, DSR is not appropriate for bulky and highly dynamic networks. AODV [9, 19, 20] is a combination of DSDV and DSR algorithm. It adopts the sequence number procedure of DSDV and the route discovery and route maintenance mechanism of DSR. It is adaptable for highly dynamic topologies, but it consumes more bandwidth and introduces additional delays when the network size increases. Zone Routing Protocol (ZRP) [21] is a hybrid routing protocol. It behaves like a table-driven routing protocol for the routing zone's enormous value and an on-demand routing protocol for the small value of the routing zone as it reduces routing overhead. OLSR [11] table-driven routing protocol, whose key idea is Multipoint Relays (MPRs) to reduces control overhead. As per the authors, in this algorithm, the shortest paths to every destination are available without any delay when data transmission is required. Here, we have analyzed that the conventional routing protocols are not sufficient in large and dynamic constraints. These are designed without explicit consideration in quality-of-service for the generated routes. Table 1 provides a sequential summary of the essential characteristics of conventional routing protocols.

Table 1. Chronological summary of essential characteristics of conventional routing protocols.

Existing Protocols	Routing Approach	Multiple Routes	Advantages	Disadvantages
DSVD 1994 [12]	Proactive	No	* Single shortest path	* High overhead * Consumes more bandwidth
DSR 1996 [10]	Reactive	Yes	* Multiple Routes * Promiscuous overhearing * Save a considerable amount of bandwidth	* Scalability problems * Flooding * Large delays
AODV 1999 [9]	Reactive	No	* Suitable to highly dynamic topologies * Less routing overhead than DSR	* Large delays * Not suitable for large networks * Consumes more bandwidth
ZRP 2000 [21]	Hybrid	No	* Reduces the overhead	* Behaves like proactive routing protocol for a large network * Behaves like reactive routing protocol for a small network
OLSR 2001 [11]	Proactive	No	* Reduced control overhead	* Reduces the control overhead * It needs more time to re-discovering the broken link * Requires more processing power

2.2 Evolutionary and Swarm Based Routing Protocols

The genetic algorithm is a speculative search technique and an evolutionary approach encouraged by the Darwinian principles [16] of natural selection genetics, which has shown several characteristics particularly useful for routing search in MANETs [22, 23]. GA, with its growing nature, optimizes the shortest path problem by producing improved results with the given solutions. Barolli *et al.* [24] proposed a genetic algorithm (GA) based routing method for MANETs (GAMAN) to use end-to-end delay and packet dropping rate as QoS constraints. Sanghoun Oh *et al.* [25] proposed a Genetic-Inspired Multicast Routing Optimization Algorithm, which increases the network efficiency only in terms of bandwidth and delay constraints.

Swarm intelligence is a computational intelligence technique that contains the combined performance of self-directed agents that nearby communicate in a scattered atmosphere to solve a specified problem in the expectation for asset solution to the problem. Recently, researchers show their concern in using swarm intelligence (SI) [26, 27] for routing in MANET. Ant colony optimization (ACO), particle swarm optimization (PSO), bacterial foraging optimization (BFO), and artificial bee colony (ABC) are examples of swarm intelligence. ARA [28] ant-based routing algorithm has proposed to reduce overhead in routing. AntHocNet [29] is a hybrid routing protocol that uses reactive routing protocols for path set and proactive routing protocols to maintain the path. HOPNET [30] is an ant-based routing algorithm that borrows the features of DSR and ZRP and gives better performance than AODV, ZRP, AntHocNet. AMQR [31] reactive routing algorithm based on ACO for ad hoc networks has proposed extending the path with high preference probability for the minimum delay, maximum bandwidth, and minimum hop count. AMAR [32] uses the combining ideas of artificial intelligence (AI) and multipath routing, in which the algorithm for improving network performance is achieved. Singh *et al.* [33] have provided a comparative analysis for ACO-based algorithms in MANETs for various QoS metrics. Hemlata, Uradea and Patel [34] concluded that the dynamic PSO gives better-optimized value to multi-objective optimization problems. QoRA [35] reactive routing protocol based on local SNMP (Simple Network Management Protocol) to find the path satisfies QoS constraints by finding multiple ways. CSO-AODV [36] routing protocol based on enhancing Cuckoo Search (CS) technique gives better result in terms of PDR, packet drops, and overhead. Enhanced-Ant-AODV [37] uses combining AODV and ACO ideas to improve QoS constraints and provide better results than AODV, DSR, and Enhanced-DSR in terms of PDR, throughput, and delay.

