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Secure Multiverse Optimization based Dynamic Routing Approach for Intelligent Transportation System in Smart Cities

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Abstract: VANETs, a subset of Ad Hoc Networks, have become an exciting new research area. Improving road safety and reducing accident rates are two primary objectives. Deliveries of messages may be susceptible to modest delays and overhead due to the absence of a centralized governing authority, the mobility and topological changeability of the network's nodes, and the complexity of the routing mechanism. Due to the complexity of the routing process and the urgency with which data packets must be sent due to the dynamic nature of the network, it takes a considerable amount of time to complete. Although there are several well-established routing protocols in use in VANETs, these protocols are not always a suitable solution to routing issues. Significant impacts of routing may be seen in DTR, PDR, PD Ratio, APD, and throughput. Previous research suggests a Hybrid dynamic and optimized routing approach (HDORA) employing the DTR, PDR, and PD Ratio to address these issues and improve IP performance in VANETs. The proposed study takes a hybrid optimization strategy to the introduction of a better model. With a series of head-to-head contrasts, we show how ACO, DORA, HDORA, and MHDORA do against one another. Smart city transportation requires sophisticated methods for categorizing and directing traffic. This model integrates techniques for categorization of data for security and optimization to determine the optimal path, which will be crucial for transit in smart cities.

Keywords: *packet delivery ratio (PDR), Data transmission rate (DTR), packet drop ratio (PDR), throughput, MVO, Dynamic hybrid optimization routing algorithm*

1. Introduction

1.1. VANET

A VANET is required for vehicles to share data and increase their collective intelligence [1]. This network is comprised of V2V and V2I designs, with V2V guaranteeing that vehicles can communicate with one another and V2I allowing for the sharing of data between vehicles and infrastructure [2]. As a kind of dynamic topology, a VANET may act as a stand-in for a traditional, disconnected network. Each network node only has so much output, but there is a limitless supply of battery power. Prioritizing transportation safety, this network enables the development of many apps that may be used to lower the severity of accidents, expand road capacity, and mitigate the effects of excessive traffic [3]. The phrase "data explosion" describes the dramatic increase in data volume over the last few decades.[4]. This occurs due to the high volume and demand on the network. Problems with technology, such as latency in sending messages, high rates of packet loss, low throughput, and high communication costs, are a direct outcome of the broad use of wireless networks. VANETs are a special case within the wider category of MANETs. The rapid movement of vehicles & associated dynamic topology changes provide VANETS an edge over MANETs. [5].

All of these junctions are managed by the default road system. Limits on transfer rates, congestion thresholds, and traffic control mechanisms like stoplights and directing arrows are just a few of the methods by which VANETs regulate the speeds of individual nodes. Once full power is restored, these nodes may be used for long-distance data transmission and storage [6]. Since these systems can store and utilise more energy, they make previously impossible activities possible, and even enjoyable.When determining how to route data throughout the network, certain vehicle characteristics play a crucial role. Several existing approaches fail to find the optimal routes to travel because of the lack of connection between VANETs. The impact on packet transfer between mobile nodes is inevitable. There's a chance that the local optimum will form now [7]. As a result of the overwhelming number of users, mobility nodes are unable to identify their nearest neighbors. When this happens, the nodes will hold onto the packets in a queue for a long period. Once data packets have waited in buffer for too long, the active route is disabled. As a result, network latency and packet delivery rates may suffer.This might have an effect on the overall delay and packet delivery success rate. To this end, we investigated whether a dynamic and optimal routing technique (DORA) might

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be used to remedy these issues [8]. DORA not only suggests a smart packet delivery system based on DTR, PDR, PDRatio, and throughput, but it also provides the best routing approach based on a large number of streets. Figure 1 depicts a Vehicle Ad Hoc Network (VANET) [9].

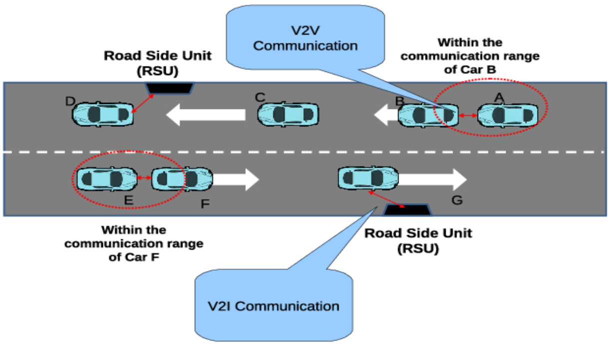

Fig. 1. Vehicle Ad Hoc Network (VANET) **[22]**

1.2. MVO Optimization

MVO is a meta-heuristics algorithm that uses notions from the multi-verse theory to guide its population-based approach to problem solving. From its designation, we may infer that Seyedali Mirjalili of 2015 fame was the first to propose the method in question. The MVO algorithm takes its cues from real-world phenomena including black holes, white holes, and wormholes, which form the basis of the multi-verse theory[10].

