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AN EMPIRICAL STUDY ON DIFFERENT ROUTING PROTOCOLS IN VANET

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ABSTRACT
Traditional routing protocols for vehicle ad hoc networks (VANETs) originated from mobile ad hoc networks (MANETs). Topology, broadcast, geographic, and cluster-based routing protocols are the common ones used by VANETs. They are not appropriate for every kind of VANET traffic scenario and have some limits. Therefore, to get optimised routing performance results in desired VANET traffic scenarios, metaheuristic algorithms such as evolutionary, trajectory, nature-inspired, and ancient-inspired algorithms can be coupled with VANET standard routing algorithms. The purpose of this study piece is to compare and contrast the current routing protocols in order to evaluate their effectiveness and performance in relation to benchmark data. Upon comparison, it was determined that the GAACO algorithm outperformed the other two in each of the three traffic scenarios. The results were satisfactory. Additionally, the more effective routing protocol will be taken into account for the particular traffic situation.

1. INTRODUCTION:
Through the cooperation of the participating vehicles, a vehicular ad hoc network (VANET), a kind of wireless network, is able to offer numerous communication services. Less than a century has passed since the invention of the first vehicle [1]. Large-scale advancements in comfort, safety, and convenience have already significantly altered the modern car from that of the previous century. The next generation of vehicles will now evolve differently due to a new technology that is characterised by the spread of low-cost wireless connectivity and distributed peer-to-peer cooperative systems [2]. The aforementioned applications, which include both stationary roadside equipment and moving cars, are dependent on metropolitan-wide VANETs. Roadside units can serve as information broadcast stations to announce services along the way, data gathering hubs to gather traffic data in real time, Wi-Fi access points, and metro mesh nodes to provide internet access, among many other purposes. All available connection is used in the network to distribute data, including vehicle-to-vehicle, vehicle-to-roadside, and roadside-to-roadside communication [3].

VANET is a wide term that essentially consists of three key areas that dictate the network's design and the kind of communication that will be established. They are Vehicle to Roadside Connection, Inter-Vehicle Communication, and In-Vehicle Communication. VANET's basic situation is shown in Figure 01 [4].

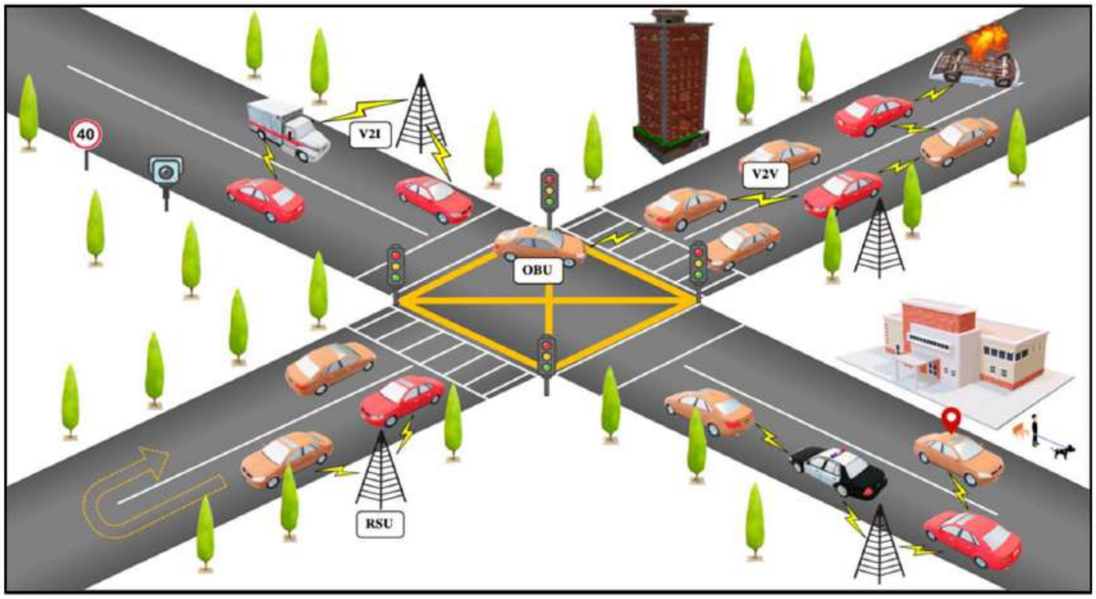

Figure.01. VANET Scenario

The reactive variety of topology-based VANET routing protocols is the subject of this paper. Only when a node's communication with one another is required does reactive routing open the route [5–6]. The first stage of reactive routing is called route discovery, during which a large number of query packets are sent to the network in an attempt to find a path. This phase ends when a route is located. Reactive routing protocols come in different varieties, including AODV, DSR, and TORA. The VANET routing protocols are covered in Figure 02 [7-8].