Hybrid PSO-GA [13] multicast routing algorithm combines PSO and GA’s strengths to balance natural selection and good knowledge sharing to provide a robust and efficient search of the solution space. Patel *et al.* [38] proposed a multicast routing optimization based on ACO and PSO, which utilize the collective and coordination process for mobile agents attached to each pattern to satisfy the QoS constraints. Table 2 provides a sequential summary of the essential characteristics of the swarm and evolutionary-based routing protocols.

Table 2. Chronological summary of essential characteristics of evolutionary and swarm based routing protocols.

Existing Schemes/ Protocols	Routing approach	Multiple Routes	Compared with	Advantages	Disadvantages
ARA 2002 [28]	Reactive	Yes	AODV, DSR, DSDV	∗ Less overhead	∗ Not support high mobility
GAMAN 2003 [24]	Reactive	Yes	–	∗ End-to-end delay ∗ Packet dropping rate.	∗ Supports only for small and medium networks.
AntHocNet 2005 [29]	Hybrid	Yes	AODV	∗ Improve PDR, delay, jitter	∗ More overhead
GA Routing 2006 [25]	Reactive	Yes	Chen’s algorithm	∗ Satisfies QoS (bandwidth, end to end delay)	∗ Not mentioned about PDR

Table 2. (Cont'd) Chronological summary of essential characteristics of evolutionary and swarm based routing protocols.

Existing Schemes/ Protocols	Routing approach	Multiple Routes	Compared with	Advantages	Disadvantages
HOPNET 2009 [30]	Hybrid	Yes	AODV, ZRP, Ant-HocNet	∗ Improve PDR and delay	∗ High communication complexity ∗ Not fit for the large network
AMQR 2011 [31]	Reactive	Yes	AODV, AntHocNet	∗ Provides good PDR ∗ Reduces delay ∗ Reduces jitter ∗ Supports node mobility	∗ High overhead ∗ Congestion problem
PSO-GA 2011 [13]	Hybrid	Yes	PSO, GA	∗ Improve PDR and delay	∗ High overhead
AMAR 2012 [32]	Hybrid	Yes	AODV OLSR AntHocNet	∗ Improve PDR and delay	∗ High overhead
HACOPSO 2014 [38]	Reactive	Yes	PSOTREE, TGBACA	∗ Satisfies delay and delay jitter	∗ Not mentioned about PDR
QoRA 2015 [35]	Reactive	Yes	AODV	∗ Avoid network congestion ∗ Avoid packet loss	∗ Jitter increases as network size increases.
CSO-AODV 2016 [36]	Reactive	Yes	AODV, ACO, PSO	∗ Supports scalability and mobility	∗ Not mentioned about the delay.
Enhanced-Ant-AODV 2018 [37]	Reactive	Yes	AODV, DSR, Enhanced-Ant-DSR	∗ Improve PDR, throughput and delay	∗ Not mentioned about packet loss ratio and jitter.

3. PROPOSED METHODOLOGY

Particle swarm optimization is an efficient method to find a reliable route while the network is dynamic. In this proposal, PSO is used to solve QoS's network constraints because it provides a more reliable route than existing on-demand routing protocols. Here, PSO operates based on a dynamic fitness function by calculating successful data received by the successor nodes from the predecessor nodes. In this proposed approach, the dynamic queue is used to improve the network QoS parameters. In the dynamic queue method, demand-based intermediate nodes update their queue size to minimize data dropping from the network. It also plays a critical role in memory management. If the bandwidth of all links are equal, then the queue size is less reserved. On the other hand, if the higher variation of bandwidth between link and data rate is consistent, then the queue is highly needed. Thus, this approach makes the dynamic queue mechanism beneficial to maintain the network QoS constraints. As the proposed model's formal notion is framed, the fitness value calculation for PSO is based on the Eq. (1) to pick the particular path using the dynamic queue method to review the network's dropping tail.

$$f_{f\_k} = 1 - \frac{\sum_{i=1}^{n}(fwd_i - f_{secr\_i})}{Rec_{prd}} \tag{1}$$

In PSO, all particles are initiated randomly. Suppose x_i^t denotes the position vector of particle i at time t. Each particle adjusts its position in the multidimensional search space (x_{min}, x_{max}) according to Eq. (2) based on its own experience and its neighbours' experience. All particles are evaluated to compute the p_{best} (best value of each particle) and g_{best} (best value of particle in the entire swarm) according to Eqs. (3) and (4) respectively. The velocity of particle i is updated according to Eq. (5). After updating the position and velocity of the particle according to Eqs. (2) and (5) respectively, evaluate the fitness function f_{f_k} according to Eq. (1). Various symbols and their meaning are summarized in Table 3. Fig. 2 shows the schematic diagram of the proposed PSO-DQ approach.