The primary focus of portfolio theory is to find the best distribution of capital across various asset classes. Mean variance optimization (MVO) is a mathematical technique for making this allocation while taking into account the risk/reward relationship. To optimize projected return within a certain tolerance for risk, traditional single period MVO has you allocate your portfolio for a single future period. Markowitz pioneered single-period MVO in his ground-breaking research. Portfolio rebalancing solutions where the allocation is reset to a predetermined value at the conclusion of each period are relevant to multi-period MVO. [11]. Sometimes referred to as "Constant Proportion" (CP) or "Constant Ratio Asset Allocation," this approach maintains a fixed percentage of assets in each portfolio (CRAAL). For a given tolerance for risk, we want to optimize for the genuine multi-period (geometric mean) return. The research paper Rebalancing, Diversification, & Geometric Mean Frontier by William J. Bernstein & David Wilkinson is the primary source for the discussion of multi-period MVO. [12].

1.3. Role of Routing in VANET

Designing effective VANET routing protocols is made more challenging by the networks' highly dynamic architecture [13]. Topology-based and position-based routing protocols, respectively, can be broken down into their own subcategories, the most well-known of which are DSR, UMB, OSPF,TORA, and AODV [14].

Packets of data travelling through a VANET are routed depending on the network topology, which is determined by the linkages between nodes [15]. Two distinct strategies use this mechanism: the proactive strategy, which is similar to table-driven methodologies, & reactive strategy, which is similar to on-demand methodologies[16].

Shortest path algorithms are often used in proactive routing systems. The primary technique in these routing protocols is the use of preconfigured tables to store information about the linked nodes [17]. Additionally, the data is shared with the complementary nodes. When anything happens that alters the network topology, each node revises its routing table accordingly [18].

Algorithms associated with on-demand operations are often used by reactive routing systems [19]. One of the key advantages of route discovery is the decrease of network traffic that occurs when two nodes commence communication [20].

Algorithms associated with the positioning mechanism used by location-based apps are crucial to the operation of geographically based routing protocols [21]. These path-finding apps provide the necessary information. In addition, these protocols do not maintain join status tables or routing data tables for neighboring nodes.

1.4. Security integration in VANET using machine learning

Machine learning could enhance the security of proposed hybrid routing approach by providing trained network that would be capable to classify the packet on the bases of their type, sender details and protocol used for transmission. Machine learning model is capable to classify data on the bases of previous experience. In order to integrate security the treats need to filter out. Thus incoming packets are filtered considering previous attacks.

1.5. Paper organization

Section 1 is presenting the introduction part in which VANET and MVO optimization is considered. This expressed the role of routing in VANET. Section 2 is surveying the literature review of existing researches. Section 3 is considering the proposed work of this research. this is presenting the MVO equation used in proposped algorithm and expressed the process flow of VANET routing. Section 4 is focusing on work flow on security through VANET. Section is presenting the secure MVO based hybrid dynamic and optimized routing approach (MHDORA) along with proposed algorithm. Section 6 is implimenting the simulation of parameters used in proposed work. Section 7 is evaluating the result by comparing multi routing protocols. Section 8 is explaining the performance parameters of MHDORA shown with the comparison among the ACO, IDBACOR and HDORA. The security simulation has been provided to assure the reliability of system. At last, Section 9 is presenting the conclusion of research.

2. Literature Survey

Various position-based routing techniques were given by Neha Goel et al. (2016). The target audience for this survey is anybody interested in learning about successful position-based routing methods and the parameters by which they operate. [1]

In a 2016 paper, Sandeep Kumar Arora et al. described in depth the different routing protocols used to distribute data between moving vehicles. In this study, they present a comprehensive classification of routing methods according to their strengths, weaknesses, and potential uses. Intelligent Transportation System was developed after exhaustively comparing available routing methods. [2]

Clustering-based routing algorithms for vehicle networks that are sensitive to soft computing were analysed in depth by Manoj Sindhwani et al. (2022). A number of different types of soft computing, including PPSO, k-means, NN, artificial bee colonies, genetic algorithms, firefly algorithms, and FL, are employed to complete the categorization. The survey also includes a comparison study that examines the goals, benefits, and weaknesses of various soft computing initiatives. To improve metrics like packet delivery ratio, throughput, end-to-end latency, cluster longevity, and message overhead in automotive networks, researchers should use this study as a guide. [3]

Two primary factors were specified by Debnath et al. (2021) to establish the transport vehicle. Our work has resulted in the first parameter, which we have labelled "Channel quality factor (CQF)". Along with CQF, the current approach also makes use of the parameter "Communication expiry time" to identify the forwarding vehicle. The first is a kind of forward vehicle selection using fuzzy logic in traffic. The second is to determine the most efficient path to take when sending a signal to an automobile at a crossroads. Results from simulations show that our proposed method outperforms popular protocols under a broad variety of traffic and population densities. [4]

With the RWCP's settings as input, Joshua et al. (2019) solved a multi-objective problem to increase the cluster's lifetime, packet delivery ratio, and overhead. Evolving Multi-Objective Firefly Algorithm is used to find optimal values for the RWCP parameters (MOFA). TETCOS' NetSim simulator and MOEA's optimization framework were used to run the simulations. The results are analysed using the same evolutionary optimization techniques. On top of that, we used OpenStreetMaps' real maps to compare our experimental results with those of two other multi-objective optimization techniques, MOPSO and CL-PSO. [5]

Singh et al. (2022) proposed a method to speed up communication in VANET. We use a hybrid of GA features and the Firefly algorithm to optimise routes across both sparse and dense VANETs. Extensive comparisons show that new HGFA algorithm outperforms Firefly and PSO methods by 0.77 percentage points in dense network settings & by 0.55 percentage points in sparse network conditions, respectively.[6]