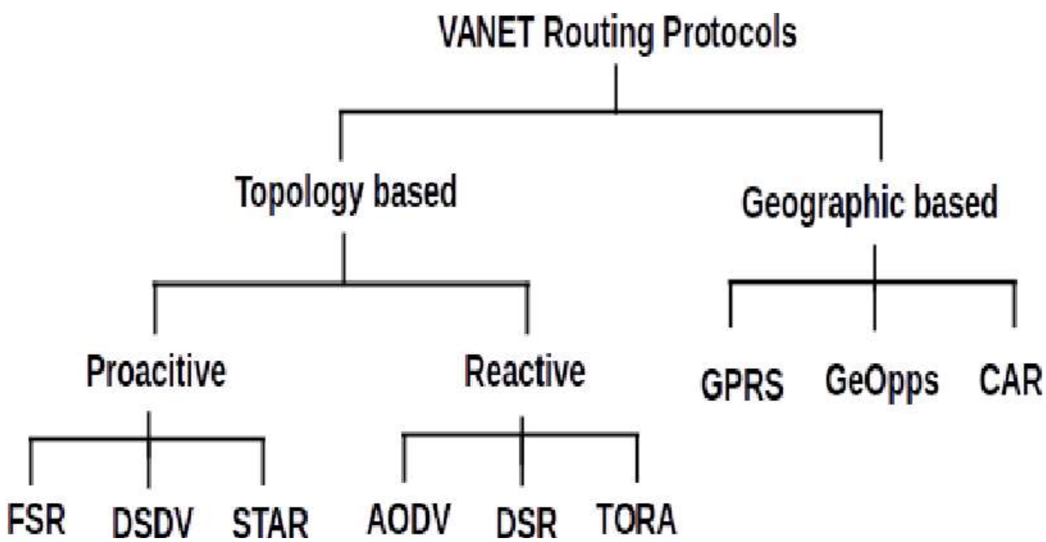

Figure.02. VANET Routing Protocols

AODV

When a node receives a broadcast question (RREQ) in AODV routing, it stores the address of the node that sent the query in its routing database [9–10]. Backward learning is the process of documenting its prior hop. A reply packet (RREP) is subsequently transmitted via the whole path discovered using backward learning to the source after reaching the destination.

DSR

DSR makes use of source routing, in which the sequence of intermediary nodes on the routing path is indicated in a data packet by the source [11–12]. The IDs of the intermediary nodes that the query packet has traversed are copied into its header in DSR. After then, the destination utilises the whole path that it extracted from the query packet to reply to the source.

TORA

TORA: Temporally Ordered Routing Algorithm routing is part of a family of link reversal routing algorithms in which the height of the tree rooted at the source is used to construct a directed acyclic graph (DAG) towards the destination [13]. In addition to directing packet flow, the directed acyclic network guarantees reachability to every node. A node broadcasts its packets when it has something to send. According to the DAG, its neighbour only broadcasts the packet if it is the transmitting node's downward link [14].

This research article's main goal is to compare several protocols in order to comprehend how they operate and what their performance ratios are. Section one of this comparative analysis provides a brief explanation of VANET and the routing protocols that are associated with it. The second section enumerates a wide range of recent and current VANET research projects. The third section discusses the standard parameters that must be used while analysing the comparative analysis. The fifth and final piece, which is the conclusion, addresses the potential and expectations of VANET in real-time experimental possibilities and concludes with the idea of future scope. The fourth section contains the illustration and its outcomes as well as the discussion of the simple and complex traffic scenario.

2. Review of Related Literature:

Bhattacharya et al. With this kind of network, security and routing are the two main issues. For vehicle ad hoc networks, there are already several routing protocols available, but none of them are designed to manage routing and security concerns simultaneously. We present a novel junction-based geographical routing system in this research that can handle both routing and security concerns. There are two modules in this protocol: (i) In order to accomplish routing, this protocol first dynamically picks the relevant junctions that a packet must send via in order to reach its destination. (ii) We have developed the idea of mix-zones to address security concerns and stop unauthorised users from tracking vehicles. In a simulated setting, the suggested work's performance was ultimately compared to a few well-known current routing protocols based on several criteria like the packet delivery ratio and normalised routing load [15].

