QOS AWARE MODIFIED HARMONY SEARCH OPTIMIZATION FOR ROUTE SELECTION IN VANETs

Ganeshkumar N

Department of Computer Science and Engineering SRM University, Delhi-NCR, Sonepat, Haryana, India
ganeshkumar.n@srmuniversity.ac.in

Sanjay Kumar

Department of Computer Science and Engineering SRM University, Delhi-NCR, Sonepat, Haryana, India
skmalik@srmuniversity.ac.in

Abstract

Nodes in VANET represent moving automobiles in a city or highway environment, and the network is built on top of mobile ad-hoc network (MANET). Routing protocols are used in VANET deployment to send data between nodes. Different MANET-designed routing protocols for VANET have been developed and been applied. Real-time implementation, on the other hand, still has difficulties in meeting VANET's quality of service (QoS). Due to this, our work focus on a proactive routing protocol, based on the well-known OLSR protocol for the VANET proactive network. Due to the need to have an up-to-date routing table for all conceivable routes, the VANET OLSR performs only moderately well. Before deploying VANET, it's critical to determine the ideal parameter con-figurations for the network's parameters and to improvise the QoS. With its simplicity and exploration efficiency, the modified Harmony Search Optimization Algorithm, an innovative metaheuristic optimization technique is proposed in this research paper which accounts by configuring the OLSR parameters for route selection and optimization using appropriate selection methods embedded in the MHSO algorithm's memory. The configured parameters are drawn by the improved Army Ants inspired Swarm Intelligence and Stigmergy based approach for QoS Routing (AASISQ) Protocol based on Ant Colony Optimization algorithm for the coordinated communication among the vehicle nodes. Comparing the suggested approach to the current algorithms through simulations with the help of the NS2 open source environment and the SUMO software assisted by Open Street Map, the experimental results reveal that it is meeting the QoS criteria.

***Keywords*: VANET, Routing, QoS, harmony search optimization, ACO, AASISQ Protocol.**

1. Introduction

Millions of people around the world rely on cars as their primary mode of mobility. As this mode of transportation becomes more widely used, it will be necessary to enable vehicle-to-vehicle communication in order to provide added security and entertainment for passengers. In addition to increasing traffic saturation and hazard circumstances, extensive automobile use has also increased the likelihood of an accident occurring. These factors prompted the creation of software that aids the driver in making judgments and ensuring the safety of all passengers.

Other benefits include helping the driver avoid traffic bottlenecks while determining the route, increasing vehicle efficiency, and reducing pollution. Creating a communication system between automobiles in the entertainment area can benefit passengers in various ways, such as allowing them to share music, films, or even interacting with other individuals in other vehicles and information stations on the roadside. Vehicle ad hoc network (VANET) deployment is an option for enabling communication between automobiles [1]. Ad hoc networks are defined by the fact that they can be set up anywhere since they are not dependent on a fixed infrastructure. Similarly Vehicular Ad hoc networks use radiofrequency waves to connect between small, portable, battery-powered devices.

Each vehicle node can be able to establish communication only with the neighbor vehicle nodes that are in its communication range. It's possible, though, that a vehicle node will have to send information to the vehicle node outside of its normal communication range. In such scenarios, the information will be transmitted from the source vehicle node in one network at its current location to the destination vehicle node at a different location in the another network by the association of the intermediate vehicle nodes that falls in the transmission ranges and by finding a route to establish communication between the source and the destination node.

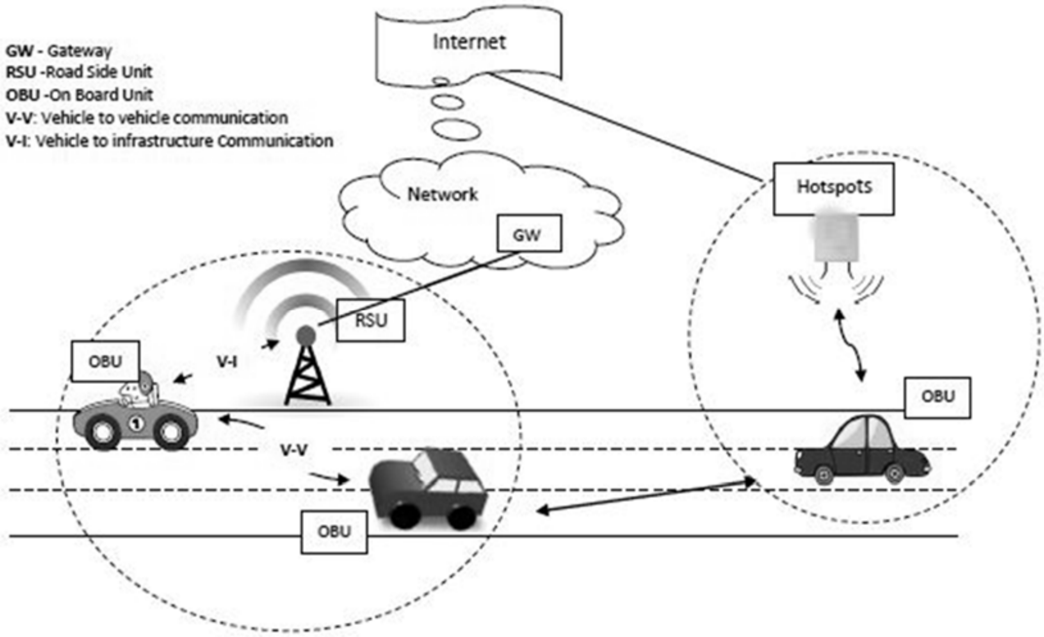

Fig. 1. VANET Network model Scenario.