$$x_i^{t+1} = x_i^t + v_i^{t+1} \text{ with } x_i^0 \approx U(x_{\min}, x_{\max}) \tag{2}$$

$$p_{best.i}^{t+1} = \begin{matrix} p_{best.i}^{t+1} & \text{if } f(x_i^{t+1}) > p_{best.i}^t \\ x_i^{t+1} & \text{if } f(x_i^{t+1}) \le p_{best.i}^t \end{matrix} \tag{3}$$

$$G_{best} = \min\{p_{best.i}^t\} \text{ where } i \in [0,1,...,\ n] \,\&\, n > 1 \tag{4}$$

$$v_{ij}^{t+1} = v_{ij}^t + C_1 r_{1j}^t [p_{best,i}^t - x_{ij}^t] + C_2 r_{2j}^t [G_{best}^t - x_{ij}^t] \tag{5}$$

Table 3. Symbols used and their meaning.

f_{f_k}	fitness function to find the best location
fwd_i	forward to next neighbor by i^{th} node
f_{secr_i}	failure in receiving the data by successor node
Rec_{prd}	Successful data received from a predecessor
x_i^t	The position vector of particle i at time t
v_i^t	The velocity vector of particle i drives the optimization process and reflects own experience knowledge and social experience knowledge from all particles.
$U(x_{\min}, x_{\max})$	Uniform distribution where is its minimum $x_{\min}$ and $x_{\max}$ maximum values, respectively.
v_{ij}^t	The velocity vector of a particle in dimension j at time t
x_{ij}^t	The position vector of particle i in dimension j at time t
$p_{best,i}^t$	Personal best position of particle i in dimension j found from initialization through time t
G_{best}^t	Global best position of the particle in dimension j found from initialization through time t
C_1 and C_2	Acceleration constants
r_{1j}^t and r_{2j}^t	Random numbers from uniform distribution $U(0, 1)$ at time t