The city's infrastructure may benefit from EHTAR, a routing system designed by Lo et al. [7] for use with VANET. The network's active nodes are stationed at major crossroads to keep a constant eye on traffic along all of the roads in the system. A Junction-Tracker is the name given to this instrument. To that end, nodes will be encouraged to share data and open up to one another in an effort to facilitate better communication. An original solution presented by Gazori et al. [8] uses traffic signals as bridges to steer moving traffic instead of idling vehicles. During the route selection process, network reliability will be ensured in this way. It is the major goal of this protocol to ease the process of sending data packets across bridge nodes. A path with the fewest number of intermediate stops and the best possible throughput is selected. Wang et al. [9] were the first to introduce the NDN routing protocol. The distance parameter is used to identify and correct hop-count issues in this cutting-edge routing system.

The cosine-similarity-based protocol and the selective broadcast routing protocol were combined in Nahar et al[10] .'s work. The optimal path for delivering data is determined through clustering in this protocol. The proposed technique often decreases latency by 25% while increasing PDF by 5- 10%.

The innovative VANET was suggested by Brendha et al., [11] to increase road safety and reduce accident rates. The difficulty in resolving routing due to the nodes' high mobility has far-reaching implications for the network's design in terms of the maximum possible throughput for data packets. Many common methods used today for fixing routing issues are discussed in this article, and all of them have failed so far.

The role of routing protocols in VANETs was explored by Nazib et al. [12]. Based on the functionality of their programme and the originality of their ideas, they may be classified into one of seven categories. The author also addresses a few potential drawbacks. Using a network-dependent approach, Qin et al. [13] analyse a variety of routing methods for VANETs and create a novel routing protocol to affect vehicle density and traffic signals. It's possible that tracking just unicast packets will provide the optimal performance. ProMRP is a novel protocol developed by Cardenas et al. [14] specifically for use in VANETs. One of the primary goals of ProMRP is to maximise the likelihood that a neighbour will pick up the packet and successfully forward it on to the destination. Distance to the target, node location, node bandwidth, node density, etc. were the four primary metrics being calculated here. Hence, the author proposed a new approach known as EProMRP. These improved results are indicative of the potential gains from using packet delivery.

Routing algorithms based on RL have been developed by Nazib et al. [15] to enhance QoS parameters in VANETs. Examples of QoS characteristics include bandwidth, latency, throughput, control overhead, and PDR. When compared to the previous method, the new one proved to be much more efficient. An intelligent transportation system that prioritises road safety and precise vehicle movements in reaction to route alterations was suggested by Khan [16] and would combine existing MANETS, VANETS, and other wireless networks. As a result, output improved. In [17], Zhenchang Xia et al. reflected on how to better VANET protocols. Multiple difficulties must be overcome. As part of their VANET research, R. Hussain et al. [18] looked at role that trust plays in this environment. Author took precautions to protect confidentiality of any information that was sent. H. Fatemidokht et al. [19] analysed UAV issues & proposed solutions. The suggested technique generally outperformed its rivals when applied to a variety of tasks. VANETS' first successful technique was proposed by N. B. Gayathri et al. [20]. The primary impetus for the technique was the implementation of the pair-free platform, which improves transmission and computation efficiency. This method not only facilitates the examination of batches more efficiently, but it also reduces the complexity of computing jobs in VANETs. Satyanarayana Raju et al. [21] proposed a dynamic and optimal routing strategy for vehicular ad hoc networks. (DORA). The study's principal objectives were to increase road safety and decrease accident rates. Minimal overhead and delay in message delivery may be attributed to the network's absence of central coordination, its mobile nodes, and its dynamic topology, all of which make routing a challenging operation.

3. Proposed Work

The transportation infrastructure of smart cities requires more sophisticated classification and routing algorithms. This model incorporates mechanisms for route classification and optimization to determine the best possible path, which will be crucial for the transportation of smart cities. Accuracy in Vanet is being considered in recent research. These techniques have been used to classify nodes as secure or insecure. It is planned to include MVO optimization into existing work.

3.1. Multi-verse optimizer equation

The MVO algorithm is conceptually related to white holes, black holes, & wormholes. Mathematical models are constructed to assess exploitation, exploration, and local search using these three concepts. It's believed that the white hole is the primary factor in universe formation. As a result of their immense gravitational pull, black holes consume everything in their path. Wormholes function like shortcuts across time and space that allow items to swiftly traverse throughout the cosmos. Key applications of MVO in universes:

1. If inflation rates are high enough, white holes could exist.
2. Second, the likelihood of a black hole being there decreases as inflation rates increase.
3. Third, in universes with a higher inflation rate, matter is ejected via white holes at a faster pace.
4. For four, black holes in universes with a lower inflation rate may take in a greater variety of materials.