A characteristic of VANETs is that the nodes (vehicles) can move throughout the network at fast speeds due to topological limitations imposed by highways and/or urban roads. Vehicles are scarce or distributed unevenly in VANETs, and communication between nodes is constrained as a result [2]. VANETs, like most networks, must adhere to the Open Systems Interconnection (OSI) standard for inter-node communication. An example of a network operating standard would be one that is separated into seven levels to set general principles for network operation. When it comes to VANETs, the three layers –physical, data link and the network layers had most definitions, therefore they are deserving of special attention.

Radiofrequency communication must employ the DSRC- Dedicated Short-Range Communication standard [3] at 5.9 GHz for the physical and data link layers. IEE-developed (WAVE) wireless access in vehicular environments should function within the DSRC-specified frequency range. IEEE 1609 is a new family of 4 protocols developed by WAVE specifically for vehicle-to-vehicle communication (IEEE 1609.1, IEEE 1609.2, IEEE 1609.3, and IEEE 1609.4). The protocols of the network layer, for instance, are specified by IEEE 1609.3.

The WAVE is constructed in accordance with the American DSRC's requirements, which divide the frequency spectrum into 7 channels, each of ten MHz. Factors like the vehicle node velocity, inter-communication range, and transmission data rate are taken into account as the pattern for VANETs scenario. While maintaining minimal latency, the WAVE moreover provides a Medium Access Control layer to handle huge node velocity. As a result, the MAC layer must adapt the IEEE 802.11e Medium Access Control layer. The network layer is in charge of, among other things, determining packet routing rules. Routing protocols govern the packet routing process, which discovers and maintains routes between the source and destination nodes. There are different types of routing protocols for different types of architectures. These four types of operation modes are grouped under the term "routing type," and they are all used to describe how traffic is routed.

VANET routing protocols are discussed and compared in this article with a focus on the possibilities of applying bioinspired and harmonic search optimization methodologies as solutions to the routing problems, which has emerged as a major trend these days.

1.1 QoS in VANET networks

The network's ability to provide applications with a assured level of service is referred to as QoS [quality of service]. VANET networks estimate QoS based on the supported apps. VANET applications have a variety of constraints, such as traffic monitoring, comfort applications, and road safety applications. Traffic monitoring and road safety applications are hampered by the veracity of real-time information. Comfort applications, on the other hand, necessitate constant communication. Media Access Control (MAC) layer, the resource reservation schemes and QoS routing protocol, are the few network components that needs to work together and coordinate in order to achieve VANET QoS. Because QoS routing techniques are critical to providing network-layer QoS [4], enhancing VANET QoS by optimizing routing protocols is an important goal. As a result, the main goal of the latter is to ensure that the network is capable of delivering the anticipated results.

1.2 QoS routing in VANET

Due to network topology changes and the imprecise nature of accessible state information, QoS routing is problematic in an Ad Hoc network. It is not enough to find a route from one point to another in order to satisfy QoS requirements when using QoS routing [5]. Few examples of QoS requirements includes maximum delay, minimum bandwidth, minimum packet loss rate are the service requirements that can be applied to a service. As a result, choose the best available path has a significant impact on QoS metrics. VANET's unique characteristics, such as its high mobility, low connection quality, and inadequate conveying distance, can cause various challenges for typical routing methods commonly used in cable networks, such as intermittent connectivity. There are numerous QoS routing protocols that can fulfil VANET's reliability and security criteria that have been developed to address these issues [6].

1.3 QoS routing parameters for route optimization:

This section introduces the fundamental Quality of Service (QoS) characteristics to optimise and improvise the performance of protocols during routing. In order to select the best incoming neighbour node or an ideal link between a source vehicle node and a destination vehicle node, the QoS routing parameters are employed.

Routing protocols take latency [7] into consideration above all others. They are the time it takes to get something done after you request it. The access delay or the queuing delay is defined as the time it takes for a node to transmit a packet since when it first tries to do so until it actually transmits it. The propagation delay is defined as the time it takes for a packet to travel from where it was sent to where it was received. An online packet's transmission delay measures the time it takes to transmit a packet. If you have a processing delay, you're waiting for a message to be validated by the destination before it can be delivered.

Distance is defined as the distance between a node and its next forwarding neighbour. The most commonly utilised fundamental parameter is distance. Reliability of communication links: In highly dynamic networks like VANET, communication links are extremely prone to disconnection. As a result, the routing reliability must remain carefully monitored. With regard to link availability, the likelihood that a straight transmission link between two nodes would be operational for a predetermined period is measured.

The number of link associations across which resources are allocated over the pathway amid the source and destination vehicle nodes is known as the Hop Count (HC). Wireless networks that aim to provide QoS and security guarantees use secured QoS routing algorithms as a critical component. Routing attacks and manipulation of routing control signals represent substantial issues in terms of secure routing as well as degrading QoS for the entire network [8]. As a result, when optimising routing, security must be taken into account.

At the start of the network deployment, this value specifies the amount of energy a node has. The goal of an energy-conscious routing system is to extend the life of a network.

A node's transmission range includes a number of one-hop nodes called neighbours. Neighbor nodes are nodes that only have one hop. By sharing the Hello message, they keep their current location, time, speed, and direction up-to-date. A node and its neighbours move randomly and frequently in a dynamic mobile ad hoc network [9]. In order to improve routing protocol performance, it is critical to take neighbours' quality into account.

Mobility creates frequent topology changes and network fragmentation in wireless mobile networks like VANETs due to the high mobility of nodes. Packet routing is a difficult operation because of these factors. By considering mobility, routing performance can be improved significantly. The routing algorithms' efficiency has been found to be strongly influenced by the mobility models used in VANET simulations.

