

Impact of Improved Chicken Swam Optimization Based A* algorithm In MANETs Routing



Gondi Yasoda Devi, Gurralla Venkateswara Rao

Abstract: Wireless devices utilization had increased drastically, which has shown an impact on over-all demand and utilization Mobile Ad-Hoc Network (MANET). Routing protocol is the fundamental and vital performance factor in the Mobile Ad-hoc Network (MANET). The routing protocols in MANET are accomplished to handle a lot number of nodes with restricted resources. Multiple routing protocols exist in MANETs. Once of the main challenges in routing protocols is its generation of adverse influence on network performance. Accordingly, this paper plans to implement an obstacle-ware MANET routing model using improved meta-heuristic-based A* algorithm. The algorithm efficiently plots a path between multiple nodes avoiding obstacles, or points, on the graph that results in producing a shortest path without any obstacles. The improved meta-heuristic algorithm termed as Fitness and Position Ratio-based Chicken Swarm Optimization (FPR-CSO) is used to improvise the A* algorithm. The comparative analysis of different optimized A* over Ad hoc On-Demand Distance Vector (AODV) confirms the consistent performance of the proposed model.

Keywords—MANET Routing; Optimal Shortest Path; Obstacle Aware Routing; A* Algorithm; Fitness and Position Ratio-based Chicken Swarm Optimization

Nomenclature

Abbreviations	Descriptions
CSO	Chicken Swarm Optimization
MANETs	Mobile Ad hoc Networks
FPR-CSO	Fitness and Position Ratio-based Chicken Swarm Optimization
PSR	Proactive Source Routing
FSR	Fisheye State Routing
AODV	Ad hoc On-Demand Distance Vector
CAODV	Cognitive Ad-hoc On-demand Distance Vector
ZRP	Zone Routing Protocol
B-iHTRP	Bio-inspired Hybrid Trusted Routing Protocol
QoS	Quality of Service
PDR	Packet Delivery Ratio
FFAOMDV	Fitness Function Ad hoc On demand Multipath Distance Vector
ESCT	Evolutionary Self-Cooperative Trust

MBRA	Modified Bi-directional Routing Abstraction
ACK	Acknowledgement
BAP	Best Afford Path
IDS	Intrusion Detection System
DSR	Dynamic Source Routing
CHNN	Continuous Hopfield Neural Network
CE-OLSR	Cartography Enhanced Optimized Link State Routing

I. INTRODUCTION

MANETs is the assortment of nodes those are automated in wireless communication networks that are mobile and self-organized. The nodes in MANETs dynamically delineate temporary system that utilize and prevail network. The path selection in MANETs is relayed on considerable amount of intermediate notes to reach the destination. The exploration of impulsive mobile nodes can be considered as a process of complexity at meeting point of each node. Stable communication cannot be found with nodes that randomly meet, which in turn miss-leads to packet loss. Instead of relying on other resources the mobile nodes through wireless interfaces interact with each other [9]. In infrastructureless system of temporary communication MANETs are applicable easily to any type of environments for instance large wild event places, earthquake-stricken areas[10]. The nodes communicate with each other within the given cluster or nodes within the another cluster directly. Hence, in networking each node accomplish client and route functionalities simultaneously[11]. In designing the routing algorithm design will integrate with several other factors that effect the features of MANETs, e.g., node's trust, save energy, network topology dynamic changes. Considering the trust of node, the interaction of multi-hop nodes is relayed on the node's consistency of the route. Therefore, the existing node's trustworthiness is recognized significantly in the routing protocols. The added belief is that in MANET's conventional routing algorithms all nodes does well. The battery capacity of mobile node is limited in MANETs, which is going to affect the network survival as the connection of the node's links in the network may be worn out due to low battery. To enhance the span of life of the considered network and maintain the network connectivity the routing protocol has to balance the mobile node's energy consumption levels[12].

During routing, the flexibility of the nodes made it complex to identify the network topology utilized by nodes. Moreover, the volatile environment, the untrustworthy mobile nodes, and the wireless medium might cause different defects in MANETs.

Revised Manuscript Received on December 30, 2019.