At every given inflation rate, the materials and things of each universe have the opportunity to randomly migrate via wormholes to the universe with the best survival rate. The items are relocated from an inflation-rate universe to one with a lower inflation rate. With enough repetitions, it might guarantee an increase in the overall average inflation rate of all conceivable cosmologies. Each time through, a white hole in the shape of a roulette wheel is used to randomly select a universe from a list sorted by inflation rate. The following are the stages taken throughout the procedure. Let's act as if

$$U = \begin{bmatrix} X_1^1 & X_1^2 & . & X_1^d \\ X_2^1 & X_2^2 & . & X_2^d \\ . & . & . & . \\ . & . & . & . \\ X_n^1 & X_n^2 & . & X_n^d \end{bmatrix} \text{.......................................} (4)$$

the number of variables is shown in equation (d). Number of possible answers, represented by n:

$$X_i^j = \begin{cases} X_k^j; & r1 < NI\,(Ui) \\ X_i^j; & r1 \geq NI\,(Ui) \end{cases} \text{.....................................} (5)$$

When NI (Ui) is used to represent the normalised inflation rate of Universe I, where X (i)(j) is the j variable of Universe I, we get I r1 is a random integer between 0 and 1, and X _(k)(j) shows a randomly selected variable from universe k.

Allow the universe to factor in wormhole channels, along with the greatest universe ever built, for more possibilities and a greater shot at boosting the inflation rate via wormholes. A technique like follows has been developed:

$$X_i^j = \begin{cases} \begin{cases} X_j + TDR * \left(\left(ub_j - lb_j \right) * r4 + lb_j \right); & r3 < 0.5 \\ X_j + TDR * \left(\left(ub_j - lb_j \right) * r4 + lb_j \right); & r3 \geq 0.5 \end{cases} & ;\mathrm{r2} < WEP \\ X_i^j; r2 \geq WEP \end{cases} \text{......} (6)$$

Where X j represents the jth variable of the best universe ever created, lbj represents the jth parameter's minimum value, ubj represents the jth parameter's maximum value, , $\mathrm{X}_\mathrm{i}^\mathrm{j}$ represents the jth parameter of the ith universe, and r2, r3, and r4 are uniformly distributed random numbers between 0 and 1.

Based on this formulation, we can infer that WEP and TDR are two of the most important coefficients. For those interested, the formula for determining these coefficients is as follows:

$$WEP = min + l * \left(\frac{max - min}{L} \right) \text{..} (7)$$

Where l indicates the current run and L the maximum number of runs/iterations.

$$TDR = 1 - \frac{l^{1/P}}{L^{1/P}} \text{..} (8)$$

In where p represents the robustness of the exploiting iteration. Exploitation speed and precision both increase with p. The complexity of MVO algorithms is a function of several factors, including the number of iterations, the number of universes, the roulette wheel mechanism, and the method for organising the universes. In order to better understand the extent of the computational complexity, we will divide it down as follows:

$$O\,(MVO) = O(1(O\,(Quicksort) + n * d * (O\,(roulette_{wheel})))) \text{...................................} (9)$$

$$O\,(MVO) = O\,(1\,(n^2 + n * d * \log n)) \text{.....................} (10)$$

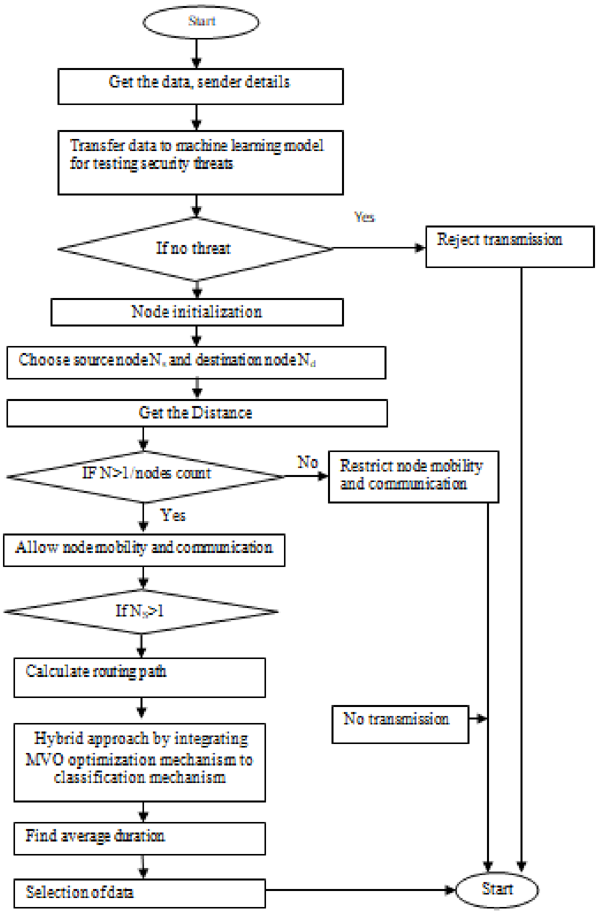

Fig. 2. Process Flow of VANET Routing

The following expression is obtained by using the values n for the total number of universes, l for the maximum number of runs/iterations, and d for the total number of substances. A total of 200 nodes are considered in the simulation, 100 of which are trusted and 100 of which are not. The Dynamic and Optimized Routing Approach is currently being studied by academics. Once the price of sending request messages from node to node has been calculated, the model's reliability may be guaranteed by integrating security measures. Results are compared at last. Identifying the optimal location to send data packets is difficult in a desert or other communication environments when DSRC is unavailable due to the nodes' erratic movement.