Directness and node density of linkages (i.e., junctions) in street networks are terms used to describe street connectedness. Streets with many short linkages, many crossroads, and few standoffs characterise a neighbourhood with a well-connected street network. In a vehicular ad hoc network, street connection is a critical design component.Further, this paper aims at proposing an improved AASISQ protocol by drawing configuration parameters of OLSR with the assistance of modified Harmony Search Optimization Algorithm for route selection in VANETs.

2. Problem statement

As a result of these key QoS (Quality of Service) characteristics, routing protocols are optimised and improved. As a result of utilisingQoS routing parameters, the best incoming neighbour node or most efficient path between a source and destination node can be selected.

Latency is the most important factor to consider while designing routing systems [9]. After you make a request, the turnaround time is how long it takes to complete the task. If a node first tries to send a packet, it takes time until the packet is actually transmitted before the access delay, which is also known as the queuing delay, occurs. The transmission delay of an online packet is a measurement of the time it takes to send the packet. When a packet travels from one location to another, it experiences propagation delay. When a communication has a processing delay, it's because the destination needs to confirm it before it can be delivered. Distance is the separation between a node and the next forwarding neighbour it has. Distance is the utmost recurrently adopted essential parameter.

Communication link reliability: The communication links are especially susceptible towards interruption in dynamic VANETs. Thus, these networks' routing dependability must be closely monitored. Link availability refers to the probability that an explicit correspondence link between two nodes will be active for a given period. The Hop Count refers to the number of links that must be traversed in order to distribute resources between the source node and the destination node (HC).

Secured Quality of service routing algorithms are a vital part of vehicular ad hoc networks that give QoS and security guarantees. A significant difficulty in secure routing and lowering QoS for the entire network is routing attacks and the manipulation of routing control signals. As a result, security must be considered when optimising routing. During network deployment, this variable determines how much power each node has. Increasing the lifespan of a network is the purpose of an energy-conscious routing system.

There are a number of one-hop nodes in the transmission range, collectively referred to as neighbours Nodes with only one hop are referred as asneighbour nodes. They keep their present locality, period, velocity, and path up-to-date via sharing the Hello message. In a dynamic mobile ad hoc network, nodes and their neighbours move randomly and often. Routing protocol performance can be improved by considering the quality of the neighbours.

In wireless mobile networks like VANETs, whose nodes are highly mobile, mobility leads to frequent topology changes and network fragmentation. Due to these considerations, packet routing is an arduous task. Routing performance can be greatly enriched by taking mobility into account. Ad hoc network simulations' mobility models have a significant impact on the efficiency of routing algorithms. Street connectivity can be described using concepts like "directness" and "density" of linkages at intersections. A neighbourhood by a well-associated street network has streets with several short linkages, many junctures, and few stand-offs. Street connection is a key design element of a vehicle ad hoc network.

2.1 QoS assessment Parameters

It's not just the standard metrics for evaluating routing protocols, such as the time it takes for packets to go from one end of the network to the other, the packet delivery ratio, and packet loss. To evaluate the VANET QoS routing protocols, we give certain routing metrics [10].

- End-to-End Delay (E2ED): the time taken by a packet to travel from the source to the destination after it has been transmitted]; (E2ED): When there is network congestion, latency increases, which has a detrimental impact on QoS.

- Packet Delivery Ratio (PDR): the number of data packets successfully delivered to the destination vs the number of packets communicated by the source, it's known as the PDR.

- PLoss: The inability of a transmitted packet to arrive at its destination, also known as packet loss (PLoss), can be caused by transmission mistakes or network congestion. When it comes to packet loss, it's expressed as a proportion of total packets transmitted minus total packets received.
- Bandwidth: For a network link or a network path, bandwidth measures the data rate at which packets can be transferred at.

- Throughput: It is the average number of bits sent successfully through a communication connection per time period. Node mobility, hop count, and transmission range are all factors that affect throughput.

- Jitter: Jitter is the difference between the longest E2ED and the shortest E2ED (the divergence of the delay). Due to the disparity in sequential packet queuing delays, this occurs.

- Overhead: Routing packets are regarded an overhead in the network since they share network bandwidth with data packets most of the time.

- Connectivity Probability (CP): For example, if a node moves, how it affects network connectivity is measured using connectivity probability (CP). It is capable of capturing crucial network features as node and link state changes over time.

- Network load (NL): the number of vehicles getting duplicate message copies, and the overall number of hello messages necessary for the packet to be forwarded.

- Normalized Routing Load (NRL): Data packets delivered at the destination are counted independently for each hop for calculating Normalized Routing Load (NRL).

- Normalized Overhead Load (NOL): The ratio of routing packets to successfully delivered data packets is represented by this metric. NOL shows how much extra bandwidth is used when packets are routed.

- Average Routing Replay ratio: the time to submit a route demand to a explicit terminus and for that destination to reply with the route it has requested.

- Routing Request ratio (RReq): When calculating the Routing Request Ratio (RReq), take the total number of requests sent and divide it by the total number of packets received by the vehicle node at the destination.

- Link Failure (LF): In routing, mean of links that fails is referred to as the link failure rate (LF). Measuring routing protocol effectiveness in preventing connection failures is done using this metric.

- Percentage idle time (idle time): In this context, "percentage idle time" refers to the average idle time observed in one second by a node. When neither a packet is being transmitted nor received, the channel is considered idle by the node.

3. Related Work

MahaKadadha et al. handled the concern of directing in metropolitan VANETs utilizing proactive OLSR convention within the sight of inactive pernicious hubs [11]. OLSR convention courses through MultiPoint Relays (MPRs) that are chosen by neighbors' reachability and uniqueness. Nonetheless, in metropolitan VANETs, different boundaries, for example, hub's portability and road geography are likewise of importance.