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There are several suggestions on different strategies and protocols, as the “Internet Engineering Task Force and academic and industrial undertakings” are taking additional standardization efforts [24]. The conventional routing algorithm is categorized into three groups, such as proactive, hybrid, reactive routing on the basis route discovery time triggered [13] [25]. In proactive routing, every node communicates its route table occasionally for its neighbours to the extent that each node is having a global view of the network, for example PSR [14], and FSR [15]. Nodes create routes only on request in reactive routing such as AODV [23], and CAODV [16]. In general, hybrid routing separates the network into various regions, and then proactive routing is selected in the region and reactive routing between the regions, like ZRP [17], and HOPNET [13]. Excessive emphasis on routing trust leads to improve the control overhead and decrease the routing efficiency. At the same time overemphasis on routing efficiency refuses the additional features that might react to routing efficiency. Few existing methodologies are implemented to enhance the efficiency and routing trust i.e., cryptography and data hiding, location-aware and their combinations, trust value, and detection [18] [19] [20] [21] [22].

The major contributions of the paper are depicted as follows

- To frame an optimized A* algorithm using improved CSO algorithm termed as FPR-CSO for accomplishing the obstacle-ware MANET routing, in which the CE-OLSR performs the obstacle detection.
- To perform the FPR-CSO- A*-based MANET routing by concerning the constraints like node availability, distance of the path, and congestion of each node.

II. REVIEW

Although the performance of the MANET is high then the calculation has become a burden for broad-sized networks, still there are many disadvantages that need to be fulfilled in the future researches. ACO [1] [4] easily adapts to changes, ensures convergence, it is utilized in dynamic application, and positive response details for quick finding of solution. But, there are some disadvantages such as theoretical evaluation is complex, and time taken to convergence is not known. M-Lion WOA [2] has high performance, and it is efficient in resolving real time problems even with uncertain search spaces. Yet, restricts speed convergence. DSR [5] [7] is less expensive, it doesn't need symmetric links, routes are detected only when they are required, and it quickly responds to the network alterations. Although there are some defects such as route request packet will reach all the nodes present in the network, it is not measured to huge networks, and it requires more number of processing resources. MBRA [6] reduces the ACK overhead, and increases the PDR with less delay. However, it cancels out the complimentary situations. Fuzzy logic [8] handles problems with incomplete information, and it is simple and flexible. Yet, it requires real time response. Hence it is concluded that the future developments are to be effective and overcome the challenges mentioned above in a successive manner.

III. ROUTING STRATEGY IN MANET: NETWORK AND SYSTEM MODEL WITH PROPOSED ROUTING

The major theme of the routing protocol in ad hoc networks is to create an effective and exact path between the nodes and delivers the messages in time. As there is restricted number of resources in MANETs, the protocols adjust themselves according to the alterations happen in the network status i.e., network size, and traffic density, and the resources are utilized efficiently. The network involves a flat network infrastructure. Moreover, a shared medium is available in the network, which is extremely demandable for the radio communication. The computer, or node or any device in the architecture could be referred to a router, or the end host, in which the nodes are generally autonomous. The development of wireless communication in MANET could be accomplished for the nodes that are adequately near to the sender i.e., within the sender's transmission range, the message is received with more signal strength. At the time of whole communication delay, the sender and the receiver will move out or in the network by not concerning the transmission range of sender.

A. System Model

MANETs in general, consists of arbitrary and random movable platforms named nodes. The information pertains to the network is transmitted from one node to other through the cable network. The network architecture of MANET is shown in Fig. 1.

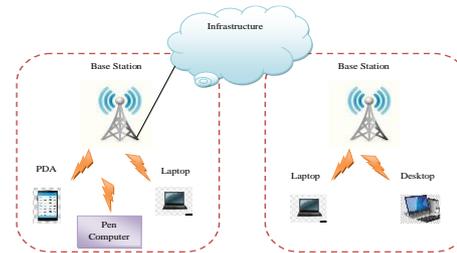


Fig. 1. General Architecture of MANET

B. Communication Model

MANET is a self-organizing structure, which consists of more wireless linked mobile devices. For the communication, each device can move in any direction, but should aware of the signal strength. Accordingly, the communication pattern of MANET is shown in Fig. 2. Here, the nodes that are present in the range of communication will communicate with each other, and the nodes that are far away from the communication range will follow the theory of multi-hop communication to communicate.

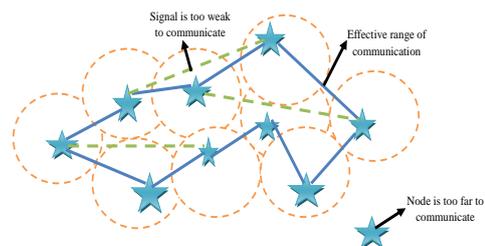


Fig. 2. Communication Pattern of MANET

One of the primary challenges in framing a MANET is enabling each device to incessantly sustain the data transmission without any traffic.