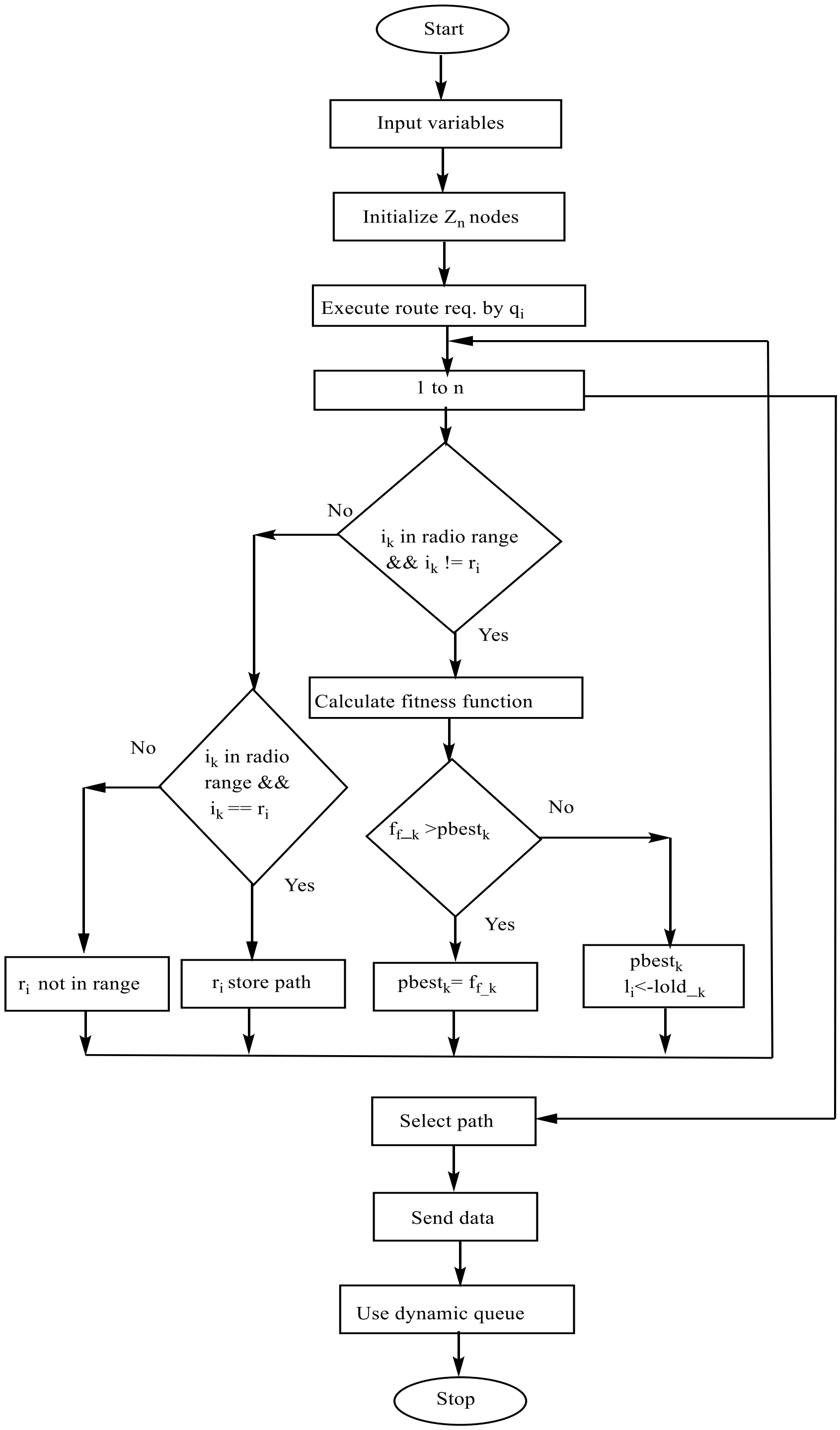

Fig. 2. Schematic diagram of the proposed PSO-DQ approach.

The pseudo-code of the proposed PSO-DQ algorithm is described as follows:

Proposed PSO-DQ for QoS under MANET

Input: Z_n: n number of mobile nodes
q_i: source node $\in Z_n$
r_i: receiver node $\in Z_n$
i_k: kth intermediate node $\in Z_n$
d_n: queue $\forall Z_n$
ψ: Radio Range 550m^2 $\forall Z^n_{k-1} = Z_{k-1}$
R_p: PSO
f_f: fitness function to find best location
$pbest_i$: past best location (initial = 0.0)
R_v: random position
S_p: search space 550m^2
l_i: current location
Rec_{prd}: success full receiver data from predecessor
fwd_i: forward to next neighbor by i^{th} node
f_{secr_i}: failure to receive by successor node
Pa_r[]: population array
V_i: velocity of i^{th} node
$path_i$: path between q_i to r_i
Output: Data Send, Data Receives, *nrl*, delay, *pdr*
Procedure:
Step1: Z_n initialize Pa_r[], R_v under S_p
q_i execute route_req(q_i, r_i, R_p)
Step2: for i = 1 to n
If i_k in ψ && i_k! = r_i **then**
Calculate $f_{f\_k} = 1 - \frac{\sum_{i=1}^{n}(fwd_i - f_{secr\_i})}{Rec_{prd}}$
If $f_{f\_k} > pbest_k$ **then**
$pbest_k = f_{f\_k}$
i_k forward (q_i, r_i, R_p) to next-neighbor
$l_{new\_k} \leftarrow l_{old\_k} + V_{kd}$
Else
$pbest_k$
$l_i \leftarrow l_{old\_k}$
Discard route packet
End if
Else if i_k in ψ && i_k == r_i **then**
r_i store ($path_i$, f_{f_i}, $l_i \in path_i$)
r_i generate reverse path to q_i
q_i receives ack from r_i
Send-data (q_i, r_i, $path_i$)
Else
r_i not reachable or not in range
End if

End for
Step3: send-data (q_i, r_i, data)
Step4: q_i check $d_{j=1}^{n}$ those node in $path_i$

Step5: **for** j 1 to n
  If data receives at i^{th} node&& $i_j! = r_i$ **then**
    $d_j \leftarrow d_j + 1$
    i_j check route table to send next-successor
  Else if data forward from i^{th} node&& $i_j! = r_i$ **then**
    $d_j \leftarrow d_j - 1$
    i_j forward (q_i, r_i, data) to next-successor
  Else if data receives at i^{th} node&& $i_j == r_i$ **then**
    $d_i \leftarrow d_i + 1$
    Retrieve data from d_i
    Send ack to q_i from reverse $path_i$
  Else
    r_i not in ψ or $path_i$ break
    Connection terminate
  End if
 End for

We used the event-driven network simulator NS2 version 2.31 to evaluate the efficiency of the results obtained. The simulation area is 1000∗1000 square meters with node numbers 50, 75, and 100, where the nodes are placed randomly. Table 4 shows the other network simulation parameters.