These boundaries can likewise be thought about to work on the nature of chose MPRs. Notwithstanding, a MPR can take on a detached malevolent conduct by not helping out different hubs except if compensated. As an answer, we propose a multi-pioneer multi-devotee Stackelberg game model that persuades hubs to act helpfully, being MPRs, by expanding their standing. Gathered standing augmentations are utilized to decide the arrangement of hubs (adherents) that a MPR (pioneer) will course for dependent on hubs' standing. Recreations directed utilizing NS3 exhibit that the proposed Stackelberg game model further develops the organization execution as far as dependability of MPRs, throughput, and normal jump count contrasted with OLSR and the road driven QoS-OLSR convention in metropolitan VANET. Furthermore, the proposed convention presents a comparative level of chosen MPRs and start to finish delay contrasted with the benchmarks.

Nitin Singh Rajput et al. expressed that applications and administrations which run on top of VANETs range from human wellbeing and traffic the board to helped driving and continuous front line correspondence. Large numbers of these applications might have low-versatility QoS necessities [12]. Qualities like high portability of vehicles, dynamic geography, inborn circulated nature and ensuing absence of focal coordination make it trying to give QoS support in such organizations. Since, QoS provisioning and way finding can be conceivably taken care of together, this work targets taking advantage of such a chance. Subsequently, an endeavor has been made to address the multi-limitation QoS ideal way issue by utilizing a creative mix of multitude insight based improvement systems and a particularly planned expense work. This work presents a point by point hypothetical just as trial investigation of the proposed calculations, most likely first of its sort. Furthermore, the examination part likewise researches the appropriateness issues and related arrangements thinking about select calculations considering taking care of the given issue for VANETs. Meta-heuristics inferred in this cycle have been applied on reasonable displayed VANETsgeography and as the introduced investigation would demonstrate results are empowering.

Zemin Sun et al. expressed that VANETshave great needs on both (QoS) and security because of their interesting remote components like exceptionally powerful vehicles and untrustworthy channels [13]. In any case, it is trying to mutually enhance QoS and security since they are clashing destinations that battle for restricted organization assets. The recreation results show that the proposed game empowers a vehicle to acquire good QoS and security levels by progressively changing its ideal procedures as per the arranged organization and traffic climate.

Huda Abualola et al. handles the issue of working on the alliances' solidness for Qos-Optimized Link State Routing (QoS-OLSR) convention in metropolitan Vehicular Ad-hoc Networks (VANETs) [14]. VANETs have presented correspondence among vehicles for the Intelligent Transportation System (ITS) permitting a few wellbeing and client situated applications to be carried out in a specially appointed way. The directing conventions in VANET assume a critical part in the conveyance of information bundles for such applications. In any case, the quick changes in the geography of metropolitan VANET influence the general security among moving vehicles and subsequently cause a high drop in the organization execution. A few works considered metropolitan measurements and game hypothesis models for stable transfer determination and group development where the dependability of a hand-off is estimated contrasted with all the neighbor vehicles as opposed to choice dependent on relative solidness between a vehicle and its hand-off. Likewise, a few works proposed coordinating with hypothesis that spotlights on the singular inclinations of players, to present dependability. On the other hand, the Hedonic game considers inclinations and upgrades soundness through joining alliances to work on the general utility of all partaking individuals in every alliance. Along these lines, in this paper, they proposed a two-stage Hedonic game model that works on the alliances' steadiness for QoS-OLSR in metropolitan VANET by considering the metropolitan attributes, for example, traffic signals, crossing points, and paths' bearings. Players play the game in an unplanned way by trading a bunch of messages and join alliances that incorporate somewhat more steady individuals. Consequently, the overall security among alliance individuals is the utility of the alliance. An alliance utility relies upon the metropolitan attributes which influence a few measurements, for example, an opportunity to leave the road and the likelihood of the course to leave the closest convergence. Recreations, that are directed utilizing SUMO and NS3, show high organization execution as far as bundle conveyance proportion, throughput, and start to finish delay contrasted with benchmark conventions.

ArindamDebnath et al. limited the issues for Vehicle to Vehicle correspondence, brought about by the speed of the vehicles, the deterrent brought about by elevated structures and steering circle issue at the street intersection [15]. This causes less throughput and information bundle drops for a given organization. To stay away from these issues, we have characterized a bunch of fixed intersection focuses (FJP), a specific vehicles around FJP, is doled out as a handset for the information correspondence. That vehicle, called Virtual intersection point (VJP) which has relegated weight to each street, relies upon number of vehicles on that street and the distance between two intersections focuses along that street. Aside from the idea of VJP, a recently evolved strategy, we call it Center of Mass (CM) technique, is utilized by source vehicle for choosing the following sending vehicle. In this technique, one limits the amount of the relative multitude of distances of all adjoining vehicles from a given nonexistent point, which is the CM point. In this point, genuinely there may not be any vehicle, yet the vehicle near that point is utilized for the following sending vehicle in our strategy. Recreation result shows our technique performs better compared to different conventions.

HamidehFatemidokhtet al. expressed that VANETs are considered as a subset of versatile specially appointed organizations (MANETs) that can be utilized in the transportation field [16]. These organizations significantly further develop the traffic wellbeing and mishap anticipation. Due to the attributes of VANETs like self-association, regular connection detachments and fast geography changes, creating proficient steering conventions is a difficult undertaking. To resolve this issue, bunching is a proper methodology in a portable climate. Bunching intends to parcel the vehicles into various groups dependent on some predefined measurements like speed, distance and area. In this paper, a grouping directing convention, named QMM-VANET, which thinks about Quality of Service (QoS) prerequisites, the doubt esteem boundaries and versatility requirements, is proposed. This convention indicates a solid and stable bunch and builds the security and network during interchanges. This convention is made out of three sections: (1) processing the QoS of vehicles and choosing a trustier vehicle as a group head, (2) choosing a bunch of legitimate adjoining hubs as entryways for retransmitting the parcels and (3) utilizing passage recuperation calculation to pick one more door if there should arise an occurrence of disappointment of the connection. NS-2 test system is used to represent the presentation of our proposed convention in a parkway situation. The exhibition examinations show that the QMM-VANET convention can accomplish low start to finish postponement and high bundle conveyance proportion and keep up with the organization security.