Since MANETs are a type of wireless ad hoc networks, it usually poses a routable networking environment on top of a Link Layer ad hoc network. Moreover, the routing strategy often suffers from some obstacles, which need to be focussed for the development of enhancement desires. Assume N_M number of mobile nodes is uniformly distributed in the network with area $MD \times ND$.

C. Proposed Obstacle Aware Routing in MANET

In the past years, many researchers had dedicated their precious time for improving the efficiency of MANETs routing algorithms. The main intend of this paper is to develop obstacle-aware routing protocol in MANET using optimized CSO-A* algorithm. The flow diagram of the proposed MANET routing is shown in Fig. 3.

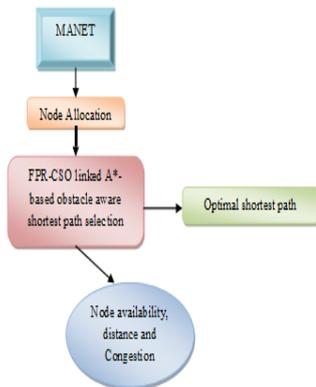


Fig. 3. Diagrammatic representation of proposed Secure MANET Routing

Initially, the number of nodes in the MANET should be allocated at specified places. Since the MANET make use of open air medium for communication, they happen to suffer from high sensitive issues when compared over the wired medium. CSO-A* algorithm, which is a well-performing path selection algorithm by concerning the obstacles. Even though this algorithm is optimally efficient to solve complex routing problems, its performance has to be still improved by taking into account few more constraints other than node availability and distance. Hence, in order to further improve the performance of shortest route path selection by CSO-A* algorithm, an improved meta-heuristic algorithm termed as FPR-CSO is deployed for optimally placing the obstacles in different locations for finding the optimal shortest path. Here, the improved shortest path selection is done in such a way that the total cost concerning the sum of the distance between the path and the congestion of each node in the network is minimized.

IV. INTEGRATION OF IMPROVED CHICKEN SWARM OPTIMIZATION ON OBSTACLE AWARE MANET ROUTING

A. Objective Model

Even though the A* algorithm finds the shortest path by concerning the obstacles, the improved meta-heuristic algorithms called FPR-CSO is proposed to improve the A* algorithm. As a modification, the barriers or obstacles in the grid constructed for performing the A* is optimally

placed at different locations. The obstacles are changed by both row-wise and column-wise. The main intention of the proposed FPR-CSO is to find the optimal location of the obstacles, in such a way that the new path with minimum distance and congestion is determined. Hence, the objective model of proposed FPR-CSO linked A* based optimal MANET routing is given in Eq. (4).x

$$Fitness = Min(F1 + F2) \tag{1}$$

In Eq. (1), $F1$ refers to the distance of the paths, and $F2$ refers to the congestion of each node in the path. The Euclidean distance between the starting point pe and ending point qe of the path with coordinates x and y is represented in Eq. (5).

$$F1 = \sqrt{(pe_x - qe_x)^2 + (pe_y - qe_y)^2} \tag{2}$$

Moreover, the congestion cost of MANET is defined as the interference of nodes during the concurrent data transmissions. It is based upon the number of nodes being served for communication. The congestion cost $F2$ is expressed in Eq. (6).

$$F2 = \begin{cases} CG_k^{over}; & \text{if } CG_k^{over} > 0 \\ 0; & \text{Otherwise} \end{cases} \tag{3}$$

$$CG_k^{over} = \sum_{\substack{ma=1 \\ na \neq 1}}^{M_{paths}} CG_k(ma, na) - CG_k^{lim} \tag{4}$$

$$CG_k(ma, na) = \begin{cases} 1; & \text{if } p_{ma,na} \in CG_k \\ 0; & \text{otherwise} \end{cases} \tag{8}$$

Here, $p_{ma,na}$ refers to the different path, CG indicates congestion, CG_k^{lim} indicates the congestion limit, and M_{paths} denotes the total number of paths.

B. Solution Encoding

For optimizing the position of obstacles in grid to improve the A* algorithm, FPR-CSO is used. The solution encoding for optimal placement of obstacles is shown in Fig. 5. Here, Ro_{min1} , Ro_{max1} , Co_{min1} , Co_{max1} , etc are the row and column elements of the grid, in which the obstacles have to be placed. The optimal location of the obstacles in the grid is decided by the proposed FPR-CSO algorithm, in which the maximum and bounding limit of the solution is (1,128), where 128 is the maximum number of nodes being considered.