Through the provision of a trained network that is able to categorize the packet on the basis of its kind, sender characteristics, and transmission protocol, machine learning has the potential to improve the security of the suggested hybrid routing strategy. A machine learning model may make predictions about new data based on its understanding of similar data from the past. The goodies must be filtered out before security can be properly integrated. Therefore, incoming packets are screened taking into account prior assaults.

Monitoring and updating a routing database in real-time is inefficient, and it may be too resource-intensive to find the best route for each packet before delivering it. This necessitates one-of-a-kind strategies for routing. Using just node locations as a routing metric is one approach that might work for VANETs in the desert. Since RSUs, crossroads, and other infrastructure are not always present in the desert, using location-based protocols might be problematic. Our study presents a suite of routing protocols optimized for usage in VANET groups (CBVRP).

4. Workflow On Security Through VANET

Numerous attacks may be performed against the network. A threat might originate from inside the system or from outside it. An insider attacker might cause network congestion by sending out false information and severing legitimate connections. Users' information has been encrypted and kept secret using cryptographic methods for their safety. In a denial-of-service attack, a remote adversary exploits a system by sending bogus messages signed with forged signatures utilising the victim system's network or other resources. This assault is limiting VANET's capacity to provide services to real vehicles. Network congestion is the main purpose of this attack, which involves sending a false message to TSU and then having it sent to the victim car. During a black hole attack, malicious nodes attempt to persuade their target node that they have the best route by sharing route information with it. This is done to specify the path over which the data should be sent. During this kind of attack, the rogue node's main tactic is to ignore or mishandle the packets that it has blocked. Because of this assault, the planet now contains a sizable quantity of hostile cars that are categorically against the concept of receiving communications from trustworthy automobiles. The Wormhole assault enabled uninterrupted data transport from origin to destination by using destructive vehicles. One hostile vehicle used a wormhole to rapidly transmit data to another malicious vehicle at another place (tunnel). This exploit demonstrates how such data packets may be used to undermine network security by masking the usage of legitimate channels. Here we see an attack in action. In this assault, two hostile vehicles are dispatched down the tunnel to steal sensitive data. Sinkhole attacks include malevolent vehicles broadcasting signals that distribute erroneous routing information across the network. This increases the likelihood that more data will be routed via routing.ly. This attack illustrates the far-reaching effects that tampering with or erasing data packets may have on a network. An authorised vehicle's provision of bogus routing information to a hostile vehicle will result in the latter wiping its memory clean of whatever data packets it may have received. Attackers using Sybil techniques may cause damage to other cars in a VANET by creating a large number of phoney signatures and inserting them into the network. Due to the large number of cars involved, this attack will have a substantial effect on the VANET network via the dissemination of misleading information. Forging the positions or signatures of other cars might have a major effect on the network if this attack succeeds. The goal of this assault is to steal sensitive data by creating a large number of bogus vehicles on the network. Disseminating data across vast VANETs while still maintaining user privacy is a challenge that has to be overcome.

5. MVO Based Hybrid Dynamic and Optimized Routing Approach (MHDORA)

MHDORA is an on-the-fly geographical routing system. A person could look at traffic and vehicle density at junctions to decide on trustworthy routes in the network. With the help of the maps, we can pinpoint the exact spots where two roads meet. Based on a score that takes into account the traffic volume and the mean transit time between metric curves, the junction is selected as the next stop. Especially on heavily used sites, performance has been enhanced. When determining the most efficient path to take, a packet's previous travel is considered. When a node in the network is within communication range of the server (gateway), it will send the information there. Each node has its own unique connection to the gateway. The programme takes into consideration several factors, such as finding the best routes, recovering lost ones, rerouting on the fly, and maintaining constant power to all cars. The MHDORA determines the route based on the base stations' route requests. The messages are used by the BS to reply to the route inquiry. In order to find the fastest and most economical route, it is necessary to calculate the distances travelled by two vehicles. The fact that we use the Euclidean distance as our standard for calculating how far apart cars should be demonstrates the importance distance has in this context. The algorithm takes into account a wide range of conditions, such as the ability to locate and recover routes, to dynamically reroute cars, and to maintain consistent power to all vehicles. The MHDORA selects a route based on requests from the base stations. The messages are used by the BS to reply to the route inquiry. In order to find the fastest and most economical route, it is necessary to calculate the distances travelled by two vehicles. The fact that we use the Euclidean distance as our standard for calculating how far apart cars should be demonstrates the importance distance has in this context.

$\text{Dist} = \sqrt{(a1 - a2) + (b1 - b2)}$ (1)

(a1, b1) represent neighbour nodes and (a2, b2) represent the destination node's spatial region in Eq. 1. By transmitting information from a source node to an end node, optimal route may be calculated. Measuring many factors—including constant, lifespan, and buffer availability—shows how much of an impact they have on deciding what steps to take next. These factors are integrated with response packets for different data formats. PDR is improved by using HDORA with a fitness function that seeks the steadiest route. Thus, additional routes may be added and packet loss is reduced.

route(l) = packets(transfer until the availability t + Predict (P)t | available t)…… (2)

Predict (P)t predicted time for the link availability among two vehicles Va, Vb. The reliability (R) is expressed as: Right now, that connection is active. That's why in Lab, separations between cars are shown as

$\text{Lab} = \sqrt{(a1 - a2)2 + (b1 - b2)2}$ ………. (3)

The result is an enhanced capacity for communication and a more reliable connection between vehicles.