4. QoS-aware routing Challenges

VANET QoS-aware routing is not only about the availability of the network resources and the link connectivity; it is also about the mobility and speed of those resources, as well. Because the topology changes so rarely in cloud networks, the routing protocol isn't burdened. Because of the routing protocol's continual reaction to topology changes, VANETs' fluctuating topology places a substantial burden on the protocol. In an ideal world, QoS is accomplished by allocating network resources efficiently, which is enforced by reserving resources with enough infrastructure.

Though, with ad hoc networks like VANETs, allocating network resources efficiently is challenging, if not impossible. While there may be infrastructure for bandwidth guarantee, the dynamic nature of the network makes it nearly impossible to reserve resources, which presents a significant difficulty. When it comes to traffic congestion and other time-constrained applications, warning messages, traffic congestion data, accident or crash information, and infotainment services are all expected to be routed through VANETs. Delay-sensitive services necessitate high levels of connection stability for these applications, which have strict QoS requirements [17]. Many variables affect how stable a link is, including the amount of jitter in the link as well as the amount of packet delay and loss. For this reason, it's critical that the principal networks maintain a high data rate and affinity to ensure smooth communication between cars. It's difficult to provide such a guarantee in VANETs since it necessitates the preservation of information about topology change at each node in the network.

However, due to frequent connection failures and path breaking in VANETs, it becomes impossible to retain reservations and revamps in a routing path as such information must be re-computed each time a path disruption occurs.

These issues can be addressed by considering QoS for VANETs routing.

1. A dynamic topology is required. Vehicle nodes nature of high speed, density of vehicle nodes, and movement patterns of vehicle nodes create network architecture changes often, resulting in frequent link disconnection and broken paths. As a result, a link that was previously built with the required QoS possibly will no longer gratify QoS requirements due to node mobility.

2. The wireless network transmission is unreliable because of the common radio channel's proneness to failure. These factors can have an impact on packet delivery ratio as well as link longevity by making them more susceptible to interference, having low throughput, losing packets frequently, and having long end-to-end delays.

3. Using network properties in a self-organized, decentralised VANETs is exceedingly difficult when there is no central control. With no central controller to coordinate and manage node activity, channels may be underutilised.

4. Ease of use during rush hours at intersections in urban areas, the number of nodes in VANETs is very high. Large networks impair routing QoS because of the higher routing protocol overhead and decreased dependability caused by broadcasts due to widespread network flooding. QoS degradation occurs when the network grows. Routing scalability in VANETs is hampered by high node mobility and an expanding node population, which necessitates reducing routing control message overhead.

5. End-stage disease that is not readily apparent VANET safety info conversation is subtle to the concealed terminal problem because of the broadcast nature of VANETs. When transmissions from two nodes collide at a shared neighbour, the hidden terminal problem develops. This happens because the nodes don't know about each other.

It is difficult to preserve correct network status information because of the adequate changes in topology and the pace of vehicles that travels. Information sent to a node, such as the data rate available, may vary when the message is relayed to the node to its right. It's possible that this data is outdated, and as a result, an incorrect routing decision will be made.

4.1 Desired QoS features in VANET Routing

As long as the interactive nodes are adequately nearby (i.e., within each other's broadcast range), communication in VANET can be done in a single hop; otherwise, it must be done in a multi-hop fashion by means of intermediate nodes. But unalike MANETs, finding and sustaining routes in VANET is difficult because of the specific properties in particular dynamic topology, multihop communication and wireless interface that frequently change connectivity. The protocols considering QoS for VANET routing must be:

- Able to deal with concerns, caused by increased node mobility,
- Adaptive to often changing topology.
- Converging quickly after each topological modification.
- Responsive in order to make the best use of limited network resources, such as available bandwidth.
- When it comes to ITS-Information Technology, real-time /isochronous ITS-Infotainment is typically expected.

5. Proposed Methodology

Modified harmony search optimization (MHSO) algorithm [18] is applied to the improved AASISQ protocol constructed on using OLSR routing protocol to escalate the QoS performance in the VANET [19]. This is done by creating and solving an optimization problem. It will be addressed to explain how the strategy works on moving cars on a highway, we'll look at a hypothetical scenario. There is a significant overhead and packet loss in this network since the topology is constantly changing. We look at this scenario and use the proposed MHSO method to address these difficulties. Nodes are moving at rapid speeds, and messages are constantly being exchanged throughout the network.

OLSR, enhances the normal link state routing protocol to optimize the route path and flood the information with one hop neighbors for its route establishment and the maintenance through the Multi-Point relays. Hello messages, Topology control messages generated are circulated among the one-hop neighbors to update the changes in the routing information. Every participating vehicle is considered to be a node in VANET scenario and the Road side Units along the moving direction of the vehicles and the intersecting points at road junctions are considered to be the Multipoint Relays as assumption in the OLSR protocol implementation. Every participating vehicle nodes will update and maintain the topological information through hello and tc messages by considering parameters like node_id, distance calculated by Dijkstra's algorithm. MPRs maintains routing parameters including the node_id, distance, source and the destination vehicle node addresses, and the hop count. Any changes in the topology will lead to update in routing information at the MPRs by flooding this information with the one-hop neighbors.