Abdeen.et.al. The deployment of vehicular ad hoc networks (VANETs) and autonomous vehicles has become more necessary in order to help with communication and relieve traffic congestion during peak seasons for famous places like Madinah City. This study's main objective is to assess how well communication routing methods in VANETs between human- and autonomous-driven cars in Madinah City operate under various traffic scenarios. Using a combination of traffic and network simulation tools operating in tandem, a simulation of various traffic distributions and densities were modelled on an extracted map of Madinah city and then evaluated in two application scenarios with three ad hoc routing protocols. The average trip time results indicate that, in high traffic densities, choosing a fully autonomous vehicle scenario shortens vehicle trip times by about 7.1%, and that reactive ad hoc routing protocols cause the least amount of latency for network packets to arrive at nearby VANET vehicles. Based on these findings, it is possible to conclude that autonomous cars significantly cut down on journey time and that Madinah City could use either of the two reactive ad hoc routing protocols for the VANET deployment [16].

Neha.et.al. To prevent collisions and traffic jams, vehicles in VANETs can interact with the roadside units (RSU) or with one another. VANETs require a routing mechanism for this communication, which enables vehicle information interchange inside the network. One of the difficult challenges in the vehicular network is packet routing because of the dynamic nature of VANET. While there are numerous routing protocols for VANETs, position-based routing appears to be the most promising since it allows for the efficient routing of vehicles in vehicular networks by utilising their geographic positions. Several position-based routing techniques are presented in this study. This survey aims to provide interested readers with an effective presentation of position-based routing methods along with sound parameters [17].

Rizwan.et.al. The field of wireless technology is expanding quickly. The majority of researchers are employed in the wireless communication industry. VANET is a wireless communication technology that is still in its infancy, but as it develops, it will become more and more integrated into the smart transportation system. The communication architecture provided by VANET has improved traffic service and assisted in lowering the number of traffic accidents. In this system, transferring data is time-sensitive and necessitates the establishment of a strong network connection quickly. Although VANET is fulfilling its stated objectives, there are still certain problems and difficulties, such as the effective management of quick handovers for video streaming applications. Therefore, in order to determine which routing protocol is ideal for video applications in VANETs, we have analysed and discussed a number of papers connected to the topic in this work. Additionally, we have critically examined the various systems the researchers have created and identified their benefits and drawbacks for further investigation. Additionally, simulation is used to compare the routing methods' throughput and latency. Additionally, our investigations have demonstrated that, in the VANET context, AODV performs better than other ad hoc protocols. [18].

Gagan.et.al. Traditional routing protocols for vehicle ad hoc networks (VANETs) originated from mobile ad hoc networks (MANETs). VANET uses geocast, topology, broadcast, geographic, and cluster-based routing protocols as standard operating procedures. They are not appropriate for every kind of VANET traffic scenario and have some limits. Therefore, to get optimised routing performance results in desired VANET traffic scenarios, metaheuristic algorithms such as evolutionary, trajectory, nature-inspired, and ancient-inspired algorithms can be coupled with VANET standard routing algorithms. In order to create an optimised routing algorithm for three distinct actual VANET network traffic scenarios, this study suggests integrating the genetic algorithm (GA) with the ant colony optimisation (ACO) technique (GAACO). In addition to comparing the metaheuristic techniques and the conventional VANET routing algorithm, the research also addresses the experimental VANET simulation scenario. To validate the outcomes, the suggested method's implementation is validated using free and open-source network and traffic simulation tools. NS3.2 was used to test the three distinct traffic situations that were implemented on Simulation of Urban Mobility (SUMO). Upon comparison, it was determined that the GAACO algorithm outperformed the other two in each of the three traffic scenarios. The results were satisfactory. The four performance metric metrics of average throughput, packet delivery ratio, end-to-end delay, and packet loss in a network are used to extract realistic traffic network scenarios from Dehradun City. According to the experimental findings, in three distinct VANET network scenarios, the suggested GAACO algorithm performs better than particle swarm intelligence (PSO), ACO, and Ad-hoc on Demand Distance Vector Routing (AODV) routing protocols with an average significant value of 1.55%, 1.45%, and 1.23%. [19].

Suman.et.al. In recent years, vehicular ad hoc networks, or VANETs, have drawn a lot of attention as a developing field of study because of its importance in the development of intelligent transportation systems. It encompasses message flows between vehicles and infrastructure, or V2V and V2I, and is enabled by IEEE 1609 WAVE and IEEE 802.11p wireless access technologies. A significant scientific obstacle in the deployment of VANETs is the creation of a routing protocol that enables dependable and effective node-to-node packet transfer. In an urban setting, routing in VANETs is a challenging task. The overall performance assessment of two popular routing protocols for VANETs, Ad hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR), is presented in this study. The goal of this study is to optimise the choice of the optimal routing protocol to provide efficient and reliable distribution of data packets. Using the NetSim software tool, the impact and efficacy of the current topology-based routing protocol for VANET applications have been assessed. According to the simulated results, the link throughput of the VANET is improved for a fixed network size when a suitable channel model and an effective routing protocol are combined. Additionally, performance study shows how network sizes and routing algorithms affect overhead transmission, packet loss, packet delivery ratio, average end-to-end delay, and packet delivery. [20].