Table 4. Parameters for the simulation scenario.

Parameters	Used in Simulation
Network type	MANET
Simulator	Ns2
MAC type	IEEE 802.11b
Area	1000*1000 sq. m
Routing protocol	AODV, DSDV, ACO, PSO, QoRA, Enhanced-Ant-AODV, CSO-AODV, PSO-DQ
No. of nodes	50, 75, 100
Transport layer	TCP, UDP
Application layer	FTP, CBR
Packet size	512 Bytes
No. of connection	15-20
Antenna Model	OmniAntenne
Propagation model	TwoRayGround
Queue mechanism	Droptail/PriQueue
Mobility Model	Random Waypoint
Simulation time	480 sec
Pause time	10 sec

Performance measuring QoS parameters:
(1) Data sending: Data sending depends on the data rate and path availability between the sources to the receiver nodes.
(2) Data received: The number of data received depends on network behaviour such as path availability, queue utilization, bandwidth, *etc.*
(3) PDR: PDR is a ratio of total data packets received successfully to the total data packets sent from the initial node to the final node.

$$PDR = \frac{Total\ received\ packets}{Total\ sent\ packets} * 100 \quad (6)$$

(4) End-to-end delay: It is the average time of the data packet to transmit successfully from the initial node to the final node.
(5) Routing overhead (RO): It is the ratio of the total packet sent to the number of control packets sent.

$$RO = \frac{No.\ of\ \ sent\ packets}{No.\ of\ \ control\ packets\ sent} \quad (7)$$

4. RESULTS AND DISCUSSIONS

(1) Data Sending Analysis: Fig. 3 shows the performance comparison of data sending of DSDV, AODV, ACO, PSO, QoRA, Enhanced Ant-AODV, CSO-AODV, and PSO-DQ. In this graph, PSO-DQ gives better results concerning node variation as compared to all the existing protocols.

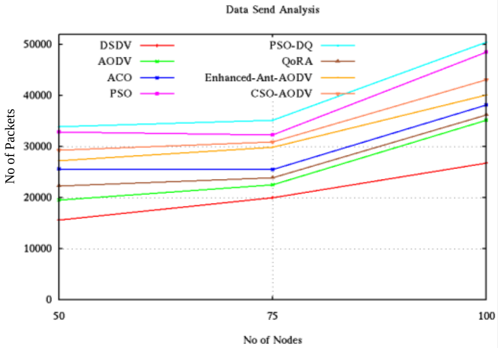

Fig. 3. No. of nodes vs. data sending analysis.

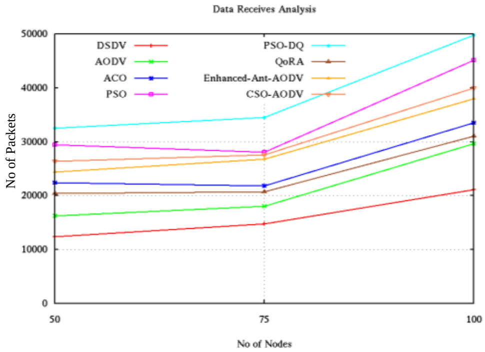

Fig. 4. No. of nodes vs. data receiving analysis.

(2) Data Receiving Analysis: The number of data received depends on network behaviour such as path availability, queue utilization, bandwidth, *etc.* Fig. 4 shows the performance comparison of data received by DSDV, AODV, ACO, PSO, QoRA, Enhanced Ant-AODV, CSO-AODV, and PSO-DQ. The performance comparison shows that the dynamic queue with the PSO-based mechanism gives excellent results compared to the existing routing protocol.