5.1 Improved AASISQ protocol through Modified Harmony Search Algorithm for route selection:

The fitness function for deciding the decision variable set and their constraints to find out the optimized solution to the available problem is dealt by the musician by selecting the suitable harmony from the memory or the neighbor pitch or the arbitrary value. In VANETs scenario, the modified harmony search is to select the routing information stored in routing tables of Multipoint relays assumed to maintain the Harmony's memory or the routing table information selected from the neighbor vehicle nodes. The complete activity is summarized as follows:

Step 1: Initialize the problem, harmony memory routing table at MPRs and routing tables at the one-hop neighbor vehicle nodes by means of Hello messages and TC messages

Step 2: Assign pheromone values to the routing table entries at the harmony memory's routing table and the neighbor vehicle node routing table by updating the timestamp with the recorded information. Add New Harmony memory or the neighbor routing table by replacing the existing information if any change in topology is detected to accomplish path maintenance.

Step 3: when a source vehicle node (SVN) has certain information to be sent to the destination vehicle node (DVN), create a list that maintains the visited nodes from SVN to DVN.

Step 4: Initially choose and initialize the SVN, and initiate path request to the MPR or the one-hop neighbor vehicle node to reach the DVN by generating the Forward Foraging Army Ant.

Step 5: The Forward Foraging Army Ant chooses (senses) the optimized pheromone value of modified Harmony search from Step 2 by selecting the greatest pheromone value among the routing table information in MPRs and the one-hop neighbor vehicle nodes through all its neighbor vehicle nodes to reach the DVN.

Step 6: When the Forward Foraging Army Ant reaches the DVN, convert the Forward Foraging Army Ant as the Backward Foraging Army Ant

Step 7: The generated Backward Foraging Army Ant senses the visited nodes list and look for update in pheromone values (if any) by comparing it with the routing table information at the MPRs and the one-hop neighbor vehicle nodes to select the shortest path and reach the SVN.

6. Simulation Results

The NS2 wireless package with a one-second stop time is used in our simulation. The mobility model is generated using the SUMO by importing the local map from OpenStreetMap [20]. We've compared our results with those of our existing AASISQ protocol and the OLSR protocol to evaluate the performance of the improved AASISQ protocol using MHSO algorithm. Because of network structure and breakdown path rate, raising maximum speed raises average E2Ed in all existing methods. Since the simulation environment and node distribution are different from other methods, the suggested method has reduced considerable delay and overall control overhead.

Simulation Parameter	Value
Simulator	NS 2.35
Node-Movement Model	Random-Waypoint model
Size of the Vehicle network	25 Vehicle Nodes
Speed of Vehicles	10 to 250 KMPH
Mobility Model	Random-Mobility model
Communication range	150-500m
Simulation area	1KM X 1KM
MAC Layer	IEEE 802.11p
Simulation Type	100s
Antenna type	Omnidirectional Antenna

Table 1. Simulation parameters in NS2.

OLSR results through simulation is compared to the AASISQ protocol and the improved AASISQ protocol with vehicle nodes moving along a highway scenario to obtain the E2E Delay, PDR (total correctly delivered packets from source to destination) and the throughput.

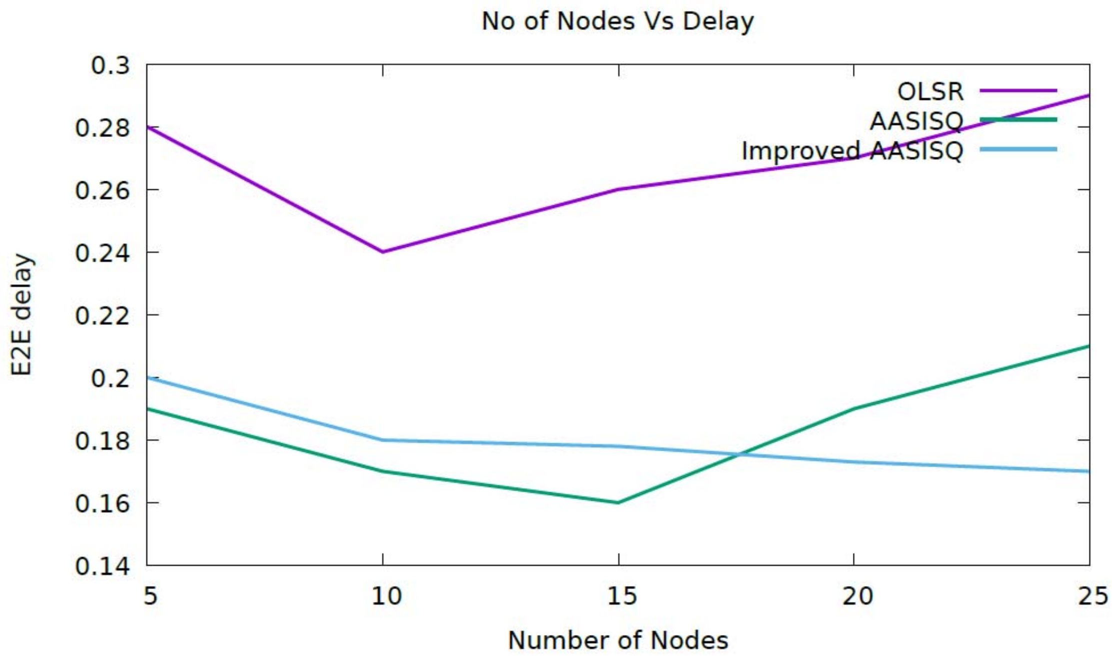

Fig. 2. No. of nodes Vs. Delay

The Avg. E2E Delay of the improved AASISQ protocol using MHSO algorithm is almost better in routes of the proposed system as in Figure 3 as each path communicates more packets in a smaller period.