Fig. 4. Solution Encoding for optimized A*-based obstacle aware MANET routing

C. Conventional Chicken Swarm Optimization

The behaviour of chicken swarm inspires CSO [26], which imitates the hierarchal order of chicken swarm. The chicken swarms are divided into numerous groups based on the behaviour.

Every group comprises of chicks CS , hens HS , and rooster RS . The separations of these are done based on the fitness values. The chickens with top fitness value is represented by RS and called as head rooster, whereas the worst fitness value is denoted as CS , and the rest is considered as hens. The hens choose the group on their own to stay in. In addition, the mother-child relationship among the hen and chick is defined at random, and the mother hens are denoted by MHS . The dominant and mother-child relationship is unchanged and the position of each is updated for several time steps st . Chickens follow the dominant rooster to strive for the food because they are prevented from taking their own food. Moreover, chicks follow mother hens to search for food. The head rooster has more advantageous in fight to get food.

In order to search for food, all the C chickens are denoted by the positions $Po_{c,d}^{st} (c \in [1, \dots, C], d \in [1, \dots, dms])$ at st time steps. The chickens who is having the best fitness values has the ability to search for food in broad regions than that of roosters with worst fitness values and the mathematical formula is shown in Eq. (9).

$$Po_{c,d}^{st+1} = Po_{c,d}^{st} * (1 + Rn(0, \sigma^2)) \quad (9)$$

$$\sigma^2 = \begin{cases} 1, & \text{if } fn_a \leq fn_b \\ \exp\left(\frac{(fn_a - fn_c)}{|fn_c| + \varepsilon}\right), & \text{Otherwise, } a \in [1, c], a \neq c \end{cases} \quad (10)$$

In Eq. (9), the Gaussian distribution with mean 0 and standard deviation with σ^2 is represented as $Rn(0, \sigma^2)$. The numerical equation for standard deviation is given in Eq. (10). The fitness value fn is the position of Po . For avoiding zero-division error, ε is employed that is the least constant, and a is the rooster's index. The more dominant hens are having more advantages than the worst ones to search for food and the corresponding equation is given in Eq. (11).

$$Po_{c,d}^{st+1} = Po_{c,d}^{st} + D1 * Rnd * (Po_{rs1,d}^{st} - Po_{c,d}^{st}) + D2 * Rnd * (Po_{rs2,d}^{st} - Po_{c,d}^{st}) \quad (11)$$

$$D1 = \exp\left(\frac{(fn_c - fn_{rs1})}{(abs(fn_c) + \varepsilon)}\right) \quad (12)$$

$$D2 = \exp(fn_{rs2} - fn_c) \quad (13)$$

From Eq. (11), $rs1$, and $rs2$ are the indices of the roosters belongs to c^{th} hens group and randomly selected from the swarm, respectively, in which $rs1 \neq rs2$. The random number is indicated by Rnd . Here, $fn_c > fn_{rs1}$ and $fn_c > fn_{rs2}$, thus $D2 < 1 < D1$. Here, $D1$ and $D2$ are represented in Eq. (12), and Eq. (13), respectively.

Moreover by moving around the mother, the chicks seek their food and the formulation is represented in Eq. (14).

$$Po_{c,d}^{st+1} = Po_{c,d}^{st} + FM * (Po_{mc,d}^{st} - Po_{c,d}^{st}) \quad (14)$$

In the above equation, the position of c^{th} chick's mother ($mc \in [1, C]$) is given by $Po_{mc,d}^{st}$. The chick follows the mother to search for food is given by the parameter

$FM (FM \in (0,2))$. On considering each difference, FM of each chick is chosen at random from $[0, 2]$. The pseudo code of existing CSO is given in Algorithm 1.

Algorithm 1: Pseudo code of existing CSO Algorithm [26]

```

The chickens population is initialized as C
The fitness values of C chickens is evaluated, st is
initialized to 0
while (st < Max_Gen)
    if (st%TS == 0)
        Fitness values of chickens is ranked and generate a
        hierarchal order in swarm
        Split the swarm into various clusters, and identify the
        relationship between chicks and mother hens present
        in the group.
    end if
    for c = 1: C
        if C == RS
            Update its location by Eq. (9)
        end if
        if c == HS
            Update its solution using Eq. (11)
        end if
        if c == CS
            Update its solution by Eq. (14)
        end if
        Validate the new solution
        If the new solution is best than the earlier one, update
        it
    end for
end while
    
```

D. Proposed FPR-CSO Algorithm

The conventional CSO strategy has strong ability of local development, and gain optimum outcomes in terms of both robustness and accuracy. Since CSO attains the ability to inherit many other heuristic algorithms, it is having the high performance. In addition, the diverse movements of chickens are adaptable for the algorithm to hit the superior balance among the determinacy and randomness for attaining the optima. Even though it is having the best performance, sometimes the global ability is weak that results in falling in local optimum, which is also due to the unfair characteristics of the conventional CSO. In the conventional CSO, the rooster, chick, and hen update were decided by the fitness values. To further improvise the performance of conventional CSO, the proposed FPR-CSO updates the solution based on the fitness ratio and position ratio.