3. COMPARISON PARAMETERS

Throughput

Network throughput is the volume of data that is successfully transferred from one location to another in a predetermined amount of time. Typically, gigabits per second (Gbps) or megabits per second (Mbps) are used to express network performance in bits per second (bps). [21]

The formula for throughput is TH = I / T.

End-to-End Delay

From the time a packet leaves the source application until it reaches the destination application, the end-to-end delay is calculated. The statistic known as the mean Bit Life Time per Packet quantifies the overall latency. [22]

Packet Delivery Ratio

The ratio of data packets received at the destination to all packets originating from the sources is known as the packet delivery ratio, or PDR. The definition of packet delivery ratio is

PDR = Ri / Si

In this case, the number of nodes that are really sent through the senders is Si, while the number of nodes that are received through the receiver is given by Ri. [23-24]

Packet Loss Ratio

The packet loss rate is a measure of a communication network path's dependability. This measure is calculated by dividing the total number of packets transmitted by the number of packets that were not received. The packet loss rate is a measure of a communication network path's dependability. This measure is calculated by dividing the total number of packets transmitted by the number of packets that were not received. [25]

4. Comparison Parameters, Results and Discussions:

In order to validate its performance issues, the research experiments' findings must be compared to the current benchmark results to ensure its efficiency. This comparative study compares its findings to the current benchmark results in order to achieve that goal.

Simulation Details

Parameters	Specifications
Open source network simulator	NS3.26
Open source traffic simulator	Simulation of urban mobility (SUMO-0.32)
Model	Manhattan mobility model
Transmission network range	150 to 200 m
Size of data packets	200 bytes
Data rate	2 Mbps
Protocol	MAC layer 802.11p
Velocity	20 to 80 km/h

NS3.26 aims to provide an open, scalable network simulation environment for networking education and research. In conclusion, ns-3 provides models that represent the features and functioning of packet data networks, in addition to a simulation engine that enables users to run their models and assess their effectiveness and performance.

The performance study of the packet delivery ratio calculated for a simple traffic network at a random speed is defined in Table.01 and Figure 3. It is also emphasised that the GAACO outperforms the other benchmark results that are currently available.

Table.01. Performance analysis of packet delivery ratio computed for simple traffic network at a random speed.

No. of. Vehicles	20	25	30	35	40	45	50
GAACO	80	75	70	65	60	55	50
ACO	50	43	33	28	20	12	8
PSO	45	40	35	30	25	20	15
AODV	35	33	30	27	25	19	13
DSR	30	28	26	24	20	15	10

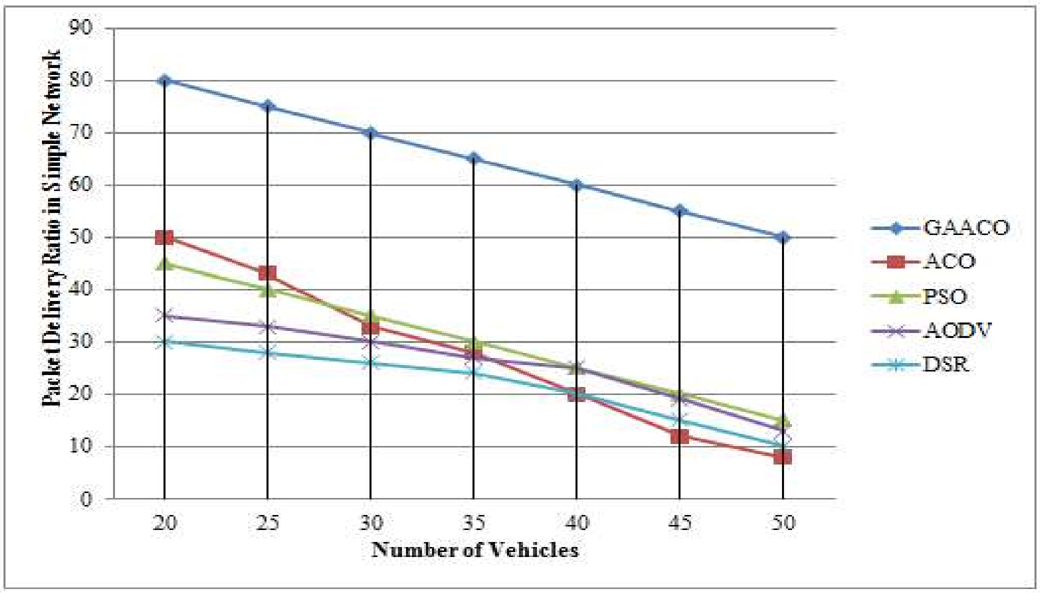

Figure.03. Performance analysis of packet delivery ratio computed for simple traffic network at a random speed.