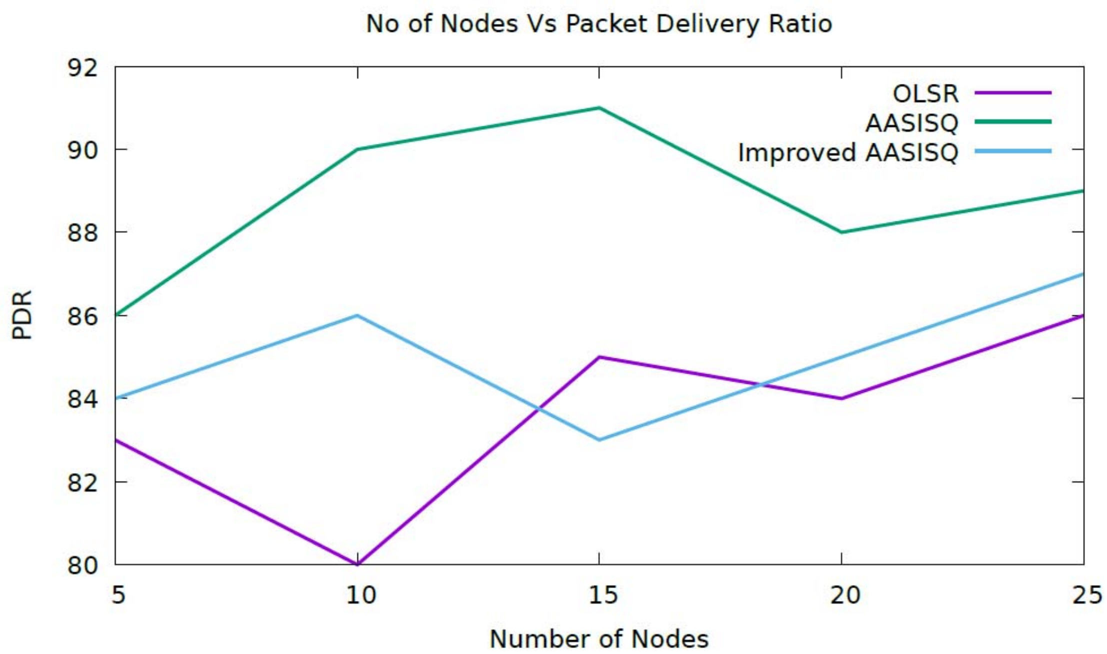

Fig.3.No. of nodes Vs. PDR.

The PDR of the improved AASISQ protocol using MHSO algorithm is improved as in Figure 4 when related by means of the prevailing method as this proposed method uses the fitness function to adopt an optimal path.

The throughput of the improved AASISQ protocol using MHSO algorithm is performing moderately well as shown in Figure 5 when compared to the existing methods.

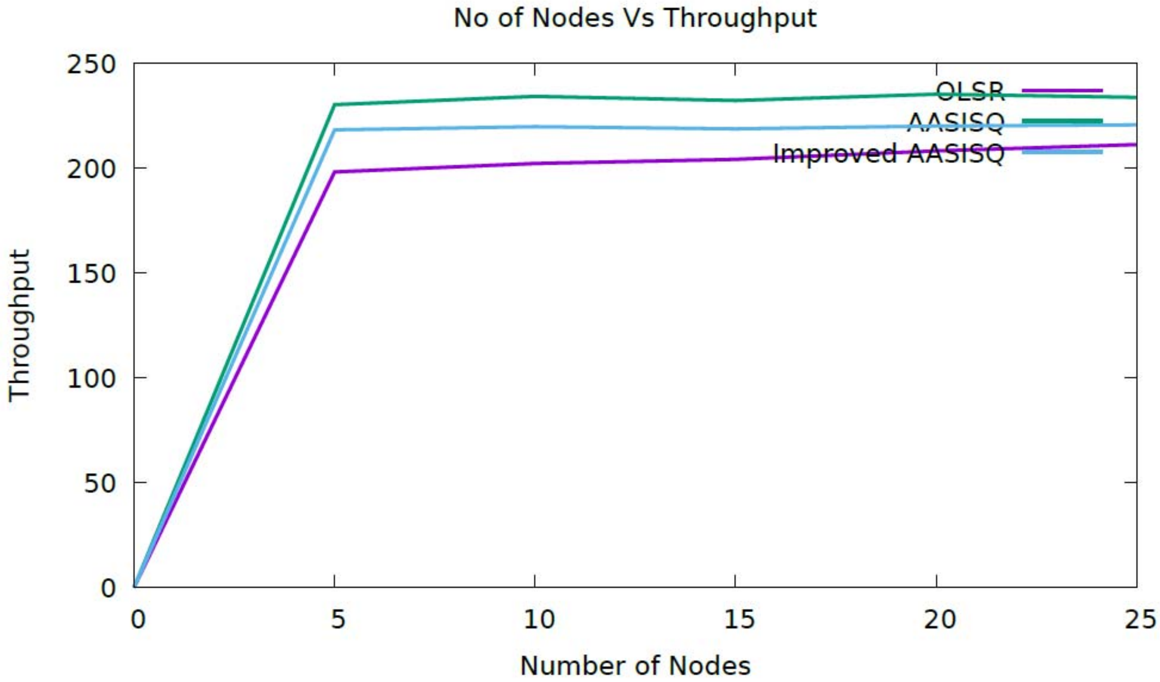

Fig. 4. No. of nodes Vs. Throughput

7. Conclusion

A rapid rise in the standard of living VANET has had a significant impact on a variety of aspects of our daily life, including road safety. The topology of mobile ad hoc networks hasn't been established in advance. As a result, the topology of these networks is constantly changing. Because VANET nodes are mobile, information transmission is a critical concern because it alerts other vehicles to traffic or accident scenarios. PSO searches for the best solution by simulating the behaviour of a group of particles. MHSO is simulated with the help of the NS2 open source environment and the SUMO software. By increasing the number of cars, we were able to test our proposed approach for delays, throughput, control overhead, and the average packet delivery rate.