(3) PDR Performance Analysis: PDR is a significant factor in analyzing network behaviour because it measures the percentage of data received at the receiver end. PDR not only depends on the bandwidth availability, but it also depends upon the network congestion, the number of route changes, buffering at the intermediate nodes. If network congestion is higher or routes frequently change, or buffer is full, packet delivery performance goes down. Fig. 5 shows PDR performance in three scenarios at node numbers 50, 75, and 100. Through the graph, we conclude that PSO-DQ slightly improves the packet delivery ratio as compared to DSDV, AODV, ACO, PSO, QoRA, Enhanced Ant-AODV, CSO-AODV method as well as they are found to be having a positive influence on other network parameters.

(4) Delay Performance Analysis: The delay in the network depends on the communication link, queuing process of data, channel availability, retransmission of data packets and link break, or other reasons. In MANET, nodes change their location every second and exchange information with each other, resulting from dynamic delays per-packet. Fig. 6 shows the performance comparison of the end-to-end delay of DSDV, AODV, ACO, PSO, QoRA, Enhanced Ant-AODV, CSO-AODV, and PSO-DQ. This graph shows the average delay in the duration ranging in a millisecond and indicates variation based on network size. We conclude that as the network size increases, the average network delay of proposed PSO-DQ is lower as compared to the existing protocols.

(5) Overhead Analysis: The Overhead is directly proportional to delay in the network, and it occurs due to frequent node motion, network congestion, or heavy traffic. The overhead in the network increases due to frequent link breakage in the network. Fig. 7 shows the performance comparison based on the overhead of DSDV, AODV, ACO, PSO,

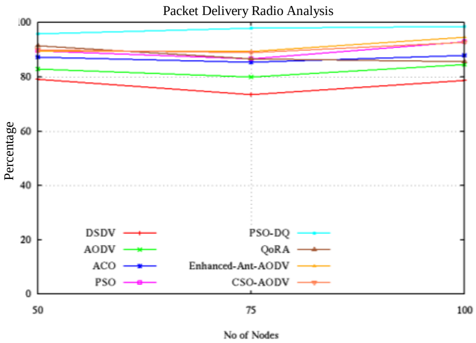

Fig. 5. No. of nodes vs. PDR.

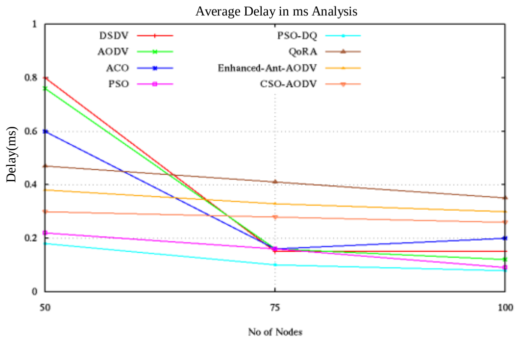

Fig. 6. No. of nodes vs. delay (ms).

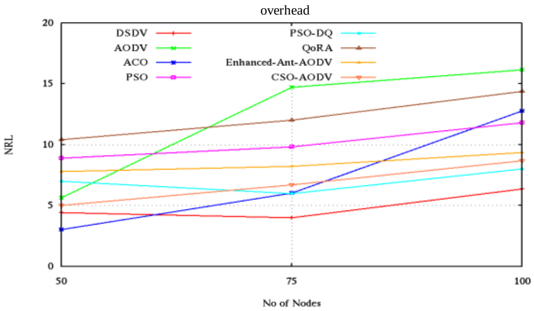

Fig. 7. No. of nodes vs. Routing overhead.

QoRA, Enhanced Ant-AODV, CSO-AODV, and PSO-DQ. Though there is a little hike in the PSO-DQ, the efficiency of packet receiving has improvised. The promenade of overhead is occurring due to the routing balancing of the load in the network. From the graph, we conclude that as the network size increases, the routing overhead of PSO-DQ is comparatively less than DSDV, AODV, ACO, PSO, QoRA Enhanced-Ant-AODV.

5. CONCLUSIONS

The novelty of this work is the use of swarm-based powerful optimizer PSO along with changing queue mechanism for minimizing packet drop and improving QoS constraints such as packet sending, packet receiving, PDR, delay, and routing overhead. Improving QoS is much significant and desirable aspect of MANETs. Nodes with a fixed queue length might cause the possibility of higher dropping, so the proposed routing schemes are planned based on varying queue size. The proposed scheme increases network efficiency, as well. The improvements in this protocol are evaluated by the network's QoS performance metrics and compared with AODV, DSDV, ACO, PSO, QoRA, Enhanced-Ant-AODV, and CSO-AODV routing algorithms. The results obtained certify the supremacy of the proposed dynamic queue-based PSO over compared algorithms.

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