The performance study of the packet delivery ratio calculated for a complicated traffic network at a random speed is shown in Table 02 and Figure 04 of the document. It is also emphasised that the GAACO outperforms the other benchmark results that are currently available.

Table.02. Performance analysis of packet delivery ratio computed for complex traffic network at a random speed.

No. of. Vehicles	100	200	300	400	500	600	700
GAACO	90	85	80	87	70	66	60
ACO	60	70	55	45	40	35	30
PSO	40	63	58	64	65	67	64
AODV	30	36	42	47	49	52	55
DSR	25	27	30	33	36	38	40

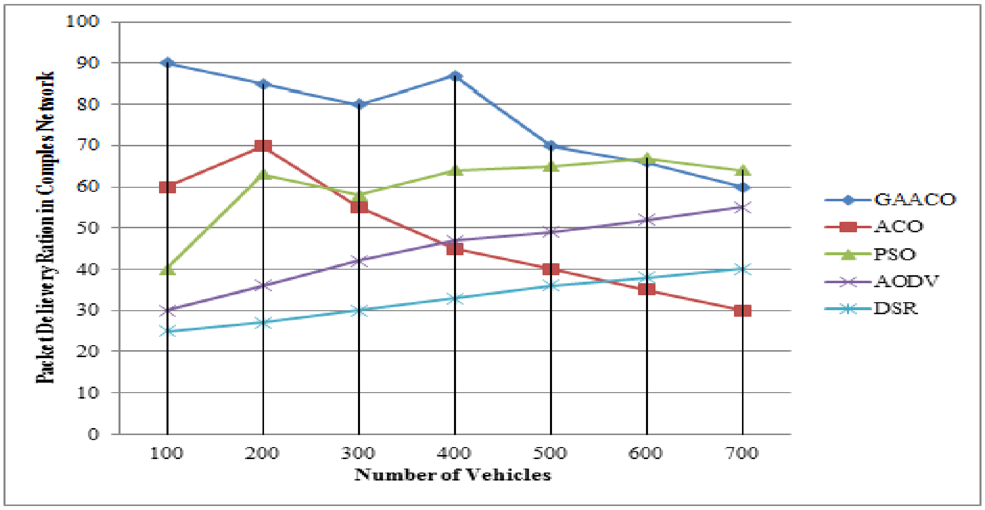

Figure.04. Performance analysis of packet delivery ratio computed for complex traffic network at a random speed.

The performance study of the average throughput calculated for a simple traffic network at a random speed is explained in Table 03 and Figure 05. It is also emphasised that the GAACO outperforms the other benchmark results that are currently available.

Table.03. Performance analysis of average throughput computed for simple traffic network at a random speed.

No. of. Vehicles	20	25	30	35	40	45	50
GAACO	100	80	70	63	60	56	50
ACO	80	70	60	57	43	38	34
PSO	78	62	58	38	30	27	22
AODV	65	55	45	35	30	25	15
DSR	55	44	34	25	15	13	11

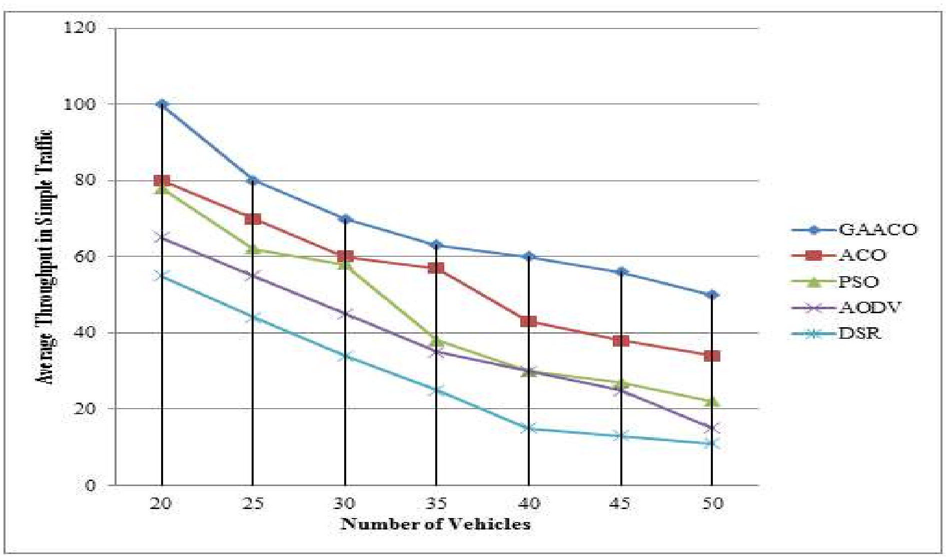

Figure.05. Performance analysis of average throughput computed for simple traffic network at a random speed.