The QoS parameters of the optimal paths obtained by the proposed and existing systems are compared for the considered network. It is observed that proposed system, improved AASISQ protocol using MHSO algorithm performs better when compared with the existing system because of its effective function. The results prove that the throughput and PDR are improved with less control overheads, and the average packet delay is minimized compared to the existing methods under consideration.

References

[1] Felipe; Cunha & Villas; Leandro & Maia; Guilherme & Viana; Aline & Mini; Raquel & Loureiro; Antonio & Boukerche; Azzedine.(2016), Data Communication in VANETs: Survey, Applications and Challenges,.
[2] Ganeshkumar N.; Kumar S. (2021), OBU (On-Board Unit) Wireless Devices in VANET(s) for Effective Communication—A Review In: Singh V., Asari V.K., Kumar S., Patel R.B. (eds) Computational Methods and Data Engineering. Advances in Intelligent Systems and Computing, vol 1257. Springer, Singapore.
[3] R. A. Uzcategui; A. J. De Sucre and G. Acosta-Marum.(2009), Wave: A tutorial, in IEEE Communications Magazine, vol. 47, no. **5**, pp. 126- 133.
[4] Belamri F.; Boulfekhar S. & Aissani D.(2021), A survey on QoS routing protocols in Vehicular Ad Hoc Network (VANET). Telecommun Syst 78, 117–153.
[5] Khairi Diyar. (2015), Survey on QoS and Security in Vehicular Ad hoc Networks.
[6] G. N and S. Kumar. (2021), Study on Routing in VANETs – A QoS Perspective, 2021 Fourth International Conference on Electrical, Computer and Communication Technologies (ICECCT), pp. 1-8.
[7] D. H. Lorenz and A. Orda. (1998), QoS routing in networks with uncertain parameters, in IEEE/ACM Transactions on Networking, vol. 6, no. 6, pp. 768-778.
[8] Yelure; Bhushan & Sonavane, S.P.. (2019). QoS Evaluation of VANET Routing Protocol.

[9] Kamini, & Kumar, Rakesh. (2010). VANET Parameters and Applications: A Review. Global Journal of Computer Science and Technology. 10.
[10] F. I. Shaikh and H. A. Hingoliwala. (2017), Path planning based QoS routing in VANET, 2017 International Conference on Big Data, IoT and Data Science (BID), pp. 37-43
[11] Kadadha, Maha & Otrok, Hadi. (2021). A blockchain-enabled relay selection for QoS-OLSR in urban VANET: A Stackelberg game model. Ad Hoc Networks.
[12] Rajput, Nitin & Banerjee, Rahul & Sanghi, Dheeraj & Santhanam, Gokulakirshnan & Singhal, Kapil. (2021). Swarm intelligence inspired meta-heuristics for solving multi-constraint QoS path problem in vehicular ad hoc networks. Ad Hoc Networks.
[13] Sun, Zemin & Liu, Yanheng & Wang, Jian & Yu, Rundong & Cao, Dongpu. (2021). Cross-layer tradeoff of QoS and security in Vehicular ad hoc Networks: A game theoretical approach. Computer Networks.
[14] Abualola, Huda & Otrok, Hadi & Mizouni, Rabeb & Singh, Shakti. (2021). A V2V charging allocation protocol for electric vehicles in VANET. Vehicular Communications.
[15] Debnath, Arindam & Basumatary, Habila & Tarafdar, Anirban & DebBarma, Mrinal & Bhattacharyya, Bidyut. (2019). Center of Mass and Junction based data Routing Method to Increase the QoS In VANET. AEU - International Journal of Electronics and Communications.
[16] Fatemidokht, Hamide & Kuchaki Rafsanjani, Marjan. (2020). QMM-VANET: An Efficient Clustering Algorithm Based on QoS and Monitoring of Malicious Vehicles in Vehicular Ad Hoc Networks. Journal of Systems and Software.
[17] A. Orda. (2005), QoS routing: challenges and solution approaches,Second International Conference on Quality of Service in Heterogeneous Wired/Wireless Networks (QSHINE'05), , pp. 2 pp.-xxii.
[18] Hammoodi, Mustafa & Muniyandi, Ravie. (2018). An improved harmony search algorithm for optimized link state routing protocol in vehicular ad hoc network. International Journal of Engineering & Technology.
[19] Ganeshkumar Natarajan and Sanjay Kumar.(2021), Army Ants inspired Swarm Intelligence and Stigmergy based approach for QoS Routing in VANETs, Turkish Online Journal of Qualitative Inquiry.
[20] Weber J.; Neves M. & Ferreto T.(2021), VANET simulators: an updated review. J Braz Comput Soc 27, 8.

Authors Profile

Ganeshkumar N received his B.E. degree in Computer Science and Engineering from Anna University, Tamil Nadu, India in the year 2010 and the M.E. Master's degree in Computer Science and Engineering from Anna University, Tamil Nadu in the year 2012 and currently working towards the PhD Degree in the Department of Computer Science and Engineering at SRM University, Delhi-NCR, Sonepat Haryana, India. He is also working as an Assistant Professor in the Department of Computer Science Engineering (CSE) at SRM University, Delhi-NCR, Sonepat Haryana, India. His research interests include VANETs, MANETs, QoS in VANETS.

Dr. Sanjay Kumaris working as Professor and Associate Dean (Students Welfare) in the department of Computer Science & Engineering (CSE) at SRM University, Delhi-NCR, Sonepat, Haryana, India with more than 20 years of teaching and research experience. His research interests include WSN, MANETs, Multimedia sensor networks, etc.