Algorithm

```
# Input: There are 95 nodes (vehicles) with 5 Joules set as the starting value at node N.
Functions (Route_Recovery $R_{recovery}$, Route_Creation $R_c$Route_Diversion $R_{diversion}$, Mobility, vehicles position change ,Speed of Vehicles)
                $N = *N_1, N_2, N_3 ....... N_n^+$
Step 1: Select Source Node $N_s$ and Destination Node $N_d$.
Step 2: Calculate distance between two nodes using equation-1.
Step 3: If the N>1 //total nodes
    Then Node Mobility & Communication starts
    else
    Node Mobility & Communication does not star
Step 4: If $N_s$ >1
    Message (“Source Node transmit data to destination node $N_d$)
    Else
    Message (“No transmission from source to destination node $N_d$ anddata loss occur)
Step 5: Now calculate the routing path duration from $N_s$ to $N_d$
        ➢ Path duration is based on probability density function ($pdf$)
Step 6:
    $L_1, L_2, L_3, …. L_{E_H}$defines the duration of links of1,2,3, … . . $E_H$ nodes
    $E_H$ − Represents the average number ofnodes required to reach the $N_d$.
Step 7: Path is expressed
    as: $Tpath = Mi(L1, L2, L3, … . LEH)$
Step 8: Apply MVO as Optimization mechanism with classification techniques.
Step 9: The course is adjusted based on the typical travel time.
Step 10: The data has finally.
```

6. Simulation Parameters

Please see below Table I including the simulation parameters:

Table 1 Simulation Parameters

Simulation/Scenario	
Simulation Time (Sec)	120-140
MAC protocol	IEEE 802.11p
Range of Transmission	260 m
Total vehicles	95
Date packet sending rate PDR	4.5-14.5 packets/s
Data packet size	512 Bytes

7. Evaluation Results

Results are compared to those achieved using ACO, DORA, and HDORA routing protocols, and an enhanced simulation of the protocol using the MATLAB simulator is shown. The proposed solution, MHDORA (MVO based hybrid dynamic and optimised routing), outperforms the current VANET protocols by a significant margin. In all, 95 cars are employed for the simulation. Varied data rates, vehicle speeds, etc., are typical features of VANETs, which are themselves highly dynamic systems. Each vehicle begins with a value of "0," and the maximum speed of the system is 120 kilometres per hour. The network's boundless reach, high degrees of mobility, and adaptable architecture make this possible. The proposed technique is more flexible, making it suitable for a wider variety of vehicles. The researchers will put their assumptions to the test across 95 vehicles utilising algorithms including ACO, IDBACOR, DORA, and HDORA. It has been shown that the proposed method increases throughput, APD, CTR, and PDRatio.

8. Performance Metrics

Through analysis of data from the ACO, IDBACOR, and HDORA, we were able to demonstrate MHDORA's efficacy and performance. DTR, PDR, and packet drop ratio are used to determine the overall performance (PDRatio). Parameters for both proposed and current methods are shown in Table II below.

8.1. Data Transmission Rate (DTR)

In VANETs, this variable is crucial to the routing process. The time it takes for the message to be sent and the vehicle to be directed to its destination is determined by this. The effect on measures like traffic, accidents, and mobility may be seen in this variable..

8.2. Packet Delivery Ratio (PDR)

PDR's primary goal was to ensure that all data packets arrived at their final destination. Equation () is used to determine the PDR (4).

PDR= $\sum_{a=1}^{K}$ Packet recieved/ $\sum_{a=1}^{K}$ Packet originated …………….(4)

8.3. Packet Drop Ratio (PDRatio)

Percentage of packets sent that were never received at their intended destination is known as PDRatio. In Eq. (5), we have formula for PDRatio:

PDRatio=($\sum_{a=1}^{K}$ No ofPackets sent - $\sum_{a=1}^{K}$ No of Packet Recieved) * 100…………………..(5)

Table 2 Performance of Algorithms Based on Parameters

Algorithm	*Packet delivery ratio (Bytes)*	*DTR (Bytes)*	*Packet Drop Ratio (Bytes)*	*Average Propagation Delay (APD) (Sec)*	*Throughput (Packet/ Sec)*
ACO	87.59	425.79	12.41	5.92	83.08
DORA [21]	91.96	493.19	8.04	5.02	88.47
HDORA	92	493.34	7.5	4.98	89.29
MHDORA	96.25340	494.12159	6.9710917	4.1185812	92.412059

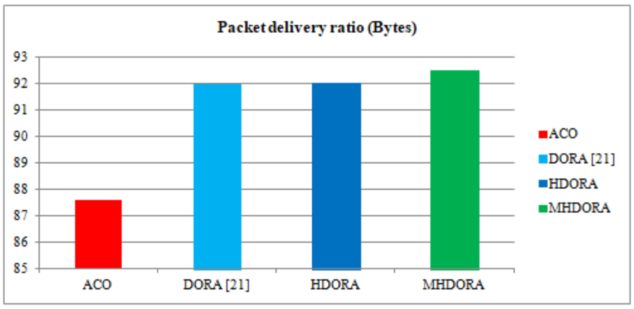

Fig. 3 Packet delivery ratio of Algorithms ACO, HDORA, DORA & MHDORA by showing PDR.