Table.04. Performance analysis of average throughput computed for complex traffic network at a random speed.

No. of. Vehicles	100	200	300	400	500	600	700
GAACO	200	160	135	125	120	115	110
ACO	140	130	120	100	110	115	120
PSO	110	100	90	95	80	85	80
AODV	90	85	80	87	85	83	70
DSR	80	70	75	70	65	60	55

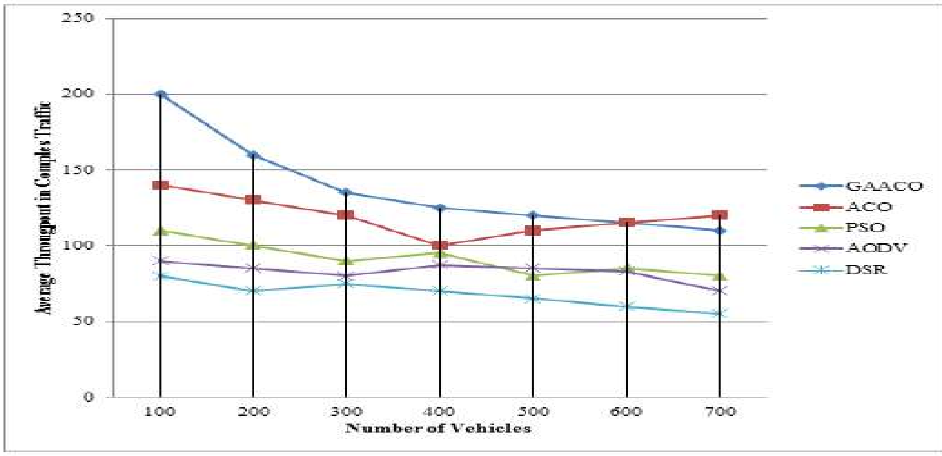

Figure.06. Performance analysis of average throughput computed for complex traffic network at a random speed.

The performance analysis of the average throughput calculated for a complicated traffic network at a random speed is covered in Table 04 and Figure 06 of the document. It is also emphasised that the GAACO outperforms the other benchmark results that are currently available.

Table.05. Performance analysis of average throughput w.r.t. no. of vehicles for dense network.

Speed of Vehicles	20	30	40	50	60	70	80
GAACO	90	87	85	80	75	70	65
ACO	80	77	74	70	60	55	50
PSO	70	65	60	50	40	30	20
AODV	60	55	45	35	30	25	15
DSR	50	45	40	30	25	20	10

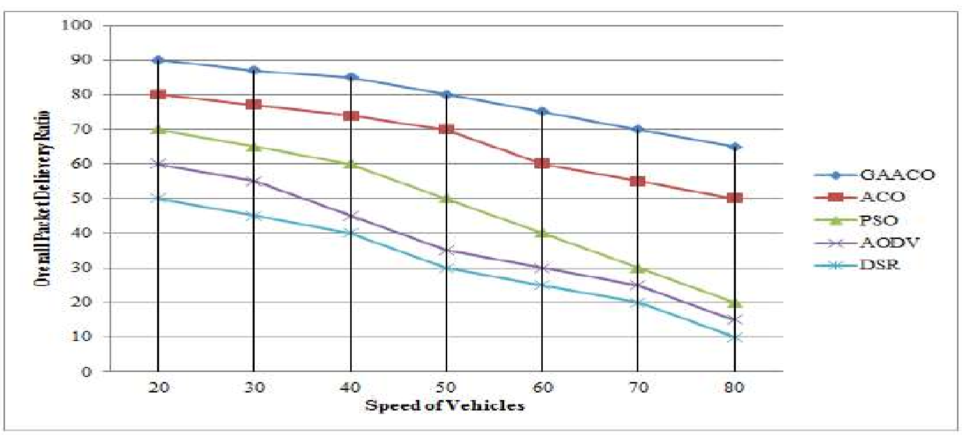

Figure.07. Performance analysis of average throughput w.r.t. no. of vehicles for dense network.

The performance study of the average throughput of cars for a dense network is shown in Table 05 and Figure 7. It is also emphasised that the GAACO outperforms the other benchmark results that are currently available.

Table.06. Performance analysis of packet delivery ratio w.r.t. no. of vehicles for dense network.