Let fn_i and fn^{best} are the fitness of the current solution, and best fitness values, respectively. Moreover, Po_i and Po^{best} are the current solution and best solution, respectively. Two parameters like fitness ratio and position ratio is determined using Eq. (15), and Eq. (16), respectively.

$$FR = \frac{fn_c - fn^{best}}{\frac{1}{C} \sum_{c=1}^C fn_c} \quad (15)$$

$$PR = \frac{Po_c - Po^{best}}{\frac{1}{C} \sum_{c=1}^C Po_c} \quad (16)$$

The updating procedure of proposed FPR-CSO is depicted in Algorithm 2.

Algorithm 2: Pseudo code of proposed CSO Algorithm
 The chickens population is initialized as C
 The fitness values of C chickens is evaluated, st is initialized to 0
while ($st < Max_Gen$)
 if ($st \% TS == 0$)
 Fitness values of chickens is ranked and generate a hierarchal order in swarm
 Split the swarm into various clusters, and identify the relationship between chicks and mother hens present in the group.
 end if
 for $c = 1 : C$
 Determine fitness ratio FR using Eq. (15)
 Determine position ratio PR using Eq. (16)
 if $FR < 0.5$
 $FR = 0$
 Else if
 $FR = 1$
 End if
 if $PR < 0.5$
 $PR = 0$
 Else if
 $PR = 1$
 end if
 if $FR = 0$ **and** $PR = 0$
 Update its solution using roster by Eq. (9)
 Else if $FR = 1$ **and** $PR = 0$
 Update its solution using hen by Eq. (11)
 Else if $FR = 0$ **and** $PR = 1$
 Update its solution using hen by Eq. (14)
 Else if $FR = 1$ **and** $PR = 1$
 Uniform random elements between lower bound and upper bound of solution
 end if
 Validate the new solution
 If the new solution is best than the earlier one, update it
 end for
end while

V. RESULTS AND DISCUSSIONS

A. Experimental Setup

The obstacle-aware MANET routing as implemented in MATLAB 2018a, and the performance analysis was carried out. Here, the MANET routing was accomplished after the detection and prevention of two major attacks like blackhole attack and wormhole attacks. The proposed model was implemented in a MANET network of area 500×500m, and

the total number of nodes assigned was 128×128. The performance of optimal obstacle-aware shortest path routing by proposed FPR-CSO-based A* algorithm was compared over the existing AODV, and A*, and CSO [26] models. Finally, the effectiveness of the proposed model was confirmed through the comparative analysis, and performance analysis in terms of few metrics like path length or distance of path, congestion cost, delay, packet loss, and throughput.

B. Performance Measures

The following are the measures considered for experiment.

(a) **Path Length:** The equation for path length is given in Eq. (5).

(b) **Congestion cost:** The mathematical formula for congestion cost is shown in Eq. (6).

(c) **Delay:** “The average time it takes a data packet to reach the destination”. The numerical equation for delay is denoted in Eq. (17), where ST indicates the sum of the time spent for delivering the packets to each destination node, and NP indicates the count of packets received by all the destination nodes.

$$Delay = \frac{ST}{NP} \quad (17)$$

(d) **Packet loss:** “It is defined as the ratio of number packets received by the destination to the number of packets originated by the source”. The numerical equation for packet loss is given in Eq. (18).

$$Packetloss = \left(1 - \frac{Packetreceived}{Packetsent}\right) * 100 \quad (18)$$

(e) **Throughput:** “The average network throughput refers to the amount of the data packets in seconds that are transmitted over a communication channel to the final destination node successfully.” The equation of throughput is given in Eq. (19).

$$Throughput = \frac{Numberof\ packetsdelivered * size\ of\ the\ packet * 8}{Total\ duration\ of\ simulation} \quad (19)$$