Using bar & line graphs, Figures 3 and 4 depict PDR's efficacy. HDORA's data-transmission between nodes outperformed previous methods. HDORA enhanced the CTP to keep the total power level where it needed to be for the nodes.

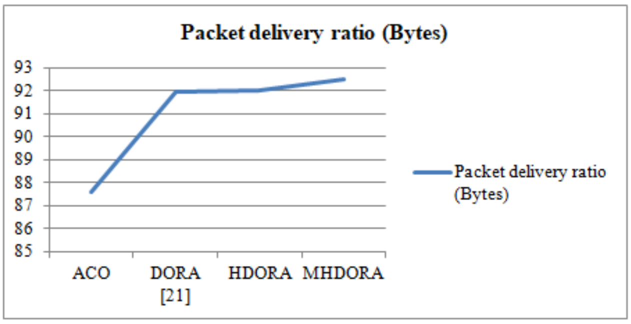

Fig. 4 Displaying PDR Performance of Algorithms Derived from ACO, HDORA, DORA, and MHDORA

DTR performance is shown in Figures 5 and 6 by estimating the time required to send each individual message. This is the total time it takes for the signal to get from its source to its target.

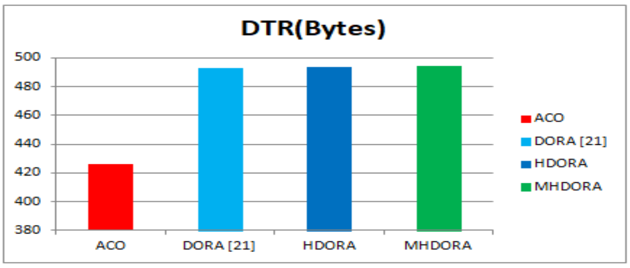

Fig. 5. Performance of Algorithms DORA, ACO, HDORA & MHDORA by showing DTR (Bytes)

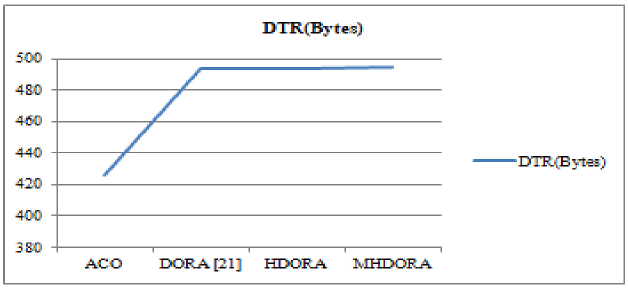

Fig. 6. Performance of Algorithms DORA, ACO, HDORA & MHDORA by showing DTR

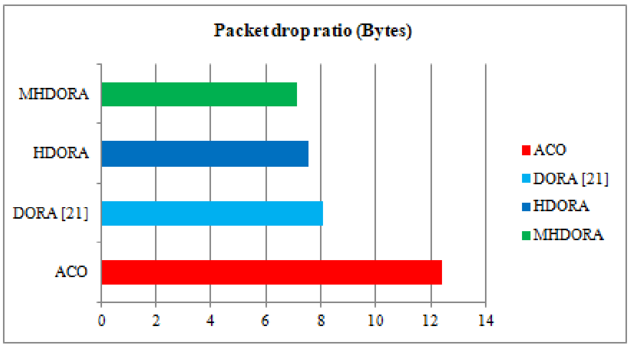

Fig. 7. Displaying Packet Drop Ratio as a Function of Time for ACO, DORA, HDORA, and MHDORA

Figs. 7 and 8 illustrate the packet drop ratio. There is a drastically reduced drop-off when using MHDORA compared to other methods. Again, this is based on the PDR.

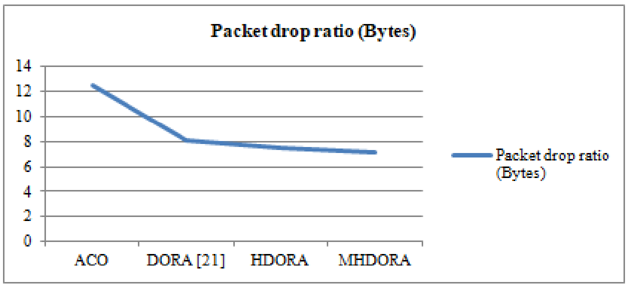

Fig. 8. An Evaluation of the Packet-Drop Performance of the ACO, HDORA, DORA, & MHDORA Algorithms

Bar graphs and line graphs depicting APD and throughput performance are presented in Figures 9, 10, 11, and 12. When comparing MHDORA to other methods, the APD is found to be lower. When compared to ACO, DORA, HDORA, and MHDORA, throughput is improved. In order to quantify how long it takes for data to be sent from its origin to its destination, the APD is used. When compared to other methods, MHDORA yields a comparatively small APD.