Speed of Vehicles	20	30	40	50	60	70	80
GAACO	125	120	90	80	70	60	50
ACO	100	90	85	65	60	40	30
PSO	90	80	75	60	50	35	25
AODV	75	65	55	45	35	30	20
DSR	60	55	45	35	25	20	15

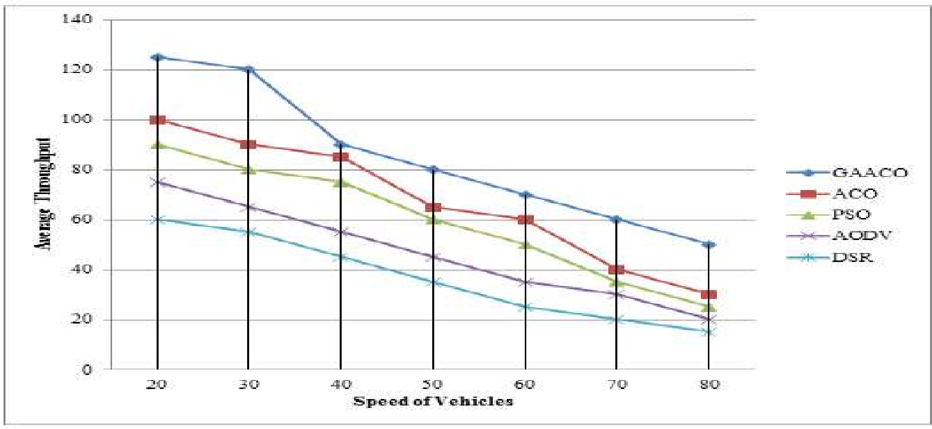

Figure.08. Performance analysis of packet delivery ratio w.r.t. no. of vehicles for dense network.

Table.07. Performance analysis for end-to-end delay.

Speed of Vehicles	20	30	40	50	60	70	80	90	100
GAACO	55	58	60	75	90	100	110	115	120
ACO	70	100	140	180	220	270	290	350	370
PSO	65	90	115	170	195	215	250	270	290
AODV	40	50	60	80	100	120	140	180	210
DSR	35	45	55	66	90	108	125	165	200

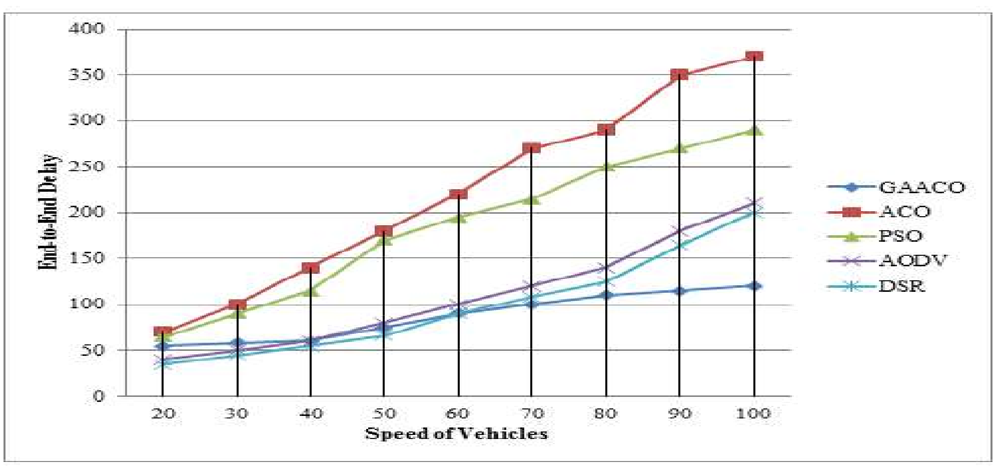

Figure.09. Performance analysis for end-to-end delay.

The performance analysis for end-to-end latency for the simulation scenario is explained in Table 07 and Figure 9. It also indicates that the GAACO outperforms the other benchmark results that are currently available.

Table.08. Performance analysis for packet loss in the network

Speed of Vehicles	20	30	40	50	60	70	80	90	100
GAACO	20	25	30	45	60	70	80	95	110
ACO	110	215	300	350	400	450	490	520	530
PSO	100	150	200	250	300	350	390	400	410
AODV	50	75	100	140	180	240	300	350	390
DSR	60	65	95	135	170	230	290	345	385