C. Convergence Analysis

The convergence analysis of the proposed and the existing MANET routing models are shown in Fig. 6. In Fig. 6 (a), the number of nodes considered is 78. The cost function of the proposed FPR-CSO is minimum from 1st iteration to 100th iteration. In the cost function at 100th iteration, the proposed FPR-CSO is 4.2%. Moreover, the number of nodes considered in Fig. 6 (b) is 108. Initially, the suggested FPR-CSO is having somewhat more cost function, and later, on increasing the number of iterations, the cost function of the developed model is minimized. At 1st iteration, CSO having less cost, FPR-CSO. On the degree of improvement, the proposed FPR-CSO is 0.6% superior to CSO, 3.3%. In Fig. 6 (c), the cost function of the proposed and the conventional models with respect to different iterations are depicted. The number of nodes considered for experiment is 128.

At 1st iteration, the proposed algorithm is having the minimum cost function. On increasing the number of iterations, the cost function of the suggested FPR-CSO model is minimum. On the basis of enhancement, the improved FPR-CSO is 1.9% improved than CSO. Similarly, Fig. 6 (d) shows the cost function of the proposed and the existing approaches based on iterations and the nodes considered in this graph is 158. At 1st iteration, FPR-CSO is exhibiting the minimum cost function. Later, the proposed FPR-CSO, CSO are exhibiting the minimum cost function. At 50th iteration, the proposed FPR-CSO is performing best and producing minimum cost function. Finally, it has been concluded that the proposed FPR-CSO model is exhibiting minimum cost function over conventional models.

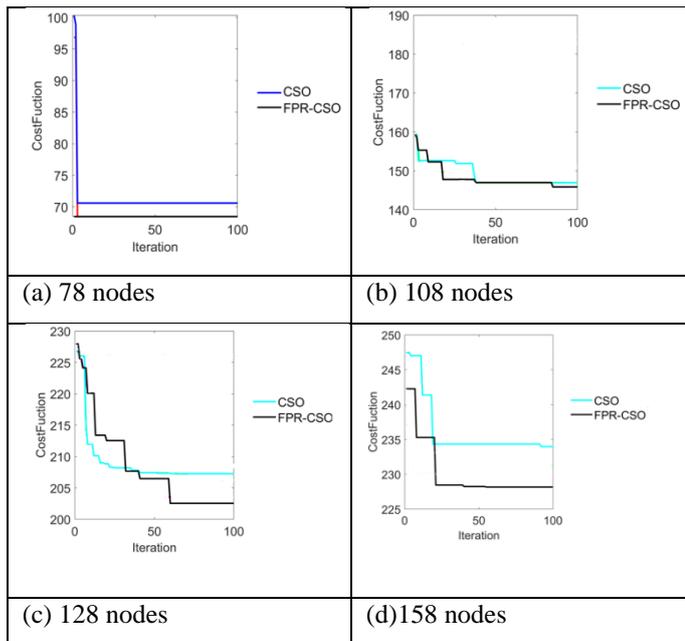


Fig. 5. Convergence analysis of proposed and the existing heuristics-based A* algorithm for MANET routing

D. Obstacle Detection by CE-OLSR

In order to obtain shortest path, the obstacles need to be detected at first. The detection of obstacles is done using CE-OLSR. The graphical representation of the obstacle detection in MANET with varied number of nodes is shown in Fig. 7. Here, Fig. 7 (a) is considered with 78 numbers of nodes, Fig. 7 (b) with 108 nodes, followed by 128 in Fig. 7 (c), and finally, the number of nodes considered in Fig. 7 (d) is 158. Thus, for different number of nodes, obstacles are detected effectively by CE-OLSR

E. Experimental Results of Shortest Path Selection

The shortest path selection for MANET routing by proposed FPR-CSO-based A* over other AODV, existing A*, and other heuristic-based A* algorithm is shown in Fig. 8. This diagrammatic representation shows the shortest path by overcoming the obstacles using different methods.