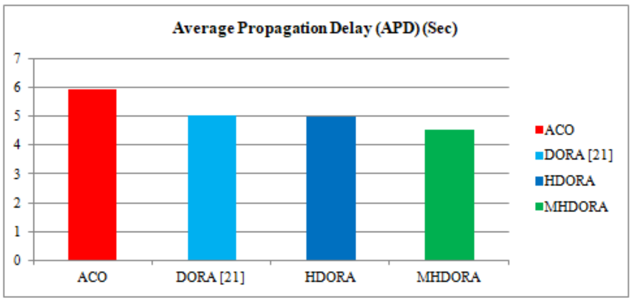

Fig. 9. Performance Representation of APD by using Bar Graphs

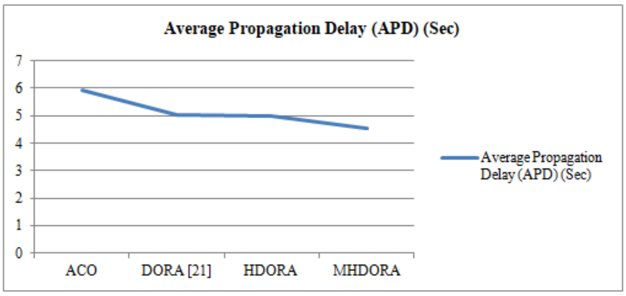

Fig. 10. Performance Representation of APD by using Line Graphs

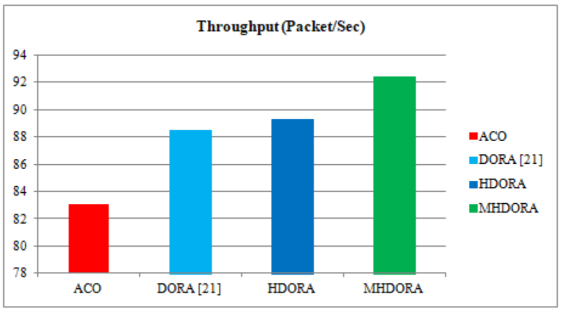

Fig. 11. Performance Representation of throughput by using Bar Graphs

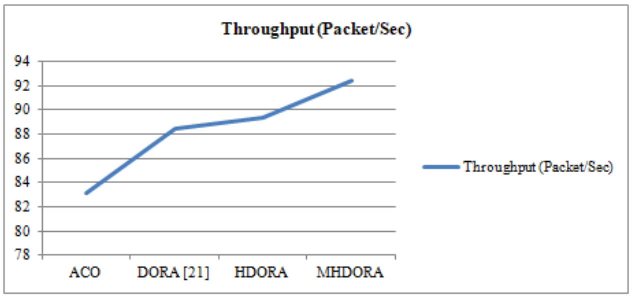

Fig. 12. Performance of Throughput

9. Simulation of Security

Focus of proposed is security enhancement along with increasing throughput and performance. However previous research work focused on performance but they failed to provide security enhancement. Present work is focused on security. If data is coming from suspicious source then it should be restricted. Proposed work has made use of machine learning model in order to assure the reliability of data. If data is not secure then routing operation should be cancelled. Integration of machine learning allows restriction of routing considering source of data and type of data. Proposed work is providing better security toward man in middle attack and denial of service attack.

9.1. Probability of man in middle attack

Table 3 compares the likelihood of a man-in-the-middle attack using the standard HDORA method to that using the proposed MHDORA method.

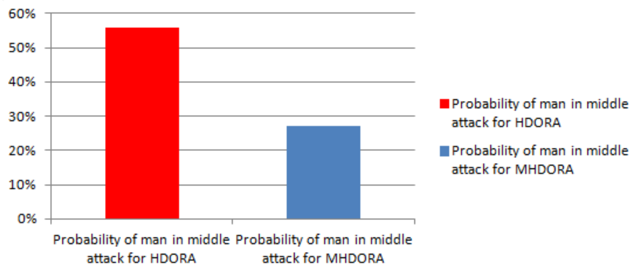

Fig. 13. Comparison of probability of man in middle attack

9.2. Probability of Denial of service attack

Table 3 is presenting probability of denial of service attack in case of conventional HDORA approach and Proposed MHDORA approach

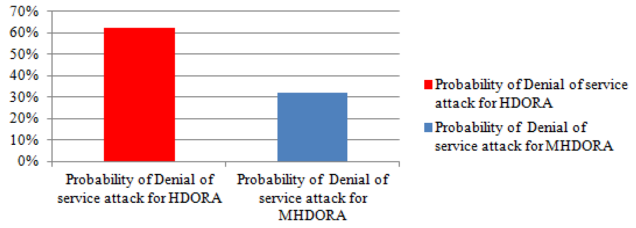

Fig. 14. Comparison of probability of denial of service attack

10. Conclusion

Transportation in smart cities need cutting-edge methods of classification and routing. This model classification and optimization includes mechanisms to discover the optimal path, which is crucial for smart city transportation. To combat the various difficulties associated with VANET networks, including dynamic routing, the approach we provide in this study combines dynamic routing with optimal routing. The proposed technique pinpoints the quickest path between the starting and ending locations. Additionally, this technique compensates for the little packet loss experienced. When developing the HDORA, the VANET data connection layer and inter-node communication were the key areas of study. System performance may be optimised with the help of MHDORA by keeping an eye on things like DTR, PDR, PDR ratio, APD, and throughput. The studies use about 95% of the nodes. The performance of the proposed technique was better than that of ACO, DORA, and HDORA. Improved simulation approaches will be required in the future to address the many issues with dynamic routing. Integration of machine learning approach has improved the security of proposed system. It has been observed that probability of man in middle attack & denial of service has been reduced in case of proposed work. Proposed is this performing better with high security.

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