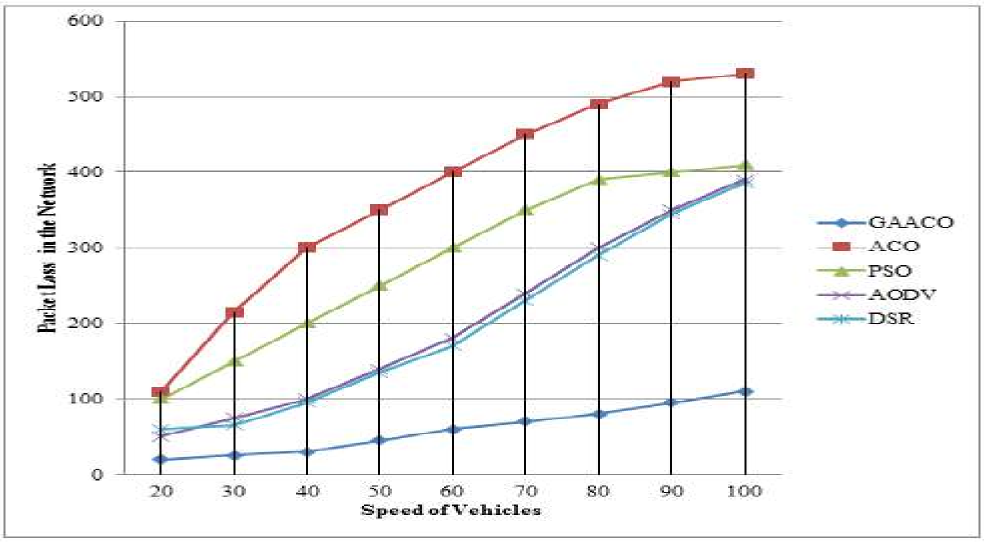

Figure.10. Performance analysis for packet loss in the network

Table.09. Performance analysis for packet delivery in the network

Speed of Vehicles	20	30	40	50	60	70	80	90	100
GAACO	980	975	970	955	940	930	920	905	890
ACO	890	785	700	650	600	550	510	480	470
PSO	900	850	800	750	700	650	610	600	590
AODV	950	925	900	860	820	760	700	650	610
DSR	940	935	905	865	830	770	710	655	615

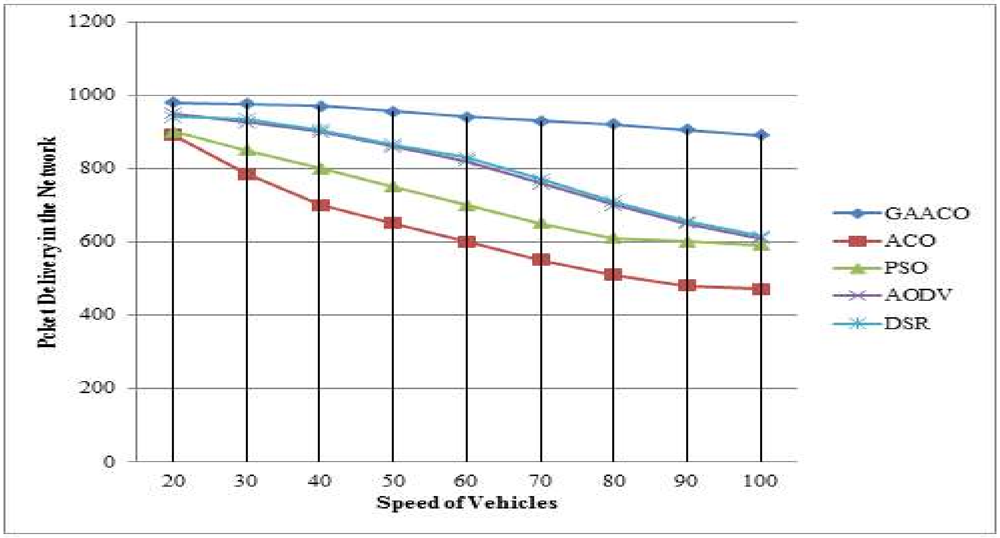

Figure.11. Performance analysis for packet delivery in the network

Figure 11 and Table 09 provide details on the network's performance analysis of packet delivery. It also indicates that the GAACO outperforms the other benchmark results that are currently available.

5. CONCLUSION AND FUTURE ENHANCEMENT:

This paper presents a comprehensive review of classic and metaheuristic VANET algorithms along with a description of the many study areas of VANET. Although a great deal of work has been done in the field of VANET routing, it has only dealt with particular routing circumstances. Additionally, they are unable to meet the current demands in a variety of traffic routing scenarios. There is a great deal of room to build and test more effective routing that can function in a variety of traffic conditions. Testing for average throughput and packet delivery ratio significantly improves the routing performance. Additionally, there were gains in a network's packet loss and end-to-end latency. Future study may examine testing and applying the suggested technique in various VANET contexts with varying performance criteria.

Additionally, the goal of this research is accomplished in this paper by comparison with some of the previous research and its benchmark outcomes. There is a great deal of room to build and test more effective routing that can function in a variety of traffic conditions. In the future, more effective routing will be created and taken into consideration to apply to certain instances, resulting in better performance concerns, efficiency gains, and better outcomes.

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