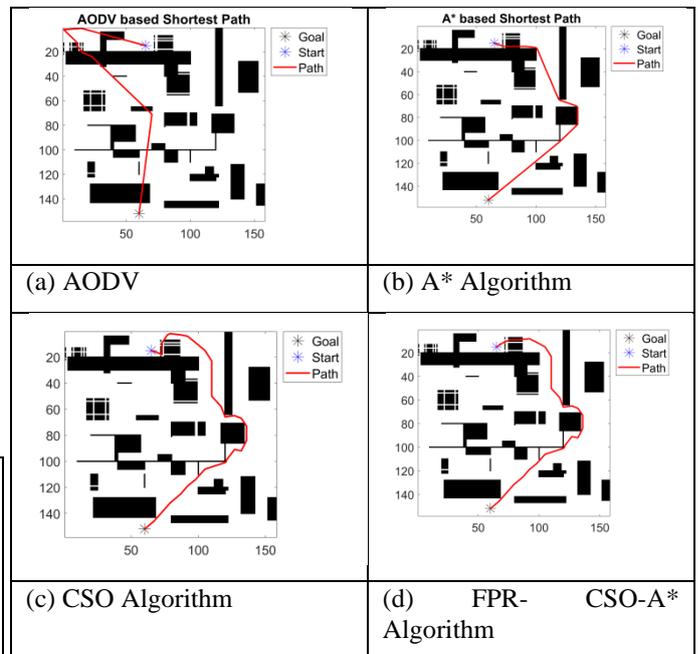


Fig.6. Experimental Results of shortest path selection for MANET Routing

F. Performance Analysis

The performance analysis of the developed FPR-CSO – based A* algorithm over the conventional algorithms for MANET routing is tabulated in Table II for nodes 78. From Table II, the throughput of the proposed FPR-CSO-A* is 22.28% better than A*, 63.4% better than AODV. Moreover, the cost function of the developed FPR-CSO is 18.4% improved than A*, and 78.3% improved than AODV. Moreover, when considering the number of nodes as 108, the performance of the proposed and the existing models are given in Table III, where the cost function of the suggested FPR-CSO is 65% enhanced than AODV, 15.1% enhanced than A*, 1.1% enhanced than CSO. Therefore, the above results have shown that the proposed model is outperforming in determining the optimal shortest path. In Table IV, the performance of the suggested model is described and the nodes considered here are 128. In addition, the throughput of the improved FPR-CSO-A* is 48.1% superior to AODV, 83.9% superior to A* and 25.9% superior to CSO. Similarly, the total cost function of the proposed FPR-CSO is 4.8% improved than AODV, 2.4% improved than A* and 53% improved than CSO. Table V describes the performance of the modified and the traditional algorithms when the number of nodes is considered as 158. Thus, the total cost function of the proposed FPR-CSO-A* is 46.1% better than AODV, 7.7% better than A* and 4.6% better than CSO. Thus, from the above results, it has been proven that the proposed algorithm is superior to the conventional algorithms in determining the optimal shortest path.

TABLE I. PERFORMANCE ANALYSIS OF PROPOSED AND CONVENTIONAL OBSTACLE-AWARE MANET ROUTING FOR 78 NODES

Measures	AODV	A*	CSO-A*	FPR-CSO-A*
Path Length	176.29	67.52	68.063	68.063
Congestion Cost	15.882	25.638	8.1075	8.1075
Penalty for Node Availability	160	0	0	0
Delay	0.71	0.35	0.38	0.38
Packet Loss	0.1	0.34	0.02	0.02
Throughput	126.76	94.286	257.89	257.89
Total Cost	352.99	93.859	76.575	76.575

TABLE IV. PERFORMANCE ANALYSIS OF PROPOSED AND CONVENTIONAL OBSTACLE-AWARE MANET ROUTING FOR 158 NODES

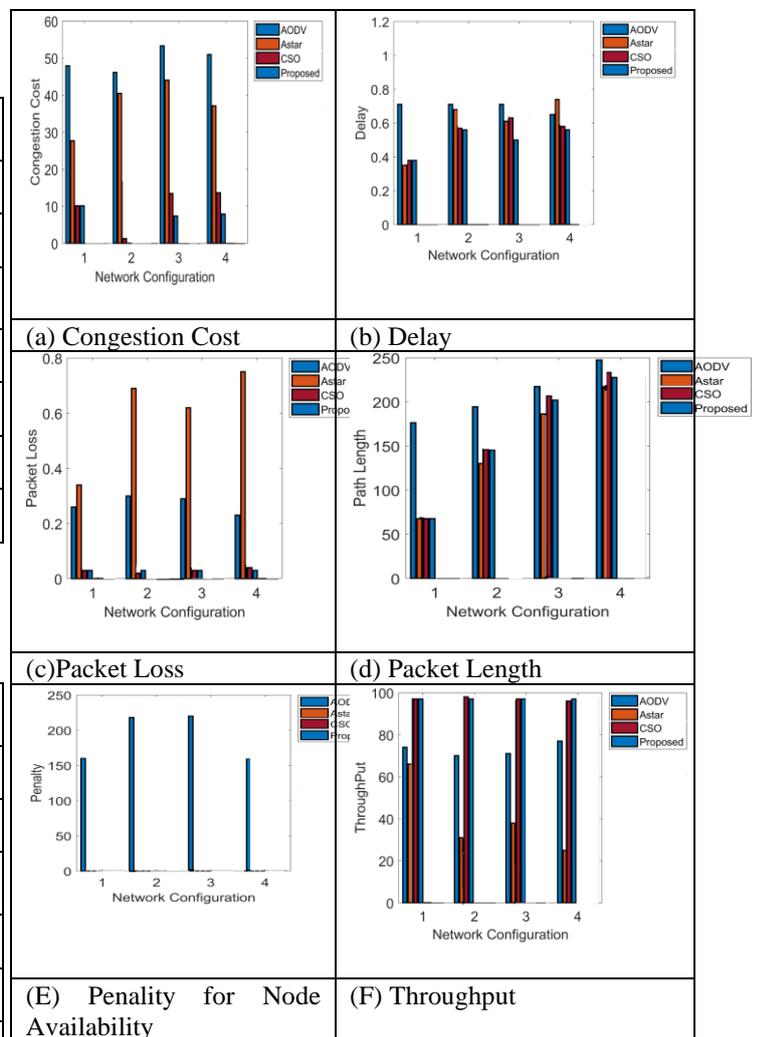
Measures	AODV	A*	CSO-A*	FPR-CSO-A*
Path Length	247.45	217.22	233.38	227.59
Congestion Cost	16.943	37.1	13.642	7.8996
Penalty for Node Availability	170	0	0	0
Delay	0.65	0.74	0.58	0.56
Packet Loss	0.06	0.75	0.04	0.03
Throughput	144.62	16.892	165.52	173.21
Total Cost	435.11	255.87	247.65	236.09

TABLE II. PERFORMANCE ANALYSIS OF PROPOSED AND CONVENTIONAL OBSTACLE-AWARE MANET ROUTING FOR 108 NODES

Measures	AODV	A*	CSO-A*	FPR-CSO-A*
Path Length	194.29	130.03	145.73	145.25
Congestion Cost	2.1272	40.416	1.2343	0
Penalty for Node Availability	220	0	0	0
Delay	0.71	0.68	0.57	0.56
Packet Loss	0.08	0.69	0.02	0.03
Throughput	129.58	22.794	171.93	173.21
Total Cost	417.22	171.86	147.57	145.85

TABLE III. PERFORMANCE ANALYSIS OF PROPOSED AND CONVENTIONAL OBSTACLE-AWARE MANET ROUTING FOR 128 NODES

Measures	AODV	A*	CSO-A*	FPR-CSO-A*
Path Length	217.36	186.39	206.61	202.01
Congestion Cost	9.269	44.007	13.445	7.367
Penalty for Node Availability	220	0	0	0
Delay	0.71	0.61	0.63	0.5
Packet Loss	0.07	0.62	0.03	0.03
Throughput	130.99	31.148	153.97	194
Total Cost	447.41	231.66	220.72	209.91



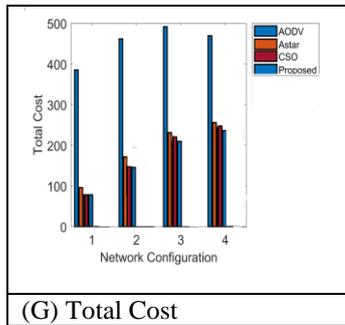


Fig. 7. Graph Representation of comparative results with proposed and other routing algorithms(AODV, Astar,CSO) based on the tabular results depicted above.

VI. CONCLUSION

This paper has proposed an approach by implementing a MANET routing with the help of optimized A* algorithm. The routing issue in MANET was resolved using A* algorithm, which was utilized for determining the path and graph traversal. Moreover, the algorithm effectively plotted a walk able path among several nodes on the graph; as a result it provided a shortest path without any obstacles. In this, the obstacles were defined by CE-OLSR method that determines the obstacles data, filtering, concave hull construction, and pruning. The next phase concentrated on determining the optimal shortest path using optimized A* algorithm. In order to enhance the A* algorithm, the improved meta-heuristic algorithm named FPR-CSO was utilized. From the experimental results, the total cost function of the proposed FPR-CSO-A* was 4.8% improved than AODV, 2.4% improved than A*, 53% improved than CSO-A*. Thus, all the protocols meanwhile show different performance with improvement in proposed model.

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